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Résumé de l'article

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LIQUEFACTION OF HELIUM AND THE PROMOTION OF NATIONAL SCIENCE

Andrew Ede[1]

ABSTRACT

In 1923 John McLennan and his assistants succeeded in the liquefaction of helium. This event was heralded by the Canadian media as a major triumph of science. Yet it was neither a scientific first, nor a terminal experiment, but simply a means of producing material for use in McLennan's cryogenic research program. This article examines the events surrounding the liquefaction as they related to McLennan's efforts to promote national science and establish a post-war national science council.

RESUME

En 1923, John McLennan et ses assitants réussirent à liquéfier l'hélium. Les médias canadiens en firent un triomphe de la science. Cependant il ne s'agissait pas vraiment d'une première scientifique mais simplement d'un moyen de répondre aux besoins du programme de recherche en cryogénie de McLennan. L'article examine comment le événements entourant la liquéfaction se rattachent aux efforts de McLennan pour promouvoir la science au Canada et mettre sur pied un Conseil national de recherche dans l'après-guerre.

In the twentieth century large segments of scientific research are conducted under the auspices of government, frequently as part of a national science programme reflecting policy aims which relate science, technology, education and other disciplines such as health care to industrial, military, and social programmes. The increased involvement of government is largely a function of economics, but the original reason for government involvement was as much a matter of national pride, as the hope for economic and military advancement. Generally, it is the government which determines the nature of this abstract rating of national pride based on competition with other countries over a broad

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range of issues. Through the utilization of science either through funding and promotion, or simply by capitalizing on science in private hands, scientific achievement can be added to the scorecard of national achievement. However, there is a distinction between science as part of a national policy of support for science, and a national science. Even if support for a broad spectrum of scientific research is part of a national policy, certain projects frequently become the focus of special attention as national sciences. For any scientific event or programme[2] to become a national science requires not only national competition, but public awareness.

The actions which propel a particular scientific event into public consciousness are usually based on a combination of promotion from within by the protagonists, and by some external situation which facilitates the quick adoption of the event as important by the public. Because a national science requires public awareness it must be a publicly witnessed science. Being publicly witnessed does not necessarily guarantee the adoption of a project as important. Some programmes fail to elicit public interest, or even gain public antipathy despite the actions of the protagonists and supporters, and thus fail to become national sciences. The current public distrust of nuclear power has not stopped research, but most of the work is done without the public attention and hopeful feelings associated with nuclear development in the 1950's and 1960's.

Between the wars, there existed in Canada a number of nascent scientific and technical institutions which produced significant work when the social and political climate was favoring nationalism and a desire for greater recognition of Canadian accomplishments in the Empire and on the international scene. While much of the Canadian government's involvement in the sciences stemmed from war work, a number of powerful groups including the Canadian Manufactures' Association, the Royal Canadian Institute, and the Society of Chemical Industry[3] sought to prevent the government from withdrawing from research funding after the war and instead move it towards the creation of permanent commitments to finance research and formulate national science and industrial policies. Such efforts met with much popular support, especially in the 10 years just after the First World War.

2 The definitions which I use for event and programme are that a scientific event has a single conclusion, while a programme is an ongoing process which may be made up of many events. For example, sustained nuclear fission was an event within the programme of nuclear energy research.

3 Philip C.Enros, 'The "Bureau of Scientific and Industrial Research and the School of Specific Industries": The Royal Canadian Institute's Attempts at Organizing Industrial Research in Toronto, 1914-1918,' **HSTC Bulletin**, 7:1 (1983), 20-21.

The creation of a national science programme would not likely have been possible without some form of scientific achievement and a great deal of promotion. One of the major successes was the liquefaction of helium, which can be called a national science event since it was done against a background of international competition and was very much a publicly witnessed event. The key figure in the event was John Cunningham McLennan, who was one of the founding members of the Honorary Advisory Council for Scientific and Industrial Research in 1916. The Honorary Advisory Council (which later became the National Research Council) was created by the Privy Council of the Dominion government, promoted by Sir George Foster, the Minister of Trade and Commerce.[4] In what might be viewed today as suspiciously self-serving, the Honorary Advisory Council in turn helped to fund McLennan's work. As a case study, the liquefaction of helium also demonstrates that being a scientific event which is publicly witnessed does not mean there is public comprehension, since it is clear that the fact of the event was far more important than the purpose of the event.

