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RESEARCH ARTICLE

Science by Nobel committee: decision making and norms of scientific practice in the early physics and chemistry prizes

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Abstract

This paper examines the early years of decision making in the award of the Nobel Prize in physics and chemistry, and shows how the prize became a tool in the boundary work which upheld the social demarcations between scientists and inventors, as well as promoting a particular normative view of individual scientific achievement. The Nobel committees were charged with rewarding scientific achievements that benefited humankind: their interpretation of that criterion, however, turned in the first instance on their assessment of the groundbreaking nature of the 'science', with the applied or practical 'benefits' of that discovery being treated as very much secondary factors in the award. Through an interrogation of the reports sent by the committees to the Royal Swedish Academy of Sciences, this paper shows how committee members depended on a notion of 'post-dated utilitarianism' in reconciling potential tension between rewarding basic and applied science, and explores the ways in which the annual prize both shaped, and was shaped by, media perceptions of scientific virtue.

The inventor and industrialist Alfred Nobel died in 1896, leaving a vast fortune made from patents of dynamite and ballistite. His will stated that his estate should be used to create a prize to reward those who had 'conferred the greatest benefit to humankind' in the fields of physics, chemistry, medicine, literature, and peace. The rules created for choosing the recipients stated that for each category there would be a Nobel committee: a group of five experts who evaluated the proposed candidates for the prize. This paper will look at the discussions in the early committees for physics and chemistry, and specifically at how they interpreted the 'benefit' that Nobel mentioned. That the prize has generally been awarded to discoveries in basic science, with only a few instances of applications or inventions being recognized, might seem surprising given Nobel's background as an inventor.

In 1901, when the prize was first awarded, the professional identity of the scientist was still being negotiated, and the tension between practical benefit and the disinterested pursuit of knowledge was part of the public discourse about science at the time. There existed simultaneously the image of the scientist as a disinterested seeker of truth and the image of the inventor or engineer who used knowledge to create new technologies from which they could potentially personally profit. Not only did they have different motives – truth or financial gain – but the 'benefits' they conferred were of different kinds. Academic scientists upheld the boundary between these groups by arguing that they produced knowledge of how the natural world worked, which could then be used by inventors and engineers, thus relegating their work to the status of applied science. However, as Steven Shapin notes, this separation was not complete. Putting theory into applied practice was still important for the scientists since this provided a reason beyond personal curiosity to devote one's time to science. Shapin calls this motive 'postdated utilitarianism' – the idea that basic science would lead to practical benefit in the long run.[1] This trope as a motivation for basic science has been enduring.

In this context, the Nobel Prize can be seen as an important new institution where these values could be expressed, especially since the prize was seen by the prize awarders as a resource for raising the status both of the academy and of Swedish science in general. The academic scientists in the Nobel committees were especially wary of Sweden's growing international reputation as a nation of engineers, and saw the prize as a way to respond to that aspect of national identity.[2]

The Nobel Prize has now been in existence for over a century. This period has seen immense change in the role played by science in society and expectations placed by society on scientists. The presumed existence of a distinction between basic scientific innovation and its practical applications has been critical to managing these differences over time. The prize has been a significant factor in preserving this potential contradiction: even today, the prize can be used to present science as both integral to and separable from its applications.

Scientists, inventors and the Nobel Prize

The distinction between basic and applied science can be seen in a number of different cultural and economic contexts. For example, the Nobel Prize has been compared to the World's Fairs, or 'World Expos': during the twentieth century, both have provided a cultural context in which national competence and status could be measured via scientific and technological achievements. At these public exhibitions of technological invention and innovation, much emphasis was placed on advances in consumer products and industrial machines. Science was present, but applications were the main attractions.[3] In contrast, the Nobel Prize prioritized academic science, and viewed applications as both separate from and linked to basic, curiosity-driven science. During the nineteenth century, the term 'applied science' referred to certain sets of rules taught to artisans and engineers as a way of formalizing access to these occupations as they became increasingly professionalized.[4] This meant that the concept of applied science was associated with a social group that was distinct from scientists. In fact, in general the boundary between scientists and engineers was drawn by separating applied from basic, 'pure' science – which was also expressed in the scientists' aversion to patents.[5]

1 Stephen Shapin, *The Scientific Life: A Moral History of a Late Modern Vocation*, Chicago: The University of Chicago Press, 2008, pp. 39, 42–6.

2 Staffan Bergwik, Michael Godhe, Anders Houltz and Magnus Rodell (eds.), *Svensk snillrikhet? Nationella föreställningar om entreprenörer och teknisk begåvning 1800–2000*, Lund: Nordic Academic Press, 2014.

3 Svante Lindqvist, *Changes in the Technological Landscape: Essays in the History of Science and Technology*, Sagamore Beach: Science History Publications, 2011, pp. 255–7; Paul Greenhalgh, *Ephemeral Vistas: The Expositions Universelles, Great Exhibitions and World's Fairs, 1851–1939*, Manchester: Manchester University Press, 1988.

4 Robert Bud, 'Modernity and the ambivalent significance of applied science: motors, wireless, telephones and poison gas', in Robert Bud, Paul Greenhalgh, Frank James and Morag Shiach (eds.), *Being Modern: The Cultural Impact of Science in the Early Twentieth Century*, London: UCL Press, 2018, pp. 97–100.

5 Paul Lucier, 'Court and controversy: patenting science in the nineteenth century', *BJHS* (1996) 29(2), pp. 139–54, 153–4.

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This separation had consequences not just for social but also for economic capital. 'For both scientists and inventors', writes Paul Lucier, 'it was becoming increasingly obvious that the rhetoric of useful knowledge had come face-to-face with the reality that money (sometimes a great deal of money) might be made from such knowledge'.[6] Scientists decried inventors making money through patenting ideas that, in their view, came from and belonged to basic researchers, while inventors saw scientists as obstacles who made it harder to make science useful. These differing views were important since the patent system was changing at this time – rather than being descriptions of specific physical objects with functions, they were increasingly understood to describe the ideas and concepts behind the functions. It was not the machine but the principle behind the machine that was patented, thus making patents part of intellectual property.[7]

Neither group was inclined to narrow the gap between patents and papers, the two key formats for documenting knowledge. For scientists it was important to downplay the role of patents as a source of scientific information, and inventors did not want scientific papers to be accepted as prior art in patents, since that might give basic scientists influence and priority that would remove status from inventors.[8] The documents were kept separate and tied to different social roles: papers represented 'pure' science carried out by academic scientists, and patents belonged with applications and inventors.[9] As this paper will show, the Nobel committees were clearly on the side of 'pure' science and valued papers by scientists over patents and inventors.

In this hierarchy technology was seen as 'just' an application, a continuation of basic science.[10] For scientists, this was – and has continued to be – a useful argument for the autonomy of science. 'The social contract', writes Jon Agar, 'has been that science will deliver, if left autonomous'.[11] This view was based on a 'linear model' of dissemination of science from academia to industry which, while often seen as artificial and oversimplified, has endured because of its political usefulness. The model came under serious strain during the First World War, but survived, and, in the post-war period, physicists in both Europe and the United States sought to establish their control over science policy by claiming that applications were the consequences of their work, and the result of independent, basic, research.[12] This was successful largely because of the increasing influence of what historians have called 'committee-room science'. Science policy was shaped by committees consisting of academic scientists who tended to view basic science as the base for further applications, 'thus protecting the independence and autonomy of science', with effects on both science and innovation policy.[13] Committees helped entrench the idea of post-dated utilitarianism.

