Exhibit P-90

The Defence Research Board of Canada, 1947 to 1977

by

Jonathan Turner

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Institute for the History and Philosophy of Science and Technology
University of Toronto

That evening he gave a lecture attended by members of the Board, Lester Pearson from External Affairs and many other government officials. The meeting was mutually beneficial. Bush learned a little about the Defence Research Board; unfortunately his influence over defence and science policy had significantly diminished and he was a mere six months away from leaving the government out of frustration and illness.[182]

The DRB, within its first year of existence, heard directly from the two most public and influential managers of science coming out of the Second World War. The good feelings wrought by visits from Bush and Tizard were only useful if real scientific exchange resulted. It did not. Neither official visit improved the exchange or lessened the American restrictions. Aside from the liaison officers the only other opportunities for exchange were the aforementioned Commonwealth Advisory Committee and a series of tripartite conferences.

The annual tripartite conferences started during the war to deal with special weapons as a result of the tripartite organization of Suffield. By the end of the war there was an additional conference dealing with armaments and explosives. These continued after the war, and when the DRB was created in 1947 it assumed responsibility from the Services for sending representatives. Additional conferences and topics were added starting in 1950. This was the result of two things. First, the Korean War had erupted, and the utility of tripartite collaboration was rediscovered. Second, by 1950 the DRB had built up an establishment and research capacity to discuss a wider variety of topics.[183]

3.7 The Program

3.7.1 Research at the DRB

Each establishment had unique capabilities and projects between 1947 and 1950. This is one point on which Goodspeed's account is an excellent resource. He covers each of the different fields of research in detail, including the key people and significant projects. A very brief summary follows, which has been supplemented with additional information or context that was not available to Goodspeed.

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[182] LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43-1 Vol 2, "Notice from MacNeill to Defence Research Board, 2 March 1948," and "Letter from W Gordon Mills (Deputy Minister) to RG MacNeill regarding Bush Lecture, 4 March 1948;" Zachary, *Endless Frontier*, 279-347.
[183] Goodspeed, *A History of the Defence Research Board of Canada,* 84.

Canadian Armaments Research and Development Establishment (CARDE) in Québec worked with explosives and armaments. Three of the projects it undertook are worth mentioning.

The pot sabot projectile was designed to obtain better penetrating power than normal shells, because of its delivery of a higher amount of energy in a smaller package, which is obtained by shedding a carrier mid-flight. It was both safer and more accurate than other anti-armour weapons. It was the first Canadian-designed weapon endorsed under the Tripartite Standardization Agreement. However, in 1948, the projectile was made of tungsten carbide, an incredibly strong material that was in short supply.[184]

A second project that scientists and engineers at CARDE worked on was the Heller. Like the sabot shot, the Heller is an anti-tank weapon, but designed for infantry rather than a tank or artillery. Because the Heller burns its propellant entirely within the hollow tube it is more accurate than a Bazooka; for the same reasons it is also safer because there is no back-blast.[185]

The Canadian Army accepted the weapon, but tripartite acceptance was much harder to come by. In their analysis of the trials of the Heller for the Research and Development Board in the summer of 1953 the American Committee on Ordnance did not look at the Heller favourably in comparison to the Bazooka and the Recoilless Rifle. The Committee's Panel Director, Melvin Bell, acknowledged the admirable features of the Heller, but discussed at length the exorbitant costs of the improved accuracy and materials. Bell suggested that neither the United States Army nor the Marines were likely to accept the Heller. The preference in the US was for weapons developed in the US, despite trials' performance and in spite of promises not to duplicate efforts within the tripartite.[186]

Tripartite standardization remained an issue for the Heller into 1961. The UK was leaning towards a Swedish model (Karl Gustav 84), because it was outperforming the Heller in

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[184] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Report of a Special Meeting of the DRB Held at 2:30pm, September 26th, 1948, in Quebec City to Discuss the Programme and Future Development of the CARDE at Valcartier," 4; "History," *American, British, Canadian, Australian and New Zealand Armies' Program*, accessed 13 July 2011, http://www.abca-armies.org/; Goodspeed, *A History of the Defence Research Board of Canada,* 126.
[185] Goodspeed, *A History of the Defence Research Board of Canada,* 127.
[186] NACP, RG330 Entry 341 Box 424 File 215, "Memorandum from Melvin Bell to Executive Director, Committee on Ordnance regarding CJS letter to Mr Whitman of 16 June 1953, 3 July 1953," and "Memorandum from Melvin Bell (Panel Director, Committee on Ordnance) to Chairman, RDB regarding Project Heller, 19 June 1953."

trials. The Minister of National Defence, Douglas Harkness, and Chairman of the Defence Research Board, Hartley Zimmerman, did their best to sell the Heller to the British Minister of Defence, Harold Watkinson, even promising that minor adjustments could be made that would certainly allow the Heller to outperform the Swedish weapon. The British, sceptical of Canada's balance of trade problems with both the United Kingdom and the United States, remained unmoved.[187]

A third and final example of a project undertaken by CARDE, in conjunction with the Consolidated Mining and Smelting Company (long known by its acronym COMINCO) of Trail, British Columbia, was improving the production of picrite. Picrite, also known as nitroguanidine, began to be used extensively in propellants for navies during the Second World War. It is ideal for heavy fire situations because picrite allows gunpowder to burn cooler, which reduces both wear and fouling inside gun barrels; it does not flash, nor does it increase the amount of smoke associated with firing.[188]

Throughout the Second World War a government-owned facility, Welland Chemical Works, Ltd., in Welland, Ontario was the only producer of picrite in the world. Because of the effectiveness of picrite-based munitions, the Board expected demand for picrite to rise in the next war. During the Second World War the Welland facility was using 6500kW to produce a ton of picrite and it could produce 700 tons per week. Estimates for the combined use of the tripartite allies in the next war started at a low of 9000 tons of picrite each month and increased significantly from there; Ontario was not producing enough electricity at the time to allow that much consumption by a single plant, which was purchased after the war by North American Cyanamid, Ltd. The only feasible solution was to search for a less power intensive production

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[187] TNA, DEFE 7/1357 "Defence Research Policy Committee – Research and Development in Canada, Part III," "Discussions with Mr Harkness, Canadian Minister of National Defence, 31 October 1960. Note for the United Kingdom Minister of Defence," 1-5, "Brief for Minister for his Visit on Canadian Equipment Proposed for Adoption by the UK, undated," 1, "Record of Meeting between the Rt Hon Harold Watkinson, MP, United Kingdom Minister of Defence, and the Hon Douglas Harkness, MP, Canadian Minister of National Defence, in Ottawa on Saturday, 18th March, 1961," 5-6.

[188] LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43-1 Vol 4, "Memorandum from AW Duguid (Research Coordination (Armament)) to VDG and Sec/DRB regarding Picrite, 12 October 1950."

method and to apply the limited amounts of picrite-based propellants where they were most useful.[189]

The Canadian Army requested that the Defence Research Board begin looking for a more efficient production process in August 1948. By the time of the special meeting of the Board to discuss the research program of Canadian Armaments Research and Development Establishment on 26 September, picrite research results were already on the agenda. What CARDE discovered in their preliminary research was that a process involving natural gas, which was plentiful in Canada's West, would be the most efficient.[190]

By April of 1949 the Defence Research Board had brought Consolidated Mining (COMINCO) into the research collaboration with a $15,000 contract, the first industrial contract awarded by the Board. COMINCO's early research from December 1949 suggested that their process would be about 70% effective, which they were able to boost to 90% in April 1950 after an additional input of $3,000 from the DRB. Funding for a pilot plant was setup immediately ($50,000), and the DRB and COMINCO negotiated funding for full scale production of $300,000 to cover the period from 1950 to 1952, plus ongoing funding for research. The advantage for COMINCO, and to a lesser extent the DRB, was that picrite had applications in plastics (melamine), as well as ammunitions.[191]

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[189] LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43-1 Vol 4, "Memorandum from AW Duguid (Research Coordination (Armament)) to VDG and Sec/DRB regarding Picrite, 12 October 1950;" LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43-1, "Attachment to Chairman's Agenda for the Fifteenth Meeting of the Defence Research Board regarding Picrite (Avon) Production, 8 June 1950;" LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 4, "Minutes of the Fifteenth Meeting of the Defence Research Board held at Trenton, 9-10 June 1950," 7-8 and Annexure Q "Memorandum to DRB regarding Research on Picrite Production Processes."

[190] LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43-1 Vol 4, "Attachment to Chairman's Agenda for the Fifteenth Meeting of the Defence Research Board regarding Picrite (Avon) Production, 8 June 1950;" LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Report of a Special Meeting of the DRB Held at 2:30pm, September 26th, 1948, in Quebec City to Discuss the Programme and Future Development of the CARDE at Valcartier," 3; Goodspeed, *A History of the Defence Research Board of Canada,* 123-124.

[191] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 4, "Minutes of the Fifteenth Meeting of the Defence Research Board held at Trenton, 9-10 June 1950," 7-8 and Annexure Q "Memorandum to DRB regarding Research on Picrite Production Processes," and "Minutes of the 17th Meeting of the Defence Research Board held at Ottawa, Ontario and Fort Churchill, Manitoba, 6-9 December 1950," 1; LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43-1 Vol 4, "Memorandum from AW Duguid (Research Coordination (Armament)) to VDG and Sec/DRB regarding Picrite, 12 October 1950," and "Attachment to Chairman's Agenda for the Fifteenth Meeting of the Defence Research Board regarding Picrite (Avon) Production, 8 June 1950;" Goodspeed, *A History of the Defence Research Board of Canada,* 124.

