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The Defence Research Board
The First Four Years

An Address to the Staff

of the Defence Research Board in Ottawa
Marking the Occasion of the Board's Fourth Birthday

Dr. O. M. Solandt

Report No. DR 34

March 30, 1951.

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THE BADGE OF THE DEFENCE RESEARCH BOARD

The printing of the Defence Research Badge on the cover of this Address marks the first public use since it was recently approved by His Majesty the King. The badge consists of an Armillary Sphere as a symbol for science; the three crowns associated with the Armed Services, indicating that the Defence Research Board is responsible for research for the Royal Canadian Navy, the Canadian Army and the Royal Canadian Air Force; and a border of Canadian maple leaves.

CONFIDENTIAL

O. M. Solandt.

Chairman.

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by

Dr. O.M. Solandt
March 30th, 1951

INTRODUCTION

This gathering is being held today to celebrate the fourth anniversary of the Defence Research Board, so this address is directed primarily toward the members of the Defence Research Board staff. I hope, however, that it will also interest our many visitors.

The presence of visitors from so many different groups is in itself an evidence of the success of defence research. An effective organization for applied research cannot be operated from the proverbial 'ivory tower'. It can only do good work if it is in close touch, on the one hand, with the needs of those that it seeks to serve, and on the other, with the whole scientific community in Canada and in other friendly countries. Our visitors here today represent these two groups. The representatives of the armed forces are here as our customers, and most of the others are colleagues who share with us the task of meeting the research and development needs of the armed forces. Since this is primarily a family gathering of the Defence Research Board, I would like to welcome you here as guests. But insofar as I shall discuss defence research in its larger sense, I feel that many of you are here as active participants rather than merely as guests.

The task of building up an organization in the Department of National Defence to meet the research needs of the three armed forces was begun just over five years ago. As a result of the first year's work, the Defence Research Board was formally constituted on 1 April, 1947. (We like to think that this date was selected in relation to the Government's fiscal year, and not for other reasons which may suggest themselves to you,) Throughout its brief history all the Board's work has been marked by an excellent unity of purpose and team spirit.

When the organization was small it was quite easy to maintain this atmosphere, since every member of the staff was able to know what was going on and to see how his particular job was contributing toward the realization of the major tasks that the Board undertook. Now that the staff is getting larger, the organization inevitably gets broken up into sections dealing with relatively narrow fields. This compartmentalization in turn means that many members of the staff know only about the accomplishments or the difficulties and frustrations in their own particular spheres. They often do not see how the jobs they are doing are related to the larger purposes of the Board. When this happens, initiative declines and team spirit weakens. As an organization, we must strive to retain unity of purpose and enthusiasm for our work. To do this we must strive to give each member of the staff a feeling of participating in the larger objectives of defence research, even though his immediate job may seem small and narrow.

My talk to you today is intended as a contribution toward this end. I plan to review for you the basic policies of the Board, its broad accomplishments in the past four years, and its general objectives for the future. If I do this job well, each one of you will be able to see how your particular task fits into and contributes toward the whole.

The occasion of this gathering is the fourth anniversary of the founding of the Defence Research Board. Coincidentally it occurs at a time of far greater importance in the history of the Board than any mere anniversary. It marks the first real challenge to our growing organization. When the Board was first set up we had hoped that we would have far more than four years in which to build up an organization that would meet Canada's peacetime needs and also serve as a basis for mobilization in time of war. Now, with our basic organization well developed but still far from complete, we are called upon to join with the armed forces and all the other elements of the nation in a

partial mobilization to prevent war. We must rise to the occasion and help to maintain the splendid traditions of Canada's defence efforts in the past. The demands that will be put upon our growing organization in the next year will certainly strain it to the limit but if we all pull together as a team we can meet this challenge. We on the staff of the Board feel that any successes that we have achieved in the past four years have been to a considerable extent due to the enthusiastic support and cooperation that we have recieved, not only from the armed forces whom we serve but from all the other government departments with which we work. Since this cooperation has been the basis of our success in the past, it is certain that we can only meet the tremendous challenge of the immediate future if you all continue to help.

BASIC POLICIES

I will not trouble you with the history of the Defence Research Board since most of you are familiar with it and many of you have helped to make it. The Board was legally constituted in April 1947. The task given it was to meet the research needs and to coordinate the development work of the three armed services, and to do development of an inter-service nature. In making plans to discharge this responsibility, the Board laid down certain important policies. The most important ones which still shape the Board's programme are:

First - With the limited number of scientists available for defence research in Canada, it is not possible to meet all the research needs of the armed forces. It is essential to select a few limited fields of research in which Canada has a special interest or can make a noteworthy contribution.

Second - Close cooperation with the United States and the United Kingdom is essential to the success of a research and development programme in Canada. This can best be achieved by a rigid application of the policy of specialization so that the results of our research and development will be good enough to be accepted by our larger partners as an effective contribution to the work of the team.

Third - In order further to concentrate our research effort, the Board has refrained from setting up laboratories to deal with problems that civil research agencies were willing to tackle. The money and resources available for defence research have been concentrated in fields of military interest.

Fourth - The Board has considered that one of its tasks was to be sure that the whole scientific structure of the nation was sound and ready to contribute to defence when the need arose. This policy has led the Board to support research in universities to ensure an adequate supply of well-trained research workers and to support research in industry where it seemed to need special encouragement. The programme of support of university research, which has paid particularly large dividends, has been evolved in close collaboration with the National Research Council and other agencies that support research in the universities

I shall not attempt to describe in detail how these policies have shaped our growing organization. I shall merely outline the salient features of our progress in the past and our plans for the future.

RESEARCH ESTABLISHMENTS

Before reviewing in detail the research accomplishments of the Board, it might be well to list the laboratories which it operates and indicate briefly the character of the work carried out at each of them.

