DEFENCE RESEARCH IN CANADA

by

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Chairman, Defence Research Board, Ottawa.

A paper presented at the 65th Annual General and Professional Meeting of The Engineering Institute of Canada, at Montreal, May 11, 1951.

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This paper describes the role and the growth over four years of Defence Research in Canada. Within the limits of security regulations, the curtain is lifted on some of the principal activities of the Defence Research Board, in the realm of weapon development in aeronautical and electronic research, as well as in the related fields of mechanics and metallurgy. The growing need for trained scientists and engineers is emphasized.

The Defence Research Board was legally established on April 1, 1947. It is a part of the Department of National Defence, and has the status of a fourth service. The Board is responsible for meeting the research and development needs of all three armed forces. The Board does not attempt to do research on all problems of concern to the Canadian armed forces. It has instead selected a relatively small number of fields of special importance to Canada, or for which Canada has particular resources or facilities, and has concentrated its efforts in these fields. The Board maintains close liaison with the United States and the United Kingdom in order to ensure that the Canadian armed services have the very latest research and development information on fields which concern them, whether or not actual research is being done in Canada.

The Defence Research Board itself consists of twelve members, six ex officio, and six appointed to represent science and industry throughout Canada. The ex officio members include the Chiefs of Staff of the three armed services, the President of the National Research Council, the Deputy Minister of National Defence, and myself as Chairman. The Engineering Institute is well represented on the Board by Dr. Mackenzie, a former President of the Institute, by Alan Cameron of Nova Scotia Tech., and by the Chairman, who has the misfortune to be only an affiliate of the Engineering Institute because of unfortunate deficiencies in his earlier education. Dr. Paul Gagnon of Laval University and Colonel R. D. Harkness, both members of the Institute, are former members of the Board. Many members of the Institute also give invaluable assistance as members of Advisory Committees and Panels.

Four Years of Growth

The Board now has a staff of more than 1,600, and operates nearly a dozen research establishments scattered from Halifax to Victoria and from Toronto in the south to Churchill in the north. The total budget of the Board for the fiscal year 1951-52 is about $35,000,000. This will be divided almost equally between research and development. The greater part of the development expenditure is, of course, being made in industry. The greater part of the research budget goes for the support of the Board's own establishments, but the research expenditure also includes a substantial amount of research being done in the universities and in industry. This budget does not by any means represent the total of research that is being done in Canada for the armed forces since other government departments, especially the National Research Council and the Bureau of Mines, devote a considerable part of their budget to research for the armed services.

When the Board began work there was no immediate prospect of orders for new equipment from the armed forces. It was therefore obviously wise to devote our time and energy during that period to more basic research which would build up a background of knowledge and experience on military problems in Canada. Consequently during the early years of the organization emphasis was on basic research, and the need was for chemists and physicists rather than for engineers. However, now that we are entering a stage of partial mobilization, with the armed forces actively re-equipping with new weapons, there is much greater emphasis on applied research and development, with consequently increasing emphasis on the work of the engineer.

Armament Research at Valcartier

The Defence Research Board took over the Canadian Armament Research and Development Establishment, better known as CARDE from the Canadian Army in 1946. The establishment had been formed on paper by the union of several pre-existing organizations, but had never really existed in fact. Its new buildings had not been completed when the war ended and the majority of its key scientific and technical staff had left before the Board took over. In the ensuing five years the Board has, with the full co-operation of the Army and Laval University and more recently of the Air Force, built CARDE into a research and development establishment for armaments and explosives of which Canada can be justly proud. It is interesting that the majority of those who have been directly responsible for this success are members of the Engineering Institute of Canada. They include particularly Dr. D. C.

Rose, who was the first Chief Superintendent, Mr. Carleton Craig of McGill University, the present Chief Superintendent, and Dr. Paul Gagnon of Laval University.

The establishment is now adequately staffed and equipped to do research and development, design, and even limited production on a wide range of armaments and explosives. It has a very completely equipped explosives pilot plant, and limited outdoor range facilities. It is just completing the construction of an indoor range for ballistic research and measurement. In addition to the good facilities of the establishment, we are particularly pleased with its organization. We feel that we have achieved here a very close collaboration between the services and the civilian scientists.