[6] Lucier, op. cit. (5), p. 141.

[7] Mario Biagioli, 'Patent republic: representing inventions, constructing rights and authors', *Social Research* (2006) 73(4), pp. 1143–7, 1150–1; Eva Hemmungs Wirtén, 'How patents became documents, or dreaming of a technoscientific order, 1896–1937', *Journal of Documentation* (2019) 75(3), pp. 577–92.

[8] Lucier, op. cit. (5), p. 152.

[9] Eva Hemmungs Wirtén, 'The patent and the paper: a few thoughts on late modern science and intellectual property', *Culture Unbound* (2015) 7, pp. 600–9, *passim*; Biagioli, op. cit. (7), p. 1142–3; Alan Pottage and Brad Sherman, *Figures of Invention: A History of Modern Patent Law*, Oxford, Oxford University Press, 2010, pp. 1–3.

[10] Bud, op. cit. (4), pp. 100–1.

[11] Jon Agar, 'The 2016 Wilkins–Bernal–Medawar lecture: the curious history of curiosity-driven research', *Notes and Records of the Royal Society of London* (2017) 74(3), pp. 409–29, 425.

[12] Cathryn Carson, 'Objectivity and the scientist: Heisenberg rethinks', *Science in Context* (2003) 16(1–2), 243–69; Benoît Godin, 'The linear model of innovation: the historical construction of an analytical framework', *Science, Technology, & Human Values* (2006) 31, pp. 639–67; Graeme Gooday, '"Vague and artificial": the historically elusive distinction between pure and applied science', *Isis* (2012) 103, pp. 546–54; Daniel Kevles, *The Physicists: The History of a Scientific Community in Modern America*, Cambridge, MA: Harvard University Press, 1995, pp. 352–3, 364–7, 383.

[13] Jon Agar, *Science Policy under Thatcher*, London: UCL Press, 2019, pp. 2–3, 10–11, 31–49, 106–8, quote at 3.

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While not directed at policy makers, the Nobel committees still contributed to a value system where scientists were defined as separate from inventors, and scientific importance held a higher value than practical usefulness by providing it with substantial symbolic capital. Historians have previously studied the committee to see how prize decisions were influenced by personal or social considerations in the prize-awarding institutions.[14] To understand the broader implications of these discussions, we can also draw on the work of several scholars who have investigated the prize's broader place in the relation of science and society, which shows that the decisions made by the academy were influenced by the perception of science in different cultural arenas, while in turn the arguments put forward by committees members contributed to normative ideas about scientific practice.[15] For example, the committees were very concerned with what might constitute excellence in research, and also understandably wanted to use the prize to further their own particular fields.[16] They were also deeply concerned about the impact, status and legitimacy of the prizes, not least because they would reflect directly on the reputations of the committee members.[17] The media visibility of the prize gave the committes' views the potential to become influential among both scientists and the public.[18]

As other scholars have shown, committees played an essential role in making tacit norms of scientific discursive practice explicit.[19] This paper will examine these norms in the context of boundary work between scientists and inventors.[20] By examining the Nobel committees, this paper will contribute to this growing historiographical tradition of examining committee-room science, as well as providing an example of how a

[14] Ragnar Björk, 'Inside the Nobel Committee on Medicine: prize competition procedures 1901–1950 and the fate of Carl Neuberg', *Minerva* (2001) 39(4), pp. 393–408; Elisabeth Crawford, *The Beginnings of the Nobel Institution: The Science Prizes, 1901–1915*, Cambridge: Cambridge University Press, 1984; Robert Marc Friedman, *The Politics of Excellence: Behind the Nobel Prize in Science*, New York: W.H. Freeman, 2001; Aant Elzinga, *Einstein's Nobel Prize: A Glimpse behind Closed Doors. The Archival Evidence*, Sagamore Beach, MA: Science History Publications, 2006; Franz Luttenberger, 'Arrhenius vs. Ehrlich on immunochemistry: decisions about scientific progress in the context of the Nobel Prize', *Theoretical Medicine* (1992) 13(2), pp. 137–73.

[15] Robert Marc Friedman, '"Has the Swedish Academy of Sciences … seen nothing, heard nothing, and understood nothing?" The First World War, biased neutrality, and the Nobel Prize in Science', in Rebecka Lettevall, Geert Somsen and Sven Widmalm (eds.), *Neutrality in Twentieth-Century Europe: Intersections of Science, Culture, and Politics after the First World War*, London: Routledge, 2012, pp. 90–114; Gustav Källstrand, 'Warburg's dogs: Nobel laureates and scientific celebrity', *Celebrity Studies* (2022) 13(1), pp. 56–72; Sven Widmalm, 'Science and neutrality: the Nobel prizes of 1919 and scientific internationalism in Sweden', *Minerva* (1995) 33(4), pp. 339–63; Harriet Zuckerman, *Scientific Elite: Nobel Laureates in the United States*, New Brunswick, NJ: Transaction Publishers, 1996.

[16] Cf. Nils Hansson, David S. Jones and Thomas Schlich, 'Defining "cutting-edge" excellence: awarding Nobel Prizes (or not) to surgeons', in Nils Hansson, Thorsten Halling and Heiner Fangerau (eds.), *Attributing Excellence in Medicine: The History of the Nobel Prize*, Leiden: Brill, 2019, pp. 122–41.

[17] Gustav Källstrand, 'More than a prize: the creation of the Nobel system', in Hansson, Halling and Fangerau, op. cit. (16), pp. 39–58; Sven Widmalm, 'The Nobel science prizes and their constituencies', *Public Understanding of Science* (2018) 27(4), pp. 397–404.

[18] Alberto Brodesco, 'Nobel Laureates in fiction: from *La Fin du Monde* to *The Big Bang Theory*', *Public Understanding of Science* (2018) 27(4), pp. 458–70; Declan Fahy, 'The laureate as celebrity genius: how *Scientific American*'s John Horgan profiled Nobel Prize winners', *Public Understanding of Science* (2018) 27(4), pp. 433–45; Hillevi Ganetz, 'The Nobel celebrity–scientist: genius and personality', *Celebrity Studies* (2016) 7(2), pp. 234–48; Jean-Baptiste Gouyon, 'From engaged citizen to lone hero: Nobel Prize laureates on British television, 1962–2004', *Public Understanding of Science* (2018) 27(4), pp. 446–57; Gustav Källstrand, 'The image of the Nobel Prize,' *Public Understanding of Science* (2018) 27(4), pp. 405–16; Källstrand, *Medaljens framsida: Nobelpriset i pressen 1897–1911,* Stockholm: Carlsson, 2012.

[19] Agar, op. cit. (11); Agar, op. cit. (13); Godin, op. cit. (12).

[20] Thomas F. Gieryn, 'Boundary-work and the demarcation of science from non-science: strains and interests in professional ideologies of scientists', *American Sociological Review* (1983) 48(6), pp. 781–95.

prestigious institution mirrored themes in the contemporary discussions on the use of science and the status of scientists.