McLennan wanted to do research on low temperatures physics, and the liquefaction of helium was done as part of a project to establish a cryogenic laboratory at the University of Toronto. The liquefaction generated a great deal of public interest, being treated with the same kind of attention as a moon launch might receive today. Yet McLennan was not the first to liquify helium, so that it could not be claimed as a scientific 'first,' nor was the process used an innovation, but was based on a previously demonstrated system. Further, the production of liquid helium had no use outside the laboratory. Consequently much was made of the achievement of the liquefaction of helium, but little was said about why the costly, dangerous and laboriously manufactured material had been produced. The importance of the liquefaction lies not in its scientific achievement, but the role it played in the promotion of a national science programme.

John McLennan's credentials were based on both his scientific work and his institutional connections. McLennan studied physics at the University of Toronto, and at the Cavendish lab, Cambridge, and received the first doctorate awarded for physics by the University of Toronto in 1900. He rose from assistant demonstrator at the University of Toronto in 1892 to head of the Physics Department in 1907, but much of his stature in the scientific and public world came from war work for which he received an OBE in 1917.[5]

4 H.H. Langton, **Sir John Cunningham McLennan: A Memoir** (Toronto, 1939), 69.

5 Langton, op. cit., 69.

McLennan served on the Honorary Advisory Council while he was President of the Royal Canadian Institute. The Royal Canadian Institute had in 1914 created a Bureau of Scientific and Industrial Research, modeled on the Mellon Institute, but it had failed to attracted much interest. When McLennan became President of the Royal Canadian Institute in 1916, he attempted to find a place for the Bureau within the Honorary Advisory Council.[6] While the Bureau failed to achieve its goals, McLennan continued to argue and lobby for federal support of science and technology.

McLennan's other institutional credentials included election to the Royal Society of London in 1915, and the position of President of the British Association for the Advancement of Science in 1923. McLennan was knighted in 1935, the same year that he died.

McLennan's involvement with helium started in 1904 when he identified helium in natural gas from wells in Welland, Ontario,[7] but real interest began in 1917 when he went to England to work on the war effort, where he was involved in a number of top secret projects, primarily for the British Admiralty. McLennan helped to perfect hydrophones and sonar location devices, and he also devised a method of guiding ships through dangerous waters by equipping them with sensors which would register a current in an underwater cable, among a number of other projects.[8]

The possibility that helium could be a strategic war material came from a suggestion by Sir William Ramsay, the discoverer of terrestrial helium.[9] In 1915 Sir William Ramsay had written to Dr R.B. Moore at the U.S. Bureau of Mines that airships filled with helium could have sailed into Germany '...fearing neither airplanes nor shells,' and carrying 90 tons of bombs.[10] Helium, although heavier than the hydrogen which was used to fill airships, had the advantage of being nonflammable, and far less likely to migrate through containment vessels. The incombustibility of helium meant protection from hostile fire and accidents, but also that the gas could be heated to improve lift and control buoyancy. The lack of gas migration made containment simpler, but further, the general chemical

6 Enros, op. cit., 14-26.

7 Langton, op. cit., 104. This was following a suggestion by Sir Richard Trelfall.

8 Ibid., 41-61.

9 Lockyer had identified helium spectroscopical in the sun in 1868 before it was discovered to exist on earth.

10 Copy of correspondence, B65-0012/001, University of Toronto Archives [UTA]

neutrality of helium was far greater than that of hydrogen. Materials subjected to high hydrogen environment tended to absorb hydrogen. In metals this could mean brittleness, or forms of corrosion which would lead to further leaking or worse, the failure of the component.

