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# Demonstrating the Melbourne University Respirator

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The First World War was a theatre for the demonstration of Australia's contribution to the Empire, and the role of science and technology. This paper explores this relationship by tracing the history of the Melbourne University Respirator, a gas mask developed by scientists at the University of Melbourne during the Great War. In the immediate post-war period, the Respirator was used as a political technology to educate citizens about the actual and potential contribution of scientific research to national and imperial defence. Scientists in this manner promoted national scientific and technological development and a more equal partnership with Britain. The political use of the Respirator was staged in the vivid medium of an exhibition, in which sentiment was conceivably used to motivate political action.

At a Melbourne University physics exhibition on 26 October 1920,[1] Captain Arthur Lyle Rossiter gave a lecture on the topic of gas warfare, which included a demonstration of the Melbourne University Respirator, a gas mask developed at Melbourne University in the First World War.[2] Rossiter, a graduate of that university (M.Sc. 1911) and a demonstrator in physics from 1913, embodied the soldier-scientist. He served as a Gas Officer in the Fourth Australian Division in France and was mentioned in despatches in 1919.[3] His lecture and demonstration performed at the 1920 exhibition provide a snapshot of the ways in which some Australian experiences of the First World War were subsequently narrated. The story of the Respirator was mobilised by scientists to motivate the transformation of science and industry, and the relationship of nation to Empire, between the wars. The occasion also indicates the role of public science in motivating scientific research and national development. Indeed, the somewhat theatrical form of interwar public science had much contemporary resonance.

If the First World War began for Australia as a show of imperial loyalty it was soon conceived, in addition, as a theatre for the demonstration of national prowess. Promoted from the first notorious engagement of the Australian and New Zealand Army Corps (ANZAC) at Gallipoli by war correspondent and official historian C.E.W. Bean as a stage for the display of bushcraft, egalitarianism and inventiveness,[4] the war created new opportunities for Australian participation in imperial governance such as

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[1] Catalogue, Natural Philosophy Department, University of Melbourne, Exhibition of Physical Apparatus and Experiments, Tuesday, October 26th, 1920.

[2] "The University Appeal. Progress in Scientific Discovery. An Interesting Display", *Age*, 27 October, 1920.

[3] University of Melbourne Student Record, Rossiter, Arthur Lyle, Enrolment No. 050133; *Melbourne University Calendar (MUC)*, 1916-24; Rossiter, Arthur Lyle, National Archives of Australia (NAA), B2455.

[4] Charles Bean, "Sidelights of the War on Australian Character", *Journal of the Royal Australian Historical Society*, Vol. 13, 4 (1927), pp. 209-23; Russel Ward, *The Australian Legend* (Melbourne, 1958), pp. 228-32.

the capture of German New Guinea and representation in the Imperial War Cabinet, legitimising increasing confidence in world affairs. However, Australia's participation in the war was subservient to Britain and the Australian experience more ambiguous, as shown ironically in the failed landing at Gallipoli and rejection of conscription in national referenda in 1916 and 1917.[5] While imperial ties remained strong, Australia's stance towards Britain arguably grew more self-interested and, potentially, self-reliant. Political attitudes were reinforced by cultural expressions, ranging from literary accounts[6] to memorials,[7] intended to express and evoke emotional responses. This powerful combination of politics and sentiment made the First World War a turning point in the national historiography. The Anzac legend "converted military defeat into moral victory",[8] failure into success.

On the other hand, the war was significant to scientists as a theatre for the demonstration of the role of science and technology in national development and imperial defence. In Britain, scientific manpower was mobilised, and war research led to the formation of a national research organisation, the latter precedent soon followed throughout the dominions. The idea of an Australian "national laboratory" was spawned in the First World War by Prime Minister Hughes, who was impressed with Germany's technological might.[9] At stake was the very survival of a British Empire that would have to emulate aspects of the scientific culture of the German Empire in order to defeat it.[10]

Australian scientists felt they had answered the call to arms. "The Empire", T.H. Laby, Professor of Natural Philosophy at Melbourne University, reminded daily newsreaders in 1919, "has every reason to be proud of the extraordinary success of its scientists, gathered in Britain from every dominion and colony".[11] Scientists also felt much more should be done to secure the place of white Australia and the Empire in post-war trade and geopolitics. They suggested that national achievements in wartime proved Australians could develop science and industry should they resolve to do so. Laby's correspondent in Adelaide, biochemist and physiologist T. Brailsford Robertson, argued in the journal of the new Institute for Science and Industry (ISI, founded 1920) that "our brains, our versatility, resourcefulness, and adaptability" were "qualities which distinguish Australians above other peoples" and should be directed

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[5] Craig Wilcox, "World War One" in Graeme Davison, John Hirst and Stuart Macintyre, eds., *Oxford Companion to Australian History* (Melbourne, 1998), pp. 693-95; W. Hudson, *Billy Hughes in Paris: The Birth of Australian Diplomacy* (Melbourne, 1978).

[6] One of the most pertinent accounts in the context of this article is the technological dystopia of George August Taylor that imagines a defeated Australia, *The Sequel: What the Great War will mean to Australia* (Sydney, 1915).

[7] Ken Inglis, *Sacred Places: War Memorials in the Australian Landscape* (Melbourne, 1999).

[8] Jay Winter, "Anzac Legend" in Davison *et al*., *Oxford Companion to Australian History*, p. 29.

[9] Tim Sherratt, "CSIRO", in Davison *et. al.*, *Oxford Companion to Australian History*, pp. 164-65.

[10] Professor of Experimental Physics at the University of Sydney, Richard Threlfall had, at the close of the previous century, called for a "*Geist des Forschers*" [spirit of the researcher] in the context of national and imperial rivalry in "Anniversary Address", *Proceedings and Journal of the Royal Society of New South Wales*, Vol. 29 (1895), pp. 1-30. Threlfall's chemical engineering firm near Birmingham made phosphorous bombs in the First World War: Richard E. Threlfall, *100 years of Phosphorous Making, 1851–1951* (Oldbury, 1951).