From 1947 to 1950 Suffield Experimental Station (SES) continued working on chemical weapons. At the time that Goodspeed wrote his history of the Defence Research Board most of that work was still classified, but some of the materials have been declassified in the meantime, largely thanks to journalist and Member of Parliament John Bryden. Throughout the war Canada stockpiled mustard gas to test (both the gas and the defences against it) and to use in retaliation of any chemical attack by Germany or Japan. The Defence Research Board's interest after the war was primarily in developing defences against the nerve agents developed by the Germans – GA (Tabun), GB (Sarin) and GD (Soman). Post-war testing at Suffield revealed that the G series were more toxic and acted faster, even when delivered in lower concentrations, than phosgene and mustard gas.[192]

The preliminary tests of the G series conducted at Suffield required discussion by the Board. It was obvious to Otto Maass that the existing standard against leaks had to be improved by a factor of about 100, ideally obtaining a completely leak-proof mask; he detailed several other flaws with the current mask such as comfort and usability. Foulkes wanted the DRB to invest its effort into a mask that could be worn full time by fighting men, rather than a mask that was completely leak-proof; he was also convinced that the DRB's research into an Arctic-use mask was going to be fruitless. Grant wanted perfect protection, which reflected the different operational environments in which the Army and Navy expected to use gas masks; the matter was put off until Maass and the Chemical Warfare Research Panel could investigate the matter and report to the Board. Maass attended a tripartite conference in the United Kingdom and missed the Twelfth Meeting of the Board, so the report waited until the Thirteenth Meeting held at the University of Toronto, 1 December 1949. The Board agreed to focus on Arctic respirators based on Maass' memorandum and his claim that it is difficult to compare by quantification comfort, durability and effectiveness.[193]

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[192] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2, "Minutes of the Thirteenth Meeting of the Defence Research Board held at the University of Toronto, 1 December 1949," Annexure K "Memorandum from Maass (Army HQ) to Sec/DRB regarding Respirators, 16 November 1949," Appendix A, 1; Goodspeed, *A History of the Defence Research Board of Canada,* 150; Bryden, *Deadly Allies*, 180-181.

[193] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2, "Minutes of the Thirteenth Meeting of the Defence Research Board held at the University of Toronto, 1 December 1949," 1-2 and Annexure K "Memorandum from Maass (Army HQ) to Sec/DRB regarding Respirators, 16 November 1949," Appendix A; "Minutes of the Eleventh Meeting of the Defence Research Board held at Halifax, 12 June 1949," 4-5; "Minutes of the Twelfth Meeting of the Defence Research Board held at Ottawa, 17 September 1949," 1.

The continuing responsibility for respirator assembly rested with the team in Ottawa at the Respirator Assembly Plant which was established in 1936. Originally it was a collaborative project run by the Army with scientific input from the National Research Council, but building respirators to British specifications. Throughout the Second World War the plant became more independent of British specifications and was assumed by the Chemical Warfare Laboratories, which provided the research input to improve design. In 1947 authority for the Respirator Assembly Plant, as part of the CWL, was transferred to the Defence Research Board. Starting in 1950 the DRB attempted to divest itself of the plant, feeling that production was not its responsibility, and that the plant would be better as part of Canadian Arsenals Limited or a private enterprise. Neither Canadian Arsenals Limited nor any private industries saw a profit in the limited production and reconditioning of respirators for Canada, especially in the face of changing biological and chemical threats that would require constant scientific research. Respirator assembly and research remained a Defence Research Board responsibility in spite of misgivings.[194]

Between the Chemical Warfare Laboratories in Ottawa, which was rechristened as the Defence Research Chemical Laboratories (DRCL) in late 1947 and the Suffield Experimental Station defence researchers explored the chemicals used in flame throwers and incendiary bombs as well as options in protective-clothing in addition to gas masks. Three of these projects were representative of the DRB's interests and the direction of defence research at the time. First, based on observations that wolverine fur exhibits ideal hydrophobic properties, scientists worked with industry to develop nylon pile fabric to replace traditional coats in the Arctic. A second project was developing a thickening agent for flame thrower fuel; Harry Sheffer led a team that developed octal, which was a stable and reliable silica. To deliver this new and improved fuel from tanks the team at Suffield worked on a flamethrower, the Iroquois.[195]

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[194] LAC, RG 24 A 1983-84/167 S F1 Vol 7327 File DRBC 100-21/0 Part 1, "Memo from Colonel DA Kellough (DEE) to DQMC (EE), Brig DAG Waldock, regarding Assembly, Reconditioning, Product Improvement, Canister Filling and Testing, Mask Protective NBCW; Canadian Arsenals Ltd. Participation, 24 October 1962," 1-2; Jim Norman, "DREO," 3-4, Miles Benson, "Prologue – The Pre-WWII Years and NRC," 15-16, Miles Benson, "The War Years," 17-21, Jim Norman, "Postwar – DRB, DRCL, and the Move to Shirleys Bay," 23, and Jim Norman, "Overview," 27 all in Norman and Crow, *A History of the Defence Research Establishment Ottawa*; Board, *A Brief History of the Defence Research Establishment Ottawa*, 3-4.

[195] Norman, "DREO," 4, and "Programs Once Part of the Chemical Warfare Effort," 101-102 both in Norman and Crow, *A History of the Defence Research Establishment Ottawa*; Board, *A Brief History of the Defence Research Establishment Ottawa*, 11, 14; Goodspeed, *A History of the Defence Research Board of Canada,* 142-143, 150.

Closely related to the work in defences against chemical threats was the research in defences against biological weapons. Guilford Reed in Kingston continued to work with biological and bacteriological agents from 1945 to 1947. The Grosse Île establishment (War Disease Control Station) was suspended in 1946, but authority to use the site was given to the Defence Research Board in 1947. After the war there was a shortage of specialists in the specific areas needed by the Kingston Laboratory so the professional staff working under Reed, who was still teaching at Queen's University, was minimal. Reed continued to work on fundamental studies of the types of diseases and viruses that were likely to affect humans and ways to manufacture vaccines and toxoids.[196]

In 1950 a Bacteriological Warfare Review Committee was formed under the chairmanship of Charles Best; after a short study this Committee decided that Canada was experiencing a drastic shortage of medical bacteriologists that extended beyond the needs of defence to all civilian requirements as well. The Defence Research Board sought to offer financial aid, post-doctoral support and employment to anyone who could be persuaded to pursue a career as a bacteriologist. The plan yielded a few candidates in its first year, but does not appear to have had a long-term presence in the DRB's funding or priorities. The Defence Research Board preferred to work in fields where they could draw on uniquely Canadian expertise or on problems with the potential for unique Canadian application.[197]

The Radio Propagation Laboratory (RPL) arose from the wartime Canadian Signals Research and Development Establishment. RPL was based in Ottawa but had field stations across northern Canada; scientists with RPL investigated the behaviour of radio waves in the Canadian Arctic, in particular the fluctuating electromagnetic properties of the ionosphere. The research began in the Second World War and its continuation was encouraged by Solandt and by United States' Department of State, Armed Forces and Bureau of Standards. It was a unique scientific situation that only Canada, or someone operating on Canadian soil, could investigate

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[196] Goodspeed, *A History of the Defence Research Board of Canada,* 153, 156.
[197] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 3, "Minutes of the Fourteenth Meeting of the Defence Research Board held at Ottawa, 20 March 1950," 8; LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 4, "Minutes of the 17th Meeting of the Defence Research Board held at Ottawa and Fort Churchill, 6-9 December 1950," 7-8, Annexure O "Memorandum from Best (Chair of BW Review Committee) and Doupe, Farquharson, Maass, Smith, Billingsley (sec) to CDRB regarding Introductory Review, No Date; LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43-1 Vol 4, "Attachment to Chairman's Agenda for the 17th Meeting of the Defence Research Board;" Goodspeed, *A History of the Defence Research Board of Canada,* 153, 156-157.

for the Western allies. Sensitivity to protecting Canadian sovereignty in the Arctic that arose in the wake of the Northwest Staging Route demanded that Canadians, rather than Americans, should be the ones investigating the properties of the ionosphere in Northern Canada.[198]

The Naval Research Establishment (NRE) in Halifax worked on the most pressing problems for the Royal Canadian Navy. The transfer from the Navy to the Defence Research Board started in the calendar year 1948 and was fluid in terms of research initiatives and personnel. From Victory in Europe Day (8 May 1945) until October 1947 the staff at NRE was aided in their research of anti-submarine warfare by the use of two surrendered German submarines, U-190 and U-889, including acoustic towed array and acoustic torpedoes.[199]

The interest in the propagation of sound underwater continued after October 1947 with trials on sonar equipment (Sound Navigation and Ranging, formerly known as ASDIC), including a new invention – variable depth sonar. One thing that scientists at the Naval Research Establishment discovered in these early years was that sound propagates underwater differently depending on the frequency of the sound, the depth of the water, the temperature of the water (which also varies with depth), the currents and flow of the water and of course the depth and motion of both the target and the tracker. This was the type of basic scientific information that would be invaluable to the military as well as the advancement of oceanography.[200]

Many of these projects undertaken by the DRB in the first three years were geared towards improving basic and applied scientific knowledge. The Defence Research Board also undertook several projects on the development end of the research and development spectrum. The goal of these projects was to build a valuable weapon, while also learning about all the important sciences and technologies that were necessary for the production. The NRE worked on two projects that were on the development end of the spectrum.