The problem with the use of helium was that there were few naturally occurring sources, and the production of helium was enormously expensive. The estimates for pre-war production of helium ran between $1500 and $6000 per cubic foot. To give an idea of just how much money this was in 1915, an article in the journal Nature in 1919 said '...before the war a proposal to utilize helium as a filling for airships would have been viewed, even by men of science, as akin to the proposal at the present time to pave the Strand with diamonds.'[11] In terms of dirigibles, the capacity of rigid airships in the 1920's ran between 2,100,000 and 3,700,000 cubic feet. The last and largest of the US Navy rigid ships were the *Arkon* and *Macon*, launched in 1931 and 1933 respectively, each having a 6,500,000 cubic foot capacity.[12] Without a cheap source of helium it would be impossible to substitute it for the hydrogen being used.

It was known that helium occasionally made up part of the gasses found in natural gas wells.[13] Two sites, one in Brazil, and the other in the Texas oil fields, were known in 1915 to contain significant sources of naturally occurring helium. Neither of these sources could be considered both secure and productive by the Admiralty, even after the United States entered the war. While Ramsay had been in contact with the Americans about the possibility of gas extraction, their domestic sources were quickly sequestered for the American military, and there was not enough to go around for allies.[14] McLennan received a cablegram from Lord Fisher, who was chairman of the Admiralty's Advisory Board of Invention, asking him to survey possible Canadian sources. To do this, McLennan, with aid from Lord Shaughnessy, received a special pass for the Canadian Pacific Rail-

11 **Nature**, 102:2573 (1919), 488.

12 Basil Callier, **The Airship. A History** (London, 1974), 244.

13 Only a few natural gas fields have geological formations of the type which traps helium. Small quantities of helium produced from the decay of radium in crude oil are constantly being made, but the gas tends to percolate into the atmosphere very quickly.

14 **Toronto Star Weekly**, 19 April 1919.

way and a directive to every superintendent to offer him aid in his work. He collected samples of gas from every identifiable natural gas source in the country, and had them shipped to Toronto for analysis.[15]

By 1918 a major source of helium had been identified as existing in the Bow River gas field near Calgary, Alberta. The natural resources of the region were at that time under the direct control of the federal government, and permission to establish an extraction plant was quickly granted, with funding and equipment from a number of sources. McLennan received money from the Honorary Advisory Council for Scientific and Industrial Research, the British Admiralty, the University of Toronto, and the Carnegie Foundation, plus equipment from the Admiralty, the British Air Ministry, the Hydro-Electric Commission of Toronto and the Provincial Hydro-Electric Commission of Ontario.[16]

In its own way, the extraction plant, built in 1919 and made operational early in 1920, was an interesting bit of technology, being the first large scale production facility in the world. The design and construction was worked out with the help of several other researchers, Professors Satterly, Dawes, Ainslie, and McTaggart, John Patterson of the Canadian Meteorological Office, and R.J. Lang.[17] The process was a relatively simple idea -- take natural gas from the well head and by regeneration (refrigeration by free expansion of compressed gas,) gases with relatively high liquifying or solidifying temperatures could be separated from the others like helium and hydrogen. The remaining gases would be passed through filters of coconut charcoal and copper oxide which removed almost everything but the neutral helium, leaving a compressible helium which was approximately 97% pure. The difficulty was that a very large amount of natural gas had to be processed to get the helium, since helium only amounted to 0.3% of the gas. The process reduced the cost of helium from between $1500 and $2000 per cubic foot to around 10 cents per cubic foot.[18]

McLennan estimated in 1918 that due to natural percolation into the atmosphere, the Bow gas field was 'wasting' 12,000,000 cubic feet of helium a year.[19]

15 Langton, op. cit., 43, 46; Toronto **Globe**, 26 August 1921. According to Langton, the suggestion to do the survey came from McLennan who had direct access to Lord Fisher even though he was not a member of the Advisory Board.

16 Toronto, **Globe**, 23 January 1923.

17 Langton, op. cit., 46.

18 J. McLennan, 'The Production of Helium from the Natural Gases of Canada,' **Trans. of the Royal Society of Canada**, 13 (1919).