Naval Research Establishment,
Halifax, N.S.

NRE's main activity is in the field of underwater warfare, including the development of methods of submarine detection, the oceanography of Eastern Canadian coastal waters, and related problems. Work is also done on problems of ship corrosion.

Canadian Armament Research and Development Establishment,
Valcartier, Quebec.

At CARDE, research and development on new weapons and on explosives and propellants are carried out.

Grosse Ile Experimental Station,
Grosse Ile, Quebec

This laboratory, located on an island in the St. Lawrence River, is used for research and production of rinderpest vaccine.

Defence Research Chemical Laboratories, Ottawa, Ontario.

DRCL's main problems are associated with the defensive aspects of chemical warfare. It also does work in other fields which are mainly chemical in character.

Defence Research Telecommunications Establishment, Ottawa, Ont.

DRTE consists of two laboratories:

Radio Physics Laboratory, which carries out research on radio propagation phenomena, and an

Electronics Laboratory, which is located in conjunction with the Army's Canadian Signals Research and Development Establishment, and carries out research on problems mainly related to telecommunications.

Defence Research Kingston Laboratory, Kingston, Ontario

DRKL, which is located at Queen's University, does research on bacteriological problems.

Defence Research Medical Laboratories, Toronto, Ontario

DRML is situated in conjunction with the RCAF Institute of Aviation Medicine and does research on the occupational medical problems of the armed forces.

Defence Research Northern Laboratory, Fort Churchill, Manitoba

DRNL operates with the tri-service Combined Experimental and Training Establishment at Fort Churchill, and carries out research on arctic problems. It also provides laboratory services for scientists from other establishments working on arctic research projects.

Suffield Experimental Station, Ralston, Alberta

SES is essentially an establishment for carrying out large-scale field trials of weapons and toxic materials. The bulk of the research programme at the station is related to CW and BW.

Defence Research Pacific Naval Laboratory, Esquimalt, B.C.

PNL's primary task is to carry out research on the oceanographic problems of the Pacific coast. In addition, it makes investigations into submarine detection and related problems.

STAFF

The first job the Board had to tackle was to build up a staff. This has proven to be a continuing project requiring a great deal of time and energy. (See Chart A). The gains which have been made in the face of the general shortage of scientific personnel prove that the scientific reputation of the organization is high. As a basis for comparison, the increase in the scientific staff of the National Research Council during the past three years is also shown on the chart. Making due allowance for the Board's youth and for the difficulties introduced by the necessity for security clearances, there is every reason for satisfaction in the rate of growth and in the high quality of the staff which is being recruited.

BUILDING PROGRAMME

A continuing problem, almost equal in importance to that of personnel, has been that of accommodation. Most of the wartime research establishments which the Board took over in 1947 were housed in temporary structures which were unsuitable for permanent use. Some new construction was started at once, and in 1949 a full-scale building programme, planned to extend over a five-year period, was launched.

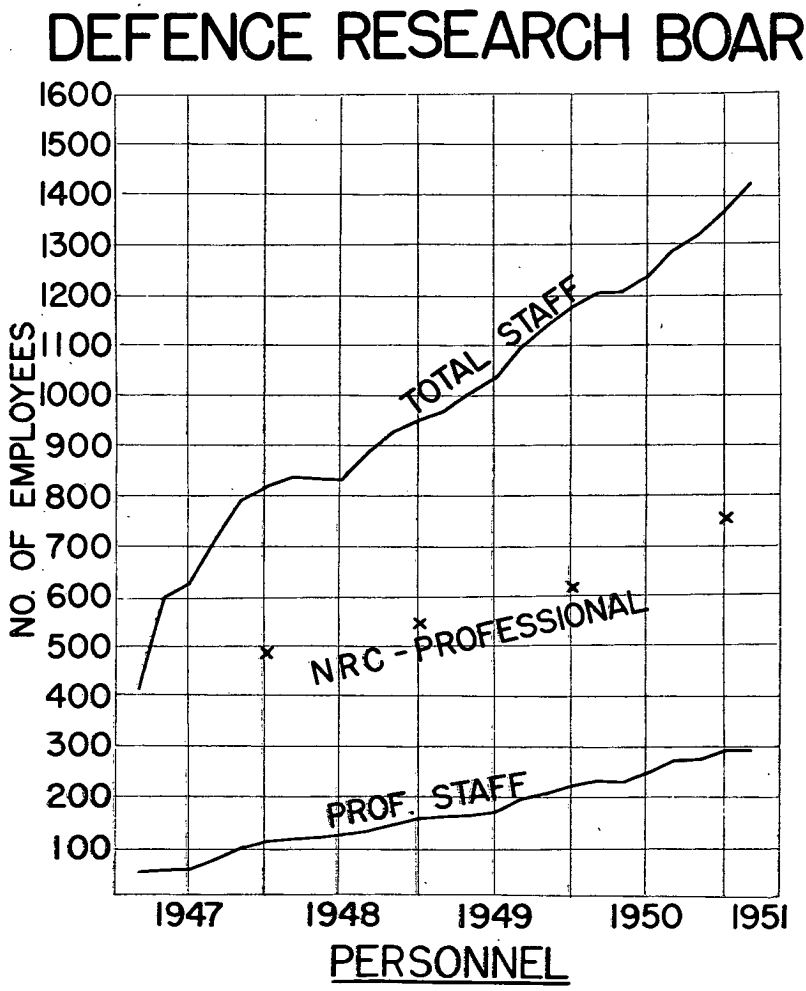
The biggest single project undertaken so far has been the construction of the village of Ralston, Alberta, the residential community for Suffield Experimental Station. It has 150 fine homes, a school and a shopping centre.