The first project was retrofitting existing vessels. That metals corrode (rust) is a long established fact; that naval vessels exposed to saltwater and underwater organisms are particularly prone to oxidization has plagued the Royal Navy since they introduced protective

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[198] Jones-Imhotep, "Nature, Technology, and Nation," 8-19; Goodspeed, *A History of the Defence Research Board of Canada,* 191, 194.
[199] Longard, *Knots, Volts and Decibels*, 35-39.
[200] Longard, *Knots, Volts and Decibels*, 57-60; Gaede and Merklinger, *Seas, Ships and Sensors*, 12.

copper plates. Starting in 1946 the NRE was in a fortuitous position to make dry dock observations of corrosion over time and to devise a method to prevent hull oxidization. By turning the ship hulls into electric circuits with a cathode (the hull) and specially attached anodes (generally made of magnesium), the corrosion resulting from the saltwater could be concentrated on the magnesium anodes which were cheaper and easier to replace. After initial work by the Defence Research Board, during which the basic and applied scientific knowledge was established, the Royal Canadian Navy began retrofitting its existing vessels and incorporating the technique into new vessels. The knowledge was also declassified and shared with other countries and industries.[201]

The second project was the development of a hydrofoil. A hydrofoil uses lift generated by forward motion to raise the hull of a ship out of the water, which reduces drag. The faster the ship goes, the higher it is raised from the water. The result is boats that can travel at a higher speed more economically than similar vessels that lack hydrofoils. The most common hydrofoil design is an arrangement of two or more submerged pontoons attached to the hull. The Canadian versions used three hydrofoils, and those foils looked like ladders attached to the hull.

Canadian interest in hydrofoils started prior to the First World War; inventor and sometimes Canadian Alexander Graham Bell, along with F.W. Baldwin, experimented with hydrofoil designs at Bell's summer home overlooking Bras d'Or Lake in Nova Scotia. Canadian military interest in hydrofoils started in the Second World War when then Major General George Pearkes discussed the requirement of a smoke-laying vessel to cover an amphibious assault with E.Ll. Davies. The Defence Research Board relied on the efforts of several men who had been involved in the production of four hydrofoil craft in the Second World War, including an American designer, Philip Rhodes; Rhodes designed a new hydrofoil craft for the DRB in 1947, and it was built by J.E. McCrea, the Robert Mitchell Company Limited and Ingersoll Machine and Tool Company.[202]

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[201] Goodspeed, *A History of the Defence Research Board of Canada,* 217-218; Longard, *Knots, Volts and Decibels*, 41-47, 57.
[202] Goodspeed, *A History of the Defence Research Board of Canada,* 220-221; Longard, *Knots, Volts and Decibels*, 85.

The Naval Research Establishment did not get involved in the project until the craft, known as the *Massawippi*, R-100 or KC-B, was tested on Lake Massawippi in the Eastern Townships of Québec; the timeline of NRE involvement was unusual for the Defence Research Board that normally pushed projects to development and then scaled back its participation. Over the next five years NRE scientists ran trials with the craft both on Lake Massawippi and later in the Atlantic Ocean from Halifax; a replacement was built by the British company, Saunders-Roe Limited, in 1957 according to Naval Research Establishment specifications. The hydrofoil project is one example of close collaboration between industry and the DRB.[203]

In addition to the new projects at existing establishments the Defence Research Board also created four new establishments between 1947 and 1950. The first new establishment was started in 1947 in Fort Churchill, Manitoba. The Defence Research Northern Laboratory (DRNL) was created to meet the DRB's contribution to tripartite defence research. The first winter only one employee was in Churchill, James Croal who was a veteran of the Royal Canadian Navy; Croal looked at ice core samples and made other preparations for the creation of a more permanent facility the following year. Once formally established in 1948, and with a laboratory building contributed by the Canadian Army who ran Fort Churchill, the staff at DRNL investigated cold survival, equipment and clothing for northern climates, and mosquitoes. The projects were largely focussed on human physiology – the response of soldiers under the duress of either the cold in the winter (scientists at DRNL invented the wind chill factor) or the mosquitoes in the summer. A report covering the history of DRNL compiled by Superintendent Archie Pennie illustrated the one thing that nearly everyone stationed at Churchill learned in their free time – alcohol is the key to surviving the remoteness and boredom. Although symbolically important to the DRB's program, the DRNL was never a major part of that research program in terms of funding or personnel.[204]

Within three years the research program at Defence Research Northern Laboratory was either exhausted or superseded. The British, and presumably the Americans, began working with

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[203] Goodspeed, *A History of the Defence Research Board of Canada,* 220-221; Longard, *Knots, Volts and Decibels*, 85.

[204] LAC, MG 31 G 34 Vol 1 File 1 "Biographical / Personal Documents – Biographical and personal information, resumés, etc, nd, 1976," "Biographical Sketch;" Goodspeed, *A History of the Defence Research Board of Canada,* 177-184; Pennie, *Defence Research Northern Laboratory 1947-1965*, 5, 31-35, 41-42, 51, 60, 62, 77.

climate controlled chambers, because advances in refrigeration and air conditioning had made it possible to replicate the extreme cold of a Churchill winter in a laboratory at a lower cost. A climate chamber was also more predictable and could be run year round. These advances in science and technology chipped away at the Defence Research Board's ability to make a unique contribution to tripartite defence research.[205]

The second new establishment was created to give the Defence Research Board geographic balance. The Pacific Naval Laboratory (PNL) was devoted to generic naval questions not being handled at NRE as well as research problems specific to the Pacific Ocean. Frederick Sanders was recruited to be its first Superintendent.[206]

The first project that Sanders and his small team undertook at PNL was looking at how sonar equipment behaved in the Pacific Ocean. The new laboratory was located on the naval base in Victoria on Vancouver Island in 1948. The advantages of the Victoria location over Halifax were both climate and geography. Victoria is generally more temperate than Halifax, and it has the added benefit of being sheltered to the north by islands, sounds and straits, while still having access to ice floes and the Arctic Ocean.[207]

The third new establishment was created at the beginning of 1949. For its first eight months it was known as the Operational Research Division, before being renamed as the Operational Research Group (ORG). Whitman Morton, who was already working for the Defence Research Board on psychology problems, was placed in charge of the ORG when it was created. Psychological research went with Morton to the ORG from the Biological Research Division.[208]

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[205] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 5, "Minutes of the 20th Meeting of the Defence Research Board held at Valcartier, 29 September 1951," 2; LAC, RG 24 A 1983-84/167 S F1 Vol 7407 File 173-1 Vol 2 "Committee, Defence Research, General," "Memo for 29 November 1963 Board Meeting from Office of the CDRB regarding Future of Defence Research Northern Laboratory, 15 November 1963," 1.
[206] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Minutes of the Seventh Meeting of the Defence Research Board held at Suffield, Alberta, 20-21 June 1948," 3; Chapman, *Alpha and Omega*, 3.
[207] Chapman, *Alpha and Omega*, 3-4.
[208] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 3, "Minutes of the Ninth Meeting of the Defence Research Board held at Ottawa, 20 December 1948," 9; N.W. Morton, "A Brief History of the Development of Canadian Military Operational Research," *Operations Research*, 4, No. 2 (April 1956), 187-192; Goodspeed, *A History of the Defence Research Board of Canada,* 168; Mayne, *The Origins and Development of Operational Research in Canada*, 71.

Operational researchers during the war had frequently been integrated with military units. The laboratories for most operational researchers were battlefields, so it was logical to have them in uniforms. By the end of the war the military leadership saw the value of operational research in wartime. After the war operational research was dismantled in Canada, since its utility in peace was not apparent nor was the direction of Canadian defence entirely evident; the scientists who had participated returned to their academic careers.

When the Operational Research Group was created, its members were integrated with the military, and responsible to military commanders, but paid by the Defence Research Board. A small contingent of operational researchers responsible for inter-service problems and for operational research questions that arose within the DRB were housed at headquarters in Ottawa.[209]

Canada faced two basic long-distance threats in any future hostilities, especially any war involving Russia: submarines and bombers. The Operational Research Group, as part of the Department of National Defence, had to work through the ramifications of the two evolving threats and the new defences intended against those threats. In 1949 submarines were the more immediate threat since the Russians did not have intercontinental heavy bombers. John Abrams was loaned to the British Admiralty to work on problems associated with anti-submarine warfare. When he returned to Canada and the Defence Research Board he continued to work on both anti-submarine warfare and air defence. Abrams was one of only a handful of operational researchers that the Defence Research Board was able to convince to leave university and return to defence research permanently. It took several years to build up strength in ORG.[210]

The fourth and final new establishment was the Defence Research Medical Laboratories (DRML) in Toronto. The most active medical research in the Second World War in Canada was conducted at the Royal Canadian Air Force's Institute of Aviation Medicine (IAM). This was where Wilbur Franks, a former student of Frederick Banting's, invented and tested the anti-g

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[209] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 3, "Minutes of the Ninth Meeting of the Defence Research Board held at Ottawa, 20 December 1948," 9; N.W. Morton, "A Brief History," 187-192; Goodspeed, *A History of the Defence Research Board of Canada,* 168; Mayne, *The Origins and Development of Operational Research in Canada*, 71.