19 Toronto, **Globe**, 9 July 1920.

To McLennan this waste must have seemed monstrous, even at 10 cents per cubic foot. Further, Canada had the only source of helium in the British Empire. To understand the scale of this, the escaping gas would fill five or six airships of the size of the US Navy's Shenandoah, (capacity 2,100,000 cubic feet). A great deal was made of the wasting of this precious resource with newspapers frequently quoting the 12 million cubic foot figure as late as 1923 in strong calls for the exploitation of helium for the good of Canada and the Empire. This consideration was not merely military, because Toronto was in 1919 one of the largest aviation centres in North America, and the aviation industry was very active in its attempts to keep Canada in the forefront of aviation development. With the availability of helium in Alberta, there were even calls to establish a central base near Calgary for an airship fleet which could send ships to either coast in 48 hours.[20]

The degree to which helium was considered a strategic material following the war can be seen in the Ontario Natural Gas Conservation Act of 1921, which stated in section 4, subsection 5a:

> Where the Minister is of the opinion that helium, or any other rare gas is found capable of production in commercial quantities in any part of the province, the minister may make such directions and may make such orders as he may deem proper compelling the owner, lessee or proprietor in such territory to close and keep closed for such time as the minister may deem necessary any natural gas wells in such territory in such a manner that no gas may escape therefrom until such steps may have been taken as the minister deems necessary for the extraction and conservation of any such rare gas.[21]

This act was not as unnecessary as might be thought, since Ontario did (and still does) have some small sources of natural gas. More particularly, McLennan's helium survey had uncovered a source of helium at Inglewood, Ontario, (located about 50 kilometres northwest of Toronto) which was keep secret during the war, and only revealed in 1925.[22]

The close of the war, combined with the advances in heavier-than-air craft and a number of dirigible disasters curtailed the military and commercial interest in the use of helium. The Bow River plant was closed, but not before McLennan had collected 20,000 cubic feet of helium, which he held as a kind of private

20 **Toronto Star Weekly**, 19 April 1919.

21 Ontario Natural Gas Conservation Act, 1921.

22 Officials of the Ontario government knew about helium in natural gas, but it is not clear if provincial officials knew specifically about McLennan's secret findings.

stock although the ownership official rested with the British Admiralty. This stock became the basis of his cryogenic work.

McLennan was an important figure in Canadian society who had no intention of labouring in obscurity. His interest in self-promotion and the promotion of science led him to make his work known to people outside the scientific community. Consider the following report of in the Toronto *Globe*:

> McLennan is trying to liquefy helium. If he should succeed in this and it is quite possible that he will, entirely new realms of science would be opened up by the discovery of a substance that would enable experiments to be carried out at unprecedentedly low temperatures and that would allow investigators to arrive at a truer appreciation of the fundamental properties of matter. If Professor McLennan is able to liquify helium, the University of Toronto will become a mecca for scientists from around the globe.[23]

This report is interesting, because there was little doubt that the liquefaction of helium would be achieved, since it had already been done. The first liquefaction of helium was performed by Kammerlingh Onnes in 1908, at the cryogenic laboratory at the University of Leyden. Not only was McLennan aware of this, his equipment was designed from diagrams personally supplied by Onnes in exchange for a supply of helium.[24] The liquefaction of a long series of gases had been part of the physics and physical chemistry research of the late nineteenth and early twentieth centuries. The liquefaction of atmospheric air had taken place in 1895 by Linde in Germany and Hampson in England, prefacing the liquefaction of hydrogen and helium using the Claude process.

23 Toronto, **Globe**, 9 July 1920.

24 J. McLennan and G.M. Shrum, 'On the Liquefaction of Hydrogen and Helium (II Communication),' **Trans. of the Royal Society of Canada**, 16 (1922). While the plans are attributed to Onnes in the **Transactions**, the fact of the exchange of helium comes only from a student of McLennan and Onnes role in the production is not mentioned in the popular press at the time, or by McLennan's biographer. While there is certainly nothing wrong with scientific cooperation, it is certain that McLennan, his supporters and the press wanted the liquefaction to be as Canadian as possible.