A number of technical buildings have been completed for the Canadian Armament Research and Development Establishment, at Valcartier, Quebec, and the Defence Research Northern Laboratory at Fort Churchill, Manitoba. Well on the way to completion are the Radio Physics and Electronics Laboratories in Ottawa, and the Naval Research Laboratory at Halifax.

The main construction projects remaining to be carried out are the Defence Research Medical Laboratory in Toronto; the

Defence Research Chemical Laboratory in Ottawa; a biological laboratory in Kingston; a hangar and laboratory in Ottawa for the National Aeronautical Establishment; new laboratory buildings at Suffield; and a naval research laboratory at Esquimalt. Steps are being taken to accelerate the progress of these projects.

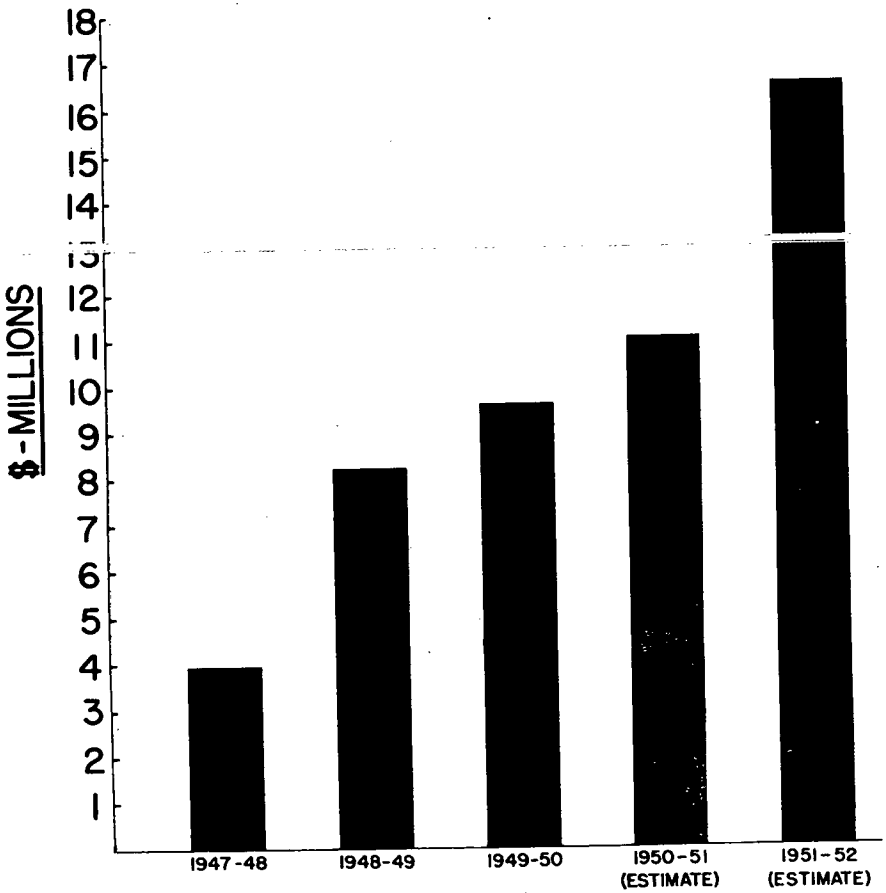
CHART A



SIZE OF RESEARCH PROGRAMME

The scale of research activity can most conveniently be measured in terms of expenditures. The next chart (see Chart B) shows how an expanding staff and improved facilities have resulted in a greater volume of research activity and consequently increased expenditures. (Note: This chart deals only with the expenditures of the Defence Research Board. It does not include the development programmes of the armed services.)

CHART B



EXPENDITURES FOR DEFENCE RESEARCH

It is difficult to determine an exact basis for comparison, but, relative to national income, Canada's expenditures on defence research have increased during the past few years to the point where they are at about half the level of the United Kingdom's and about one-third the level of the United States'.

RESEARCH ACCOMPLISHMENTS

So far we have discussed the build-up in staff and facilities, and the dollar volume of defence research activity. Now let us look at the major fields of research in which Canada is working and review briefly the accomplishments of the past four years. In doing so it should be remembered that although there is a natural tendency to put the emphasis on tangible items – new weapons and equipment – the most important products of a research organization are reports, which do not look impressive, but which may actually be of far greater significance to defence than new 'hardware'.

Special Weapons

The field of special weapons includes BW, CW, flame and smoke. The major Canadian contribution in BW research has been to carry out field trials at Suffield to meet the combined needs of the UK, USA and Canada. These trials have yielded the most significant results obtained since the end of the war, and at the same time were much less costly in time and money than previous tests carried out elsewhere.

The principal advance in chemical warfare has been in research on the characteristics of aerosols, leading toward the development of improved munitions for dispersing the new highly toxic agents, both CW and BW.

A new arctic respirator facepiece has reached the prototype stage of development. It incorporates new principles, permitting it to be worn for long periods of time in sub-zero weather without the eye-pieces frosting over. This work has been done at DRCL.

DRCL has developed a new process for the production of flame thrower fuel, resulting in a much-improved product, and at Suffield a new flame-thrower of great efficiency and greatly simplified design has reached the stage of prototype manufacture. DRCL has also developed a new type of incendiary compound which shows considerable promise.

During the war Canada and the United States jointly developed and produced a large supply of rinderpest vaccine. Work has been done recently to recover the virus strain, which had been lost, and to ensure that adequate stocks of effective vaccine will be available in event of war.

Armament Research

The main accomplishments at CARDE have been the development of an anti-tank weapon of great accuracy, the design of a sabot armour-piercing shell, which has been adopted by both the UK and the USA, and the development of a pack howitzer to meet a British and Canadian requirement.