[210] DHH Col 2003/32 (Box 1) File 49, "Operational Research Memorandum 11 by JW Abrams regarding Present and Prospective State of Anti-Submarine Warfare, April 1951," v.

flying suit using a human centrifuge. After the war the RCAF continued a research and development program at IAM.[211]

3.7.2 Extramural Research

It was not until 1948 that the Board began to consider its policy for medical research. First Solandt had an informal meeting with Charles Best and James Bertram Collip on 6 March 1948. At the time Collip was the Director of the National Research Council's Medical Research Division; Collip and Best had previously collaborated on the discovery of insulin with Banting and John J.R. Macleod in 1921. Later in 1948 Best and Collip, on behalf of the Board and NRC respectively, attended the first meeting of the DRB's Medical Research Advisory Committee; the Committee was chaired by Toronto's Ray Farquharson. The Medical Research Advisory Committee included medical research representatives from the three Services, National Health and Welfare (H.A. Ansley), the Department of Veterans' Affairs (D.H. Starkey), the Directing Consultant from IAM (Wilbur Franks), five members from universities (George Lyman Duff of McGill, Joseph Doupe of the University of Manitoba, Guilford Reed of Queen's University, Louis-Paul Dugal of Université Laval and A. Lawrence Chute of the University of Toronto and the Hospital for Sick Children), plus a secretary from the Defence Research Board's fledgling medical research staff (Morley Whillans). This distinguished team laid out the direction of the DRB's policy for defence medical research.[212]

The first initiative was for the Defence Research Board to finally take over responsibility for medical research from the Services, primarily the Institute of Aviation Medicine. Franks, with the backing of the Chief of Air Staff Curtis, ran as much interference as possible to protect the unique interests and needs of the Royal Canadian Air Force. It took two years for Solandt with the assistance of Farquharson to work out what elements of IAM would be absorbed by the DRB (primarily triservices research) and what elements would stay with Franks under RCAF

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[211] Defence Research and Development Canada – Toronto (DRDC-T), Franks Drawer 9 File "Curriculum Vitae 1;" Brooks and Landolt, "Medical Military R&D During World War II," 116-117 and Rawling, "Applying our Expertise," 128-133 both in Lindsey, *No Day Long Enough*; Eggleston, *Scientists at War*, 219-221; Goodspeed, *A History of the Defence Research Board of Canada,*233-240.

[212] LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43-1 Vol 2, "Agenda No 5.6 (Medical Research Advisory Committee), Defence Research Board from MacNeill, 22 September 1948; Goodspeed, *A History of the Defence Research Board of Canada,* 227-228; Terence Moore, *Joe Doupe, Bedside Physiologist* (Toronto: Hannah Institute, 1989); Alison I-Syin Li, *J.B. Collip and the Development of Medical Research in Canada* (Montréal: McGill-Queen's UP, 2003).

control (primarily development and aviation medicine). Morley Whillans became the first Superintendent of the Defence Research Medical Laboratories and moved from Ottawa to Toronto to initiate research in 1950.[213]

The second policy initiative was to distinguish what work should be done by the Defence Research Board and what could be left to researchers at hospitals and universities. The DRB was primarily interested in problems affecting Service personnel. Problems of diagnosis and treatment, because of their broader applicability, were delegated to researchers at hospitals and universities. The unique occupational problems of the Services included training, response to environment and hazards, efficiency, protective clothing, food and equipment. Some of these problems overlapped with the research agendas of the Defence Research Northern Laboratory and the biological and chemical warfare initiatives.[214]

Where medical research undertaken at universities and hospitals had an overlapping interest for the Services the Defence Research Board agreed to supply funding through grants. One area that received heavy interest initially was studies of the medical aspects of cold on physiology. G. Malcolm Brown of Queen's University received a grant for studies of Eskimos; Louis-Paul Dugal won a grant for "physiological factors involved in resistance and adaptation to cold environments." Another grant appears, at first, to follow in this line of research interest, Wilfred Bigelow was awarded a grant for the study of "factors affecting survival and resuscitation from severe cold." It was the first in a series of grants Bigelow received for research into hypothermia and resuscitation. Ultimately that work had little application to Arctic warfare, but it did result in the development of open heart surgery and the pacemaker.[215]

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[213] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 3, "Minutes of the Twelfth Meeting of the Defence Research Board held at Ottawa, 17 September 1949," 6, "Minutes of the Thirteenth Meeting of the Defence Research Board held at the University of Toronto, 1 December 1949," 5, "Minutes of the Fourteenth Meeting of the Defence Research Board held at Ottawa, 20 March 1950," 4; LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 4, "Minutes of the Fifteenth Meeting of the Defence Research Board heldt at Trenton, 9-10 June 1950," 6; DRDC-T, Franks Drawer 9 File "Correspondence, W/C WR Franks, 1 May 49 to," "Letter from Franks to Curtis, 5 January 1950;" Goodspeed, *A History of the Defence Research Board of Canada,* 231.

[214] Goodspeed, *A History of the Defence Research Board of Canada,* 232-233.

[215] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2, "Minutes of the Fourteenth Meeting of the Defence Research Board held at Ottawa, 20 March 1950," Annexure L "Minutes of the Tenth Meeting of the Standing Committee On Extramural Research of the Defence Research Board held at National Defence Headquarters, Sunday, 19 March 1950," Appendix A; W.G. Bigelow, J.C. Callaghan and John A. Hopps, *Radio-Frequency Rewarming in Resuscitation from Severe Hypothermia* (Ottawa: Defence Research Board, 1952); W.G. Bigelow, *Cold Hearts: The Story of Hypothermia and the Pacemaker in Heart Surgery* (Toronto, Ont.: McClelland and Stewart, 1984).

Bigelow's work was one of many examples that the Defence Research Board could point to as proof that their early funding priorities were having a global impact on the health of people. Not everything the DRB funded was as auspicious or beneficent.

Amidst the Arctic medical research was a grant to D. Ewen Cameron of McGill for "behavioural problems in the adaptation of white men to the Arctic." Cameron also had an ongoing grant from the DRB for work looking at community responses to disasters, which had the endorsement of Morton and the Psychological Research Panel, as well as Solandt and the Board (contrary to Solandt's later reckoning), but was resisted by the Minister of National Defence. Cameron was assisted in the project by James Tyhurst, and the line of research was similar to that being undertaken by their McGill colleague Donald Hebb who served on the Board's Psychological Research Panel. The three men were interested in depatterning, also known as mind control or more popularly as brainwashing. In 1951 Cameron was removed from his project on community disasters and Tyhurst was given a limited amount of funding to complete it before being offered employment by the DRB. Forty years later both Cameron and Tyhurst were the subjects of court proceedings; Cameron's former patients at the Allan Memorial Institute sued the Canadian government and the Central Intelligence Agency for what amounted to torture without informed consent (Cameron died in 1967, long before the proceedings), and Tyhurst was convicted of assault and sexual assault for incidents with patients later in his career.[216]

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[216] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Minutes of the Third Meeting of the Standing Committee on Extramural Research held at Suffield, Saturday, 20 June 1948," 1 and "Minutes of the Eighth Meeting of the Defence Research Board held at Valcartier, 26-27 September 1948," 1-2; LAC, RG 24 S F1 Vole 11995 File DRBS 1-0-43-1 Vol 2, "Memorandum from MacNeill to the Defence Research Board regarding Business Arising from the Minutes of the Seventh Meeting, Reconsideration of DRB Grant No 65 – Minute 3.1 (includes comments from N.W. Morton), 8 September 1948;" LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 3, "Minutes of the Eleventh Meeting of the Defence Research Board held at Halifax, 12 June 1949," 2 and "Minutes of the Fourteenth Meeting of the Defence Research Board held at Ottawa, 20 March 1950," Annexure L "Minutes of the Tenth Meeting of the Standing Committee On Extramural Research of the Defence Research Board held at National Defence Headquarters, Sunday, 19 March 1950," Appendix A; LAC RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 4, "Minutes of the Sixteenth Meeting of the Defence Research Board held at Ottawa and Chalk River, 16-17 October 1950," 7, "Minutes of the Thirteenth Meeting of the Standing Committee on Extramural Research of the Defence Research Board held aboard RCAF Aircraft No 977 en route to Winnipeg from Ottawa, 5pm, Wednesday, 6 December 1950," 2 and "Minutes of the Fourteenth Meeting of the Standing Committee on Extramural Research of the Defence Research Board held at National Defence Headquarters, Friday, 9 March 1951," 2; LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 5, "Minutes of the 20th Meeting of the Defence Research Board held at Valcartier, 29 September 1951," 4; LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43-1 Vol 4, "Agenda Item 3.4 for the 20th Meeting of the Defence Research Board, List of Reports Issued During the Last Quarter;" LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 5, "Minutes of the 18th Meeting of the Standing

The Defence Research Board awarded grants to supplement all areas of its research program, not just medical research. The DRB was not the first government division to ask universities or hospitals to conduct research towards the government's program. Nor was the DRB the first division to award grants for research conducted outside of the government. The National Research Council had been awarding grants and scholarships since its inception in the First World War. The NRC was merely copying the policies and process of the Department of Scientific and Industrial Research (DSIR) in the United Kingdom. In his overview of the DSIR Sir Harry Melville reviews "two early objectives of DSIR – to assure an adequate supply of properly trained research workers, and to support and extend research in pure science."[217] These same justifications applied to the NRC and the DRB.