The prize awarders

Alfred Nobel gave the task of selecting the laureates in physics and chemistry to the Royal Swedish Academy of Sciences, which in 1901 had about one hundred members, divided into classes by subject. Five members each from the physics and chemistry classes were selected to form Nobel committees. The academy had engineers among its members, but by the early twentieth century it consisted mainly of scholars whose interests lay more in academic scientific research than in technological or practical developments.[21] Intriguingly, the academy had been founded in 1739 with the aim of producing and disseminating useful knowledge. This was an aim similar to the 'benefit' that Nobel wished to reward, and might have been the reason why Nobel, who was an inventor and not a scientist, chose it as a prize-awarding institution. However, the Academy underwent key changes during the nineteenth century, placing more emphasis on supporting research, publishing scientific papers and upholding international contacts. This movement away from 'useful' and towards 'academic' knowledge was still under way in the early twentieth century. In 1904, however, a class was created for 'technical science' where engineers could become members. This meant that there were at least two groups with potentially different views of the value of the practical application of knowledge in the academy, and that 'benefit' could be interpreted in several ways.[22]

The task of awarding the Nobel Prize was accepted only after some hesitancy in the academy.[23] One concern was whether the academy would be able to make the right choices – or rather, if the choices made by the academy would be recognized as correct. Would a small group of researchers in Sweden carry enough weight with the wider scientific community to make the prize an accolade of the highest order? The solution was to ask scientists to nominate candidates. Several members of the academy had personal international networks among researchers in their fields, which they could enrol both to give the academy a broader sense of which choices would be appreciated in the scientific community and to make sure their favourite candidates were nominated. (The academy also had foreign members, but they did not serve on the committees).[24]

Through the prize, the academy was granted funds that could be used for financing research, and the hope was that the Nobel donation would help to make Stockholm an international scientific centre.[25] Thus the prize became a resource for the academy in terms of both status and finances. In this context, it becomes easier to see that recognizing inventors and engineers would not be a high priority for the academic members of the committees. In fact, it could contribute to undermining their status. The Nobel Prize was a resource that the Nobel committees could use to demonstrate and legitimize their norms of scientific practice, and to appropriate the practical applications of basic science. By celebrating scientific knowledge as a better basis for social progress than technological expertise, the academy upheld the hierarchy of these two concepts.

This paper explores the first five years of the Nobel Prize, a time when the Nobel committees developed strategies that would shape Nobel decision processes for a long time.

[21] Ingrid Carlberg, *Nobel: Den gåtfulle Alfred, hans tid och hans pris*, Stockholm: Norstedts, 2019, pp. 175, 221.

[22] Henrik Björck and Thomas Kaiserfeld, 'Akademiens historia', in Johan Kärnfeldt, Karl Grandin and Solveig Jülich (eds.), *Kunskapens nya vägar: Kungl. Vetenskapsakademien och skapandet av det moderna samhället*, Göteborg: Makadam, 2018, pp. 25–373, 25–6, 34–5, 43, 50, 53.

[23] Crawford, op. cit. (14), pp. 60–86, esp. 70–1.

[24] Crawford, op. cit. (14), pp. 75, 81–2.

[25] Källstrand, op. cit. (17).

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Their work consisted of reviewing nominations, evaluating the candidates and submitting a report to the full academy which then made the final decision. The strategies developed in the committees stemmed both from social circumstances in the prize-awarding institutions and from committee members' views of what should be considered good science.[26]

The academy did not have to vote according to the committee's recommendations, and this is important for understanding how the committees wrote their reports. In part, these were scientific reviews of the work of the nominees, but they were reviews that performed a key rhetorical function, aiming to convince the academy of the excellence of the committees' choices. Tensions between the committee and the academy soon became apparent, partly because the committees favoured relevance in their discipline over a more practical interpretation of Nobel's 'benefit for humankind'.[27]

The Nobel Prize and the public

The discussions in the committees took place amid considerable media attention. From the outset, expectations had been high in the Swedish press that the prize would become a source of national pride.[28] Newspapers all over the world wrote about the prize, and, to a large extent, international interest followed the distribution of prizes. In France, Germany and Britain, this meant that the papers wrote about the prize more or less every year, which was crucial for ensuring a high international status.[29]

Research on the history of the Nobel Prize has stressed how useful it was for its stakeholders, and these included not only the prize awarders but also the public and the media.[30] The prize played a significant role in how science was communicated and could also make valuable contributions to national prestige. The more prestigious the prize became in the public sphere, the more useful it became for the prize-awarding institutions and the committee members. By adhering to strict secrecy, the attention was directed to the laureates and their work rather than to the prize awarders.[31] These kept in the background, as faceless 'paragons of Solomonic wisdom', whose choices could thus be seen not as the result of negotiations, but as part of the natural order of things.[32]

When discussing the prizes, the press described both the discoveries and the laureates as spectacular. 'Discoveries', writes Elisabeth Crawford, 'awarded the prize were expected to involve surprises, startling effects, and leaps into the unknown'.[33] Sometimes, as with the 1903 award to the Curies, this was easy, but even when the awarded work was less captivating and the winners less engaging they were still described as groundbreaking and interesting. Nobel laureates were characteristically described as atypical, unique and brilliant.[34] Notably, press coverage was not concerned with whether the prizes were given to inventors or to reward basic science. Since the status of the prize depended

[26] Crawford, op. cit. (14); Friedman, op. cit. (14); Hansson, Jones and Schlich, op. cit. (16); Luttenberger, op. cit. (14).

[27] Crawford, op. cit. (14), pp. 157–8, 186–7, 198.

[28] Källstrand, 'The image of the Nobel Prize', op. cit. (18), p. 408.

[29] Massimiano Bucchi, 'Visible scientists, media coverage and national identity: Nobel laureates in the Italian daily press', in Bernard Shiele, Michel Claessens and Shunke Shi (eds.), *Science Communication in the World: Practices, Theories and Trends,* Dordrecht: Springer, 2012, pp. 259–68; Crawford, op. cit. (14), pp. 189–90.

[30] Friedman, op. cit. (15), pp. 110–11; Gustav Källstrand, *Andens olympiska spel: Nobelprisets historia*, Stockholm: Fri Tanke, 2021, *passim*; Widmalm, op. cit. (17), pp. 397–8.

[31] Crawford, op. cit. (14), pp. 196–7.

[32] Crawford, op. cit. (14), pp. 192–3.

[33] Crawford, op. cit. (14), pp. 195–6.

[34] Crawford, op. cit. (14), p. 196; Källstrand, op. cit. (15), pp. 9–10.

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on the prize awarders' status as paragons of wisdom, undercutting their legitimacy by questioning the wisdom of their choices would have been counterproductive. The media instead remained loyal to the post-dated utilitarianism of the prize awarders' definition of benefit – that in the long run, even basic discoveries would lead to practical benefit.

The paper

This paper will explore the reports that the committees sent to the academy. As noted, these were rhetorical documents meant to get the academy to agree with the committees' proposed prize winner. The first section consists of a close reading of the reports from 1901 to 1905. It does not single out prizes identified as relating to invention or technological innovation, but instead focuses on how the phrase 'benefit for humankind' was interpreted, understood and deployed. Of particular interest are the ways in which arguments focusing on research for its own sake were understood in relation to practical application. In Nobel's will, 'benefit for humankind' was the reason for choosing laureates, but unofficial criteria emerged in the committees which gave scientific influence primacy over practical applications. The paper's second section examines two cases from 1905 and 1909, where inventions or technologies were in fact awarded the prize, to see how the separation between pure research and 'practical application' was upheld in cases where applications appeared to be the most obvious motivations for the award. The cases show how the committees' definition of benefit was successful, but also that in certain circumstances, other views in the academy could be used to overrule the committees. The paper's conclusion is that while the primacy of influence over application was established in the early period, it remained an ongoing point of negotiation in subsequent years.

