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04a "CONTRIBUTIONS OF DEFENCE SCIENCE

— TO CANADIAN NATIONAL GOALS".

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by Dr. L.J. L'Heureux,

0204a Chairman, Defence Research Board,
0204b Ottawa ONT (CAN)

04b An Address to the

— Manitoba Chapter of Sigma Chi

— at Winnipeg, Manitoba

— February 18, 1970

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Thank you, Mr. Chairman for your very kind introduction. It is a great pleasure to be with you in this gateway city of Winnipeg, a city so closely linked with the development of the Canadian prairie. I do not come as a stranger, for I enjoy most pleasant memories of my early life here in the west, and I am always delighted to renew that happy association.

But over and above that personal comment, at this period in our national history when so many schismatic influences seem to be at work, it is a privilege to visit a centre where people of many ethnic origins have solved the problem of working together effectively.

I wonder how many of you realize that defence science has benefitted Canada economically to a figure exceeding $200,000,000? Tonight I will describe to you how defence research extends its economic benefits into a wide variety of areas of civilian interest.

The time is particularly appropriate for reflection on this topic. During the past two years, much publicity has been given to the destructive aspects of war and the employment of scientific research in devising tools to aid in that destruction. Let me place before you however, the broader spectrum and evaluate the benefits contributed by defence science to a better civil environment.

Before developing this main theme however, it may be useful to sketch the organization of defence science in Canada. Canadian Armed Forces do not engage directly in research; that responsibility was transferred in 1947 with the creation of the Defence Research Board which in turn, was charged with carrying out research for the Armed Forces. That decision was wise and timely -- wise, because it eliminated the possibility of interservice rivalry -- and timely, because just as scientific research and rapid technological development had brought Second World War offensive capabilities to new heights of efficiency, so science and technology should be combined to carry out the same role for a defensive capability in a still unsettled and unstable world. For purely economic reasons, it was also a wise decision because

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a single research agency would prove less costly than three separate agencies, each with its own hierarchy.

Organizationally, the Board was headed by a Chairman, responsible directly to the Minister of National Defence and acting as his scientific adviser, plus a "Board of Directors" or Members, appointed to represent the Armed Forces, Canadian business and industry, and the universities.

To carry out specific research, laboratories or "establishments", staffed by scientists supported by technical and clerical elements, were organized. The establishments were assigned specific areas of research and co-ordinated to obviate duplication of effort. The laboratories were apprised of the Forces' research requirements and conversely, the Armed Services have been kept informed of scientific developments of likely operational interest.

Finally, to ensure Canadian co-operation with defence research agencies of other Western countries, and vice versa, liaison offices were opened in London, Washington, and Paris. The primary function of DRB's establishments has been to engage in applied research. A different system was evolved to conduct basic research which I shall describe later.

With minor changes, this organization continues in effect. The unification or integration of the Armed Forces has not affected materially the role of the Board's professional staff which at the outset, was designed to minister to the broad interests of defence science rather than to individual Service requirements.

Admittedly, it is trite to say that the concept of defence has undergone more radical changes in the past 30 years than in all the preceding span of recorded history; the implications of those changes are of such significance however, they merit our attention today.

When war was a comparatively simple matter of manpower and rudimentary "individual" weapons, the civilian was relatively unaffected unless his home and family chanced to be in a combat area.

In the modern context however, with the emergence of new types of weapons of mass destruction complemented by sophisticated delivery systems, no country, no community, no individual, is immune from attack. And despite our hopes for arms control, arms limitation or perhaps eventually disarmament, the delicate balance of terror remains a potent force in international politics.

Canada has no aspirations towards territorial expansion, casts no envious eyes upon the resources of other nations -- in short has no interest in an offensive type of war. We adhere firmly to the principle of maintaining our sovereignty over what we deem to be rightfully ours, but such maintenance is defensive and not offensive in character. Thus defence, and not offence, is the entire theme and goal of our military policy.

In that frame of reference, ladies and gentlemen, I should like now to suggest to you how defence research contributes usefully to other aspects of our national life.

As individuals each of us strives towards certain goals. As the state is the sum total of its citizens, it follows naturally that the state also should have goals of a national character.