Briefly, the process to liquify helium was an elaborate regeneration system, using the same principle as the extraction system. In a simple regeneration system, the gas is alternately cooled, compressed, and expanded, and with each successive expansion heat is carried away by the circulation of the cooled gas itself. To reach really low temperatures, a faster method of extracting the heat is required, so a coolant is added to the cycle.[25]

The production of liquid helium requires several steps. The first is the production of liquid air, which takes place at -180 C. The liquid air is used as a coolant to make liquid hydrogen (which liquifies at -259 C). When enough liquid hydrogen has been produced, it is used as the coolant to make liquid helium at -270 C. The equipment must be gas tight, and parts of it must stand pressures of 150 to 200 atmospheres. Any impurities which are not trapped or filtered out will cause the equipment to fail, because the impurities will freeze solid, clogging up the tubes, nozzles or valves.[26] The system was dangerous, becuause leaks of hydrogen were extremely dangerous, and there were a number of fires and at least one small explosion in the laboratory.[27]

McLennan reported the successful liquefaction of hydrogen to the Royal Society of Canada in 1921,[28] and reported on the construction of the equipment for helium liquefaction in 1922.[29] On January 10, 1923 he completed his first liquefaction.[30] McLennan's work made the front page of the Toronto papers, but this was really a preface for the January 23 liquefaction which was arranged to take place during a special lecture on the eve of the formal opening of the

25 For a brief but detailed account of the process, with diagrams and photographs of the liquefaction equipment used by McLennan, see 'The Cryogenic Laboratory of the University of Toronto,' **Nature**, 28 July 1923, 135-9.

26 McLennan and Shrum, 'On the Liquefaction of Hydrogen and Helium (III Communication),' **Trans. of the Royal Society of Canada**, 17 (1923).

27 Gordon Shrum, **Gordon Shrum. An Autobiography** (Vancouver, 1986), 40-42. Shrum was the chief technician for McLennan, and he reports that part of the reason he got the job was that he had been in the Artillery during the war, and therefore McLennan judged that he would be less afraid of explosions. Ibid., 38.

28 McLennan, 'On the Liquefaction of Hydrogen,' **Trans. of the Royal Society of Canada**, 15 (1921).

29 McLennan and Shrum, 'On the Liquefaction of Hydrogen and Helium (II Communication).'

30 Langton, op. cit., 105.

Cryogenic Division of the Physical Laboratory. The evening lecture was attended by the university's Board of Governors, the lieutenant-governor, Sir Robert Falconer and other notables. During the lecture, an assistant rushed in (possibly McLennan's assistant and chief mechanic, Gordon Shrum) and gave McLennan the information that the liquefaction had been successful. McLennan promptly took the assembled group to the laboratory.[31] There would not have been much to see since most of the equipment was enclosed,[32] but the sense of powerful forces at work with compressors running, gas hissing and gauges pointing, would have been quite exciting.

The news of this success made the front covers of newspapers from Halifax to Medicine Hat. The press coverage of the liquefaction of helium seems to be largely a product of McLennan's promotion. The lead up to the liquefaction would have required several weeks of work through the holiday season, and although science frequently seems to move at its own pace, there was no apparent technical reason to do the work during the holidays. This suggests that McLennan may have had other considerations in mind when the work was being done, such as the opening of the Cryogenic Laboratory. In the case of the second liquefaction, although there was some risk of the equipment failing, it was clearly designed to be a public demonstration for some highly placed public figures, as well as for the people who had funded the work.

Despite the excitement about McLennan's success, the popular media said little about what liquid helium was for. Liquid helium had a limited number of uses in the laboratory, and it was simply a device which McLennan wanted to aid in his real research in the areas of fundamental properties of matter, magnetism, and electricity. There was no apparent industrial application, unlike gaseous helium, which in addition to airships, had some potential for illumination systems, pressure valves, and atmospheric control. McLennan wanted to study a number of questions which required a cryogenic laboratory such as the disappearance of resistance in materials at low temperature,[33] and he was further aiming to produce solid hydrogen to examine atomic behaviour but this aspect was ap-