Committee room papers 1901–1905

The Nobel committee reports became resources that their members could use to further views on boundaries between scientists and inventors, and between basic and applied science. In their reports to the academy, scientific influence was the *primary* factor for favouring a certain candidate. Once this was established, there were also *secondary* ways to convince the academy that a candidate would be accepted by the scientific community as worthy of a Nobel Prize – factors that were not enough for a prize, but which could support a candidate perceived to have the right scientific credentials. Among these were presumed historical importance, status in the scientific community and practical applications. The committees did not deny the importance of applications, but nevertheless upheld the hierarchy between basic and applied science by making them secondary factors in the decision-making process.

The primacy of scientific impact

Since neither Nobel's will or the statutes of the Nobel Foundation gave any clearly defined criteria on how the laureates should be selected, the Nobel committees came up with what historian Franz Luttenberger in a study of the medicine committee's first decade calls 'unofficial criteria'.[35] The discovery should be generally accepted as correct and it should have resolved some major problem. Both practical usefulness and scientific influence were seen as a good for a Nobel candidate – but Luttenberger's study does not

[35] Franz Luttenberger, 'Konsten att utse nobelpristagare', in Thomas Kaiserfeld (ed.), *Från moderna helgonkulter till självmord: Föredrag från idé- och vetenskapshistorisk konferens 1995,* Stockholm: KTH, 1995, pp. 53–61.

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identify any hierarchy between these. This study will demonstrate that such a hierarchy was present in the physics and chemistry committees, and it may have existed in the medicine committee as well. For example, internal guidelines for the medicine committee from 1926 stated that 'benefit' should not be interpreted as practical utility, but as the 'originality and scientific significance' of the nominated work.[36] These guidelines were written by J.E. Johansson, a professor and a one-time collaborator with Nobel himself, who had claimed during the negotiations leading to the establishment of the Nobel Prize that Nobel's interest had been in basic rather than applied research.[37] This testimony provided the prize awarders in all the scientific categories with a mandate to interpret 'benefit' more broadly than just as practical usefulness. When the physics committee met for the first time, in January 1901, the chairman raised the issue of whether patented inventions should even be eligible for the prize. According to the statutes, a nominated work should have been 'issued in print' – and this could include patents as well as scientific papers. The chairman worried that this might give the impression that the Nobel was a prize for inventors. The committee eventually decided that changing the statutes would not be necessary – since they would not consider patented works for the prize, this issue would settle itself with time.[38]

This view of usefulness as of secondary importance was demonstrated as soon as the committee started discussing the first physics prize, which ended with the recommendation that Wilhelm Conrad Röntgen and Philipp Lenard should share the prize. Röntgen was worthy of the prize, the committee stated, because his discovery of X-rays had 'increased our knowledge' and thereby 'opened a new field of unsuspected interest for scientific research', and because of the importance of 'its practical results'.[39] These might suggest that the practical results were equally important, but they were in fact an anticipated rather than actual application, since X-rays did not become a functioning diagnostic tool until several years later. But for the committee future usefulness could be credited to the basic discovery. If this had been a primary factor, they would have had to confirm its utility, but what mattered primarily to the committee was the basic scientific impact of the discovery. This became clear in the further discussions on whether Röntgen should receive the prize alone. When evaluating Philipp Lenard's work on cathode rays, the committee found that it and the X-rays were of equal scientific importance. The only difference between the candidates was the practical value expected from Röntgen's discovery, which was not considered important enough to separate them and only recommend Röntgen, especially since Lenard's work had paved the way for Röntgen's discovery. Being scientifically equal was what mattered.[40]

The same point was made in a report on the 1901 chemistry laureate, Jacobus Henricus van't Hoff, which stated explicitly that 'benefit for humankind' should be read not as 'the direct practical use of the discovery' but 'also, and perhaps to an even higher degree, [as] the idealistic benefit which for example springs from an increase in man's insights into the workings of nature'.[41] In other words, post-dated utilitarianism. The report was written by the physical chemist Svante Arrhenius, who was a member of the physics committee and an expert in the chemistry committee and thereby was very influential in Nobel Prize matters. Arrhenius was also a popular writer and lecturer, who described the benefit

[36] J.E. Johansson, *Minneslista för Nobelprisgruppen i fysiologi eller medicin*, Stockholm: Norstedt, 1926, p. 16.
[37] *Protokoll hållna vid öfverläggning om Alfred Nobels testamente*, Stockholm: P.A. Nordstedt & Söner, 1899, p. 30.
[38] Nobel Committee for Physics 1900–1909, Royal Swedish Academy of Sciences, pp. 7–8.
[39] Minutes on Nobel matters, Royal Academy of Sciences 1901, pp. 60–1.
[40] Minutes on Nobel matters, Royal Academy of Sciences 1901, p. 61.
[41] Minutes on Nobel matters, Royal Academy of Sciences 1903, p. 93.

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that technology had for society – and how this benefit flowed in a linear fashion from scientific discoveries.[42]

The main point in Arrhenius's report was the broad impact of Van't Hoff's work on osmotic pressure. Only at the end did it mention its 'extraordinarily great practical benefit for humankind'.[43] Van't Hoff had not worked on these applications himself, which meant that when it was used as a motivation for the prize, usefulness was not credited to those who made the application. Instead, the linear understanding of innovation meant that the social boundary between scientists and engineers was upheld partly by the scientists' appropriation of technology in their own support.

Definitions of impact

The Nobel committees both implicitly and explicitly interpreted 'benefit for humankind' as 'benefit for science', with applications as a positive but not necessary side effect. Therefore the primary goal of their reports was to demonstrate how the work of the proposed candidates had contributed to the expansion of the body of scientific knowledge. The committee report on Arrhenius, when he himself was considered for the 1903 chemistry prize, emphasized that his theory of electrolytic dissociation had made 'electrolysis and its applications in chemistry … fully elaborated parts of the natural sciences'. The report argued that Arrhenius had put chemistry on a firmer scientific basis, and that had led to new knowledge in several scientific fields, such as physics, geology and physiology.[44]

What mattered for the Nobel committee was that a candidate's work had become influential, and the committee described influence in three ways: the introduction of new methods, the confirmation of existing theories, and opening new avenues for research, preferably in many fields. This was demonstrated in the 1902 report on Emil Fisher and his work on synthesizing purines and saccharides. Fisher had developed new methods that were applicable for synthetic chemistry in general, his work gave experimental support for existing stereochemical theories, and since it was relevant for the mechanisms of enzyme activity, Fischer's work was useful not only for chemical but also for physiological studies.[45] The benefit of Fischer's work was how the new knowledge it produced contributed to science in a broader sense. In the discussions on William Ramsay in 1903, this broader impact was also the primary reason for recommending a prize to him. Ramsay's discovery of the inert gases was proposed for a chemistry prize, and the committee said that while discovering a new element was in itself an achievement worthy of a prize, the importance of Ramsay's discoveries went beyond 'the new facts with which they have enrichened science', since they were also valuable for laying a theoretical foundation for chemistry.[46]

Solving old problems which had become bottlenecks for development in a field was considered important. Still, this was part of what Kuhn would call 'normal science', in which research aimed at solving questions arising within a given paradigm.[47]

[42] Olov Amelin, 'Physics as ideology: Svante Arrhenius as a writer of popular science', in Svante Lindqvist (ed.), *Center on the Periphery: Historical Aspects of 20th-Century Physics*, Canton, MA: Science History Publications, 1993, pp. 47–54; Elisabeth Crawford, *Arrhenius: From Ionic Theory to Greenhouse Effect*, Canton, MA: Science History Publications, 1996.