The Science Council of Canada, which accepted this thesis, has enunciated six goals as falling within that category. Somewhat abbreviated, they are: (1) physical and mental health (2) improved educational standards (3) improved use of leisure time (4) personal freedom, justice and security for all in a united Canada (5) contributions to world peace and stability, and (6) national prosperity.

As progress towards the fulfillment of these aspirations must be the responsibility not only of individuals but also of government, agencies like the Board must be alive to the contributions they can make either directly or indirectly.

Because the Board's terms of reference stipulate that its research program must be "mission-oriented" or related to problems of Canadian defence, defence science cannot contribute equally to all six national goals. We do not, for example,

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claim improvements in the use of leisure time and in the field of education, the DRB contribution is narrowly specific and not associated directly with the popular understanding of the term education.

Respecting the other four goals however, defence science has made effective contributions. Physical and mental health is as important now as it was hundreds of years ago. The primary interests of defence medical science however, are neither clinical nor remedial. They concentrate upon keeping men, under a wide variety of environmental conditions, healthy and capable of carrying out their duties effectively. To that general objective, the Board has assigned the term "Environmental Physiology".

Physiologically man is, up to a point, a reasonably adaptable organism; to some extent also, the environment can be modified, at least insofar as the individual is concerned. Our aim is to determine how physical stamina and environmental modification may be combined to maximum advantage.

Our research laboratory in Toronto has a team of medical, scientific, and technological personnel carrying out research studies on physiological effects of various types. These investigations include the effects upon humans of severe climatic conditions such as those encountered in the Arctic; of high atmospheric pressures; oxygen or nitrogen narcosis; decompression sickness; visual acuity under marginal lighting conditions, and auditory problems associated with high noise levels where prolonged exposure may result in permanent hearing loss.

We are also interested in the effects of diet upon man's ability to cope with a hostile environment, and in the reasons why certain animals have such high resistance levels. How, for example, does the muskox on his limited diet survive long periods of exposure to temperatures 50 or 60 degrees below zero?

Our research in all these physiological subjects was initiated because they represent very real practical problems to Service personnel. The fact that civilians

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are engaged in activities presenting similar hazards means that our research findings, which have gained international recognition, are equally valuable in the non-military sector.

Traditionally, Arctic clothing was heavy, cumbersome, and restrictive to physical activity -- all anathema to military requirements. Our research has resulted in new arctic fashions, light in weight, liberal in their use of synthetics, and employing layers of thinner material with the air between layers acting as a series of insulators. While not the latest in high fashion, the clothing is functionally effective. Such advances are significant when applied to the civilian context, particularly at a time when Northern development looms so large in our national view.

In many parts of Canada, particularly at certain seasons of the year, insect pests are an all too familiar feature of the environment. From a defence standpoint, mosquitoes, black flies, midges and tabanidae constitute a hazard because they hamper the individual in his tasks and they sometimes serve as vectors of diseases. For these reasons we have supported research programs in the entomology of such insects as well as in methods of control.

Manitoba's Fort Churchill area has proved an excellent natural laboratory for testing the effectiveness of control methods and for assessing residual effects of toxic agents. This whole area of research has been particularly significant as a co-operative effort involving not only DRB scientists but also, other government departments and a number of universities in Canada and elswhere.

I turn now to the polluted environment with reference specifically to pollution resulting from overtly hostile motives and employing chemical, biological or radiological agents.

Chemical weapons were not employed in the Second World War although most of the powers possessed them. At the conclusion of hostilities, it was discovered that the Germans possessed stocks, not only of chemicals of the First World War type, but also of new highly lethal agents, the "nerve gases."

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These compounds had been discovered in Germany in the late 1930's and during the war years had been manufactured on a large scale and loaded into munitions ready for use. Much of this stock fell into Russian hands.

It was not surprising therefore that nations were very concerned about the threat of chemicals should a third war occur. Bacteriological agents had never been employed in modern warfare but with the rapidly expanding knowledge of microbiology in the post-war period, it could not be concluded that these agents would not be developed and used in the future. Therefore the Board has devoted a considerable portion of its effort to chemical and biological warfare defensive problems. The scientists assess the threat of potential agents, both chemical and biological, perfect methods for their rapid identification and effective decontamination, design and develop protective measures such as respirators and protective clothing, and study means for treating casualties.

As a result, Canadian service personnel have available today some of the best protective equipment against chemical and biological agents.