[11] "Needy Students Assisted. Method is explained", press clipping, 28 May 1919, University of Melbourne Archives (UMA), Laby Papers, Box 4.

for the greatest impact into scientific development.[12] Scientists envisaged what Australia could become if the skills and determination legendarily displayed in battle could be turned to scientific and industrial development. The first two sections of this paper discuss one attempt to apply scientific innovation in Australia to national and imperial defence during the Great War.

In doing so, this paper addresses two broader themes in the period of the First World War and after: the relations between Australia and Britain; and the role of science in government. Prevailing historical accounts reinforcing the Anzac legend give credence to the re-emergence of Australian nationalism after the war. In this paper, another — to some extent complementary — response to the successes and failures of Australia's war is witnessed in a scientific context. Like the nation more generally, Australian scientists entered the war enthusiastically and emerged critically. Some used the Anzac legend to create moral pressure for a reformed Empire with scientific development as a means of achieving imperial defence, prosperity and coordination. While scientists were primed to defend the Empire, this did not necessarily entail the acceptance of scientific and technological subservience to Britain.[13] Rather, many Australian scientists saw the best opportunity to develop national potential was through contributing on equal terms, where possible, to imperial defence. Where contributing on equal terms was not possible due to unequal demographic, industrial and scientific progress, they aimed to change this through national development.

The efforts of First World War scientists to promote science and industry have to some extent been overshadowed by subsequent events. The depression undermined the economic basis of post-war reconstruction in Australia.[14] Nonetheless, scientists and administrators active in the Great War established many of the institutions central to Australian defence and civilian science through the middle decades of the twentieth century. The Council for Scientific and Industrial Research (CSIR) was established in 1926, as a more effective successor to the fledging ISI initiated by Hughes during the war.[15] Despite an industrial science remit, the CSIR initially carried out mainly agricultural research supported in part by imperial organisations like the Empire Marketing Board.[16] However, the Radio Research Board of CSIR that Laby helped establish built a scientific foundation in Australia for the military applications of radio

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[12] T. Brailsford Robertson, "Scientific and industrial research in the United States, Canada, and Austalia", *Science and Industry* Vol. 2, 3 (1920), pp. 145-49. Indeed, "Anzac brains" was a contemporary phrase, studied thematically by Tim Sherratt in a chapter of his PhD thesis, "Atomic Wonderland: Science and Progress in Twentieth Century Australia" (Australian National University, Canberra, 2003).

[13] For an account of the diffusion of scientific expertise from centre to periphery in the Australian context, see Roy MacLeod, "On Visiting the 'Moving Metropolis': Reflections on the Architecture of Imperial Science", *Historical Records of Australian Science*, Vol. 5, 3 (1982), pp. 1-16.

[14] Seen not least in the failure of soldier settlement, which combined issues of both repatriation and agricultural science: see Marilyn Lake, *The Limits of Hope: Soldier Settlement in Victoria, 1915-38* (Melbourne, 1987). Scientists promoted "scientific government" as a remedy for the depression, as in T.H. Laby "Science and the economic depression", *Australian Quarterly*, Vol. 5 (June 1933), pp. 80-91.

[15] George Currie and John Graham, *The Origins of CSIRO: Science and the Commonwealth Government, 1901-1926* (Melbourne, 1996); C.B. Schedvin, *Shaping Science and Industry: A History of Australian's Council for Scientific Research* (Sydney, 1987).

[16] For an account of imperial science between the wars, see Barry Butcher, "Science and the Imperial Vision: The Imperial Geophysical Experimental Survey, 1928–1930", *Historical Records of Australian Science*, Vol. 6, 1 (1984), pp. 31-43.

technology.[17] Equally significant for defence, the Munitions Supply Laboratory supported munitions production, which A.T. Ross argues was key to Australian preparedness and capacity in the Second World War.[18]

Industrial growth during the Second World War afforded more profound changes in science and industry, and the dominions were encouraged to play a more active role in these developments.[19] Such growth can in part be attributed to the changing politics of Empire following the fall of Singapore, necessitating more Australian self-reliance in defence, which Australian scientists had been advocating since the First World War. Radar research was able to build on the earlier initiatives of the Radio Research Board, a new wartime industry developed in Optical Munitions, and CSIR fulfilled its original remit by diversifying into industrial science.[20] More widely, Britain sought collaboration with Canada in atomic warfare to be closer to the United States programme,[21] in which British and Australian scientists like Mark Oliphant participated. In Australia, interwar initiatives in hydroelectricity, Laby's proposal for a national university, and early efforts in nuclear research in his department were recycled to win the support of the Federal Government as part of an integrated Empire defence programme, as described by Wayne Reynolds.[22] In the Second World War

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[17] W.F. Evans, *History of the Radio Research Board, 1926-1945* (Melbourne, 1973).

[18] A.T. Ross, *Armed and Ready: The Industrial Development and Defence of Australia, 1900–1945* (Sydney, 1995). Also see "Introduction" to Jean Buckley Moran, "Scientists in the Political and Public Arena: Australian Association of Scientific Workers, 1939-1949", M.Phil. thesis, (Griffith University, Brisbane, 1983); and Graeme Snooks, "Economy", in Davison *et. al.*, *Oxford Companion to Australian History*, pp. 203-04.

[19] Compare the place of science and industry in the official war histories of Ernest Scott, *Australia During the War, Vol. 11*, *Official History of Australia in the War of 1914-1918* (Sydney, 1921-1942); and D.P. Mellor, *The Role of Science and Industry, Series Four, Vol. 5, Australia in the War of 1939-1945* (Canberra, 1958). For the growth of physics, see R.W. Home, "Origins of the Australian physics community", *Historical Studies,* Vol. 20, 80 (April 1983), pp. 383-420; and "The Physical Sciences: String, Sealing Wax and Self-Sufficiency" in Roy MacLeod, ed., *The Commonwealth of Science, ANZAAS and the Scientific Enterprise in Australia, 1888-1988* (Melbourne, 1988).

