FIGHTERS

to fit the Country

By GROUP CAPTAIN H. R. FOOTTIT

"You of Canada and we of the United States can and will devise ways to protect our North America from any surprise attack by air."
—*U.S. President Dwight D. Eisenhower.*

JUST OVER a century ago Canadians in the forests, on the sweeping plains, and in the ramshackle towns from York to Fort Edmonton, turned their faces to the south. For across the St. Lawrence, the Great Lakes, and the 49th Parallel lived the hated Americans. Periodically this hatred flared into flames of violence: Canadian militia burned the U.S. ship "Caroline"; the Americans retaliated in the same coin on the steamer "Sir Robert Peel"; the little, undeclared Aroostook "War" broke over the Maine border.

But the passing of some hundred years has welded the Canadians and Americans into almost one nation. And the eyes of both are turned northward now, since the threat is from the Arctic skies. Only last May, during the air show over Moscow, did we realize how great this threat is. For the May Day celebrations were highlighted by the whine of new light and heavy jet bombers. As General Twining, Chief of Staff of the U.S. Air Force observed: "They would need the new heavy bomber only to reach important targets in North America."

Weaving a Web: Against this threat from the North we have built, and are still expanding, a great air defence system. Radar stations, airfields, communications centers, and ground observer posts have been spotted into the Canadian countryside. And working within this vast ground network is the fighter aircraft —the Avro CF-100. This all-weather fighter, similar to any other in this specialized age, must be designed to fit the defence system. And the system is, of necessity, matched to the country. Thus the fighters that we build or buy must be specifically screened for their suitability for the Canadian air defence cell. If we fail to get the proper fighter to fit the country, then we fail to get the most defence for the taxpayers' dollar.

The basic idea of calculating the performance requirements for a fighter so that they dove-tail with the layout of the defence system is a relatively new concept. In the feverish days before World War II fighter performance requirements were shuffled to agree with the aeronautical state of the art at the time. The Spitfires, Hurricanes and Mustangs were products of this moulding of speed, climb, ceiling and range requirements into the best all-round engineering compromise that the designer could work out.

But the seed of the idea that was to change all these hit-and-miss requirements was planted when Sir Robert Watson-Watts discovered radar. True, this remarkable achievement took place in the mid '30s. And before the last war the British had radar stations stretching from Scotland to the South Coast. But the basic concept of designing the fighter as part of this system did not arise until after the last war. At this time it was realized that the actual air defence cell is a three dimensional block of land and air bounded by the radar screen. And the fighter, anti-aircraft guns, ground to air missiles, and any other weapons that modern science may devise, are housed within the cell to protect the target.

Clearing the Way: Karl von Clausewitz, the famous German strategist of the last century, stated that, "The first business of every theory is to clear up conceptions and ideas which

