Research for Defence

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FROM earliest times men have prepared themselves for defence against a possible aggressor. Such preparations might be the building of a stockade or moat, the construction of ships of war, or the accumulation of artillery pieces, coupled with the appropriate training of military units to handle the weapons. In modern times, when it became recognized that all the resources of a nation must be mobilized in the event of war, pre-war preparations generally consisted of the establishment of forces to meet the first shock, with later mobilization of men and production of material to carry on to the end. These shock forces, to hold off the invader till further preparations could be made, took different form in different countries. Large continental powers maintained large standing armies, while countries separated from powerful neighbours by water kept large fleets in being. With the further conquest of space which the aeroplane brought, squadrons of 'planes in a state of readiness became an additional requirement.

The quality of the fighting man upon whom the battle ultimately depends is of prime importance in any defence force, but the quality of the weapons given to that man comes a very close second. As a classic example, the battle of Agincourt would never have been won by the English had it not been for the superb long-bow in the hands of the well-trained and steadfast archers. Similarly the Battle of Britain was won by a dauntless few airmen piloting aeroplanes of first-class quality.

As the weapons and equipment of war have become more and more complex, their production has required an increasingly complex process. The 15th-century long-bow was simple to design and produce, but the 1940 Spitfire required intense research and the application of many complicated engineering skills. Today every effort must be made to ensure that weapons and equipment of the most advanced types are put in the hands of the armed forces and as part of this effort an active program of research and development is imperative. The complete defence force in the advanced industrial countries now consists of army, navy and air force plus a research and development organization to support the armed services by the development of the best in weapons and equipment that science can devise.

II

IN considering the part which research must play in the defence of Canada, it will be helpful to look at the steps which occur between the birth of an idea or the discovery of a new phenomenon and the eventual development of a piece of equipment upon it. If we want the final product, we must give some regard to the early and intermediate stages which of necessity precede it. The whole process is like the growth of a plant. A new phenomenon discovered is the newly sprouted seed. If one had not seen the plant before, one knows only that a new growth has begun. As the seedling is tended and watered, leaves develop and the plant grows. Some plants grow quickly and some very slowly. Eventually the

plant may flower, though as in the Century-plant, blooms may not appear for a very long time. Finally if the conditions are right, fruit may develop, and it may turn out to be very useful indeed.

It is important to note that for a considerable time it may be impossible to determine whether a plant will be of any use or not. We only know that a good many in the past have been most valuable and there is a strong possibility that a good proportion will be equally so in the future. A knowledge of the slow growth of many scientific "plants" is now becoming more widely recognized and although the final development of a device or process may appear rapid, it is appreciated that a great deal of earlier work may have preceded it. For example, although the atomic bomb itself was produced in about five years, the scientific effort which had gone before in looking after the "plant" was spread over several decades.

If we want to keep up with unfriendly competitors in the development of new weapons for defence, we must not neglect any of the stages which occur in the process which has been described. Although our interest is primarily in applied research, to ensure successful application in the future, investigations into new phenomena must be continually encouraged.

This is particularly true today when one examines what happened in science during the last war. As scientists from nearly all fields were drawn into the defence effort, so were all known plants examined to see if some of their fruits might not be used. Very few of them remain unused today, and so many current developments consist only of attempts to improve on plants already known. It is recognized that we need new plants—new phenomena to be employed in solving some of the problems which are particularly difficult of solution with what we know today.

The universities form the ideal seed-bed for the germination and early growth of new scientific plants. Their concern is the advancement of new knowledge, the investigation of new phenomena, and they are not immediately concerned with any particular application. From what has been stated, however, it is obvious that it is of considerable importance to defence that they be supported in their fundamental research. When a phenomenon is well understood, those scientists who have knowledge of the basic requirements of the fighting forces are ready to examine the new phenomenon to determine the feasibility of applying it to a particular requirement. If such an application appears possible, a "bread-board" model is made and the possibility tested. Next, a working model is required, to be followed by an engineered prototype. This later stage is generally done in industry, where the final development is adapted to the manufacturing processes current in a particular factory.

A far-sighted research policy for defence should take into account all stages of research and development from seed to fruit. Hence, the Canadian program ranges from research grants to universities to development contracts let to industry, and includes a variety of applied researches in various intermediate stages going on in special defence research laboratories. Although research and development at all stages is encouraged, no attempt has been made to cover completely all defence requirements. If this country were alone, it would be necessary to develop and produce essentially all weapons. Since we do not conceive of our being involved in a war in which either or both the United States and the United Kingdom were not our allies, however, we can make a selection, with the reasonable hope of being able to make up our deficiencies by supplies from one ally or the other. What we select to do may be determined by several factors—e.g., if a requirement is specific to Canada and is unlikely to be met by our larger friends, if we have some special facility which makes it appear that we can do a particularly good job, and so on.

III

DURING the last war, the National Research Council was the principal research agency for the Canadian armed forces. In 1939, the Research Council had weathered the depression and was

actively engaged in a research program designed to assist in the industrial and agricultural development of Canada. This contribution was effected through assisted researches (generally to university scientists) and through the work going on in the Council's own laboratories. When war came, this effort was largely switched to research for the Army, Navy and Air Force. The story of the National Research Council's contribution has been told in a recently published book and is a striking illustration of what can be accomplished by concentrated scientific effort.