[43] Minutes on Nobel matters, Royal Academy of Sciences 1901, pp. 93, 95.

[44] Minutes on Nobel matters, Royal Academy of Sciences 1903, pp. 189–90.

[45] Minutes on Nobel matters, Royal Academy of Sciences 1902, pp. 86–8.

[46] Minutes on Nobel matters, Royal Academy of Sciences 1903, pp. 199–200.

[47] Thomas Kuhn, *The Structure of Scientific Revolutions* (2nd edn), Chicago: The University of Chicago Press, 1970, pp. 5–6, 35–42, 52–65.

Even more value was placed on unexpected discoveries, which could create new paradigms, or at least new research fields. This was the case with the 1903 physics prize to Henri Becquerel and Marie and Pierre Curie. The committee argued for their importance by describing how they had created a new scientific field:

> Through the discovery of the radioactive elements … a new field of the greatest importance and interest has been opened for physical research, new phenomena have been discovered through which our basic understanding of certain physical questions has been modified to a considerable degree, and ideas have been given to an extent that we are still not able to grasp completely.[48]

Furthermore, the results obtained were described as 'epoch-making' and the report said that 'a new energy source has been found, which lies completely outside of the boundaries of our current knowledge on physical laws and phenomena'.[49] That the importance of the discovery was largely due to its unexpectedness meant that much was still unknown about radioactivity, and this was not seen as problematic. On the contrary, that there was so much more to discover was what made the discovery of radioactivity so deserving of a prize. A new field of research had been opened, and this made the importance of Becquerel's and the Curies' work 'indisputable'.[50]

The benefit of a discovery was measured by influence, and the subsequent work of others could increase the influence and thus make a discovery more and more worthy of a prize over time. We have already seen how Philipp Lenard's work on cathode tubes became more important through the discovery of X-rays, and the 1903 physics prize to Lord Rayleigh was partly motivated by William Ramsay's discovery of the other inert gases (neon, krypton and xenon) and his isolation of helium. Conversely, Ramsay's work had not been possible without the discovery of argon, to which he also contributed.[51] In a similar way, Becquerel had actually discovered radioactivity, but it was through the work of the Curies that it became truly influential (and received its accepted name rather than the initial 'Becquerel-rays'). This kind of postponed influence was foreseen in the statutes of the prize. While Nobel's will referred to awarding work done 'during the preceding year', the statutes recognized the difficulty in judging impact so soon. Instead, this was taken to imply that the committees should strive to award recent science, and discoveries which had recently become important. The benefit of a scientific discovery was determined by its relation to the scientific landscape not when it was made, but at the time when it was considered for an award.

Secondary factors

Apart from scientific influence, there were also other unofficial criteria for choosing a laureate. These were the secondary factors, in themselves not enough for awarding someone a prize, but necessary for making the committees able to convince the whole academy of their choices. These can be separated into three groups: historical importance, social acceptance and practical usefulness. Together, these factors gave the academy confidence that the proposed award was of sufficient historical, social and practical sense to be accepted by posterity as well as by the contemporary scientific community.

48 Minutes on Nobel matters, Royal Academy of Sciences 1903, p. 93.
49 Minutes on Nobel matters, Royal Academy of Sciences 1903, p. 104.
50 Minutes on Nobel matters, Royal Academy of Sciences 1903, p. 104.
51 Minutes on Nobel matters, Royal Academy of Sciences 1903, p. 107.

Historical importance and longevity

Temporality played an important role for the cultural status of the Nobel Prize. It rewarded past achievements while pointing to their future usefulness, and this placed the prize itself in the centre, as the pinnacle of historical development as well as the stepping stone for further exploration. The repetitive nature of the prize contributed to this temporal dimension, since it gave the prize a sense of permanence, making the announcement of new prizes each year seem like part of the natural order of things. This has been described in terms of the prize becoming what Hobsbawn calls an 'invented tradition'.[52] This created the image that 'science is always new and yet always the same, that it constantly produces novelties using an established formula', an image that lives on in the prize today and continues to affect public understanding of scientific progress.[53]

The temporal aspect of the prize was clearly present in the committee reports. These often included a historical framing of the discovery, in which science was presented as cumulative and driven by individuals, and the candidates' discoveries were described as the latest step forward. This steady march towards increased knowledge and further progress was in keeping with how scientists who communicated with the public at this time described the development of science.[54]

Svante Arrhenius was one of these public scientists, and in the 1901 report on Van't Hoff he used a historical narrative to emphasize the importance of his work. Before Van't Hoff, wrote Arrhenius, there had been two major chemical laws, and now there were three. The first two were Lavoisier's law of the conservation of matter in chemical reactions, which said that matter is neither created nor destroyed in reactions, and Dalton's law of multiple proportions, which said that elements combine in relations of whole numbers. To these, Arrhenius stated, a new law could be added – the law of matter 'striving to spread in the surrounding space' (because of osmotic pressure).[55] In this way, he established a historical chain linking Lavoisier, Dalton and Van't Hoff. Given the influence of both Lavoisier's and Dalton's laws and their status in the history of chemistry, this was a powerful rhetorical chain indeed.

Historical importance could also be described in terms of ensuring a firm theoretical basis for a field. The 1903 report on Arrhenius himself depicted pre-Arrhenius chemistry as without a firm theoretical basis. Then came Arrhenius, whose ionic theory of electrolytical dissociation supplied quantifiable laws for chemical reactions. To strengthen the historical perspective, a narrative was established where Arrhenius had to overcome adversity to his theory before being vindicated, notably by the already Nobel-awarded Van't Hoff.[56] The story positioned Arrhenius as a historical figure who had ushered in a new era for chemistry as a discipline. Another example of how history mattered to the committee was the 1905 report on Phillip Lenard. It claimed that the behaviour of electricity in gases had previously remained unexplained despite contributions from several important scientists in the late nineteenth century. Lenard's work, however provided the solution. He had carried out a series of experiments on cathode rays in the 1890s, to which 'almost everything of importance that physics has learned about these rays' could

[52] Eric J. Hobsbawn, 'Inventing traditions', in Eric Hobsbawn and Terence Ranger (eds.), *The Invention of Tradition*, Cambridge: Cambridge University Press, 1983, pp. 1–14; Källstrand, *Medaljens framsida*, op. cit. (18), pp. 16–19.

[53] Widmalm, op. cit. (17), p. 399.

[54] Cf. Peter Bowler, *Science for All: The Popularization of Science in Early Twentieth-Century Britain,* Chicago: The University of Chicago Press, 2009, pp. 53–77.

[55] Minutes on Nobel matters, Royal Academy of Sciences 1901, p. 91.

[56] Minutes on Nobel matters, Royal Academy of Sciences 1903, pp. 206–10.

be traced back.[57] This gave Lenard's work historical significance – and meant that giving him the prize would probably reflect well on the academy for a long time.