Work has also been proceeding actively on the development of a process for producing a modern propellant from natural gas. The existing process requires a great deal of electric power, and if the new method proves satisfactory it will release this power for other defence needs.

Steps were taken as early as 1947 to start the training of CARDE scientists in the field of guided missiles. Last year, in cooperation with the RCAF and with the assistance of the UK and the USA, a project for the design and development of an air-to-air guided missile was launched. Work on this project is being pushed as rapidly as possible.

Electronics Research

The element in the Board's electronics programme which is of longest standing, and in which the greatest progress has been made, is radio propagation research. Because of the location of the auroral belt in Canada, the Radio Physics Laboratory has been able to make a significant contribution to research on the effect of the ionosphere on telecommunications. This research is of particular importance to radio communications and aircraft detection in northern Canada.

The Defence Research Electronics Laboratory has been in operation for only about one year. Its research programme is centred on problems of telecommunications.

In planning its electronic research programme, the Board has made every effort to utilize existing non-military research facilities, and to assist the universities in increasing the quantity and quality of research workers. To this end a large number of research contracts were placed with industry, to help them to maintain nucleus research staffs. The need for contracts of this type has now passed, and current contracts are all related to specific requirements.

Naval Research

The problem of greatest importance to Canada in the field of naval research is the detection of submarines under the difficult conditions which exist in Canadian coastal waters. Considerable progress has been made, both in the improvement of detection apparatus and in addition our knowledge of the oceanographic conditions of Canadian coastal waters. Cooperation with the Fisheries Research Board has been close in carrying out oceanographic surveys. These oceanographic studies are to be extended this year to the Arctic and in particular to the Beaufort Sea.

A method of cathodic protection of ships' hulls against corrosion has been developed, which, besides being important to the Navy, has obvious commercial implications. Also developed is an experimental high speed craft capable of speeds up to 50 knots in rough water. This craft is now undergoing sea trials.

Arctic Research

In the field of arctic research, progress has been made in a number of different directions. For arctic air navigators a handbook on arctic navigation has been prepared and is now being published, and a twilight computer has been developed which has been adopted by and is in production for the RCAF.

Considerable work has been done on the identification of arctic terrain from air photographs. Dilution tables have been evolved for the use of lubricants under low temperature conditions, and the development of a heat pump for use in isolated areas under arctic conditions is nearing completion.

Aeronautical Research

For many years the Mechanical Engineering Division of the National Research Laboratories has been the centre for aeronautical research in Canada, and has done a great deal of first-rate work. In order to increase the scale of aeronautical research activity, the Government has recently approved the

setting up of a National Aeronautical Establishment, which is to be based at Uplands Airport, in Ottawa, and will consist of the aeronautical elements formerly a part of the Division of Mechanical Engineering of the National Research Laboratories.

The National Aeronautical Establishment will be administered by the National Research Council on behalf of the National Aeronautical Research Committee. This committee, which is to provide the policy direction for NAE, consists of the President of the National Research Council, the Chairman of the Defence Research Board, the Chief of the Air Staff, and the Chairman of the Air Transport Board. The Defence Research Board is supplying part of the funds for the NAE and in this way will be able to influence the size of the research programme in relation to the needs of the defence forces.

The Defence Research Board has also financed the establishment of the Institute of Aerophysics at the University of Toronto in order to provide facilities for teaching and research in supersonic aerodynamics, and the operation of the Gas Dynamics Laboratory at McGill University, for teaching and research on combustion, with particular relation to jet engines.

A joint programme with the Bureau of Mines, the National Research Council, the University of Toronto, and industry, on the methods of refining and producing titanium, has recently been launched. This has great importance in the manufacture of high-temperature alloys for use in jet engines.

Operational Research

The programme of operational research has been evolved cooperatively with the armed services. In the field of weapon and equipment design, studies have been carried out contributing to the design of the cockpit layout of the CF-100, the accommodation and equipment layout in RCN escort vessels, and the arrangement of the navigator's 'office' in RCAF aircraft.

Studies have been made concerning various problems in connection with the Canadian air defence scheme, the preparation of an inter-service manpower classification system is nearing completion, and the Canadian Army Operational Research Establishment has made an experimental assessment of the effects of snow on mortar lethality.

Medical Research

Intramurally, the major accomplishment in medical research has been the establishment of the Defence Research Medical Laboratories in Toronto. It is concerned with the occupational medical problems of the armed forces and has a large programme under way.

The Board also maintains a large programme of medical research in the universities. Research is in progress on the effects of cold, effects of radiation, blood preservation and similar problems of defence interest.

Environmental Protection Research

The development of satisfactory arctic clothing has received a great deal of attention by the Canadian services, and the clothing now available is of a high standard. The most interesting single development by DRB scientists is nylon pile fabric, which has many possible applications to northern clothing requirements.

The Defence Research Board and the Department of Agriculture, with the assistance of the RCAF, have also been conducting a joint programme on the problem of insect control in the Arctic. As a result of this work, life around service bases in the north has been made much pleasanter during the summer months.