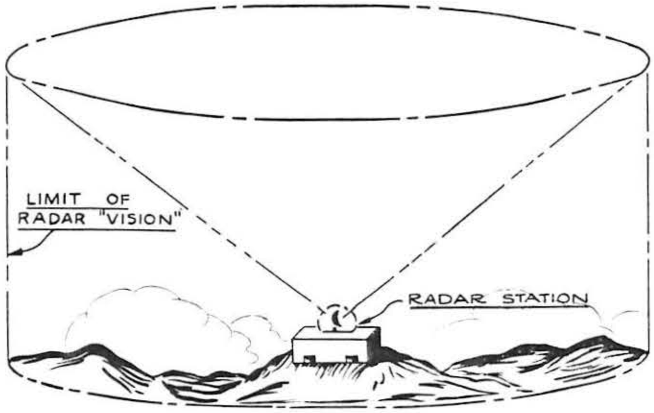

FIGURE 1
SIMPLIFIED AIR DEFENCE CELL

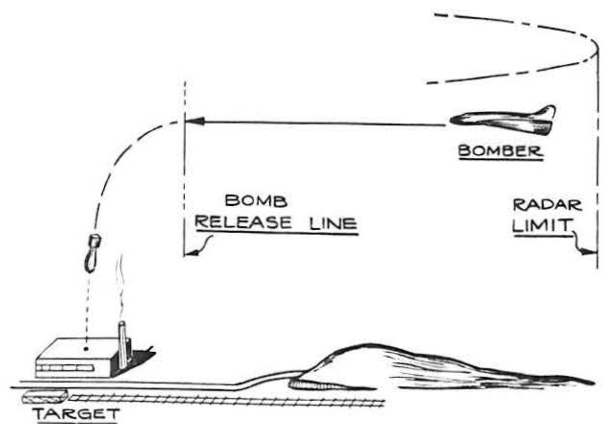

FIGURE 3
INTERCEPTION DISTANCE

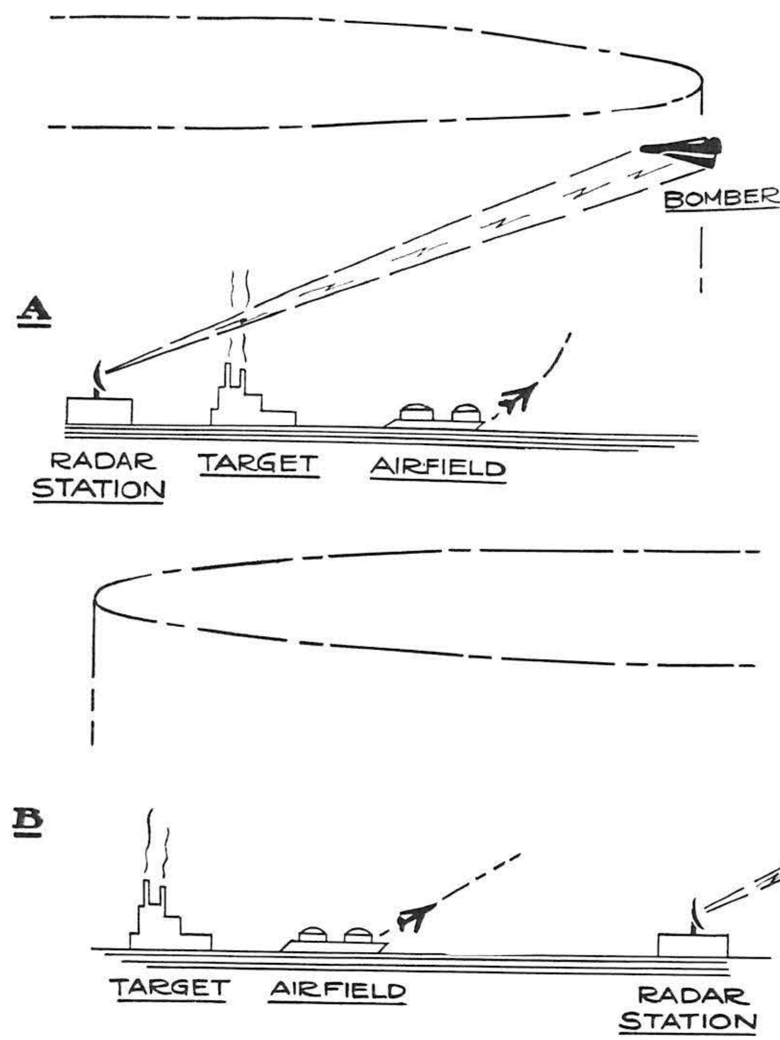

FIGURE 2
VARIATIONS IN THE CELLS

have been jumbled together, and, we might say, entangled and confused . . ." So to develop the theory of designing the fighter to fit the country, it is necessary to sweep away any confusing conceptions of any military might that may be crammed into the cell, and over-simplify the cell itself to its three prime components—the radar station, the airfield and the target.

To these components the characteristics of the best fighter are inextricably bound. And from the disposition of these components, and the performance of the enemy bomber, the minimum requirements for the fighter can be calculated.

the air defence cell

A SIMPLIFIED air defence cell is shown in Figure 1. The central radar "eye" sweeps the cell, to the power-limits of its seeing ability, and thus defines the perimeter or radar screen. Anything within the cell is "visible." But in this day of high flying, fast bombers, any aircraft outside the cell can be considered as "invisible." Even if a ground observer was lucky enough to spot a hostile bomber before it entered the cell, it would be practically impossible for a fighter to make an interception until the enemy had actually pierced the cell and came under the continuous close scrutiny of the Early Warning & Interception Radars that form the cell's core.

However, once the hostile invader is within the cell walls it is picked up on the radar scopes and its altitude, speed and direction can be continuously tracked on a plotting table. Now there is positive, continuous information, and the counterattack can be launched. Through the communications network the fighters are scrambled. And with a steady flow of information on the bomber's whereabouts streaming from the plotting board to the airborne fighter, the defenders of the cell can be funnelled into position to attack the invader before it can release its bombs or missiles on the target.

Performance Factors: The setting of the airfield and target, relative to the radar station largely determines the performance requirements of the fighter to fit the cell. For example, if the target and airfield are forward of the radar station (Figure 2a), then the fighter must feature a rapid rate of climb, and a high speed. So when the scramble warning is sounded, it can zoom to altitude in a hurry, and down the bomber in the short space between interception and bomb release line.