Service personnel work together harmoniously with scientists in combined teams, the leaders being sometimes scientists and sometimes service officers. This has proved to be very valuable. It gives service technical officers a sound understanding of the problems of weapon development and the scientist a better comprehension of the difficulties of the user. But most important of all, the combination of the user and the scientific approaches in the design team will produce better weapons more economically and more quickly.

An important trend in evidence at CARDE is the increasing application of electronics and photography to the instrumenting and recording of transient phenomena encountered in many of their engineering tests. Strain gauges and piezzo electric crystals trace their reports on cathode ray tubes, which are photographed to give a permanent record. Microflash photography, applying modern developments in radar pulse techniques, permits projectiles to be studied in flight and on impact with targets. These new methods enable the scientist to observe quantities which were previously inaccessible, and to provide the engineer with more accurate design data from fewer tests than has previously been possible.

New Weapons

The development of a new guided missile is just beginning at CARDE. Like all of its kind, it will be a complex device in which all aspects such as structure, aerodynamics and electronics are extremely closely interrelated. This presents some interesting problems in the organization of a development team to ensure that the specialists in each field work smoothly and effectively within the larger plan. I realize that much study has been given by engineers in recent years to improve organization. In this project however, we have not only to make sure that the engineering organization is first-class, but also that scientists such as chemists, physicists, aerodynamicists and mathematicians are all brought together to produce a smooth and orderly flow both of information to the engineer, and of problems from the engineer to the scientist.

We are developing a new infantry anti-tank weapon not unlike the American Bazooka which we expect to be considerably more accurate. On account of some of its novel features this device has presented some difficult problems to the engineers in devising economical production methods.

An improved anti-tank shot for the 17 pdr. and 76 mm. guns has been successfully developed. This shot has improved the accuracy and penetration obtainable with these guns, and has been accepted by both the U.S. and U.K. In our efforts to meet the wide temperature range from far below zero to over 100° above, many problems of tolerances and differential expansion had to be solved. Work is also proceeding on the design of a howitzer for mountain warfare. This is the first attempt at gun design which has ever been made in Canada, even though thousands of guns were produced in this country during World War II.

In this, as in our other armament projects, we have run up against the comparative scarcity of trained mechanical design engineers in this country. This, we realize, stems from the fact that much of our engineering production is based on the designs of others. Until this situation is changed many of our engineers with real mechanical design talent will seek employment outside Canada or be forced, through economic necessity, to concentrate mainly on production engineering. Until these two aspects of mechanical engineering come into a better balance, we will have to rely in peace and in war on the goodwill and co-operation of others. This is a national weakness, particularly in a period of crisis when the resources of others are fully committed. Your Institute, through its many members, can do much to provide the opportunity for young designers to use their talents in this country.

I shall now say a few words about each one of a rather heterogeneous list of other defence research activities of special interest to engineers. I know that you will realize that many of our most interesting engineering accomplishments are secret and cannot be discussed at a public gathering. I hope that these examples of our unclassified projects will give you a clear idea of the sort of work that we do.

For the Armed Services

The Suffield Experimental Station in southern Alberta, again in close co-operation with the Canadian Army, has recently completed the development of a greatly improved and simplified flame-thrower for infantry use. The development of the flame-thrower itself has been paralleled by a series of research projects designed to improve the properties and methods of manufacture of flame-thrower fuel. This work has been done both at Suffield and at the Defence Research Chemical Laboratories in Ottawa.

In the field of naval research, the Board's two laboratories at Halifax and Esquimalt have been concentrating mainly on anti-submarine problems. Unfortunately most of their progress in these fields cannot be reported. They have, however, made some progress in other fields that is of considerable engineering importance. The work of the Naval Research Establishment at Halifax on the cathodic protection of ships' hulls and ships' equipment by the use of magnesium anodes has attracted much favourable attention, and is already being fairly widely applied in industry. This laboratory has also done extensive work in oceanography and particularly in the development of new equipment for oceanographic research.

In the field of electronics, the Board has been working in co-operation with Canadian industry and with the National Research Council, to increase the total volume of

research and development effort available to the Canadian armed forces. The Board now operates in Ottawa the Defence Research Telecommunications Establishment. This consists of two sections: the Radio Physics Laboratory, which is concerned primarily with ionospheric and radio propagation research, and the Electronics Laboratory which is concerned with communications and radar problems. The work of this section is closely co-ordinated with that of the Radio Division of the N.R.C., which devotes a part of its resources to military research.