At the end of the war, the National Research Council returned to its peace-time research interest, and another body, the Defence Research Board, was set up to undertake research on behalf of the armed services. The Defence Research Board forms a part of the Department of National Defence and its inclusion therein affords recognition of research as an essential part of modern defence requirements. The necessity of retaining close contact between university research, civil research and industry and the needs of the services was recognized in naming the composition of the Board, for representatives are appointed from all of these fields. In the internal organization of the Board, too, provision has been made for effective co-operation at working levels. Thus the Board is served by a number of advisory committees, bringing in scientists from universities and various civil research agencies from one side of Canada to the other.

As an operating body, the Defence Research Board performs several functions. It has a headquarters staff which is set up, (1) to coordinate the research requirements of the three services with work undertaken directly by the Board or by other government departments, (2) to procure and make available as much information as possible on defence research and development undertaken elsewhere, and (3) to offer advice on scientific matters to the services as and when required. The Board also operates laboratories, scattered across Canada, established to undertake research in fields where there is a special defence requirement. Thus, there are two naval laboratories, one on each coast; there is an armament research and development establishment at Valcartier, Quebec. There are chemical, electronics and medical laboratories in Ontario, an arctic laboratory at Fort Churchill, Manitoba, and a special field trials station in Alberta. In addition, the Board has the power to enter into contracts with industry, universities and other bodies to undertake research and development, grants in aid of research (usually in universities) where the encouragement of such research appears to be in the defence interest.

For reasons of security, it is impossible to discuss in detail the actual programs being undertaken in the various laboratories mentioned. However, some indication can be given of the type of project which is under way. In armament research, a new anti-tank round for 17-pounder guns has been produced and a guided missile program has been launched. In the naval laboratories, a number of problems associated with anti-submarine warfare are under consideration, and at the Suffield Experimental Station, many chemical and bacteriological warfare field trials have been carried out. Some of the projects in hand have civil as well as defence value. For example, the work in the Naval Research Establishment on sea-water corrosion has produced results not only most useful in protecting the hulls of warships against rusting but obviously of equal interest to owners of merchant ships.

IV

AS has been stated, the total research for defence in Canada has many ramifications and is much more than is being undertaken in the laboratories of the Defence Research Board only. Co-operative effort between the Department of National Defence and other agencies as well as individual contributions from such agencies add materially to the total research in Canada of defence interest.

As an example of such cooperation may be cited the research in oceano-

graphy being carried out under the Joint Oceanographic Committee. During the war, as the anti-submarine campaign became more and more intense, a more detailed knowledge of the medium in which this campaign was being waged became imperative. "Oceanography" is the name given to the study of the sea and it has something the same meaning for the oceans that "meteorology" has for the air. The only trained oceanographers in Canada were those on the staff of the Fisheries Research Board, since this was the only organization in the country which had previously been much concerned with this subject, and in fact one of the two Fisheries oceanographers had joined the Army. In view of the Navy's requirement, however, these men were made available to it and were soon actively engaged in using their special training and experience against the U-boat. With the end of the war, an arrangement was made to pool the resources of the departments which had an interest in oceanography and the joint Oceanographic Committee was formed.

This committee has representatives of the Department of National Defence, the Fisheries Research Board, the National Research Council and the Hydrographic Survey, with contributions being made to the work of the committee by each department concerned. Two active laboratory and field groups exist under the committee, one at the Fisheries Research Board biological station at St. Andrews, N. B., and the other at a similar station in Nanaimo, B. C. In addition, the University of British Columbia has begun to teach the science of oceanography (for the first time in Canada) and to undertake fundamental research in this field. Thus, not only do we have a considerable amount of applied research now under way, but more fundamental research is being carried on and additional trained men will soon become available.

In the last two or three decades, Canada has increased its research potential by a very great amount, but such resources are still limited. To be most effective, therefore, especially from a defence point of view, cooperation and coordination are particularly important. An instance of what has been done in oceanography has already been given. Another field of very considerable importance in which cooperation has been effected is "electronics," which includes radar, communications, control mechanisms and many other devices. The Defence Research Board operates two laboratories in this field and the National Research Council, which was responsible for Canada's substantial contribution to radar in the last war, is continuing to carry on similar projects in its Radio and Electrical Engineering Laboratories. Several Canadian universities have now in operation laboratories where research in electronics is under way. This is in general of a fundamental character but it holds promise of being of defence value not far in the future. Certain industrial concerns, too, are working on applied problems whose solutions will aid materially in defence electronics.

The research program in Canada of value to defence has its roots deep in the scientific laboratories of the country. It involves cooperative effort amongst many contributing agencies. Since the organization of a scientific service (the Defence Research Board) within the Department of National Defence, close coordination has been effected between the total scientific effort and the needs of the armed services. In a world where our defence forces must be unsurpassed in quality, it appears that the research and scientific effort to back them up will not be found wanting.