Originally conceived at the Fifth Meeting of the Board, 15 December 1947, the Standing Committee on Extramural Research was formed in 1948. For its first three meetings it was known as the Standing Committee on Extra-Mural Grants. At the first meeting Solandt acted as chairman and the meeting was attended by Best, Gagnon, Johnstone, Maass and Shrum, all the academic members of the Board. The overlap of membership in the Board, the Selection Committee and the Standing Committee on Extramural Research both unified and concentrated the Defence Research Board's policy and planning in the early years. The constitution of the Standing Committee formalized the membership: the Chairman of the Defence Research Board and all the academic representatives were obliged to participate in the Standing Committee.

Committee on Extramural Research of the Defence Research Board held at National Defence Headquarters, Saturday, 15 March 1952," Appendix B "List of Research Contracts;" LAC, RG 24 S F1 Vol 11997 File DRBS 1-0-43-2 Vol 7, "Summary of Grants-in-Aid Programme 1954-55 Including Recommendations for Existing and Proposed New Grants,11 February 1954," "Human Resources Research;" George T.H. Cooper, *Opinion of George Cooper, Q.C., regarding Canadian Government Funding of the Allan Memorial Institute in the 1950's and 1960's* (Ottawa: Dept. of Justice, 1986); Don Gillmor, *I Swear by Apollo: Dr. Ewen Cameron and the CIA-Brainwashing Experiments* (Montréal: Eden Press, 1987); Harvey Weinstein, *A Father, a Son and the CIA* (Toronto: J. Lorimer, 1988); Christopher Hyde, *Abuse of Trust: The Career of Dr. James Tyhurst* (Vancouver: Douglas & McIntyre, 1991); Anne Collins, *In the Sleep Room: The Story of the CIA Brainwashing Experiments in Canada* (Toronto: Key Porter Books, 1997); Hebb only worked with patients who were informed and consented to sensory deprivation work, and he pleaded with the Morton for permission to speak about the results of his research contract at conferences: http://www.scribd.com/doc/56995549/Letters-Between-Donald-Hebb-and-the-Canadian-Defence-Research-Board-1952-1953, accessed 21 January 2012.

[217] Melville, *The Department of Scientific and Industrial Research*, 62.

Since the meetings of the Standing Committee were always scheduled to coincide with Board meetings, any other Board members could attend if they wanted.[218]

Although the academic breadth of the Standing Committee was impressive, it could hardly be expected to judge the merits of the diverse applications it received. This was especially true given the volume of applications received and the potential fluidity of the composition of the Standing Committee. To ensure that the Standing Committee, the Selection Committee and the Board had sound advice on all scientific, medical and engineering matters of pertinence to the DRB they relied on the advisory committee structure. This structure was, of course, borrowed from the National Research Council, the Department of Scientific and Industrial Research and the military.

One example which has already been addressed briefly was the Medical Research Advisory Committee. It was the last major advisory committee to be organized. There were committees for every significant research area in which the Defence Research Board had interests, and the main committees were supported by subcommittees and panels in the most active subareas of research. Other committees struck in 1947 and 1948 included the Electronics Advisory Committee, the Special Weapons Advisory Committee, the Arctic Research Advisory Committee, the Clothing and Equipment Advisory Committee, the Guided Missile Advisory Committee, the Civil Defence Advisory Committee, the Canadian Radio Wave Propagation Committee and the Armament Advisory Committee. The men chosen as representatives were mostly academics, except where there was a nascent Canadian industrial ability, which at the time was limited mostly to electronics.[219]

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[218] LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43-1 Vol 1, "Note regarding Defence Research in the Universities, 5 December 1947," and "Memorandum from Solandt to the Defence Research Board regarding Principles Governing Extra Mural Grants, 13 December 1947;" LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Minutes of the Sixth Meeting of the Defence Research Board held at 10:30am, Friday, 19 March 1948," 3-7, Annexure V "Standing Committee on Extra-Mural Grants Constitution," Annexure W "Financial Policy – Extra-Mural Research Recommended by the Standing Committee on Extra-Mural Grants of the DRB," Annexure X "DRB Policy regarding Payment of Salaries from Extra-Mural Grants," Annexure Y "Application for a Grant for Research," and "Minutes of the Eighth Meeting of the Defence Research Board held at Valcartier, 26-27 September 1948," 6.

[219] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 1, "Minutes of the First Meeting of the Defence Research Board held at 2:30PM Wednesday, 16 April 1947," 8-9; LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43-1 Vol 2, "Memorandum from Vice Chairman of the Defence Research Board to the Chairman regarding Proposed New Organization of Advisory Committees and Panels, 17 February 1948," Appendix A "Present Advisory Committees and Sub-Committees and Panels," and Appendix B "List of Recommended Advisory Committees and Their Panel Representation."

These committees and panels arose in a basically *ad hoc* manner. As the Defence Research Board learned that the Services had significant requirements in a certain discipline an advisory committee was erected. As the advisory committee began to wade through the applications for grants and the general requirements of the military and the DRB and realised that it had to devote a substantial portion of its resources to a more narrowly defined speciality, then a panel was proposed to deal with a subset of the advisory committee's responsibility. The result, according to Goodspeed, was a criticism of the Board for devising committees and panels with overlapping responsibilities.[220]

For instance there were four different chemical panels, one each for Special Weapons, Arctic Research, Armaments, and Clothing and Equipment. Likewise there were multiple physical, entomological, physiological, psychological, and electronics panels. In 1951 the Board began to disband many of the advisory committees in favour of keeping only the research panels or forming ad hoc committees when they were necessary.[221]

Extramural research was an important part of the Defence Research Board's activity, and the guiding principles were laid out at the first meeting of the Standing Committee on Extramural Research. The Standing Committee listed thirteen regulations that would govern grants. Most of these regulations dealt with routine administration (reporting procedures, countersignatures and completion), but a few of the regulations were more interesting and problematic. Only in extreme circumstances could professors' salaries be paid out of grants; the money was intended for equipment and student research assistants. The salaries that were to be paid to these assistants were dictated by a strict scale that depended on degree completion and was identical to the National Research Council scales.[222]

Another problem in the making was the requirement that all work produced was claimed as property of the Defence Research Board and the Department of National Defence, as such any

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[220] Goodspeed, *A History of the Defence Research Board of Canada,* 79.
[221] LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43-1 Vol 2, "Memorandum from Vice Chairman of the Defence Research Board to the Chairman regarding Proposed New Organization of Advisory Committees and Panels, 17 February 1948," Appendix B "List of Recommended Advisory Committees and Their Panel Representation;" LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 4, "Minutes of the 18th Meeting of the Defence Research Board held at Ottawa, 10 March 1951," 10.
[222] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Minutes of the Sixth Meeting of the Defence Research Board held at 10:30am, Friday, 19 March 1948," 3, Annexure X "DRB Policy regarding Payment of Salaries from Extra-Mural Grants," and Annexure Y "Application for a Grant for Research," 5-6.

patents arising were the property of the federal government, rather than the researchers. Equipment purchased for the research was the property of the DRB unless the project was successfully completed, in which cases the equipment would become the property of the university. Presumably these regulations were identical to those of the National Research Council, but they were questioned by the industrial member of the Board, Dickson Harkness.[223]

The only regulation that differed from the National Research Council was the one governing what types of research would be sponsored. Because the NRC had a long-standing relationship with universities and funding projects, the Defence Research Board did not wish to duplicate this (it still happened). Projects of general scientific and industrial interest would be referred to the NRC. Research with unique defence interests or applications would be the only projects considered by the Standing Committee. At its first meeting the Standing Committee reviewed those projects currently being funded by the NRC that had a military aspect and decided which of those projects should receive continued support from the DRB, and which should be terminated.[224]

Starting at its first meeting, the Standing Committee began to consider new applications. Unsurprisingly these early grants went to the same university professors who had worked on wartime research for the National Research Council. Because of the full mobilization of the country in 1941 every scientist and engineer in the country capable of defence research was actively engaged in the war effort. When the Defence Research Board started awarding grants in 1948 the only applicants were necessarily veterans of the Second World War.

During the Second World War George Wright, who was an organic chemist at the University of Toronto, was the manager of the research program into RDX (Research Department Explosive). After the war he continued working on projects of defence interest for the National Research Council and then the Defence Research Board. His ongoing project that

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[223] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Minutes of the Sixth Meeting of the Defence Research Board held at 10:30am, Friday, 19 March 1948," Annexure Y "Application for a Grant for Research," 5-6, and "Memorandum from Barton to the Defence Research Board regarding Patent Provisions for Extra-Mural Grants, 13 May 1948."