[20] Michelle Freeman, "Australian Universities at War: the Mobilisation of Universities in the Battle for the Pacific" in R. MacLeod, ed., *Science and the Pacific War* (London, 2000), pp. 119-138; Roy MacLeod, "The Boffins of Botany Bay: Radar at the University of Sydney, 1939-1945", *Historical Records of Australian Science*, Vol. 12, 4 (1998), pp. 411-493. Success in the military applications of radio-physics led to flourishing research programmes in radio-physics and radio-astronomy after the Second World War that attracted British and retained Australian scientists. For examples, see E.G. Bowen, *Radar Days* (Bristol, 1987); R Hanbury Brown, *Boffin: a Personal Story of the Early Days of Radar, Radio-Astronomy and Quantum Optics* (Bristol, 1991); and D.O. Edge and M.J. Mulkay, *Astronomy Transformed: the Emergence of Radio Astronomy in Britain* (New York, 1976).

[21] Donald Avery, "Atomic Scientific Cooperation and Rivalry Among Allies: the Anglo-Canadian Montreal Laboratory and the Manhattan Project, 1943-1946", *War in History*, Vol. 2, 3 (1995), pp. 274-305.

[22] For examples of the recycling of ideas of twentieth century scientific progress, see Sherratt, "Atomic Wonderland". For nuclear research, see Edmund Muirhead, *A Man Ahead of His Times: T.H. Laby's Contribution to Australian Science* (Melbourne, 1996); and *Leslie Martin at Melbourne: Profile of a Physics Department* (Melbourne, 1998); and R.W. Home, "The rush to accelerate: early stages of nuclear physics research in Australia", *Historical Studies in the Physical and Biological Sciences*, Vol. 36, 2 (March 2006), pp. 213-41. For hydroelectricity, see Katrina Dean, "The Physicist's Homestead: Alexander McAulay, hydroelectricity and mathematical physics in Tasmania", *Tasmanian Historical Studies*, Vol. 8, 2 (2003), pp. 56–77. Laby proposed a national research university in "A University for the Commonwealth", *Australian Quarterly*, Vol. 1 (1929), pp. 32-42. For an argument concerning the integration of such features of post-Second World War science and industry, see Wayne Reynolds, *Australia's Bid for the Atomic Bomb* (Melbourne, 2000).

both radar and nuclear research were premised on the idea that dominion science should aid national defence and development by contributing to a decentralised Empire-wide effort. This idea in turn can be traced back to the public science of the interwar years. Indeed, public accounts of the Melbourne University Respirator were addressed to this more general point. It is on the public science aspect of intellectual culture in the First World War and after which the last section of this paper focuses.

The Melbourne meeting of the British Association for the Advancement of Science (BAAS) in August 1914 allows us to characterise pre-war efforts to popularise science in Australia and New Zealand. War was declared during the voyage of many European scientists to attend the meeting, and some visitors returned home as soon as possible. Others, including the New Zealander and famous physicist Ernest Rutherford, stayed to participate in the meeting. One aim of the British Association was to promote the interaction of those who cultivated science throughout the British Empire and, to this end, the Association sponsored a rotational program of meetings throughout the provinces and colonies.[23] The meetings were a forum for the discussion of scientific theory, and in 1914 a lively debate occurred on the Rutherford-Bohr model of the atom, which they supposed to consist of a positively charged, massive nucleus orbited by electrons.[24] Nevertheless, this decentralised parliament of science institutionalised the authority of imperial experts over the reception of science in the colonies. Colonial meetings tended to be seen as opportunities to strengthen this relationship rather than change it, although the very act of bringing scientists and public together stimulated new articulations of the relationship between science and national development.[25]

The paper invites the reader to reflect on the demonstration of the Respirator at the Melbourne University physics exhibition in 1920 in reference to experiences of the First World War. The exhibition, one of five similar events staged between 1918 and 1939, aimed to promote education, research and industrial development based on scientific and technological innovation. It brought together manufacturers,[26] scientists, technicians, administrators, statesmen, and the public for displays and demonstrations of inventions (such as wireless telephony) and experiments, involving many of the emergent scientific institutions and industrial concerns of that period. The 1920 exhibition evoked wartime experiences to promote scientific development with the aim of developing and defending the nation. This was set against an implicit agenda of imperial reform. The Melbourne University respirator started out as an Australian invention intended to protect soldiers in war, but it became an iconic object that encapsulated the lessons of the war for Australian scientists, and the need for scientific and political reform as perceived by Melbourne physicists in 1920. Ironically, it was to be the Respirator's "failure" as a technology for protecting soldiers from gas attacks that made it an evocative item of propaganda. Implicitly in reference to the Anzac

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The leading Australian physicist in public life after the Second World War was Mark Oliphant who, like Laby, worked towards scientific cooperation for Empire security. For Oliphant, see Stewart Cockburn and David Ellyard, *The Life and Times of Sir Mark Oliphant* (Adelaide, 1981).

[23] Roy MacLeod and P. Collins, *The Parliament of Science: the British Association for the Advancement of Science 1831–1981* (Northwood, 1981).

[24] "The structure of the atom", Physics Conference, 11 April 1921, UMA, Laby Papers, Box 5/42.

[25] Rosaleen Love, "The Science Show of 1914: The British Association Meets in Australia", *This Australia*, Vol. 4, 1 (1984), pp. 12-16.

[26] Including Amalgamated Wireless Australasia (AWA) Ltd, a government-controlled company formed by the nationalisation of the Marconi and Telefunken subsidiaries in Australia during the First World War for defence and security purposes with regard to ship-to-shore wireless transmission.

legend, the demonstration of the Melbourne University Respirator turned a failed military technology into a moral and political agenda.

**An Australian Invention**

News of the first gas attack thirty miles North West of Ypres on the Western Front on 22 April 1915 — only three days before the first wartime engagement of Australian soldiers at Gallipoli in the Dardanelles — arrived in Melbourne at the end of April. While Australian soldiers' "baptism of fire"[27] at Gallipoli and the praise it drew for "worthy sons of Empire"[28] was said to have "brought to every eye a glow of patriotic pride" and "a flush of joy to every cheek",[29] the dead were soon mourned and enlistments to replace them soared.[30] In this context it was feared that gas warfare might spread to Gallipoli and scientists and civilians responded with concern to gruesome reports in the press of gas attacks on the Western Front. The "poison thrown by the Germans" had "coloured the ground yellow and the Canadian soldiers who valiantly defended in the line complained they "got black all over or all black and yellow". The fumes made their eyes swell. And "if it gets into your stomach", some claimed ominously "you are done".[31] Experts like physiologist J.B.S. Haldane were rushed to the scene and reported that the gas consisted of chlorine and bromine and that other lachrymatory or "weeping" gases might also be involved.[32] It was soon realised that expertise would be required to combat this new threat of scientific warfare.