By placing candidates in these historical contexts, the committees were arguing both for the candidates and for the primacy of scientific influence. The implication was that an invention, however useful in the present, paled in comparison to the historical significance of these basic discoveries. When the physics committee argued for a prize for Lord Rayleigh in 1904, it did so on the basis that Rayleigh's discovery of argon in the atmosphere meant that the accepted view, originating with Lavoisier a century earlier, that air consisted only of nitrogen and oxygen was incomplete.[58] A similar argument was made for awarding Ramsay the chemistry prize for the discovery of the inert gases. The committee emphasized that finding elements which did not enter compounds was a break with an older scientific paradigm since the accepted view was that this ability was a defining property of the basic elements.[59] This argument hinged on the view that shifting paradigms established by an authority like Lavoisier was of such historical importance that the academy could thereby be convinced of the longevity of the candidates' influence.

Recognition of the individual

Beyond great discoveries – which had long been attributed to individuals – the public understanding of scientific practice was marked by impersonality at the time when the Nobel Prize was becoming established. Contemporaries like Max Weber and Thorstein Veblen argued that science was a collective project and that the traits of individual scientists were of no significance. For Veblen, this also meant that science was not useful in itself – benefit was a consequence of how societal institutions used the knowledge that scientists produced. Despite this rhetoric, as Shapin points out, there were several practices that opposed this impersonal view of science.[60] The Nobel Prize was one such practice. Besides using historical context to heighten the value of the laureates' scientific influence, the Nobel committees were also doing normative boundary work by drawing attention to the influence of the candidates' personality and character. The prize depended both on the view that individuals mattered, and on the view that science was useful. The usefulness was interpreted along the lines of post-dated utilitarianism, but it was also a matter of boundary work between scientists and engineers. This linked it to the individual – and a consequence of the committee-room work was that living up to the norms of behaviour for a scientist become a factor in the reports.

Social relations and personal motivations certainly played a part in the committee discussions.[61] Describing the personal qualifications of a candidates was also a way for the committee to convince the members of the academy of the virtues of a candidate. The report from 1902 described Emil Fisher in terms that made these virtues explicit:

> Professor Emil Fischer has become one of the foremost contemporary scientific researchers. With a superior sagacity and an ingeniousness in choosing means and ways, he combines a tenacious energy in solving the hardest tasks [*sic*]. His experimental work has to an increasing degree won the admiration of the chemical world.[62]

[57] Minutes on Nobel matters, Royal Academy of Sciences 1905, pp. 85–7.
[58] Minutes on Nobel matters, Royal Academy of Sciences 1904, p. 127.
[59] Minutes on Nobel matters, Royal Academy of Sciences 1903, p. 200.
[60] Shapin, op. cit. (1), pp. 1, 6–13, 44.
[61] This is the major theme of Friedman, op. cit. (14).
[62] Minutes on Nobel matters, Royal Academy of Sciences 1902, p. 94.

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This was a way of saying that Fisher possessed the necessary personal qualities to be a good scientist. Being a person who enjoyed the 'admiration of the chemical world' because of his seriousness and devotion meant that he would be a suitable representative for the Nobel Prize, and that choosing him would reflect well on the academy. Likewise, when the committee in 1903 drew attention to Lord Rayleigh's 'experimental talent and … investigative superiority', this reassured the academy that Rayleigh possessed the appropriate scientific virtues.[63] By extension, it also contributed to establishing these virtues as norms for scientific practice.

An effective way to show the appreciation that candidates enjoyed among their peers was to make references to the number and status of their nominators. See, for example, the report on Arrhenius in 1903:

> The great number of nominators … instils certainty in the committee about both that, in its appreciation of Arrhenii merits it is in accordance with the general opinion in the scientific world, and that, the award in question should be bestowed on him now or in the immediate future.[64]

This was followed by a long list of the scientists who supported his candidacy.[65] Supplying the names meant that the argument was qualitative as well as quantitative – it was not only the number of nominations that mattered but also who had made them. In the case of Arrhenius, his Swedish nationality might have increased the need to emphasize broad international support. It was important that the academy did not seem biased when giving a Swede – and indeed a member of the physics committee – the prize. Showing the range of support that he could command might help convince the academy that any such criticism could be countered.[66]

Who the nominator was could be important, but there was also strength in numbers since being nominated by many colleagues was in itself a sign of credibility. That nominations were sometimes called 'votes' – as when the 1904 the chemistry report mentioned the large number of 'votes that Ramsay received from the domestic and foreign authorities' – is a sign of this.[67] Formally, the number of nominations did not matter, but it was nevertheless useful to signal a candidate's strong support. This was the case with Adolf von Baeyer, whose ranking above the other candidates was motivated by 'the circumstance that a number of the most significant authorities in the field of chemistry have recommended him for every prize since 1901', a sure sign that his 'merits [were] acknowledged everywhere in the scientific world'.[68] The committees used these nominations as a signal of the candidate's professional standing in order to show that choosing them would 'be received with satisfaction in the world of natural science'.[69] Who the candidates were mattered and awarding candidates who adhered to the norms of scientific practice would reflect well on the Swedish scientific community.

The media attention that the Nobel Prize received helped spread these norms outside the scientific community. However, the press did not present the Nobel laureates as typical scientists. On the contrary, an important point in constructing the 'persona' of Nobel laureates was to stress that they were special and exceptional individuals.[70] By putting the

[63] Minutes on Nobel matters, Royal Academy of Sciences 1903, p. 105, 1904, p. 58.
[64] Minutes on Nobel matters, Royal Academy of Sciences 1903, pp. 190–1.
[65] Minutes on Nobel matters, Royal Academy of Sciences 1903, p. 228.
[66] Källstrand, *Medaljens framsida*, op. cit. (18), pp. 121–2.
[67] Minutes on Nobel matters, Royal Academy of Sciences 1904, p. 125.
[68] Minutes on Nobel matters, Royal Academy of Sciences 1905, p. 158.
[69] Minutes on Nobel matters, Royal Academy of Sciences 1905, p. 83.
[70] Källstrand, op. cit. (15), *passim*.

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spotlight on individual researchers each year, the Nobel Prize contributed to normalizing an individual-actor-based view of science.

Practical benefit

For the Nobel committees, as we have seen, 'benefit' was a matter of impact in science, not practical utility. This was an outcome of both philosophical conviction and social boundary work. Both the historical context and the character of the scientists were used to convince the academy members to vote for the candidates suggested by the committees. History and virtues were ways to assess the scientific influence of the candidates, especially to those members who were scientists in other fields and might be sceptical as to whether the committee members were too narrow in awarding their own specialties.

There were, however, those in the academy who leaned towards a more utilitarian interpretation of Nobel's 'benefit', not least among the members in the section for technical science. The committees made a virtue of this necessity by describing the relation between science and technology. This made the usefulness of science a matter of influence, and made applications a secondary factor. This post-dated utilitarianism was a way to disarm the issue – if technological applications were consequences of scientific discoveries it was still the scientists who deserved the credit. It was in this disarmed and secondary fashion that applications were mentioned by the committees.

The report on Emil Fischer is again a good illustration. His importance for the chemical industry was mentioned (after a detailed scientific review), and the report even added that Fisher himself had been involved in expanding the possibilities of this industry for almost twenty years.[71] This demonstrated that there were practical applications of his scientifically important discoveries. But as the case of Guglielmo Marconi demonstrates, the practical applications could not be adduced as a primary reason for awarding a prize.