[224] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Minutes of the Sixth Meeting of the Defence Research Board held at 10:30am, Friday, 19 March 1948," Annexure Y "Application for a Grant for Research," 5-6, Annexure Z "List of Proposed Grants from the First Meeting of the Standing Committee on Extra-Mural Grants;" Goodspeed, *A History of the Defence Research Board of Canada,* 98-102.

was originally funded by the NRC was on a "synthesis of new insecticides." His new project, and far more lucrative gleaning $7800 in its initial year compared to the $2000 renewal, was simply called "explosives research." At a time when faculty generally took summers off, Wright agreed and then backed out of spending the summer of 1947 working at the Canadian Armaments Research and Development Establishment. He was scheduled to make $500 a month in addition to travelling expenses. The granting procedure instituted in 1948 was more agreeable to Wright than actively working for the DRB.[225]

George Langstroth, unlike Wright, increased his participation in the Defence Research Board after the war. Langstroth graduated from Dalhousie University and then taught physics at the University of Alberta. During the war he collaborated closely with the Suffield Experimental Station. From 1945 to 1948 Langstroth was the head of the Department of Physics. In 1948 his grant that was initially approved at the first meeting of the Board in 1947 was renewed by the Standing Committee on Extramural Research at its second meeting. His project, DRB Grant 1, investigated "the ageing process in aerosols" and the renewal was for $1500. At the same meeting his new proposal for "the electrostatic properties of ice fogs" was granted $2500. In June he became the first and probably only grant recipient to leave academia for permanent employment with the DRB; he moved from the University of Alberta to SES where he became the Head of the Physics and Meteorology Section. In 1952 Langstroth became the Chief Superintendent at Suffield, a position he held for five years until he moved to the Naval Research Establishment as its Chief Superintendent.[226]

As with grant recipients, the only men that the Defence Research Board could recruit to be members of the Board or members of the advisory committees and panels that helped the Standing Committee on Extramural Research were veterans of the Second World War. This

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[225] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Minutes of the Sixth Meeting of the Defence Research Board held at 10:30am, Friday, 19 March 1948," Annexure Z "List of Proposed Grants from the First Meeting of the Standing Committee on Extra-Mural Grants;" LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 1, "Minutes of the First Meeting of the Defence Research Board held at 2:30PM, Wednesday, 16 April 1947," 7, and "Minutes of the Second Meeting of the Defence Research Board held at 1100 hrs, Wednesday, 14 May 1947," 2; Brook and McBryde, *Historical Distillates*, 105-106.

[226] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Minutes of the Sixth Meeting of the Defence Research Board held at 10:30am, Friday, 19 March 1948," Annexure AA "List of Proposed Grants from the Second Meeting of the Standing Committee on Extra-Mural Grants;" LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43, "Note from the Secretary of the Defence Research Board to all Board Members regarding Ballot on Hiring of Langstroth, Tarr and Rice, 14 May 1948," Attachment "Biographical Sketh: George Otty Langstroth;" G.O. Langstroth, "Recollections of SES in the Early Postwar Years," in *Suffield Experimental Station, 1941-1961*, 43.

resulted in a significant amount of overlap between applicants and reviewers. As an original member of the Medical Research Advisory Committee, and an eventual Board member, Louis-Paul Dugal received a grant for $5900 to investigate "physiological factors involved in resistance and adaptation to cold environments." Otto Maas received grants at the first meeting of the Standing Committee for "rheology of non-Newtonian liquids" and "adsorption by porous media with particular reference to charcoal." At the ninth meeting of the Standing Committee Gordon Shrum and a team of physicists from the University of British Columbia were awarded nearly $20,000 for "investigations of superconducting bolometers, [and] of the nature of the solid state at very low temperatures." The network of defence researchers, especially the competent ones, was so small in Canada in the late 1940s that this overlap of interests was inevitable.[227]

However, how the Board handled these conflicts of interest scenarios was a topic of discussion at its sixth meeting. Mackenzie raised a concern with how the decisions were recorded in the minutes. He had no complaint with the results of the decisions, just how those decisions were made and recorded. The problem, and the sixth meeting of the Board is perhaps the only exception, was that when a conflict of interest situation arose the minutes of the meetings do not indicate that the member with the conflict of interest excused himself from the discussion. There were at least a few times when the member with the conflict of interest did not leave the room, but more often than not it was simply the case that the minutes were not meticulous on these procedural points. That the Board lapsed into its former recording habits after the sixth meeting indicates that Mackenzie was the only one who saw the issue and foresaw the difficulties it would pose.[228]

Ordinarily the Defence Research Board followed whatever precedents were set by the National Research Council. The NRC's funding of grants was primarily for work done during

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[227] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Minutes of the Sixth Meeting of the Defence Research Board held at 10:30am, Friday, 19 March 1948," Annexure Z "List of Proposed Grants from the First Meeting of the Standing Committee on Extra-Mural Grants," and "Minutes of the Seventh Meeting of the Defence Research Board held at Suffield, 20-21 June 1948," Annexure A "Grants Already Given Out by Chair (some by poll some by referral from NRC), 10 May 1948" of Annexure J "Minutes of the Third Meeting of the Standing Committee on Extra-Mural Grants held at Suffield, Sunday, 20 June 1948;" LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 3, "Minutes of the Thirteenth Meeting of the Defence Research Board held at the University of Toronto, 1 December 1949," Annexure J "Minutes of the Ninth Meeting of the Standing Committee on Extramural Research of the Defence Research Board held at the University of Toronto, 30 November 1949," 2.

[228] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Minutes of the Sixth Meeting of the Defence Research Board held at 10:30am, Friday, 19 March 1948," 9.

the academic year (September to April). The summer was traditionally a down period for scientific research. The Second World War forced nearly universal exceptions and prior to that there were notable summer research projects (e.g. Collip's participation in the discovery of insulin), but after the war there was an attempt to return to the old norm.

In 1949 the Standing Committee on Extramural Research criticised this tradition and the NRC's support of it. Defence research came with a slightly different sense of urgency than normal scientific research, and losing summers (especially for seasonally dependent investigations) seemed to be a lost opportunity. The Standing Committee decided that if researchers were willing to devote their summers to projects, and could find students willing to work, then those students should be employed. The rates were not allowed to exceed what the DRB paid its summer students, nor what the funded university deemed appropriate. At the time the DRB (and the NRC) paid summer researchers finishing their third year of undergraduate honours studies $165 per month; the salaries were scaled all the way up to those who had completed a Ph.D., who made $250 per month.[229]

Funding of laboratories, year round or not, was part of Solandt's plan to increase the overall Canadian capacity for defence research. The Defence Research Board's funding was generally heaviest to the large research-intensive Canadian universities: McGill and Toronto. British Columbia, Western Ontario, Queen's, and Dalhousie formed the core of the second tier of funding. The single biggest grants the Defence Research Board awarded from 1947 to 1950 were for the creation of new university laboratories. Both McGill and Toronto received funding from the DRB for two new laboratories apiece. Queen's University already had a laboratory funded by the DRB for Guilford Reed, but this arrangement was unique. Reed's work was a continuation of his bacteriological research from the Second World War, and the only funding available for such research was from national defence because of the security and hazards involved. The four new laboratories created from DRB funds were less hazardous and worked on projects that had non-defence applications in addition to their defence interest.

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[229] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 3, "Minutes of the Tenth Meeting of the Defence Research Board held at Ottawa, 21 March 1949," Annexure K "Minutes of the Sixth Meeting of the Standing Committee on Extramural Research held at Ottawa, 19 March 1949," Appendix A "Memorandum from the Chairman of the Defence Research Board to the Standing Committee on Extramural Research regarding Salary Policy – Extra-Mural Grants, 28 February 1949."

The first of these four laboratories was part of a burgeoning physics program at McGill. John Foster had secured funding arrangements from the National Research Council and the United States Air Force to build and operate a cyclotron in 1946, the first in Canada and third in North America. To complement Foster's work in nuclear physics Cyril James, the long-time Principal of McGill, secured funding from philanthropist Lady Flora McCrae Eaton (the widow of Sir John Craig Eaton). Eaton's money was used for the construction of a building adjacent to Foster's cyclotron. It was to house electronics research, and Garnet Woonton was lured away from the University of Western Ontario to be its director.[230]

Woonton had ties to the DRB from its inception. Both he and Foster were members of the Electronics Advisory Committee starting in 1947. Woonton, while still at Western, was the recipient of a small $500 grant in 1947 for a "study of broadband absorption of EM waves." Over the following year, in anticipation of his move to the Eaton Electronics Laboratory, Woonton was awarded a $36,000 grant to acquire equipment for the new facility. In the first year he was unable to spend the entire allotment, but the award was carried forward and supplemented in the ensuing years. In 1949, for instance, the Eaton laboratory was provided with $25,000 by Solandt, in consultation with Mackenzie, to equip an instrument-maker's shop, and an additional $15,000 for electromagnetic field measurements.[231]

In 1950 both the Eaton Electronics Laboratory and Foster's Radiation Laboratory were looking for additional funding, since they were operating over budget. By this time the Defence

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[230] Gingras, "John Stuart Foster;" R.E. Bell, "John Stuart Foster, 1890-1964," *Biographical Memoirs of Fellows of the Royal Society* 12 (November 1966), 146-161; J. David Jackson, "Snapshots of a Physicist's Life," *Annual Review of Nuclear and Particle Science* 49 (December 1999), 1-33; Flora McCrea Eaton, *Memory's Wall: The Autobiography of Flora McCrea Eaton* (Toronto: Clarke, Irwin & Co., 1956), 201; Stanley Brice Frost, *McGill University, for the Advancement of Learning* Volume 2 (Montréal: McGill-Queen's University Press, 1980; 1984), 337-339.

[231] LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43-1 Vol 1, "Revised Agenda for the Third Meeting of the Defence Research Board, 14 June 1947, 2, and "Note from MacNeill to Defence Research Board Members regarding Grants in Aid of Research (Supplementary list), 12 December 1947;" LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Minutes of the Seventh Meeting of the Defence Research Board held at Suffield, 20-21 June 1948," Annexure J "Minutes of the Third Meeting of the Standing Committee on Extra-Mural Grants held at Suffield, Sunday, 20 June 1948," 3, Annexure B (of Annexure J) "Memorandum from Barton to the Standing Committee on Extramural Research regarding Administrative Changes to Grants, 25 May 1948," and Annexure E (of Annexure J) "List of Grants Reommended for Approval;" LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 3, "Minutes of the Tenth Meeting of the Defence Research Board held at Ottawa, 21 March 1949," Annexure K "Minutes of the Sixth Meeting of the Standing Committee on Extramural Research held at Ottawa, 19 March 1949," 2, Appendix B "List of E-M Grants Recommended for Approval by the Standing Committee on Extramural Research at its Sixth Meeting."