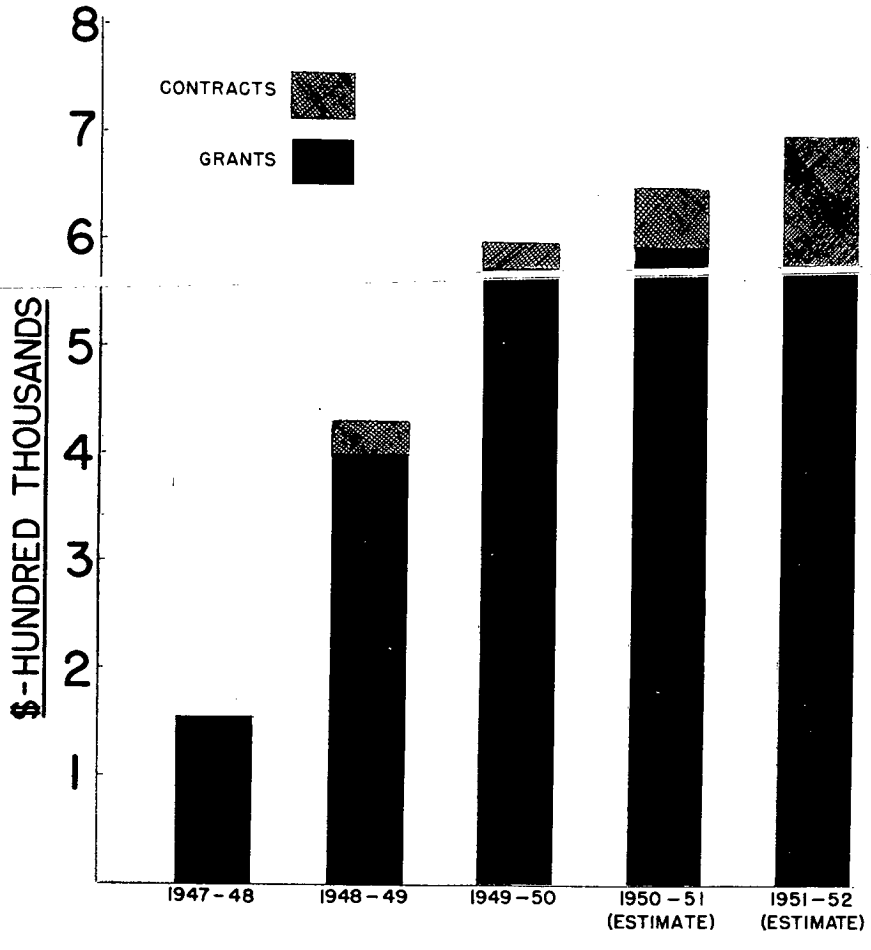
EXTRAMURAL RESEARCH

Research in Universities

In the above outline incidental reference was made to extramural research, most of which is carried out in the universities and the remainder in industrial laboratories. It is such an important element in the over-all programme of the Board that it deserves special attention. It has produced a considerable volume of valuable research, and, equally important, it ensures the training of scientists with the special skills required for defence research.

Most university research is carried out by means of grants -in-aid. There are at present approximately 150 grants in 15 Canadian universities. About 500 professors, graduate students, and technicians are employed on a part or full time basis on these projects (See Chart C).

CHART C



DEFENCE RESEARCH IN UNIVERSITIES

A few of the most noteworthy projects carried out through the grants-in-aid programme, and of mutual value to the universities and DRB are:

Dalhousie University	- Acoustics Research Laboratory (underwater sound)
McGill University	- Eaton Electronics Laboratory - equipment and operation (air defence electronics)
University of Toronto	- Institute of Aerophysics (supersonic aerodynamics)
University of B.C.	- Institute of Oceanography

Industrial Research

The research programme carried out by means of contracts with industrial firms has been relatively small. The first series of contracts were mostly in the field of electronics and were designed to keep together nucleus applied research and development teams in industry until such time as military orders created a demand for their services. During the past 18 months military procurement of electronic equipment has increased to the point where this object has been met.

Current industrial contracts are for work on projects to meet specific and immediate requirements. Typical problems are as follows:

(a) Use of natural gas as an alternative to electric power in the production of picrite

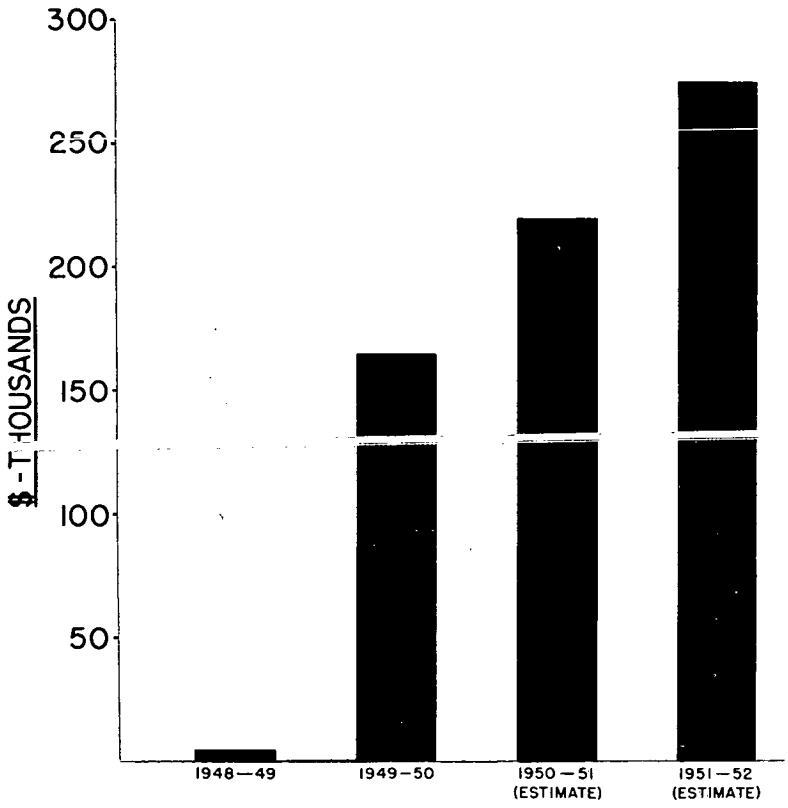
(b) Development of synthetic rubbers for use under low temperature conditions

(c) Radio tube miniaturization

(d) Research on new types of respirator filter papers using Canadian asbestos

Chart D indicates the scale of the industrial research contract programme.