In Australia, expertise had been offered to the war effort a few days earlier at a meeting of Melbourne University staff on the afternoon of 21 April 1915, chaired by the Professor of Chemistry, Orme Masson, in the biology lecture theatre. Scientists there pledged to "encourage volunteering in the university", and to offer their services to "the work of the scientific, technical or professional branches of the Government" during the war, "on any matters connected with imperial defence". Both soldiers and science were considered crucial to the war effort.[33] When the need to combat gas attacks became evident, professors in the subjects of chemistry, Masson; physiology, W.A. Osborne; and natural philosophy, Laby, decided they could make a suitable form of protection. Their collaboration brought together scientific disciplines that German men of science had already successfully mobilised for science and industry, and which now provided the scientific basis for the German war effort.

The design of the Melbourne University respirator highlights some of the problems of a decentralised scientific war effort as well as some of the possibilities presented for technological innovation in the dominions. Trawling the newspapers for information,

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[27] *Age*, 30 April 1915, p. 9.
[28] *Age*, 1 May 1915, p. 11.
[29] *Age*, 30 April 1915, p. 8.
[30] Bill Gammage, *The Broken Years: Australian Soldiers in the Great War* (Canberra, 1974), pp. 13-14.
[31] *Herald* (Melbourne), 27 April 1915, p. 5.
[32] W. Moore, *Gas Attack: Chemical Warfare 1915–18 and Afterwards* (London, 1987), p. 42.
[33] "The University and the War", *Age*, 22 April 1915, p. 8. Laby later supported conscription and appears to have campaigned for the "yes" vote with Round Table associates in the second referendum of 1917. A newspaper advertisement authorised by W. Harrison Moore, Professor of Law at the University of Melbourne warns: "German scientists and organizers might well determine that the best method of developing Australia's resources was by a coloured race directed and controlled by German officials, bankers, managers and scientists." Newspaper clipping, "The Boundary of Australia runs today along the Battlefields of France", [newspaper title and date not shown], p. 35, UMA Laby Papers, Box 4.

the Melbourne professors concluded that the offensive gas was most likely chlorine released from gas cylinders and liquid bromine exploded in shells. Considering various forms of protection — including destruction of gases before reaching the trench, or ventilation — they agreed protection of the individual soldier with some form of respirator would be necessary. In a report submitted to the Minister for Defence, Senator Pearce, in late June they stated unequivocally:

> Ordinary respirators, such as may easily be made by amateur workers, are useless or nearly useless. They might even become indeed a positive danger by inspiring a false sense of security.[34]

This followed the failure of an early War Office design for simple cotton wool masks made by the British public and distributed in France in early May 1915 that were soon found to be useless and recalled.[35] The scientists stressed scientific expertise in contrast to amateur efforts that could not be trusted.

Several amateur designs for gas warfare — for both protection and retaliation — were submitted to the Department of Defence in Melbourne between May and July 1915 including a telescopic tube for reaching fresh air and breathing through from the trenches,[36] a mica and asbestos helmet to protect against gas and sunstroke in Egypt,[37] and asphyxiating and antidote bombs and sprays.[38] One entrepreneur offered his Crockford patent rabbit exterminator to be used against the Germans.[39] However, Melbourne scientists operated with little more information — or scruples, as shown in Laby's offer in late July 1915 to design asphyxiating bombs[40] — than ordinary members of the public, some of whom also had claims to practical experience in chemical and mechanical trades. All agreed that the new weapon made new kit imperative.

The Melbourne scientists argued that protection should be simple, light and thoroughly efficient; "fool proof"; offer eye protection; prevent breathing through the nose, filter inhalation through the mouth, and exhale from a separate tube; admit of the inhalation of ten litres of air per minute; absorb six litres of chlorine and last for an hour; destroy other possible noxious gases and vapours; allow the filter to be emptied and recharged; and protect it from decay. They drew up designs, and improvised parts consisting of a cylindrical tin made from tobacco tins filled with soda lime absorbent effective against chlorine and bromine; breathing apparatus allowing the wearer to inhale air filtered through the can and exhale through a valve; a nose clip to prevent breathing through the nose; and motoring goggles to protect the eyes. Producing a prototype, a trench was dug in the University grounds. Simulating battle conditions,

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[34] Report on Asphyxiating Gases and Protective Measures, 21 June 1915, Australian War Memorial (AWM), AWM 27/314/51.

[35] *Age*, 29 April 1915, p. 9; Moore, *Gas Attack*, p. 46; D. Richter, *Chemical Soldiers: British Gas Warfare in World War One* (London, 1994), p. 11.

[36] J.H. Stevenson, South Yarra, Melbourne to Department of Defence, 9 June 1915, NAA, A2023/B217/1/306.

[37] Mr N. Hill, Neutral Bay, Sydney to Senator Pearce, 8 May 1915, NAA, A2023/B217/1/240.

[38] F.J. Corbett, Toorak, Melbourne to Secretary, Department of Defence, 22 July 1915, NAA, A2023 B217/1/467. The idea of spraying absorbent chemicals as a defensive measure was indeed adopted in the form of a vermoral sprayer, modelled on orchard spraying devices.

[39] W.T. Crockford, Kew, Melbourne to Minister for Defence, 30 July 1915; Acting Secretary, Department of Defence to Mr Crockford, 29 September, 1915, NAA, A2023/ B217/1/500.

[40] Laby to Andrew Fisher, 25 July 1915, NAA B5583/1/11. This correspondence was probably in response to the "shell crisis" of 1915 and in his letter, Laby argued that gas bombs could be manufactured more cheaply and effectively in Australia than conventional ones.

they released some gas, with only their device between themselves and the deadly miasma.[41] Judging this to be a successful experiment, they now approached the Commonwealth Government.