Research Board had started funnelling money to the National Research Council in order to help fund the Radiation Laboratory. As a result, Foster and Woonton turned to the DRB, the NRC and the Atomic Energy Control Board for funding to bridge the budgetary shortfall; the three agencies shirked, and then shuffled responsibility. Cyril James and the Board debated the terms of grants in response. James wanted to reduce the work being done by the Eaton, while the Board wanted to make arrangements to ensure that their grants were not being used for building costs, but only equipment and research costs. Eventually the three government agencies transferred the funds to McGill.[232]

Other parties had an interest in the work at the Eaton. The Royal Canadian Air Force wanted Woonton to do radar measurements for them, which the Board had to contract, and raised the issue of Foster's alignment with the United States Air Force who had funded Foster's Radiation Laboratory. The physics laboratories at McGill were investigating the right questions at the right time to benefit from heavy government investment. The Eaton was part of a larger investment by the Board, on behalf of the Department of National Defence (mostly the Royal Canadian Air Force), into air defences.[233]

In 1949 McGill University received more laboratory start-up funding from the Defence Research Board, this time for the Department of Mechanical Engineering. Mechanical Engineering and Physics at McGill were closely linked through the Engineering Physics program, and the experimental tradition that was infused into the Physics Department by Ernest Rutherford's nine-year tenure as the Macdonald Professor of Experimental Physics. Donald Mordell obtained his first grant from the DRB at the first meeting of the Standing Committee on Extramural Research in 1948, $12,100 to study "the effects of turbulence and pressure on the

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[232] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 3, "Minutes of the Eleventh Meeting of the Defence Research Board held at Halifax, 12 June 1949," Annexure K "Minutes of the Seventh Meeting of the Standing Committee on Extramural Research of the Defence Research Board held at Halifax, 11 June 1949," 2, "Minutes of the Thirteenth Meeting of the Defence Research Board held at the University of Toronto, 1 December 1949," Annexure J "Minutes of the Ninth Meeting of the Standing Committee on Extramural Research of the Defence Research Board held at the University of Toronto, 30 November 1949," 3, and "Minutes of the Fourteenth Meeting of the Defence Research Board held at Ottawa, 20 March 1950," Annexure L "Minutes of the Tenth Meeting of the Standing Committee On Extramural Research of the Defence Research Board held at National Defence Headquarters, Sunday, 19 March 1950," 3; Frost, *McGill University*, Vol 2: 339.

[233] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 3, "Minutes of the Fourteenth Meeting of the Defence Research Board held at Ottawa, 20 March 1950," Annexure L "Minutes of the Tenth Meeting of the Standing Committee On Extramural Research of the Defence Research Board held at National Defence Headquarters, Sunday, 19 March 1950," 3.

spontaneous ignition of liquid and solid fuels in a hot gas stream." Mordell's laboratory was the second of four major investments by the Defence Research Board.[234]

A year after his initial grant Mordell received an additional $21,200 from the Standing Committee to help establish the Gas Dynamics Laboratory. McGill contributed money and space for the laboratory. That same year, 1949, Mordell was given a $7,000 RCAF contract, via the Defence Research Board, for research on the effects of combustion of different fuels on jet engines. He was an inaugural member of the Gas Dynamics Research Panel, which was chaired by D.C. MacPhail who was head of the Gas Dynamics Section of the National Research Council. Other members were drawn from the University of Toronto (Gordon Patterson and Edgar Allcut), Queen's University (Frederick Goodspeed), the NRC (E. Alison Flood) and A.V. Roe, Limited. In 1950 the DRB's yearly contribution to the Gas Dynamics Laboratory had increased to nearly $50,000. A decade later, in a request to Cyril James for funding for a new laboratory centred on Gerald Bull after Bull left the Defence Research Board, Mordell reported that Gas Dynamics had successfully drawn in $1,100,000 of external funding for projects.[235]

The productivity of the two McGill physical laboratories, especially in terms of winning grants from the Defence Research Board, led the Board to implement a policy similar to the NRC. The process began at the Eleventh Meeting of the Standing Committee on Extramural Research, which was held 9 June 1950 in Trenton, Ontario. The Standing Committee made the decision to support research at the Eaton Electronics Laboratory, rather than the laboratory itself.

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[234] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Minutes of the Sixth Meeting of the Defence Research Board held at 10:30am, Friday, 19 March 1948," Annexure Z "List of Proposed Grants from the First Meeting of the Standing Committee on Extra-Mural Grants;" Frost, *McGill University*, Vol 2: 349.

[235] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 3, "Minutes of the Tenth Meeting of the Defence Research Board held at Ottawa, 21 March 1949," 11 and Annexure K "Minutes of the Sixth Meeting of the Standing Committee on Extramural Research of the Defence Research Board held at Ottawa, 19 March 1949," 2, and "Minutes of the Fourteenth Meeting of the Defence Research Board held at Ottawa, 20 March 1950," Annexure L "Minutes of the Tenth Meeting of the Standing Committee On Extramural Research of the Defence Research Board held at National Defence Headquarters, Sunday, 19 March 1950," Appendix A; LAC RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 4, "Minutes of the 18th Meeting of the Defence Research Board held at Ottawa, 10 March 1951," Annexure N "Minutes of the Fourteenth Meeting of the Standing Committee on Extramural Research of the Defence Research Board held at National Defence Headquarters, Friday, 9 March 1951," Appendix B (of Annexure N) "List of Grants;" Donald Mordell, "Research in Gas Dynamics at McGill University," *eScholarship@McGill*, accessed 21 July 2011, http://digitool.library.mcgill.ca/view/action/singleViewer.do?dvs=1311261309260~633&locale=en_US&show_metadata=false&VIEWER_URL=/view/action/singleViewer.do?&DELIVERY_RULE_ID=5&search_terms=SYS%20=%20000027449&adjacency=N&application=DIGITOOL-3&frameId=1&usePid1=true&usePid2=true; James Adams, *Bull's Eye: The Assassination and Life of Supergun Inventor Gerald Bull* (New York: Times Books, 1992), 45.

To do this they used a consolidated grant, a multiple year large-sum grant. At this meeting they also considered the possibility of funding the Radiation Laboratory at McGill if the United States Air Force withdrew its support. At their next meeting at National Defence Headquarters the Standing Committee agreed to operate their consolidated grant to the Eaton similarly to the National Research Council's operation of consolidated grants. They would exchange letters with McGill agreeing to a multi-year funding arrangement, where the DRB money would go towards research and McGill would fund operational costs. Covered by DRB Grant 230, Woonton was funded $90,000 over a three-year period.[236]

Consolidated grants were revisited again at the next meeting of the Standing Committee on Extramural Research. The Thirteenth Meeting of the Standing Committee was held on the plane en route to Winnipeg from Ottawa on 6 December 1950. Solandt explained the reasoning behind the move to consolidated grants. The Department of National Defence was operating on a surplus that fiscal year, but was expecting to operate on a deficit the following year. Solandt wanted to set aside money now, while they had it available, for projects that they expected to be running over several years. The Eaton and Gas Dynamics were large-scale laboratories working on defence research projects that were likely to be ongoing.[237]

At their last meeting before the end of that fiscal year, held 9 March 1951 at National Defence Headquarters in Ottawa, the Standing Committee expanded the number of consolidated grants beyond Woonton and Mordell to include several two-year projects. These included: Louis-Paul Dugal of Laval getting $30,000 for cold acclimatization, Balfour Currie of Saskatchewan getting $20,000 for radar reflections from the Aurora, Foster getting $20,000 funnelled through the National Research Council, E.A. Sellers of Toronto getting $50,000 for

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[236] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 4, "Minutes of the Fifteenth Meeting of the Defence Research Board heldt at Trenton, 9-10 June 1950," Annexure M "Minutes of the Eleventh Meeting of the Standing Committee on Extramural Research of the Defence Research Board held at Trenton, 9 June 1950," 2, and "Minutes of the Sixteenth Meeting of the Defence Research Board held at Ottawa and Chalk River, 16-17 October 1950," Annexure L "Minutes of the Twelfth Meeting of the Standing Committee on Extramural Research of the Defence Research Board held at National Defence Headquarters, 15 October 1950," 2 and Appendix B (of Annexure M) "List of Extramural Grants Recommended for Approval," and Annexure K "Minutes of the Thirteenth Meeting of the Standing Committee on Extramural Research of the Defence Research Board held aboard RCAF Aircraft No 977 en route to Winnipeg from Ottawa, 5pm, Wednesday, 6 December 1950," 2.