In 1901, the members of the physics committee agreed amongst themselves that they would not give the prize to patented inventions. However, since the statutes did allow patents as a possibility, this decision could not be an official criterion. When Marconi, who held a series of patents for his invention of a system for wireless telegraphy, was nominated in 1903, the committee therefore had to dismiss him on other grounds. They did this by first establishing that Marconi's technologies were not original but based on technologies that had been developed by others. This meant that his work was not scientifically influential, which was enough for the committee to reject his nomination. There was still the possibility that parts of the academy would argue that Marconi was an inventor (like Nobel) and therefore deserved the prize. In anticipation of this, the committee said that awarding Marconi the prize 'on the basis of the successful application' and the of 'significance for humankind' that his wireless system had entailed would not be possible since the 'practical significance' of the wireless was not established enough.[72] That usefulness was, as it were, useful for a scientific discovery, but not in itself enough to justify the award of a Nobel Prize, was a result of boundary work. While Marconi had a patent for the wireless, the committee did not consider him a real discoverer, as his work was based on previous research. The committees wanted to reward scientists who published papers with impact in their fields, not inventors who took out patents for applications, regardless of how useful.

In 1901, the physics committee had been unable to separate Röntgen from Lenard. The only difference between them was that Röntgen's X-rays had more potential to be applied in medicine, but this was not enough. Since they were of equal scientific value, the

71 Minutes on Nobel matters, Royal Academy of Sciences 1902, p. 94.
72 Minutes on Nobel matters, Royal Academy of Sciences 1903, pp. 91–2.

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committee recommended a shared prize. Before the report was sent to the academy, the members asked themselves what would happen if the academy were not willing to split the first prize. Two members, one of them Arrhenius, argued that in that case, the practical benefit should be a deciding factor.[73] And when the academy voted, it turned out that the members indeed only wanted one laureate, and they chose Röntgen. This may well have been the result of Arrhenius adding his recommendations to the report after all.[74] Thus usefulness could be a factor – but only to decide between otherwise equal candidates, and only if the useful discovery was firmly established as scientifically important. The fact that X-rays were a novelty in the popular press might also have played some part in choosing them over the more anonymous cathode rays for this first prize, not least for the media-savvy Arrhenius.

Two cases

The Nobel committees were largely successful in getting their candidates chosen as laureates, which implies that the academy accepted their view that it was primarily scientific influence that made a candidate worthy of a prize, with application an appreciated but secondary factor. This paper will close by examining two cases. One – the chemistry prize awarded to Adolf von Baeyer in 1905 – is an exemplary demonstration of how the committee's hierarchical treatment of basic versus applied science was expressed in their reports. The second – the physics prize awarded to Guglielmo Marconi in 1909 – is an example of an award where the relationship between the two factors was more complicated – and shows that the success of the committees' arguments did not mean that everyone in the academy agreed with their views.

Adolf von Baeyer, 1905

Adolf von Baeyer received the prize for his work on synthetic chemistry in general and in particular for synthesizing indigo, achievements which had substantial practical uses. The world-leading German chemical industry was based on synthetic dyes, but had expanded to include the manufacture of a broad array of products and compounds, including drugs. Alizarin, a synthetic red dye that was made using Baeyer's methods, had been important for the industry's development.[75]

Baeyer had first been nominated in 1902 and had been considered a top candidate every year. In 1905, his closest competitors were Dmitri Mendeleyev and Henri Moissan.[76] The latter was dismissed based on his lack of scientific impact – his work on isolating fluorine had not been as important for 'the development of the whole of chemistry' as the other two.[77] It is worth mentioning that Moissan did receive the prize the following year – motivated both by his isolation of fluorine and by the development of an electrical furnace used in chemical processes. While this was an application, the motivation for the prize made it clear that it was its 'adoption in the service of science' that warranted the prize, not any industrial use.[78]

[73] Minutes on Nobel matters, Royal Academy of Sciences 1901, pp. 57–8.

[74] Minutes on Nobel matters, Royal Academy of Sciences 1901, pp. 36–7, 41, 57–8.

[75] Diarmuid Jeffreys, *Hell's Cartel: I.G. Farben and the Making of Hitler's War Machine*, London: Bloomsbury, 2008, pp. 20–41.

[76] Minutes on Nobel matters, Royal Academy of Sciences 1903, p. 187, 1904, p. 124, 1905, p. 159.

[77] Minutes on Nobel matters, Royal Academy of Sciences 1905, p. 159.

[78] Crawford, op. cit. (14), pp. 90, 159; Friedman, op. cit. (14), pp. 32–3; Minutes on Nobel matters, Royal Academy of Sciences 1903, p. 187, 1904, p. 124, 1905, p. 159.

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Choosing between Baeyer and Mendeleyev was harder. It was clear that Mendeleyev was the most scientifically influential candidate. But there was a problem with him. The periodic table dated back to 1869, and according to the statutes, the Nobel Prize should reward 'recent' discoveries, or discoveries whose value had recently been realized. This was not the case for the periodic table, which was firmly established and therefore did not meet the demands of the prize. This is one of the more criticized decisions of the committee, since it meant that this foundational work in modern chemistry was judged ineligible for a Nobel Prize.[79] The members were probably aware that this might be controversial, but this made it all the more important that the candidate they proposed instead of Mendeleyev would be accepted. Here, the fact that Baeyer had received more nominations than Mendeleyev became very useful – this current popularity could trump historical significance.[80] At least, this was a way of saying that passing over Mendeleyev would not be embarrassing for the academy if Baeyer was the one receiving the prize instead.

Furthermore, the report could also point to the historical significance of Baeyer's work. It placed him in a context going back to August Kekulé's work on chemical structures in the mid-nineteenth century, which had urged in a creative phase in chemistry of which Baeyer was a part. Here the report also brought in the third secondary factor – usefulness – by describing this chemical renaissance as having also created an industry 'of such an importance and extent that its monetary value is calculated in billions rather than millions'.[81] The methods Baeyer had developed were described as 'useful for organic chemistry' and as a 'treasure chamber of new impulses', in the usual way of establishing the scientific importance of his work.[82] After this, however, the Baeyer report paid unusual attention to applications. Not only was Baeyer, it stated, a leading representative of modern chemistry, 'But added to this is the magnificent influence for the benefit of mankind he has exercised on the chemical industry and on the cooperation between theory and practice.'[83] Industrial chemists had used Baeyer's methods to create alizarin, and the report expanded on the practical usefulness of these methods which were stable and required only easily accessible chemicals. This had in turn created products that were having effects on the international economy.[84]

In this description we can see both boundary work and arguments from post-dated utilitarianism. The industrial chemists and engineers at BASF who had actually synthesized alizarin were not mentioned.[85] The committee instead attributed their work to Baeyer by describing it as a natural result of Baeyer's methods. The work of engineers was a consequence of basic science, and the credit for it therefore belonged to the academic scientist, placing the technicians lower in the social hierarchy of science and technology.

Guglielmo Marconi, 1909

The early years covered so far were formative for the committees. They were successful in making scientific influence rather than practical usefulness the primary factor for

[79] Minutes on Nobel matters, Royal Academy of Sciences 1905, p. 159; Ulf Lagerkvist, *The Periodic Table and a Missed Nobel Prize*, Hackensack, NJ: World Scientific, 2012.
[80] Minutes on Nobel matters, Royal Academy of Sciences 1905, p. 159.
[81] Minutes on Nobel matters, Royal Academy of Sciences 1905, p. 160.
[82] Minutes on Nobel matters, Royal Academy of Sciences 1905, pp. 163.
[83] Minutes on Nobel matters, Royal Academy of Sciences 1905, p. 170.
[84] Minutes on Nobel matters, Royal Academy of Sciences 1905, pp. 161–5.
[85] Jeffreys, op. cit. (75), pp. 20–1.