The scientists apparently convinced Pearce of the need for the local production of respirators to protect Australian soldiers as the Melbourne University plan to manufacture 10,000 sets in Melbourne at Commonwealth expense was approved.[42] In the meantime, the Australian Government tried to obtain information from the British Government about what measures were being taken to counter gas attacks.[43] In the middle of June 1915, word was received in Melbourne by cablegram that the "War Office has sent 300,000" masks and special textile helmets to be dipped in Sulphate and Carbonate solution "already to Dardanelles and deprecates separate Australian action at present".[44] Specifications and an example of the British helmets were provided to the Commonwealth Medical Officer representing Australia in London and the direction not to produce Australian respirators was reiterated in a letter to Melbourne at the end of June,[45] but the Melbourne plans were unchecked. On 24 August 1915 the Australian Governor-General, Munro Ferguson, communicated news of the Melbourne University Respirator to the Colonial Office for the information of the British Minister of Munitions of War, stating "10,000 will be made forthwith in Australia" and the War Office could only await their arrival.[46] Knowing that the British military authorities opposed the proposal to produce the Australian gas respirator, the Australian authorities most likely acted on the scientific advice that the Australian respirator offered better protection than standard issue "smoke" or "PH" helmets sent to Gallipoli.[47] However, scientific and practical confidence in the Melbourne respirator did not overcome the need for imperial approval of military kit.

In the First World War, the place of Australian science was mainly to support rather than innovate and in the case of the Respirator, efforts were made to change this situation by obtaining approval for the design from the British military authorities.[48] Blueprints of the Melbourne apparatus arrived in London in the middle of September 1915 and samples ten days later were forwarded to the Director of Army Contracts,[49] requesting, apparently with the support of Pearce, "an expression as to their efficiency". If effective, its makers hoped that the Melbourne University design might

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[41] Report on Asphyxiating Gases and Protective Measures, 21 June 1915, AWM 27/314/51.

[42] A. Gordon Smith, President, Federal Munitions Committee to Australian High Commissioner, 11 August 1915, AWM 27/314/42. For Pearce and munitions production, see Ernest Scott, *Australia During the War* (Sydney, 1936); E. Andrews, *The Department of Defence* (Melbourne, 2001).

[43] Secretary, Australian High Commission to Surgeon General Sir Alfred Keogh, Director General Army Medical Service, War Office, 16 June 1915, AWM 27/314/42.

[44] Minute on Protection from Gas Poisoning, Commonwealth Medical Bureau, London and Cablegram sent to External Affairs [Australia], 16 June 1915, AWM 27/314/42.

[45] Captain Clancy Macpherson, Member, Anti-Gas Committee, War Office to Chief Medical Officer, Commonwealth Medical Bureau, London, 26 June 1915; Memorandum to Secretary, Department of External Affairs (for the information of the Department of Defence), 30 June 1915, AWM 27/314/42.

[46] Munro Ferguson to Secretary of State for the Colonies, 24 August 1915; Director of Army Contracts to Australian High Commissioner, 31 August 1915, AWM 27/314/42.

[47] For smoke helmets and various forms of protection, see Moore, *Gas Attack*, p. 47; Richter, *Chemical Soldiers*, p. 12

[48] Roy MacLeod, "The 'Arsenal' in the Strand: Australian chemists in the British munitions effort, 1916–1919", *Annals of Science*, Vol. 46 (1989), pp. 45-67.

[49] Secretary, Australian High Commission to Director of Army Contracts, 17 September 1915, 27 September 1915, AWM 27/314/42.

be adopted as standard issue for all troops of the British Empire.[50] Entering scientific war production as the supplier of respirators for imperial troops would itself have contributed to the kind of scientific and industrial production that the Respirator was then and later used to promote.

Eventually a report was secured from the War Office, remarking that "the whole apparatus has been most thoroughly worked out" and was of "excellent make and finish"[51] under a covering letter that admitted the "respirator embodies points which are considered most useful".[52] It was considered wholly effective against gases originally acid or that became so in the presence of moisture. However, the report also noted several deficiencies: the nose clip was too tight; the goggles fogged; the mouth piece slipped in gaps between the teeth and put pressure on gums; the exhaling valve tended to stick; and the "tower" (cylindrical tin) restricted breathing during the "standard test of running a quarter-of-a-mile in two-and-a-half minutes". Moreover, the filter was no good against gases requiring oxidation, or the lachrymator group, which was considered "a grave defect".[53] The fact that chemical preparations used in gas warfare were liable to be changed by the enemy, and required quick responses in protection design, probably disadvantaged the Melbourne group, who had less access to official information about recent developments in gas warfare. As the reporter omitted to specify the points he found useful, it seems likely that the trial of the Melbourne University Respirator served as an experiment in the viability and modification of various features being considered for British designs of the "box respirator" such as the shape of the "tower". With two exceptions, "the defects of construction noted could be simply remedied."[54] It was further noted that an "improved" model was being developed by the Royal Army Medical College under direction of the Anti-gas Committee and a cablegram stated that no more of the Australian respirators would be required.[55]

Laby was notified of the findings of the War Office report on the Melbourne University Respirator by a letter written at the beginning of October 1915.[56] Yet a sample of the new War Office design was not received by the Australian High Commission in London until the middle of March the following year, failing to inspire confidence that the British authorities had the situation in hand.[57] Between October 1915 and October 1916, a debacle in the imperial distribution of technology unfolded, caused not so much by bias against Australian inventions, although this too was later implied, as the need for imperial coordination at every level to prosecute an effective war effort.

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[50] A. Gordon Smith, President, Federal Munitions Committee to Australian High Commissioner, 11 August 1915; Masson to Collins, 11 August 1915, AWM27/314/42.

[51] B. McLean, Major Royal Army Medical College, Report on the Melbourne University Gas-respirator, 10 October 1915, AWM 27/314/42.

[52] Director of Army Contracts to the High Commissioner, 29 October 1915, AWM 27/314/42.

[53] B. McLean, Major Royal Army Medical College, Report on the Melbourne University Gas-respirator, 10 October 1915, AWM 27/314/42.

[54] Report on the Melbourne University Gas-respirator.

[55] Director of Army Contracts to the High Commissioner, 29 October 1915; Cablegram sent to the Department of External Affairs, 4 November 1915, AWM 27/314/42.

[56] E.W. Moir, Comptroller of Munitions to Laby, 9 October 1915, AWM 27/314/42.