In the course of its work on ionospheric research, the Radio Physics Laboratory has designed and had built by Canadian industry a new automatic ionospheric recorder, which they consider to be the best of its kind in the world today. The Board has also given active support to various projects for the development of techniques and equipment for electric computation in Canada. We feel that before long electronic computers will be an essential part of a wide variety of military equipment, including especially data transmission and fire control systems. We therefore felt that it was important to build up a foundation of knowledge and experience in this field in Canada. This has been accomplished not only by contracts with industry but especially by support of the Computation Centre at the University of Toronto, where a small group of scientists have already made substantial contributions to computer design.

Aeronautical Research

In the field of aeronautics, the Board has supported a comprehensive programme to strengthen aeronautical research, design and development along the chain from fundamental research through basic research, design and development to production and use. The Board gave the University of Toronto a grant to set up the Institute of Aerophysics, and to equip it with a supersonic wind tunnel for postgraduate training. It has also supported gas dynamics research at McGill. To cover the field of applied research and development it has supported the setting up of the new National Aeronautical Establishment. This Establishment was recently formed as a separate entity. Its policy is laid down by the National Aeronautical Research Committee, and it is operated for this Committee by the National Research Council.

The new establishment has been formed out of the aeronautical research and development staff and facilities of the National Research Council, both at the Flight Research Section at Arnprior and at the main laboratories on the Montreal Road. A large expansion of the staff and facilities, especially for flight research, will take place in the very near future. The new extension of the airfield at Uplands was specially designed to meet the needs of this Flight Research Section. A new hangar and ancillary buildings have been planned for Uplands, and will be built this year. When the buildings are complete, the Flight Research Section of the N.A.E. will move from Arnprior to Uplands. It is hoped that this will mark the beginning of a new era in aeronautical research and development in Canada and that before long the Canadian National Aeronautical Establishment will become as famous as the Royal Aeronautical Establishment in Farnborough, the N.A.C.A. Laboratories at Langley Field, or the U.S. Air Force Establishment at Wright Field.

In Mechanics and Metallurgy

In the field of mechanical engineering, the Board has supported very interesting work being done by engineers and physicists at the University of Toronto and at the University of Western Ontario, aimed toward the production of a heat pump for use in the Arctic. This pump is intended for use where unfrozen water can be obtained beneath the ice in lakes. The pump freezes this water and makes use of latent heat of freezing as a source of additional energy to increase the efficiency of the pump. Trials have shown that the idea is practicable. There remains only the minor problem of getting rid of the ice. The experts have so far been unable to find any ready market for ice in the Arctic.

You will also be interested to know that the Defence Research Board is co-operating with the Board of Mines, the University of Toronto, and industry in a comprehensive programme of research and development on the processing and use of titanium and titanium alloys. We feel that this is a field of great potential importance to Canada, and one to which we can well afford to devote a considerable part of our effort. Another item of interest is work on the development of a new type synthetic rubber, items from which will retain their flexibility at temperatures as low as —65° F., and of an oil resistant synthetic rubber with improved low temperature flexibility.

From the point of view of the Defence Research Board, the most important event of 1951 has been the formation of the Department of Defence Production. We in the Board have always actively supported the idea that the chain from research through design and development to production and use is a continuous one. It must be arbitrarily divided for purposes of administrative convenience, but these arbitrary divisions must not be allowed to prevent the free flow of both ideas and people up and down the chain. As long as there was no Department of Defence Production we felt that there was a link missing in the chain. We are now busily co-operating with the Department of Defence Production to try to complete this link.

Need More Engineers

It is a link which connects research and development to production. It will be partly in the Defence Research Board, partly in the Department of Defence Production, and partly in the technical branches of the armed services. Wherever the parts of the link are located they must be composed of highly skilled research minded engineers, who can talk as equals to the research scientist on one hand, and to the production engineer on the other. We are quite sure that the right kind of people for this job are available in Canada, but we are equally sure that the number that is available will not be adequate to our growing needs. We feel that because of this the Defence Research Board must do everything possible to support the universities in their task of supplying engineers. The Board must also try to divert a proportion of the best engineering graduates away from the more practical aspects of engineering toward applied research, design, and development. ✓