Because the international situation has altered considerably during recent years, the threat of chemical and biological weapons appears to have lessened. The Board decided two years ago therefore that its effort in nuclear, chemical and biological defence could be safely reduced. This has been effected although small centres of competence have been maintained and could be expanded if needed. It is gratifying to note that the United States is now taking steps, somewhat similar to those taken by us, to reduce its effort in the fields of chemical and biological warfare.

A great deal of criticism has been focused recently upon the Board's research program in these areas. What the critics, well-intentioned though we assume them to be, fail to realize is that Canada has no intention of using such weapons offensively. But as a research organization concerned primarily with defence, we would be remiss in our responsibilities were we to ignore completely the possibility of such devices being used against Canadians.

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Our critics, who appear to have convinced themselves that the world is populated by kindly humanitarians, have reached the belief that the use by any nation of chemical or biological weapons is unthinkable. In their ivory tower of utopianism, they blind themselves to the harsh realities of the situation. As defence scientists we must sometimes, to borrow Herman Kahn's epigram, "Think about the Unthinkable." And to quote Herman Kahn again, in a different but related context, "Just as it would do the 'Militarists'some good to be exposed to some utopian thinking, so it would do the 'Utopians' even more good to be exposed to some military thinking."

Hence, we are conducting research of a defensive character to protect, not only military personnel but also the civil population, including the Utopians.

Turning now from environmental physiology to the mental aspects of health, we are confronted with a problem of increasing national concern -- the effects of isolation. Because Service personnel may be required to act in small groups under isolated conditions, we have conducted a number of programs in this limited area. Some of the most dramatic research in this field has been carried out via DRB grants here at the University of Manitoba by your celebrated Dr. John Zubek.

The Science Council enunciated the principle of personal freedom, justice, and security for all citizens -- linked together as a single objective. In the time available here tonight, it is obviously impossible to discuss such abstract concepts as freedom and justice. Security however, may rightfully be expected to have here a direct interest.

By law and by tradition, it has always been the task of the Armed Forces, aided now by all the support which defence science can provide, to ensure the physical security of the nation from outside attack. Protection from lawless or dissident elements within the community is the responsibility of civil law-enforcement agencies, local, provincial, or federal, as the case may be.

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Civil authorities however, may call upon the military to assist in maintaining law and order. That is an extreme step, fortunately rare in Canadian history. Nevertheless, techniques developed by military science are constantly available to the civil authority - systems of rapid communication, facilities for the acquisition of information, and methods for its display and dissemination. All these have been brought to high levels of effectiveness by defence scientists long involved with similar problems in the military sphere; their usefulness to civil law enforcement agencies can hardly be exaggerated.

The Science Council was concerned however, not merely with national security -- it took a broader view in stating that Canada should contribute to world peace and stability, or if you wish, to security in an international setting.

Although it is true that world peace could be ensured by total disarmament, practical realism negates that solution within the foreseeable future. In the interval, therefore, arms limitation or arms control constitutes a first step towards the ultimate goal. To this subject, both the Departments of National Defence and External Affairs have devoted a large measure of attention.

Scientifically, we have been examining and testing methods for inspecting the output of fissile material from nuclear reactions, and for detecting underground explosions by the use of seismological apparatus. Using operational research techniques, we are studying the make-up, equipment, and training of small "inspection" teams qualified to determine whether concentrations of men and weapons in given areas are remaining below agreed levels. On the more theoretical side, we are attempting to identify steps in arms control which are at once acceptable and feasible. The objective is to bridge the gap between impractical idealism on the one hand and suspicious international obstinacy on the other.

Pre-occupation with problems of grand strategy designed to prevent all-out nuclear war should not be permitted to make us neglect the more limited type -- border clashes, and brush fire or local wars. One of these might, for one reason or

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another, be promoted to a direct confrontation between major powers. To prevent that sort of escalation, the United Nations has requested from time to time the participation of Canadian forces in a peacekeeping role.

From a defence science point of view, we have identified a number of areas where research is needed, among them the economics of peacekeeping, and the optimum constitution of such forces. From the more theoretical standpoint, we have offered research support to Canadian universities in order that the root causes of hostility, and a host of other sociological and politico-sociological problems may be studied in depth by qualified academic specialists.

There remains to be considered the goal to which the Science Council gave first place -- national prosperity. I have taken the liberty of leaving it until the last, because, although the merit of other goals is unarguable, the fact remains that they are achievable only if a sound economy can provide the necessary financial sinews.