[57] G.H. Knight for Director of Army Contracts to Official Secretary, Australian High Commission, 11 March 1916; Memorandum, The Secretary, Department of External Affairs (For transmission to the Defence Department), 18 March 1916, AWM278/314/42.

## A Failed Technology

The Melbourne production of 10,000 respirators was almost complete in October 1915. In January 1916, Rossiter offered 2000 respirators plus 1000 replacement tins containing absorber to the Sydney geologist Edgeworth David for the Mining Corps due to depart Sydney on 23 January, and offered that a laboratory mechanic who wished to enlist could look after them.[58] With David, these respirators had apparently arrived in France by July 1916 where Gas Officer Lieutenant Colonel John Anderson of the Second Australian Division, previously a student of Masson in Melbourne, requested to trial some samples and probably showed the Melbourne kit to fellow Gas Officers at a conference on 28 July 1916; although it is not clear if and to what extent these Melbourne respirators were used.[59] Problems with the new British box respirators for which the Melbourne respirators had provided "useful hints" were nonetheless reported by Anderson at the end of July, suggesting that British scientists were not necessarily better placed to get the right kind of protection into the field.[60] Australian scientists in Melbourne and those at the front were in contact about the Melbourne respirators and could envisage ways of deploying them to protect Australian soldiers, but concerns about standard kit highlighted the practical problems of working in imperial formations.

This was reinforced when Australian Imperial Force (AIF) Commanders in Egypt chose not to train the second detachment of Anzacs using the different Melbourne respirators to those already being used in France, as new troops would reinforce units already in the field. Standardisation was promoted in military operations in order to facilitate training, efficiency and order.[61] When Rossiter arrived with 6,000 respirators in Cairo with a further 2,000 to follow by transport at the end of April 1916, he was redirected to England where he arrived towards the end of May and obtained an appointment as Gas Officer, Fourth Australian Division in France in July.

It was not until the beginning of August 1916 that advice was eventually given that the Melbourne goggles could be issued to the troops in Egypt and respirators returned to England for recycling.[62] The soda-lime could be used, and the rest written off, although one official from the Ministry of Munitions suggested that scrap aluminium was fetching £150 per ton and rubber 5 pence a pound.[63] However, the AIF Ordnance Section had already been cleared out in Egypt, and 5,784 respirators, 3,992 replacements, 4,000 valves, 257 washers, 2,010 goggle glasses and 400 goggle springs were docked at Plymouth.[64] The end of the affair was dealt with by telephone.[65] The

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[58] A.L. Rossiter to Edgeworth David, 5 January 1916, T.W. Edgeworth David Papers, University of Sydney, Archives (SUA), P11/46/2.

[59] Anderson to David, 27 July 1916, Anderson to Chemical Adviser, Second Army, 28 July 1916, AWM, 2DRL-1222, letter book JH1/12, 13, JH 3/2.

[60] Anderson to Chemical Adviser Reserve Army, AWM, 2DRL-1222, letter book JH 1/24.

[61] Brigadier-General Sellheim, AIF Headquarters, Cairo to Major-General, Sir A.J. Godley, GOC 2nd ANZAC, Ismailia, 29 April 1916; Godley to Sellheim, 2 May 1916; Sellheim to the High Commissioner, 5 May 1916, AWM27/314/42.

[62] Major E.H. Harrison, Royal Army Medical College, to Colonel Buckley, Military Adviser to Commonwealth Forces, Australian High Commission, 2 August 1916, AWM 27/314/42.

[63] Captain W.H.D. Clark, Ministry of Munitions to Secretary, Australian High Commission, 29 September 1916, AWM 27/314/42.

[64] Lieutenant Colonel E.A. Leane, Administrative Headquarters, AIF London to Official Secretary, High Commissioner's Office, Commonwealth of Australia, 10 October 1916, AWM 27/314/42.

irritation of transporting equipment that was eventually scrapped points to another important issue. In the context of the shipping crisis of 1916-17, Australia was later criticised for placing selfish economic and personnel requirements before the imperial war effort.[66] This may have been one reason why an independent supply of respirators for the Australian troops was not favoured by the British.

At another level, the Melbourne University Respirator was partly a victim of bureaucratic information networks in which the normal cumbersome paperwork was further exacerbated by wartime secrecy.[67] These networks entailed both technological and social aspects. Exchanges about the respirator were telegraphed between Melbourne and London, yet the once revolutionary communication technology of telegraphy was outpaced by the war. Further, the biases of local communication based on proximity and trust favoured local scientific advice, shown by the fact that Pearce supported the initial production of the Melbourne University Respirator, whereas the War Office listened to the Royal Army Medical College.

The failure of the Melbourne University Respirator to enter battle cannot be understood as an isolated technical failure, as it appears not to have been inferior to British respirators in the field in 1915. Some writers suggest failure is a routine aspect of design conceived as a process of making artefacts fit their context.[68] In this sense the Melbourne University Respirator could be seen as a "misfit" that helped to design a more fitting box respirator to suit the British military context. More importantly, others argue that the attribution of success and failure to technologies is primarily a social attribution that is rarely one-sided or closed,[69] requiring the negotiation of complex "interests" and circumstances.[70] The effectiveness of gas protection relied not just on the apparatus but on a system of technological innovation and use involving design, production, testing, transport, training and maintenance of technical and human resources for gas protection. The Melbourne scientists could not enter this system in the role of innovators because they were unable to generalise their own care for the device, which had nurtured its design and initial production to the imperial war theatre. It therefore languished.[71] Upset by the scrapping of the Respirator, Laby developed an account that focused on issues of scientific competence and implied national pride rather than, for example, the cost of transport. It is in drawing the lessons of the Melbourne University Respirator for the future of Australian science and imperial government that Rossiter's demonstration came to play a pivotal role at the 1920

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[65] High Commissioner's Office to Administrative Headquarters, AIF, Comptroller of Munitions Inventions, Ministry of Munitions, 12 October 1916, AWM 27/314/42.

[66] The National Archives, Kew, MT25-86, Draft Report on Shipping Control, 1914-1918. Part III, pp. 258, 260-62.

[67] For scientific information in the First World War, see Roy MacLeod, "'Secrets among Friends': The Research Information Service and the 'Special Relationship' in Allied Scientific Information and Intelligence, 1916-18", *Minerva*, Vol. 37, 1 (1997), pp. 201-33.