31 Toronto, **Globe**, 23 January 1923.

32 For photographs of the apparatus, see **Nature**, 28 July 1923, 136, 138.

33 McLennan intended the Cryogenic Laboratory to be an international research centre which could provide facilities similar to the cryogenic laboratory of Onnes in Leyden. 'The Cryogenic Laboratory of the University of Toronto,'ibid., 139. He published and co-authored a large number of papers on low temperature physics starting in 1924 (with G. M. Shrum) 'On the Luminescence of Nitrogen, Argon and Other Condensed Gases at Very Low Temperature,' **Proceeding of the Royal Society**, v.106. For an extensive list of McLennan's papers, see Langton, op. cit., 111-123.

parently not particularly newsworthy. That this event was a first in Canada and in the Empire was certainly important, but four reasons underlie the attention paid to McLennan's work: 1) A rising sense of nationalism which fueled public interest in any Canadian success story. 2) McLennan's self-promotion and promotion of the university as a leading research centre. 3) The need to demonstrate to the funding organizations that the money had been successfully spent. 4) A direct competition with scientists in the United States.

Consider this 1919 newspaper report regarding helium production from the Toronto Star Weekly:

> Not to London, or Edinburgh, or Paris, not to the laboratories of the United States, but to Toronto did the British authorities come with their troubles! To Toronto with her unostentatious and unacclaimed colleges and her unheralded Royal Canadian Institute!...This punctures the voluminous reports and claims that have so frequently been made that helium is an American discovery. It was discovered by a British scientist and brought into practical form by a Canadian scientist![34]

During the post-war years when dirigibles were still being developed, we find the following statement in 1921. 'America, I understand, is the sole possessor of a supply of helium.'[35] This from British Air Vice-Admiral Higgins at a US Navy dirigible trial. The Globe reporting the comment suggested indignantly that 'The Government of Canada ought to remind the British authorities at once that Canada also has a supply of helium.' Such sentiments about the abilities and potential of Canadian science and industry being ignored were common in the popular press.

In addition to the general indignation at being ignored by the British and combating the claims of the Americans, McLennan's direct stake in success was large, since he had convinced the Admiralty and a number of other funding sources to provide financing for his project, including $30,000 from the British Admiralty, $12,000 from the University of Toronto, $7,000 from the Honorary Advisory Council on Science and Industrial Research, and a $12,000 grant from the Carnegie Foundation. McLennan estimated that the cost of liquefaction had been about $100,000.[36]

34 **Toronto Star Weekly**, 19 April 1919.

35 Toronto, **Globe**, 8 December 1921.

36 Ibid., 23 January 1923.

McLennan, quietly overlooking Onnes when talking to the press, refers directly to the scientific competition about the liquefaction on January 22: 'It has been a race to see who would be the first, and my assistants and myself have put forth every effort to win. We have been successful after the expenditure of $100,000 and our friends have not been successful in liquifying gas with a sum of $5 million at their disposal.'[37] The 'friends' were the Americans, and Congress had indeed voted a $5 million fund for helium research. In addition to besting the Americans was added the knowledge of the frugality (and hence the implied superior ingenuity) of the Canadian effort; a point frequently identified by the newspapers.

McLennan knew that he had a good chance to beat the Americans because Shrum had visited the US Bureau of Standards laboratory and knew what stage they had reached. Shrum reported the following comment on the race:

> You know Mr. Shrum, you'll have no trouble beating us down here. You've got no professors, only the director of the laboratory and four mechanics. We've go four professors and one mechanic. Those professors have got more ideas about what to do than any one person could ever do, and we'll never make it. You'll win.[38]

Two other events contributed to the context which linked the popular interest in science with McLennan's work. This was the hosting by Toronto of the American Association for the Advancement of Science in 1921, and the British Association for the Advancement of Science in 1924. McLennan was elected head of the scientific section of the BAAS in 1923, and was part of the hosting committee for the 1924 conference. He also arranged for the American Physical Society to have its annual meeting in Toronto, and McLennan made sure that members of both groups witnessed actual liquefaction.[39] Having a significant scientific achievement to report might be regarded in the same light as an Olympic host country winning a gold medal.