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selecting laureates. While the academy as a group seems to have been swayed by the idea of post-dated utility, opposition grew among some.

The committees' insistence on the primacy of scientific impact took place in the context of engineers becoming more influential in the academy – not least through the new section for technical sciences – and when technology as a discipline was increasingly becoming a scientific discipline.[86] A sign of growing dissent came in 1907, when the secretary of the academy urged the committees to specify in their reports the ways in which the proposed candidates lived up to the status of the prize rather than just describing their scientific value. At least occasionally the engineers (and others) wanted to see utilitarianism that was not post-dated.[87] Then, in 1909, the physics prize was awarded to the inventor Marconi. Was this a further sign that the committee's priorities were not shared by the academy?

As we have seen, Marconi had not been considered sufficiently scientifically influential to be considered for a prize in 1903, and it is notable that Marconi shared the prize with the physicist Ferdinand Braun, who provided scientific credentials that could motivate the award.[88] This solution was first presented in the 1908 report, which stated that Marconi's contributions consisted of applications – and that he could not be given the award unless the individuals responsible for the basic scientific work that he had put into practice were also rewarded. The report mentioned Braun's name, but since he was not nominated that year the decision was deferred.[89] In 1909, the fact that the committee was unable to decide between its two top candidates opened up the opportunity for Marconi as a compromise, especially since he had support from a new member of the committee, Gustaf Granqvist. He had had the foresight to nominate both Marconi and Braun for a prize – Marconi for making wireless technology useful and Braun for providing it with a scientific foundation.[90]

Arguing that Marconi had first invented wireless technology, and then used Braun's scientific work to improve it to its full potential, Granqvist seemed to turn the argument of post-dated utilitarianism on its head. However, he also noted that Braun's patent for the oscillator that Marconi had used pre-dated Marconi's patents. This meant that the work of the academic scientist had become useful through the work of Marconi.[91] Whether Braun's work was indeed curiosity-driven basic science (it was, after all, patented) was left unsaid, but the addition of Braun meant that the post-dated-utilitarian view was still present, albeit in a weak form. The committee did make an exception from the social boundary work in giving the award to Marconi, but including Braun meant that the exception was to award the inventor who applied the scientist's work, whereas a prize to Marconi alone would have meant accepting application as an achievement by itself.

Usually, the committee worried about the opinions of their peers, but this year both the report and the committee discussions also mentioned that a prize for Marconi would be appreciated by the public.[92] In hindsight, this proved right. Marconi was a popular choice whose recognition with a prize had been anticipated in the popular press for years, and after his award he was described both as a man of science and as a truly worthy

86 Henrik Björck, *Teknikens art och teknikernas grad: Föreställningar om teknik, vetenskap och kultur speglade i debatterna kring en teknisk doktorsgrad, 1900–1927*, Stockholm: KTH, 1992, *passim*.

87 Crawford, op. cit. (14), pp. 157–8, 166; Friedman, op. cit. (14), p. 57.

88 Friedman, op. cit. (14), pp. 56–8; Karl Grandin, 'The Nobel Prize in 1909: the awarding process', in Karl Grandin, Piero Mazzinghi, Nils Olander and Giuseppe Pelosi (eds.), *A Wireless World: One Hundred Years since the Nobel Prize to Guglielmo Marconi*, Florence: Florence University Press, 2012, pp. 78–91.

89 Minutes on Nobel matters, Royal Academy of Sciences 1908, pp. 72–3.

90 Grandin, op. cit. (88), pp. 83–5.

91 Minutes on Nobel matters, Royal Academy of Sciences 1909, pp. 77, 81.

92 Crawford, op. cit. (14), p. 198; Minutes on Nobel matters, Royal Academy of Sciences 1909, p. 57.

Nobel laureate. Allusions was made to the fact that the academy had awarded someone who really had conferred benefit on humankind of the kind that Alfred Nobel had imagined.[93] These reactions showed the committee that using the prize to separate scientists from inventors was not central to the public's understanding of scientific practice. It also shows that even though the committees were largely successful in this rhetoric among their colleagues, the academy was nevertheless open to a less rigid separation of scientists and inventors than were the committee members.

Conclusion

Only a few years later, another inventor was awarded the physics prize. In 1912, the Swedish inventor Gustaf Dalén received the physics prize for inventing a system of automatic gas regulators for use in lighthouses. The committee did not propose him as the laureate; their report recommended a prize for the physicist Heike Kammerlingh-Onnes and his work on low-temperature physics, but this was one of the rare cases when the academy simply disregarded the committee.

Dalén's nomination came from the industrialist Erik Johan Ljungberg, who was a member of the academy, and was thus in itself a sign of the dissatisfaction in certain parts of the academy. Like all nominations, it was evaluated, but his contributions were summarily dismissed as a series of technical innovations which were useful but provided no new scientific insights.[94] The final report favored Kammerlingh-Onnes, while Dalén was not even close to being a top candidate. But by the time the academy met to cast their vote, circumstances had changed. Dalén had been blinded in an accident, and this generated much media attention and sympathy for the inventor, who became something of a national hero.[95] Ljungberg and others led the way in the academy – the prize founded by the Swedish inventor Nobel ought to be given to his follower Dalén, especially in these circumstances. This award to Dalén shows that there was an undercurrent of discontent with the committee that could be tapped into in the right circumstances. However, as the prizes for Marconi and Dalén show, these circumstances had to be special. Scientific influence remained the primary factor for the committees and the committees were still an effective route for scientists to influence the view among colleagues and the public of the primacy of basic science over technological applications.

The members of the Nobel committees used this route to define both the benefit of science and the virtues of the scientists as having influence in the scientific world, and they were largely successful in making the Nobel Prize a representation for this view. Given the Nobel Prize's status throughout the twentieth century, it has affected the way science is presented in public. It conveys a view in which science is driven by actors and events, rather than as collective process, and it also contributes to the social hierarchy between science and technology, and scientists and inventors.

The Nobel Prize was established at a time when the values of science were being negotiated. The separation of patents from papers as valid bearers of scientific information shows that this was social boundary work between different kind of practitioner: technicians (engineers and inventors) and academic scientists. Upholding this separation was important to the scientists who made up the Nobel committees in physics and chemistry, even though they were charged with awarding a prize motivated in terms of 'benefit' to humankind. They used arguments based on post-dated utilitarianism as a rhetorical way

[93] Källstrand, *Medaljens framsida*, op. cit. (18), pp. 265–73.

[94] Minutes on Nobel matters, Royal Academy of Sciences 1912, pp. 97–9; Friedman, op. cit. (14), s. 57.

[95] Staffan Bergwik, 'Ljus över mörka vatten: Gustaf Dalén, ingenjörskonsten och etableringen av det moderna Sverige' in Bergwik *et al.*, op. cit. (2), pp. 27–53, 29, 34, 38.

of solving this – usefulness would flow from scientific discoveries in time, and the important thing was therefore to support (through the award) basic science.

When promoted in committees that influenced decision making, these norms gained in legitimacy. This can be seen in the way in which this 'committee-room science' has influenced both science policy and the public perception of science. Even though neither the Royal Academy of Sciences nor Alfred Nobel necessarily wholeheartedly supported the view of post-dated utilitarianism, the committees made it possible to use the status of the prize to give this view symbolic capital.

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