CHART D



DEFENCE RESEARCH BOARD
RESEARCH CONTRACTS WITH INDUSTRY

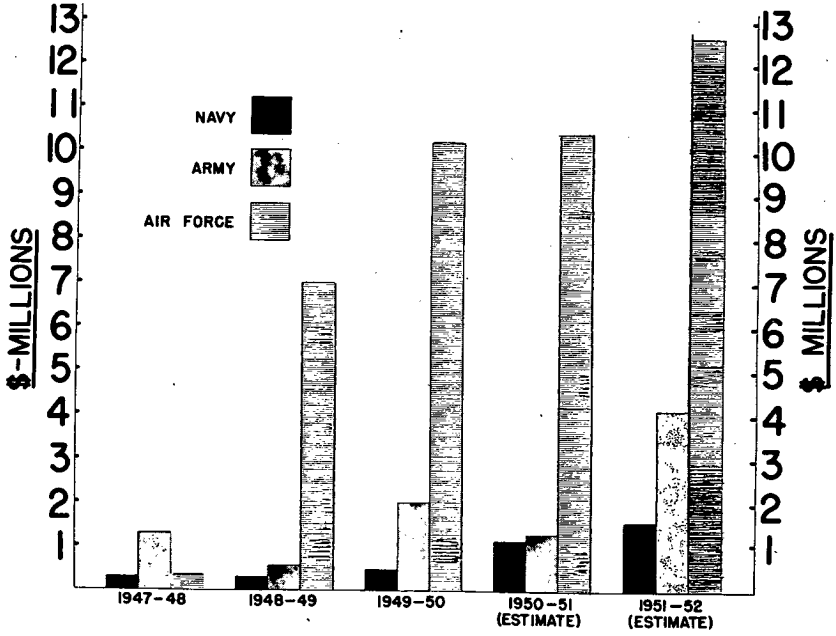
Research in other Government Departments

The National Research Council, the Bureau of Mines, the Fisheries Research Board, and the Science Service of the Department of Agriculture, carry out a considerable volume of research, both on their own behalf and jointly with the Defence Research Board, which is of importance to defence. The dollar volume of this research activity, which is not included in the defence research vote, is estimated to be in excess of two million dollars per year.

DEVELOPMENT

Defence development, during the past four years, has been carried out almost exclusively by the services, with DRB participating only incidentally. The worsening international situation during the past year has, however, on the one hand shifted the emphasis of defence research in the direction of immediate applications, and on the other, has led to the initiation of a large-scale programme of procurement of military equipment. The consequent necessity for the closest possible integration of research, development and production has led to the establishment of a Committee on Development with CDRB as Chairman and the Deputy Minister and the Heads of the Technical branches of the services as members. The scale of the service development programmes is illustrated by Chart E.

CHART E



DEVELOPMENT EXPENDITURES

The principal development activities of the three services are as follows:

Navy

1. Provision of experimental ships for Defence Research Board naval laboratories.

2. Development of electronic equipment to facilitate the tactical training of ships' crews.

3. Development of new-type mounts for A/S weapons, studies of the design and siting of ships aerials, and hydrodynamic studies in connection with the construction of the new A/S escort vessels.

4. Development of new escort vessels.

Army

1. Work at CARDE, with DRB, on an anti-tank weapon, the Pack howitzer, and pot-type sabot ammunition.

2. Modification and development of AA equipment.

3. Development of Engineer equipment, including prefabricated huts, and studies on soil and snow mechanics, and on the problem of water supply in the field.

4. Development of portable radio sets, miniaturization and arcticization of military electronic equipment.

5. Development of Northland vehicles.

Air Force

1. Jet fighter and gas turbine development.

2. Modification of existing aircraft to meet new roles - Maritime reconnaissance Lancaster, and Tactical photo version of the Mitchell.

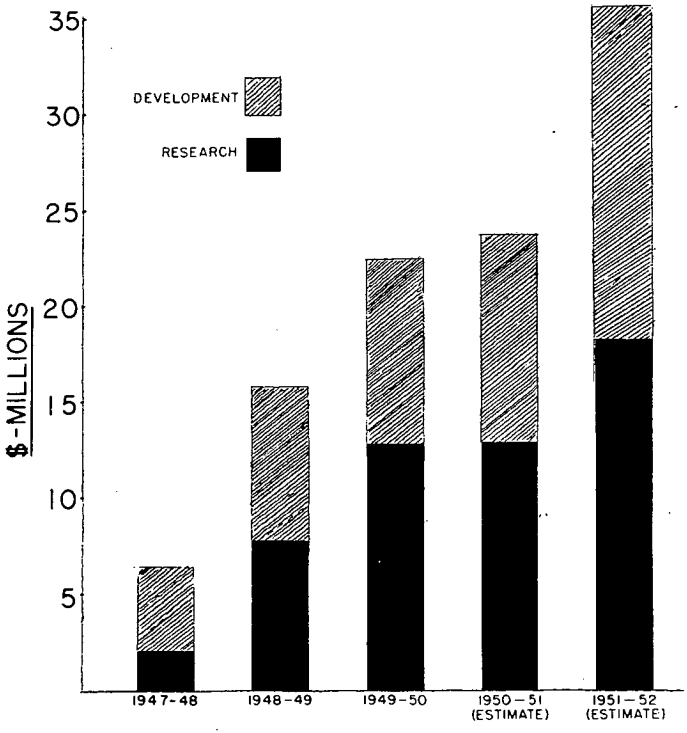
3. Icing studies in conjunction with NRC.

4. Testing programmes at the Experimental and Proving Establishment and Winter Experimental Establishment.

TOTAL DEFENCE RESEARCH AND DEVELOPMENT COSTS

Chart F consolidates the research and development expenditures of the Department of National Defence and presents a picture of the size of the programme as a whole.