[68] This view of routine failure in technology design is discussed in Graham Gooday, "Rewriting the 'book of blots': critical reflections on histories of technological 'failure'", *History and Technology*, Vol. 14 (1998), pp. 264-291

[69] This is the position favoured by Gooday in *ibid.*

[70] Henry Atmore, "Railway interests and the 'Rope of Air', 1840-8", *British Journal for the History of Science*, Vol. 37 (2004), pp. 245-279.

[71] Bruno Latour suggests that technologies in systems need to be "loved" in order to motivate continued interest and attention to problem-solving in *Aramis, or the Love of Technology* (Cambridge MA, London, 1996).

exhibition. As with the Anzac legend, the defeat of a military technology was converted into moral victory, failure into potential success.

**From Failed Technology to Iconic Object**

On 26 October 1920, the flow of activity ebbed in the Natural Philosophy Department just before 5.30 pm and again before 9.00 pm as patrons filed into the lecture theatre and the laboratory was left temporarily still. As the audience gathered and the scrape of chairs and chatter of voices died down, eyes turned to a uniformed officer of the AIF who stepped on to the podium, carrying a rectangular cardboard box. The man was introduced as Captain Rossiter, a demonstrator in physics who began to unpack the respirator. The box was illustrated with a drawing of an officer wearing the apparatus, and showing the title Melbourne University Respirator, adopted, Masson had once explained to a correspondent in the War Office, "to avoid circumlocution"[72] but also letting soldiers at the front know the origin of this life- saving device. Listed on one side were the contents: 1 Rubber Mouthpiece, 1 Elbow and Nose Clip, 1 Rubber Tube with 2 Connectors, 1 Tin containing Absorber, and 1 Tin Box containing Goggles and 4 spare rubber valves. The whole weighed about 18 ounces and only need be carried by troops "in the firing line and in actual danger of a gas attack".[73] Slowly, following instructions on the box, Rossiter put the device on: unscrew caps on Tin; connect one to tube; put shoulder strap over head; clean goggles and put on; clip nose; put mouthpiece between teeth and lips; adjust length of shoulder strap; breathe slowly and deeply. Despite its claims for being "fool proof", gas officers at the front like Rossiter quickly learned the need for training the troops to perform routinely and quickly the act of adorning and breathing through a respirator.[74] Embodying this skill, in uniform, he came to resemble in life the figure on the box.

The effect of this demonstration on an audience whose community had suffered significant casualties in the war — Melbourne University lost 271 of 1273 university men who had served overseas, including sons of senior faculty like Masson[75] — can only be imagined. However, sources relating to experiences on the front indicate that soldiers themselves thought about gas warfare in terms of adequate apparatus and effective performance of its use. In the middle of December 1916, Oswald Collett, a tramways clerk from East Malvern in Melbourne, planned to send a photograph to "Mother". Training with the Australian Field Artillery at an unnamed location in England, he told her how he hoped to be let into the Quartermaster's stores to don steel helmet, anti-gas helmet and anti-tear shell goggles to dress up and be photographed in the equipment his battery was supplied with. He also described a forthcoming training session:

> On Monday we have to walk through a room wearing anti gas helmets in which the gas is thick enough to kill a man almost instantly with only one breath. It turns gold or other metal all colours and clothes go all colours of the rainbow. In this room there is a mixture of 1 part of gas to 200 of air and in actual practice you never get it more than 1/10,000 so you see there is not much to be feared from gas at the front as long as you are warned in time.[76]

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[72] Masson to Captain Collins, 20 September 1915, AWM 27 314/42.

[73] Report on Asphyxiating Gases and Protective Measures, 6, AWM 27/314/51.

[74] Training schemes are shown in the papers of Anderson, AWM, 2DRL-1222. For later comparisons, see Nathan Schlanger, "The Trials of the Gas Mask: An Object of Fumbling", *Configurations*, Vol. 2 (1994), pp. 275–300.

[75] Richard Selleck, *The Shop: the University of Melbourne 1850–1939* (Melbourne, 2003), p. 564.

[76] Collett to Mother, 16 December 1916, AWM, 1DRL-0205.

Appropriately equipped, adequately trained and tactically prepared, no harm would come to him. Kit — knowing how to use it, and displaying this competence to those who feared for his safety — was foremost in Collett's mind as he embarked for the Western Front. In September 1917 Oswald Collett died, according to his file, "from the effects of gas poisoning at Zonnebeke" at the age of twenty years and four months.[77] This is the kind of story with which Melbourne patrons of the physics exhibitions would have been familiar and provides part of the context in which Rossiter's demonstration might be interpreted. Wartime experiences created circumstances in which questions of whether Australian soldiers had been adequately protected in gas warfare, whether they might have benefited from the distribution of the Melbourne University Respirator, and how such tragedies might be prevented in the future, were poignant. Sentiment could be mobilised in public science, as in commemoration and literature, for political purposes. However, the message of the exhibition relied not on sentiment alone, but on practical displays of scientific and technological prowess.

The demonstration of the respirator, held forth as a valuable technology to protect soldiers in warfare, in the context of a 1920 exhibition promoting scientific and industrial development, suggested that if reforms were instituted on two fronts, such failures of imperial science and technology could indeed be overcome. Firstly national and imperial confidence in Australia's scientific and industrial establishment could be built through displays of scientific, technical and industrial prowess. Secondly, the Empire could be reformed in order to allow the democratic and free flow of information and the decentralisation of important jobs. Laby argued in forums like the Round Table, the imperial discussion group which he served as the Melbourne Secretary (1917-42),[78] that this could best be achieved by imperial federation. Such arguments he based on experience in scientific laboratories like the Cavendish Laboratory in Cambridge, where scientists from around the Empire cooperated.[79] Unbeknownst to Laby, his moral to the story of the Melbourne University Respirator was somewhat vindicated in 1919 at an imperial conference of gas warfare specialists, although its findings were classified as secret information at the time. One recommendation was that dominions should be fully included in future development of weapons and protection, and scientific innovation should be pooled.[80]

The Melbourne University Respirator earned its place centre stage of the 1920 exhibition by virtue of the fact that it had not fulfilled its potential as a technology to protect soldiers due to the failure to distribute and use the respirator during the war. Some years later, in 1933, Laby alleged that British military researchers had obtained "useful hints" from the Melbourne respirator while developing their own new models:[81]