[237] LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 4, "Minutes of the 17th Meeting of the Defence Research Board held at Ottawa and Fort Churchill, 6-9 December 1950," Annexure K "Minutes of the Thirteenth Meeting of the Standing Committee on Extramural Research of the Defence Research Board held aboard RCAF Aircraft No 977 en route to Winnipeg from Ottawa, 5pm, Wednesday, 6 December 1950," 2.

cold and radiation, R.J. Rossiter of Western getting $100,000 for cold and wounds, Charles Best getting $70,000 to add a radiation unit to his eponymous Institute in Toronto, and Joseph Doupe of Manitoba getting $36,000 for frost-bite and radiation research.[238]

Two laboratories at the University of Toronto were receiving similar funding to the Eaton and Gas Dynamics. The third of the four major laboratories financed by the Defence Research Board, and the first one started at the University of Toronto, was the Institute of Aerophysics. The founder and driving force behind the Institute was Gordon Patterson, who was short-listed for membership on the interim Board in 1946. Patterson's first application for funding from the Board was in 1948, and it required special consideration given how much money he requested.[239]

The success of bombers and fighters in the Second World War led to increased responsibility and budgeting for the Royal Air Force, United States Air Force and the Royal Canadian Air Force. Canada was behind the other two in industrial research capacity, and the RCAF wanted to improve that after the war. What Patterson capitalized on was the need for basic aerodynamics research that could be used to fuel applied research and development for the RCAF in Canadian industries. He lobbied for money to found fundamental studies at the University of Toronto. The Board began to consider Patterson's proposal in April 1948.[240]

E.Ll. Davies prepared a memorandum for the Minister of National Defence on 26 April. Davies suggested that the Board should supply $500,000 for initial start-up over two years, and then $50,000 a year for continued support of research. In this proposal the Board would have a member on the committee that oversaw the research direction of Patterson's laboratory, but administration would be left entirely to the University of Toronto. The DRB would provide equipment, but the University would pay for salaries, professors and consumable supplies. There

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[238] LAC RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 4, "Minutes of the 18th Meeting of the Defence Research Board held at Ottawa, 10 March 1951," Annexure N "Minutes of the Fourteenth Meeting of the Standing Committee on Extramural Research of the Defence Research Board held at National Defence Headquarters, Friday, 9 March 1951," 1-2, Appendix A (of Annexure N) "List of Grants Approved by Minister."

[239] LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43, "Letter from Solandt to Abbott regarding Interim Defence Research Board, 20 November 1946," 1 and attached personal profile; LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Minutes of the Seventh Meeting of the Defence Research Board held at Suffield, 20-21 June 1948," Annexure J "Minutes of the Third Meeting of the Standing Committee on Extra-Mural Grants held at Suffield, Sunday, 20 June 1948," 2; Gordon N. Patterson, *Pathway to Excellence: UTIAS-the First Twenty-Five Years* (Toronto: Institute for Aerospace Studies, University of Toronto, 1977); M.L. Friedland, *The University of Toronto, Ont*. (Toronto: University of Toronto, 2002), 376-379.

[240] Goodspeed, *A History of the Defence Research Board of Canada,* 103.

were two potential options for a building, either the DRB would build something and lease it to the University, or the University would build something and the DRB would compensate the University.[241]

William Barton, on behalf of Secretary of the Board R.G. MacNeill, circulated this memorandum to the members of the Board on 28 April soliciting their approval to go ahead with the plan that had already been discussed by the Standing Committee at its second meeting. By a memorandum on 28 May 1948 MacNeill reported that the proposal had been accepted and would be official recorded as a minute of the Seventh Board Meeting.[242]

Approval was not without questions or difficulties. Harkness responded to MacNeill on 11 May wondering if the Institute of Aerophysics was a duplication of existing work at the National Research Council and whether there was enough money, personnel and equipment to proceed. MacNeill responded on the fourteenth claiming that the Institute was complementary to existing research and that funding a laboratory was the best way to keep Patterson in the country and working on projects of interest to the DRB. Patterson hinted that he might return to the United Kingdom or the United States if his demands were not met by the University of Toronto and the Defence Research Board. The foundation of the laboratory had ministerial support from Howe and Claxton, so Harkness' reservations were simply dismissed.[243]

Planning went ahead, but it still had further hurdles to overcome. In June 1948 Patterson submitted the dimensions and expected performance of the wind tunnel. Solandt relayed these to the Cabinet Committee on Scientific and Industrial Research (i.e. C.D. Howe). Solandt suggested that there was an ideal space in the Department of National Defence building at De Havilland Airport in Downsview (Toronto), Ontario. At the seventh meeting the mail-in vote

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[241] LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43, "Memorandum from Vice Chairman of the Defence Research Board to the Minister, 26 April 1948."
[242] LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43, "Letter from MacNeill to all Board Members, 28 April 1948," and "Memorandum from MacNeill to the Defence Research Board regarding Report Under By-Law No 7 Researchi n Supersonic Aerodynamics, University of Toronto, 28 May 1948."
[243] LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43, "Letter from Harkness to MacNeill, 11 May 1948," and "Letter from MacNeill to Harkness, 14 May 1948."

was recorded with an addition from Air Vice-Marshal James who strongly supported the project. The laboratory opened, in borrowed space within the civil engineering building, in 1948.[244]

Each year the Institute was allowed three or four new students based on the funding coming from the Defence Research Board. One of the first students in 1948 was the eccentric prodigy, Gerald Bull. Another was Irvine Glass who went on to a long career working alongside Patterson at the Institute. Bull's and Glass' work on the model air tunnel revealed the cramped nature of the temporary quarters of the Institute of Aerophysics when Bull knocked out the wall between the graduate student office and Patterson's adjacent office. The quest to co-locate the laboratory at De Havilland and the Downsview RCAF base became more determined in light of this space crunch.[245]

At the Tenth Meeting of the Board it was reported that the RCAF had donated a building, for which the University of Toronto was paying a nominal lease of $1.00 per year. At the same Board meeting it was reported that Toronto's President, Sidney Smith was prepared to exchange letters to formalize the arrangements. The Institute was located academically within the Faculty of Applied Science and Engineering, where it would report to Dean Kenneth Tupper. Within the Institute Patterson was the Chairman of the research committee, which would have representatives from the National Research Council, the Defence Research Board, the Royal Canadian Air Force and the University of Toronto. The expectation was that funding would end after three years (it did not), and that the research would be unclassified, except where essential. Construction at Downsview went relatively quickly and the building was ready to open in September 1950 with some last-minute help from Tupper to make the supersonic wind tunnel operational.[246]

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[244] LAC, RG 24 S F1 Vol 11995 File DRBS 1-0-43-1 Vol 2, "Memorandum from Solandt to Cabinet Committee on Scientific and Industrial Research regarding Research in Supersonic Aerodynamics, 17 June 1948; LAC, RG 24 S F1 Vol 11996 File DRBS 1-0-43-2 Vol 2, "Minutes of the Seventh Meeting of the Defence Research Board held at Suffield, 20-21 June 1948," 10.

[245] Donald J.C. Phillipson, "Gerald Bull," *The Candian Encyclopedia*, page accessed 3 March 2012, http://www.thecanadianencyclopedia.com/articles/gerald-bull; Dale Grant, *Wilderness of Mirrors: The Life of Gerald Bull* (Scarborough, Ont.: Prentice-Hall Canada, 1991), 25; William Lowther, *Arms and the Man: Dr. Gerald Bull, Iraq, and the Supergun* (Toronto, Ont.: Doubleday, 1991), 38; Adams, *Bull's Eye*, 31.

[246] LAC, RG 24 S F1 Vol 11996, File DRBS 1-0-43-2 Vol 3, "Minutes of the Tenth Meeting of the Defence Research Board held at Ottawa, 21 March 1949," 7-8; Goodspeed, *A History of the Defence Research Board of Canada,* 103; Patterson, *Pathway to Excellence*, 68-70; Friedland, *The University of Toronto*, 378.

The fourth and final of the four major grants made by the DRB between 1947 and 1950 was to the Computation Centre at the University of Toronto. The history of the Computation Centre has been documented thoroughly by Scott Campbell. The Computation Centre was the only one of the four major laboratories funded by the Defence Research Board that was not solely devoted to flight studies. Aside from this, the most noteworthy aspect of the Computation Centre was its ability to secure funding from a variety of sources, which the Computation Centre's committee began seeking in 1945. C.J. Mackenzie admitted that the National Research Council was interested in having computations performed, but expected there to be a greater demand and growth for computing in universities. Solandt and the Defence Research Board heard of the proposal in 1947 and also expressed interest. The danger from the government's perspective was the Computation Centre getting overlapping grants from both the NRC and the DRB.[247]

Prudently, a meeting was arranged between the National Research Council, the Defence Research Board and the University of Toronto for January 1948 to discuss the arrangements and funding. Coming out of this meeting the DRB agreed to fund $20,000 and the NRC $10,000 to create the Computation Centre; the university was expected to supply sufficient funding for personnel, at the very least.[248]

Originally management for the Computation Centre fell to B.A. Griffith who had participated on the founding committee, but Mackenzie and Sidney Smith, the President of the University of Toronto, found Griffith's management skills lacking and sought a replacement. The solution was found in recent physics graduate and wartime RDX researcher Calvin Gotlieb; Gotlieb was more affordable than the other options, since he was already working for the university as a lecturer in physics and would not command a top-scale salary. Like the Institute of Aerophysics a guiding committee was formed that included representation from the University of Toronto, the NRC and the DRB.[249]

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[247] Campbell, *The Premise of Computer Science*, 12, 32, 36.
[248] Campbell, *The Premise of Computer Science*, 38-40.
[249] J. Knelman, "Gotlieb, Calvin Carl," *The Canadian Encyclopedia*, accessed 21 July 2011, http://www.thecanadianencyclopedia.com/index.cfm?PgNm=TCE&Params=A1ARTA0003331; Friedland, *The University of Toronto*, 379-381; Campbell, *The Premise of Computer Science*, 53, 56-57.