On the other hand, if the airfield and target are behind the radar station (Figure 2b), then range becomes the predominating performance requirement. Climb, speed and ceiling must still, of course, be specified to give the fighter the tactical manoeuvrability for closing in combat.

In any one country there is a definite pattern to these basic parts of an air defence cell—the radar station, the airfield and the target. The geography of the land, and the growth of its civilization, have matched and multiplied these components into a particular multi-cellular quilt.

High on a Hill: Radar stations, for example, must be built on hills, to get the best performance for the least number of stations. The seeing eye of radar looks only in straight lines. Hence, the higher up the station, the better it can "see" through all altitudes. But there is only a certain number of hills, and their layout is fixed by the geography of the country. Consequently there are only so many places where stations can be built to operate efficiently.

Similarly with airfields: flat, hard land, suitable for the criss-cross of runways, is dependent on the geography of the particular country. And the growth of its civilization will limit these even further. There is no use spotting a field—or a radar station for that matter—where it is far removed from the logistics support of fuel, oil, spare parts, and the thousands of items that are vital in keeping the station operating on an immediate readiness basis.

This is particularly true in this Canada of ours. Defence Minister

Ralph Campney explains it this way: "Operations in the northern defence area pose many problems—many difficult problems. During most months the climate is terribly severe. There is the continual interference of the auroral belt with electrical communications. There is the question of accessibility over the hundreds of thousands of square miles of frozen waste. Everything required for construction and operation in the area has to be brought in either by ice-breaker convoy during one—I repeat, one—month of the year, or be flown in by aircraft . . . or both. Construction costs are six to ten times greater and maintenance costs are almost beyond comparison."

The Targets: As for the other key component of the system, the targets, these have been fitted into the geographical jig-saw by the forefathers of the particular civilization. A target system today is usually linked with a city. For here lie the rich industries that produce the weapons of war: here lie the key rail, air, and sea centers that move the weapons to the points of use: here lie the oil storage tanks, the refineries, the pipe line stations, and the multitude of other industries that play their part in the war.

Thus, the targets are fixed in the geographical setting of the land. Russia may uproot whole towns and industries and move them to a better location within her air defence cell. But such violent unheavals are not possible—or desirable—in the lands of the western world.

So the three prime components that fix the fundamental form of the air defence cell are a shifting kaleidoscope depending on the geography and civilization of the area, whether it be Canada, Russia, France, or India. Although the relative importance of the fighters specified characteristics will remain essentially the same within this cell, the magnitude will vary with progress in bomber development.

brief interval

FROM THE TIME the bomber penetrates the cell, until the time when it reaches the point in space where it must release its bombs to hit the target, is the interval that the figher has to make a successful attack. (Figure 3). As bomber

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The Super Eighteen

First deliveries are now being made on production models of the new Beech Super 18, latest version of the famous Twin Beech.

The Super 18 is the result of an extensive redesign of the basic D-18 type airplane, resulting in an increased gross weight as well as such more apparent new design features as a longer nose, jet-type exhaust stacks, reshaped wing tips, larger cabin windows, and extra height of cabin, providing "walk around" room. Insofar as performance is concerned, the changes have resulted in an airplane that can fly farther and slightly faster than its predecessors, as well as lift a greater payload.

The new airplane represents the most sweeping change in the basic design that has been incorporated at any one time since the type was first introduced back in the mid-thirties.

It seems remarkable that an airplane designed some 20 years ago should still be able to more than hold its own in both performance and appearance, even though it travels in much faster company than its contemporaries of the thirties. Though its basic appearance is little altered today, it looks as modern as the latest postwar civil airplanes.

For these reasons, the Twin Beech, as it is commonly known, is as popular today as was in its prewar period. Now, as then, the civil version most often appears as an executive transport. Other proof of its adaptability to the changing times is to bound in its continued popularity with many of the world's air forces. The RCAF, for instance, has in the past few years purchased several hundred of these versatile airplanes, using them as navigation and pilot trainers, as well as light personnel transports.

The maximum gross weight of the Super 18 has been raised to 9,300 lbs., an increase of 550 lbs. over the weight of the D-18 models. The useful load is 3,150 lbs. Normal cruising speed at 66.7% power @ 10,000 feet is 215 mph, and under this combination of power, altitude, and speed, the range (with 45 mins. reserve) is 1,120 miles; this can be extended to 1,455 miles by reducing power. The Super 18 continues to use the Pratt & Whitney R-985 (450 hp @ 2,300 rpm @ SL) for motive power.

Passengers will note many changes, including a larger cabin door that lets down to provide a stairway for easy cabin access.