To such an economic base, defence science has made a notable contribution. In making that statement I must emphasize, first, that the Defence Research Board is a research organization, not a development agency or a manufacturer, and secondly, that our primary mission is to provide research support to the Armed Services; that is the reason for our existence. But if industry, capitalizing on our research, can produce items useful in the civil sector at home or abroad, such production and its economic benefits must be regarded as an added bonus. With that thought in mind, I should now like to quote some figures concerning production orders related directly to DRB research results.

In the field of telecommunications, production orders for antennas, ionospheric sounding equipment, and oblique sounding communications sytems have to date totalled approximately $15 million, with electronic components of various types contributing an additional $28 million. The Airborne Doppler Navigation System, developed originally for Service aircraft, has resulted in civilian orders, largely from foreign

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sources, in excess of $100 million. Production of protective clothing, respirators, and radiacmeters has accounted for some $10 million. Specialized antitank weaponry has resulted in orders valued at $12 million; sonar and magnetic anomaly equipment, originally designed for submarine detection, have both found a variety of civilian uses and equipment sales have totalled some $35 million. Various specialized electrical power source devices have resulted in sales approximating $3 million.

These economic benefits for Canada represent a total exceeding $200 million. That is an impressive figure considering that more than half the Board's manpower and budget have been devoted to areas which seldom lead to equipment production, i.e., the biosciences, operational research, oceanography, geophysics, etc. Nor do these figures reflect the benefits known to have accrued as the result of improvement to Canadian Forces equipment items, improvements which have made them cheaper to produce, with a longer service life and lower costs in maintenance and repair.

In the course of my remarks thus far, ladies and gentlemen, I have spoken of the Board's program primarily in terms of applied research. I have referred also to our involvement with industry, again of course in the applied field, but I have had little to say either on the subject of basic research or about our connection with the universities. If an applied program such as ours is to remain viable, it must have a constant flow of new ideas arising from fundamental studies. With that thought in mind, I should now like to redress the balance, so to speak, and describe to you how, through the medium of our basic program, our professional scientists not only have access to new knowledge, but also maintain a working association with their colleagues in the universities of Canada.

When the Board was formed, a far-reaching decision was made concerning basic research. It was decided that the Board would not, in general terms, engage in basic research, but would concentrate on the applied type. This proved a well-founded decision for two reasons -- first, the Board was to involve itself with the direct research requirements of the Services in which rather rigid limits both in time and

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in scientific content would have to be faced. Secondly, to build, equip, and staff laboratories adequate for carrying out a basic program commensurate with the wide spectrum of the Board's projected duties would be prohibitively expensive.

Concurrently however, and very fortunately, developing in the universities was a growing desire to emphasize research as a means of expanding the boundaries of human knowledge. It made very good sense therefore, for DRB to devote a portion of its resources to supporting a basic research program in the universities -- both would benefit.

Following agreement with the universities on this system's acceptability and administrative feasibility, DRB's terms of reference legalized the arrangement in the following terms -- and here I quote directly from the National Defence Act, "The Board may make grants in aid of research and investigations with respect to matters relating to defence."

The Board members at that time favoured the close association with the universities envisaged by the proposal. As eventually stated, they were (1) to acquire new scientific knowledge (2) to maintain a link between the scientific community of the Board and that of the universities, and (3) to assist DRB in staffing its laboratories with promising young scientists. These objectives have remained unchanged.

Soon after the Board announced its intention to initiate this program, it became evident that requests for support would exceed the funds available, and that selection procedures would be necessary. The National Defence Act stipulates a defence interest factor; as a scientifically-oriented organization the Board was understandably anxious to support only programs of high scientific quality. Thus we had at the outset, and still have, two criteria on which to base our selection, i.e., scientific quality and defence applicability, in that order.

From their knowledge of the present requirements of the applied program, and the probabilities of developments in various fields, our own professional staff

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are able to assess the level of defence interest in a proposal. To evaluate scientific quality, a different system was evolved, principally because the Board wished to have, in a situation where decisions must be essentially subjective, advice free of bias.