> For sixteen months [after the first gas attacks in April 1915] the authorities muddled along with crude and ineffective forms of gas mask. At the end of that period scientific methods were adopted

[77] Note on AWM, 1DRL-0205 also refers to AWM12/11/574, 1916-1918.
[78] Leonie Foster, *High Hopes: the Men and Motives of the Australian Round Table* (Melbourne, 1986).
[79] David Picken, "Thomas Howell Laby, 1880–1946", *Obituary Notices of the Royal Society, 1945–1948*, Vol. 5 (1947), pp. 733–55. For examples in imperial chemistry, see MacLeod, "The 'Arsenal' in the Strand".
[80] "Report of the Committee on Chemical Warfare Organisation", point 13, NAA, B197 1954/1/58.
[81] *Melbourne University Reporter (MUR)* 1921; "Science in Warfare in the Post War Period", Notes for a talk to the Graduates Association, 13 April 1921, UMA, Laby Papers, Box 1.

> for the first time, and the methods were identical with those which were outlined in the report of the Melbourne University to the Government in June, 1915.[82]

However, while British scientists, imperial government, and military bureaucracy delayed in adopting and deploying "scientific methods", soldiers died from gas attacks. This account might be interpreted in the context of criticism of British management of the imperial war effort on the part of Australians like General John Monash and Frederic Eggleston, the senior public servant.[83] While dissatisfaction with the imperial war effort led some to conclude the need for national self-reliance, this was not the whole story. A colleague of Eggleston and Monash in the Round Table, Laby also used the gas respirator story to motivate imperial federation based on distributed scientific and industrial development, and he was not alone in redoubling efforts to achieve better imperial coordination based on science and industry throughout the interwar period.[84] The respirator was intended for mass production and distribution to Australian and imperial troops and indeed it travelled some way along this path. Had it been mass-produced, the respirator would have contributed to the very scientific industrialisation it was then and later used to promote. Yet as a failed technology the main purpose of the gas respirator became political, in that it was used to illustrate both the failings of the existing system of science, industry and Empire, and the potential of scientific and political reform. This would require not just transformation of the Empire, but scientific and industrial reform of the nation.

## Conclusion

The 1920 exhibition invited Melbourne citizens to envision a new Australia, a self-contained nation. This self-reliant nation would not remain dependent on Britain's naval fleet and industrial might for protection, but become a partner in imperial development, only by the extension of science to universities, industries, hospitals and homes. Participants were shown how battles had been won and lost, and how failures of the past, such as the scrapping of the respirator and the failure to protect Australian soldiers that this entailed, could be prevented in the future.

The methods and messages of the 1920 exhibition were reiterated in subsequent exhibitions between the wars. Progress was demonstrated in education, industry and research in order to recruit students, endowments and allies to scientific industrialisation. In the laboratory, members of the public could see military and social problems — for example, gas warfare, distance, the strength of materials and the health of men — being framed and solved in the same space of the exhibition. Demonstrations were like practical classes to accompany the public lectures given by scientists and published in the press and popular journals. The laboratory was portrayed as the source of innovation that enabled and stopped wars, and also the engine room of the modern industrial nation. Laby's political message was fundamentally technocratic; he argued that scientific expertise was required in order to govern sensibly. However, scientific citizens were cultivated at all levels from research scientist to workshop

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[82] "March of Science 'Politicians Lag', Machines and Men", 15 [n.d.], 1933, Laby papers, Box 4.

[83] Geoffrey Serle, *John Monash: a Biography* (Melbourne, 1982); Warren Osmond, *Frederic Eggleston: an Intellectual in Australian Politics* (Sydney, 1985).

[84] T.H. Laby and A.B. Broughton Edge, *The Principles and Practice of Geophysical Prospecting. Being the report of the Imperial Geophysical Experimental Survey* (Cambridge, 1931); Barry Butcher, "Science and the Imperial Vision: The Imperial Geophysical Experimental Survey, 1928–1930", *Historical Records of Australian Science*, Vol. 6, 1 (1984), pp. 31-43. Another example is the Empire Marketing Board.

mechanic, to members of the public who would support governments in favour of science.

Advocates of interwar imperialism such as Laby judged that it was no longer sufficient to rely on Britain for scientific innovation, development and management, a judgement supported in reality by the fall of Singapore in World War Two. Rather, Australians would have to become scientifically and technologically advanced in order to maintain, and develop their role in, the Empire. The Melbourne physics exhibitions were both lessons in physics and lessons in government; on how to make Australian centres of innovation and production important in a science and technology-led Empire. This vision for science in the dominions as part of decentralised Empire effort was in fact later realised in Canadian atomic research and Australian radar research and operations crucial in the Pacific War.

The demonstration of the Melbourne University Respirator in 1920 was chosen to frame this discussion because it encapsulated some experiences of Australian science in the First World War and motivated the development of science and industry between the wars. Rossiter's demonstration also dramatised the relationship between the role of science and industry in the war, and notions of the First World War as a theatre for the display of Australian national character as narrated in various iterations of the Anzac legend. These connections exist at the level of sources, for the history of the Melbourne University Respirator is documented in the Australian War Memorial (AWM) in Canberra, formed after the First World War to commemorate the Australian contribution to war.

The little-known story of the respirator has been pieced together from official reports and correspondence on files located in archives in Canberra, Melbourne and Sydney, supported by a viewing of one of the surviving Melbourne University Respirators in the AWM collection. In August 2002, an assistant, in white coat and gloves, unpacked the pieces, and the curator worked out how it was put together and made. Some photographs were taken. While most respirators were disassembled for scrap in the First World War, at least one respirator was retrieved in the Second World War and paraded around Melbourne University; but it seems subsequently to have rarely been displayed. On the sample examined at the AWM, the rubber was wearing, the metal tarnished and the tin containing absorber corroded. Yet, armed with a story, this museum artefact became a technological object with a purpose, history and moral. It was similarly stories told about the Melbourne University Respirator in lectures and demonstrations that created impressions of how science aided soldiers in warfare, and suggested how science and technology should be developed, and the Empire reformed.