CHART F



TOTAL EXPENDITURES FOR
DEFENCE RESEARCH AND DEVELOPMENT

ORGANIZATION

You will notice that all the accomplishments that I have described, with the exception of some in operational and arctic research, have resulted from work done outside headquarters. This is as it should be but it leads me to say something in defence of headquarters since I feel that the organizational pattern of our headquarters may well prove to be one of Canada's important and unique contributions to defence science.

The functions of the headquarters can be divided in many different ways. A convenient subdivision for this purpose is the three-fold one of: 1. General administration; 2. Formulation of research policy and the planning and reporting of programmes to implement policy; and 3. Liaison, information and intelligence services.

The highest compliment that can be paid to our administrative organization is to say that it works so well that we hardly notice it. I would like to congratulate all those in the administrative branch upon the splendid job that they are doing. One of the basic problems in any large research organization is to walk the narrow path between the two chasms of too much and too little organization and administration. I feel that we have achieved an excellent balance - all that remains is to retain it.

The broad policies of the organization are laid down by the Board itself. The details of these policies are formulated in headquarters by the senior members of the staff. The project Coordination Centre and the Research Coordination Staff play a dominant role in this process. The Project Coordination Centre is prepared to supply factual data upon the status of all research and development projects in Canada and many in other countries that are relevant to the needs of the Canadian services. The Research Coordination Staff acts as the link between the staffs of the armed services, and many advisory committees, the liaison and information services and DRB establishments and other research facilities that are available for defence work. It is this combination of the Project Coordination Centre and the Research Coordination Staff that forms the nucleus of the headquarters. It is the adoption of the military principles of 'staff' functions that have enabled us to build up a research and development organization in which the 'scientific' centre of gravity remains in the establishments and the advisory committees. If we can retain this feature as the organization grows I think that we will have avoided the domination by headquarters that reduces the productivity of nearly all large research organizations. This will call for the highest possible skill, intelligence and industry on the part of the RCS. It is much harder to guide, coordinate and integrate a programme so that it will incorporate the best thinking of many minds than it is to carry out your own ideas.

The functions of liaison and information are taking on new importance. In fields where we decide that we cannot do research in Canada to meet the needs of the armed services it is our

duty to get for them the results of relevant work in the USA and the UK to help to meet their needs. This task is potentially a much greater one than that of exchanging information on fields in which we are working. During 1950 the Scientific Information Centre received and dealt with more than 10,000 documents. This is only a small fraction of those that are available and will be needed in the future.

There is no need to emphasize the importance of scientific intelligence. We cannot know too much about the scientific work of potential enemies. We have a small but effective scientific intelligence group who cooperate splendidly with the service intelligence agencies, and are making some original contribution in their field.

Our liaison offices in London and Washington continue to play a dominant role in all our work. The unlimited assistance that we have had from every research and development agency in the USA and the UK is partly due to the splendid work of our liaison officers, partly to the high esteem in which Canada is held, and partly to the quality of our own work. We must never forget that our usefulness to the Canadian services depends to a considerable extent upon the support that we get from our colleagues in the United States and Britain. We must be continually alert to guard their secrets as well as we do our own; to do anything that we can to help them and to make sure that our own work is so dependable that they can rely on it with confidence.

THE TASK WHICH LIES AHEAD

You have heard an outline of the progress of the Defence Research Board during its four years of operation. I have deliberately included a good deal of reference to other research agencies that should be regarded as a part of Canada's potential for defence research. I have done this because the future of the Defence Research Board cannot be planned independently. It must be planned as a part of the scientific community of Canada.

The basic problem that now confronts the Board is the same one which confronts the Government of Canada in every aspect of national life; that is, how to assess the imminence of war and extent of defence preparations that must be made now. It is clear that the urgency has increased and that we must do more than was planned even six months ago. It is, however, not clear

that we are going on to total war and so we cannot plan for total mobilization now. We must aim to accelerate our defence research programme to a level that can be sustained for a long time without serious detriment to the civilian economy. It is hard to forecast the optimum level of such activity. However, from the viewpoint of defence research it seems at present as if an attempt to forecast the optimum level is a rather academic exercise. Present indications are that if the Board makes every possible effort to recruit scientists it will not be able to get enough scientists to meet the obvious and urgent needs of the defence services. It would seem, therefore, that the limited availability of trained scientific manpower will automatically prevent any excessive diversion of effort toward defence research in the period prior to total war.

Our present plans do not envisage embarking on any new major fields of research at the present time. Nearly all our research establishments are at the lower limit of size for effective operation. The increasing tempo of world events demands increasing rates of progress in both research and development if the results of our work are to be of any value either to us or to our allies. These two factors taken together suggest that we must continue to concentrate our increased effort in the fields in which we are already engaged rather than spreading it over any new fields. The greatest emphasis will be put on an acceleration of activity in the fields of guided missiles, electronics, medical research, aeronautics and scientific information.

The formation of the new Department of Defence Production will have a profound effect on many of our activities. The chain of events from research through development to production and use is a continuous one. In the past four years most of our work in Canada has stopped short of production. In the future more Canadian designs will reach the production stage. In addition the production in Canada of new equipment designed elsewhere will lead to many research and development problems. Steps have already been taken to link DRB with Defence Production to complete this chain from research to use. We must be prepared to act as research and development advisers to the new department. This will involve added burdens, especially upon the Research Coordination Staff, and will probably lead to changes in programmes and priorities. However, we must not regard it as an imposition but rather as a welcome and important step toward the completion of Canada's organization for defence. It will certainly add a new sense of urgency and realism to much of our work.