Advisory Committees, in the different scientific disciplines were therefore established with membership drawn from business, industry, other departments of government, and from the universities. Each committee examines all applications in its particular field of competence, and using a 7-point scale, assigns a merit rating to each -- our own staff assesses the defence applicability. The composite recommendations are then placed before a meeting of the Board and final decisions are made as to levels of financial support.

Our Advisory Committees now total 25 with approximately 240 members, of whom more than 3/5 are senior professors or Heads of Departments in Canadian universities. I cannot speak too highly of the assistance they provide and I should like to take this occasion to express our sincere appreciation for their contributions to the DRB program.

Initially, $250,000 was considered sufficient to support our basic research program -- but times have changed. Over the years, that sum has risen gradually -- from $1.69 million in 1961 to $2.04 million in 1966 -- and it now stands at $3 million. To the suggestion that these increases merely compensate for the expanded "cost of living", I would point out that most were effected in a period when the Board was operating on virtually a fixed budget and under the close scrutiny of the Treasury Board.

With 440 basic research projects currently receiving DRB support in universities from Victoria in the West to St. John's in the East, it is possible to describe the nature and content of our program only in summarized form. Covered are virtually all the basic disciplines; in the physical sciences, chemistry, physics, geophysics, and engineering of various types; in the life sciences we have programs

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in medicine, entomology, biology, psychology. We also support work in applied mathematics and computer science, both topics of fairly recent introduction into the system. The same holds true for economics and political science -- the changing nature of defence necessitates that we devote a measure of attention to these areas.

Conversely, we may phase out our support in areas where defence interest has declined or where a civilian interest has become predominant. In the field of medicine, for example, this year we will terminate our program in blood, plasma, trauma and shock research because the increasing incidence of highway accidents has led us to regard research in these areas as primarily of civilian concern, and therefore amenable to sponsorship by other agencies.

Throughout our basic program, research scientists in the universities are kept as closely as possible in touch with DRB staff employed in more applied aspects of the same field. A fulsome contribution to the Alouette and ISIS ionosphere-probing-by satellite programs pioneered by DRB, for example, was made by university-based scientists. In medical research, our capabilities are limited. We have been dependent on university departments of Medicine and their associated teaching hospitals for advice and research. Much of our program in psychology, primarily concerned with the man in the man-machine interface, has been carried out in university laboratories.

The research content of our extramural program and the areas of our prime interest are thus by no means fixed and immutable. Flexibility is essential in a period of rapid technological development so that we may shift emphasis in accordance with developments that impinge upon our internal program.

As an illustration, for a number of years we have worked in our own laboratories on laser research. The program has been declassified to make our findings available to the scientific community at large and you probably read recently of some of DRB's remarkable gas laser achievements at our Valcartier establishment. Concurrently, we are inviting university scientists to submit proposals for additional basic research in the laser field, because we are convinced that lasers have many

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applications, both military and civilian, as yet unexplored. After all, it is important to realize that the first operating laser was developed only ten years ago.

I could continue for some time on the inter-relationship between basic and applied research. Before I leave the subject however, I should like to mention specifically, some programs here at the University of Manitoba. As our connection with this university extends over the whole period of the Board's existence, there are many projects I could discuss, but I have selected three -- choosing them in particular because each is in a field in which our lack of facilities has made us to an unusual extent dependent upon extramural capabilities.

In the field of Arctic medical research, to which current national interests are attaching increasing importance, the work of the late Dr. Doupe and Dr. Hildes has been pre-eminent. In entomology, the research conducted by Dr. Thorsteinson and Dr. Brust has added materially to our knowledge of insect control methods. Last, but by no means least, I wish to pay tribute to the outstanding work of Dr. Zubek -- his research in the field of sensory deprivation has won international recognition and we are happy to feel that, in part at least, we have shared in his success.

I realize, Mr. Chairman, that I have spoken at some length. In doing so, I hope I have been able to give you some insight into the contributions which defence science has made and is making towards the achievement of our national goals.

I have also taken the opportunity of telling you what the Defence Research Board is and how it carries out its primary mission of providing research assistance to the military problems of defence science. And if I have been able to demonstrate that the Board is not some curious relic of World War II -- but a live organization which an eye to the future, that we are not totally involved with diabolical weapons and that our research is not oriented towards "Unthinkable" objectives, I shall have achieved my objective. I thank you, ladies and gentlemen, for your kind attention. To you, Mr. Chairman, I express my appreciation for the privilege of addressing you tonight.

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