I would argue that the origin of a national science programme depended upon

37 Ibid.

38 Shrum, op. cit., 42.

39 Ibid.

the occurrence of national science events. McLennan's skillful promotion of the liquefaction of helium was such an event. By bringing it to the attention of the public, particularly through the direct witnessing of the event by selected lay and scientific audiences, he promoted in non-participatants the sense that there was a positive value for Canada and the world in the success of the project. A similar witnessing took place with the announcement of the discovery and first human trials of insulin, which were also followed with much interested by the public.[40] A current example of this situation can be seen in the inclusion of Canadian astronauts and the development of the Canadarm for the NASA shuttle programme.

McLennan had several reasons for his promotional efforts, such as his desire for continued funding, but he clearly wanted his work to be seen as part of a national effort to promote science[41] and to show that Canada could aquit itself well on an international science stage. His involvement with the creation of the National Research Council and the effort to bring the British and American societies to Canada were as much attempts to foster national interest is science as they were to show off Canadian science.

By promoting as a significant scientific achievement a project which was in fact only the development of a tool within his larger research programme, McLennan was able to garner not only continued support for his projects, but add weight to his promotion of a nationally supported programme of science. However, it was not the success of the liquefaction which added the weight, but that the event was publicly witnessed at a time when there was a favourable public attitude towards anything which was both identifiably Canadian and progressive.

The attention of the press to the liquefaction (although not necessarily an accurate measure of public sentiment) suggests that the public's interest and appetite for Canadian success stories was quite high. Popular interest and public knowledge of successful scientific events certainly had an effect on the government's decision to continue support for scientific research. Given the three cornered relationship among government, the public (here including business), and scientists, the role of the popular media as an intermediary in the promotion (or demotion) of science needs to be examined more closely. The de-

40 Insulin was discovered in the winter of 1921-22, and Banting and Macleod won the Nobel prize in 1923. It is interest to note that Banting was knighted in 1934, a year before McLennan.

41 McLennan frequently wrote articles on science for non-scientific audiences, such as 'Atoms and Some of Their Properties,' **Globe**, March 1924; 'The Mysterious Green Line in the Aurora Borealis Spectrum,' **Illustrated London News**, July 1925; 'Scientific Research - Its Bearing on Canada,' **Canadian Magazine**, July 1927.

gree of complexity in the case of the liquefaction of helium is relatively low, since the number of participants is small and their goals fairly clear. Yet the coverage of the liquefaction of helium at the beginning of the change to large scale government support for science has within it many of the elements which would, for example, drive the American interest in science after Sputnik. Even more complex than the role of the media in the race for space, will be its role in global scientific problems such as power generation and population control.

McLennan would not have been successful in promoting science in a national context without the support of the press. The Honorary Advisory Council became the National Research Council because the federal government had been convinced that spending public funds for science and technology would be good for the country. Although it is important to recognize that there has always been an industrial, as well as a military interest in the work of the National Research Council, it has nonetheless attempted to produce and promote science for its own sake because of the efforts of people like McLennan. McLennan's promotional activities were not limited to the National Research Council, as he was also a founding member of the Ontario Research Foundation, which was formed by a provincial Act in 1928.

McLennan used a strong rhetoric of nationalism for the popular press which he reinforced by the active choice of staying in Canada despite serious offers from English research centres including Birmingham and Oxford to lure him away.[42] An indication of his feelings about the creation of a national science programme can be seen in his comments to a special committee of the Senate and House of Commons in May of 1919. The Honorary Advisory Council had only been offered an appropriation of between $500,000 and $600,000, and McLennan had this reply:

> It is a bagatelle. You may not agree with me, gentlemen, but it is true, and you and I may live to see this more clearly before fifteen years are over our heads. By that time we shall be spending far more money than this amount because I am convinced that the results will be like a geometrical progression...I would therefore advocate very strongly the establishment of the Central Research Institution under proper direction and administration.[43]

McLennan's style for promoting science and his interest in national organiza-

42 Langton, op. cit., 61.

43 Ibid., 71.

tions can still be seen in the National Research Council and the Ontario Research Foundation today. Both sponsor scientific research, but also have a strong interest in promoting public awareness of Canadian science.

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