As many of you know, we have given much thought to mobilization plans to be put into effect should war occur. It has proven very difficult to formulate detailed plans although the general lines for mobilization seem quite clear. In considering mobilization of scientific effort for defence now or in the near future, it is important to realize that the situation is very unlike that of 1939. The total amount of research being done in Canada has increased somewhere between five and ten times since then. A great part of this research is of an applied kind and most of it is done in support of industry. The industrial research workers and their laboratory facilities will be required even more urgently by industry in war than they are in peace. This means in effect that there are surprisingly few research workers or research facilities that could be mobilized and diverted to new military tasks. A brief survey of the universities suggests that there are not more than 2,000 scientists available for teaching and research. Since the majority of these must stay at the universities to continue the teaching of scientists and engineers during a war, it follows that the total number available for mobilization is surprisingly small, probably less than 1,000. This small number will have to be shared between all the defence research agencies, the industries, and the armed forces. It is therefore clear that no one of these groups will get very substantial immediate reinforcements even in the event of war. The obvious conclusion from this is that we should give high priority to increasing the output of scientists and engineers now. Although we in the Defence Research Board are not optimistic about being able to mobilize a large number of scientists from any source, we do hope that we will get a small but very important group of leaders from the universities should a war occur. It is clear from this that the major mobilization of research effort for defence in the event of war would come not by increasing the staff of the Defence Research Board, the National Research Council, or other defence agencies, but by the intelligent reallocation of the effort of existing scientific laboratories. This process is already well under way and it is hoped that during the next year plans will be evolved which will assign a fairly definite role to each major research facility in the event of war.

In conclusion I would like to say a word about the relationships of the Defence Research Board within the Department of National Defence and throughout the government. We who are in the Defence Research Board sometimes feel a little like missionaries who are attempting to convert the natives from a paganism which they enjoy to a better way of life for which

they feel no need. In the earlier days of the Board's existence, there was a little resistance to our missionary efforts in some quarters. I feel that this has completely disappeared and that our relationships with all three services are now most satisfactory. We still have to sell the results of research to them, but they are now interested customers with no more than normal sales resistance.

I hope that the time will never come when the scientific staff of DRB and other research agencies working for the services see eye to eye with the military people with whom they work. When a military and a scientific group are in complete agreement on any major problem, it means that one side or the other has yielded to pressure and given up its distinctive point of view. Real progress results from the continual interplay of the viewpoints of the military expert and the scientist and even heated debates should be encouraged as long as each side respects the other and is willing to listen to the other's arguments.

I feel certain that the good relationships that we have now established with the services will result in an increasingly effective use of the product of our laboratories. I hope that the partnership will also be greatly strengthened by increased staffs on both sides. We in DRB feel that we give the armed forces good service only in those fields where we have an adequate staff and also that they make effective use of the results of our efforts only in the fields where they have enough competent technical officers to convert research and development activities into effective operational equipments and procedures. From the point of view of the Defence Research Board an increase in the number of well-qualified technical officers in all three services is a most urgent problem.

The relationships of the Defence Research Board outside the Department of National Defence have been just as successful as those inside. We have close and happy relationships with all other government agencies doing research and with agencies that are interested in the results of research. We like to feel that the Defence Research Board has in fact been to some extent a unifying influence in the scientific community. The Board's laboratories and advisory committees have provided a meeting ground for the many scientific agencies that have a common interest in defence and this has promoted a knowledge of each other's interests and facilities which would sometimes not be gained in other ways. I hope also that the same has been true of the Board's relationships with the universities and with industry.

If you reconsider what I have said concerning the past activities of the Board and our suggested plans for the immediate future, you will realize that I have suggested no major change in policy or programme. This may suggest complacency, but I know that no one of us is complacent about the future. We feel that we have done a good job of building up a new research organization over four eventful years. The organization is not yet fully ready to meet the challenge of total mobilization but when, on an occasion such as this, we attempt to stand off and look at our basic organization and policies we feel that they are fundamentally sound and that with good team work and consistent effort we can produce research and development results which will meet the needs of the armed forces and will be a credit to Canada in the international world of military science. As a young and still struggling organization we have some very high standards to live up to. We must, on the one hand, strive to equal the splendid reputation of the Canadian armed forces, and on the other, the distinguished achievements of the Canadian scientific community.

We will succeed if we are able to retain the team spirit that we have achieved in the past four years. This will not be easy as the organization grows larger. It will be increasingly difficult to give every one of us the sense of participation and importance that stimulates initiative and effective action. We must strive to demonstrate that a government agency, as it grows larger, can retain flexibility and productivity. If we succeed we will not only have done our research job well, but will also have made a modest contribution to the evolution of democratic institutions. My own conviction is that we can achieve our goal if we all work toward it. We must strive, at all levels, to achieve the greatest possible deputation of authority and responsibility. Each one of us does better work if he feels sure that his decisions will be accepted in his own sphere, no matter how small. We must also try to have what I call, for want of a better description, a 'downward looking' organization. Each person must be primarily concerned with being sure that those under him are being used to best advantage, are doing effective work and get the advancement that they have earned. In such an organization no one must devote his or her time to impressing 'the boss' since 'the boss's' primary concern is looking after those under him. When tasks are given to us we must first decide if they are worth doing, if they are we must find ways of doing them and refuse to be defeated by bureaucracy and red tape. The very history of our organization shows that almost any worthy objective can be achieved within the present

organization of the Canadian government if you refuse to be discouraged by apparent difficulties. I am convinced that the parliamentary system is the most effective and workable kind of government that man has yet devised and that because of its small size and high level of individual competence the Canadian government is the best of its kind. If we cannot make DRB work in this environment, then either we are incompetent or there is no hope for democracy. We have made it work in the past and we will make it work even more effectively in the future, partly to show that we are a first-class team but mainly to show that mankind's faith in the democratic way of life is fully justified.

(THE END)