A new rear compartment contains two built-in baggage racks, as well as a private restroom that is separated from the main cabin. The latter is separated from the crew compartment by an accordian-type sliding door. As already noted, the main cabin has more headroom than earlier versions of the 18.

New chairs are styled for increased travel comfort. Improvements have also been made in the soundproofing, the heating & cooling system.

Observers will also note the presence of four larger windows on each side of the passenger cabin, as compared to three previously.

Additional Data: empty weight, with residual fuel & average radio, 6,150 lbs.; wing loading, 25.75 lbs./psf; power loading, 10.32 lbs./hp.; max. speed, 234 mph @ 5,000 ft. asl.; max. rate of climb, 1,250 fpm @ SL; service ceiling, gross weight, 23,400 ft.; service ceiling, one engine, gross weight, 8,400 ft.; rate of climb, single engine, SL, 250 fpm; rate of climb, single engine, @ 5,000 ft., 195 fpm; T/O distance over 50-ft. obstacle, SL, 2,080 ft.; landing distance over 50-ft. obstacle, SL, 1,570 ft.

COMING EVENTS

September 13-17—10th Annual General Meeting, IATA, Paris, France.

September 19-21—Internationl N.W. Aviation Council Conference, Vancouver.

October 5-9—SAE National Aeronautic Meeting, Aircraft Production Forum & Aircraft Engineering Display, Hotel Statler, Los Angeles.

October 11-12—Symposium on Titanium Standard Parts, sponsored by Air Industries Assoc., Cleveland, Ohio.

October 13-14—Airport Management and Operation Conference, University of Oklahoma, Norman, Oklahoma.

November 8-10—AITA Annual Meeting, Chateau Frontenac, Quebec City.

November 14-17—Annual Meeting, Aviation Distributors & Manufacturers Assoc., Mayflower Hotel, Washington, D.C.

April 18-21—SAE Golden Anniversary, Aeronautic Meeting, Aeronautic Production Forum, and Aircraft Engineering Display, Hotels Statler and McAlpine, New York City.

Variations: The J-57 is produced in a number of models, all of which are practically identical. With the exception of the afterburner-equipped engines, all military versions have a dry static thrust rating of 10,000 lbs. for take-off, and a wet rating of 12,000 lbs. The JT3-L has a dry rating of 9,500 lbs.

With afterburner, the rating is 14,000 lbs. In this configuration, the engine weighs 5,600 lbs. and its length is nearly doubled.

While flight tests by the manufacturers have been going on for several years, with test engines mounted in a B-50 and a B-45, a B-47 was recently converted into a flying test bed by Boeing Airplane Company for the USAF's Wright Air Development Centre at Dayton, Ohio. This B-47 has two J-57 engines mounted at the outboard pod positions (see photo) normally occupied by two GE J-47 turbojets. The four inboard engines are still J-47's. This aircraft is being used to test high altitude performance of the engine, and thus the necessity of tying up the B-52 prototypes with powerplant testing duties is averted.

FIGHTERS TO FIT

(Continued from page 27)

speeds inch higher and higher so this time interval will get less and less. Consequently the rate of climb and speed of the fighter must keep pace with the step up in speed of future bombers.

Moreover, the interval will be cut down by the development of self-propelled air-to-ground missiles. In effect these push back the bomb release line. With increased bomber speeds, and shorter distances from the point of cell penetration to missile release line, the future manned fighter may be hard pressed to make an interception in some parts of the air defence system. The answer in these soft spots will be super-fast ground-to-air missiles, such as the U.S. "Nike," or even more powerful and longer ranged developments of this basic idea.

Other Factors: With a firm estimate of bomber speeds and altitudes, and the vast panorama of an actual air defence system, the required fighter performance to fit the country can be reduced to finite numbers. But other factors will also play their part in the final fighter specification.

In Canada, for example, the rigors of the climate will demand fighters with equipment that can be maintained when the thermometer sinks far below zero. The difficulty of building ground navigation aids in the Arctic wastes may call for the addition of a navigator, or more and better automatic navigation equipment.

These detail factors, linked with the overall layout of the Canadian air defence system, will usually blueprint the design of a special Canadian fighter. With the Avro CF-100 we have successfully done this in the past. Development expenses may be high, but in the long run it is the best defence value for the taxpayers' dollar.

The Right Honourable C. D. Howe explained it to the House of Commons last June: "There is no question that aircraft design and development is expensive. However, if we are to attain any degree of industrial maturity, we must encourage a certain amount of this type of development in Canada . . . [However] we are limiting our activities to those areas in which we have a special interest and where Canadian requirements indicate the desirability of an independent approach."

The RCAF then, will be flying and fighting a Canadian-designed fighter "to protect our North America from any surprise attack by air."