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TRUTH FOR ITS OWN SAKE: ACADEMIC CULTURE AND TECHNOLOGY TRANSFER AT JOHNS HOPKINS UNIVERSITY

ABSTRACT. American research universities have long been a source of technical advance for industry, yet few have written on the history of university-industry relationships. This essay examines the evolution of practices and policies at Johns Hopkins University, which was established in 1876 as the first research university in the United States. Although an academic vision shaped its founding culture, the interests of technology transfer increasingly shape that culture. This essay considers the tensions between academic research and commercial orientation and the process of changing university orientation and culture.

INTRODUCTION

Since the end of the Second World War, American research universities have become vigorous engines of technological change. Facilitating technology diffusion and increasing economic growth were the primary justifications for the Bayh-Dole Act of 1980, which established the rights of universities in the United States to retain ownership of intellectual property developed as a result of research supported by Federal grants. As a result, American universities have embraced closer interaction with industry in terms of sponsored research, technology licensing, and the formation of start-up companies.[1]

Henry Etzkowitz has coined the phrase 'entrepreneurial universities' to describe the role played by universities in promoting technology transfer within national systems of innovation.[2] Critics argue that this process can potentially inhibit intellectual freedom, foster public mistrust, and distract attention from the University's fundamental mission.[3] Richard

[1] David Mowery, Richard Nelson, Bahven Sampat, and Arvid Ziedonis, 'The Effects of the Bayh-Dole Act on US University Research and Technology Transfer', in L. Branscomb, F. Kodama, and R. Florida (eds.), *Industrializing Knowledge* (Cambridge, MA: MIT Press, 1999), 269–306.

[2] Henry Etzkowitz, 'Entrepreneurial Scientists and Entrepreneurial Universities in American Academic Science', *Minerva*, 21 (2–3), (1983), 198–233. See also B. Clark, *Creating Entrepreneurial Universities* (New York: International Association of Universities and Pergamon Press, 1998).

[3] Sheila Slaughter and Larry L. Leslie, *Academic Capitalism: Politics, Policies and the Entrepreneurial University* (Baltimore: Johns Hopkins University Press, 1997).

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Nelson has questioned its long-term effect on the American system of innovation.[4] But while many scholars have examined these issues,[5] few have explored in depth their historical dimensions. Moreover, while many have looked at the 'pro-technology transfer culture' at MIT and Stanford,[6] few have considered the experience of Johns Hopkins – America's first research University – which, from its very beginnings, gave priority to basic research and scholarly publication. Until recently, some University cultures have been resistant to commercial activity and technology transfer. Tracing the experience of a 'modern' University that did not immediately embrace relationships with industry, may well afford a better understanding of the arguments involved.

There is a second important factor to consider. Johns Hopkins University was dedicated to promoting what Robert Merton called the norms of 'open science'.[7] This has been translated as implying an unwillingness to allow commercial interests to influence research; an abhorrence of profiting from patenting and commercialization; and an arms-length relationship with industry. While the University takes pride in scientific breakthroughs that lead to useful applications, these discoveries, however significant, have traditionally brought no direct economic benefit to the academic staff or to the University.[8] Instead, the experience of Hopkins

[4] Richard Nelson, 'Observations on the Post-Bayh-Dole Rise in Patenting at American Universities', *Journal of Technology Transfer*, 16 (1), (2001), 13–19.

[5] See, for example, Harvey Brooks and Lucien Randazzese, 'University-Industry Relations: The New Four Years and Beyond', in Lewis Branscomb and James Keller (eds.), *Investing in Innovation* (Cambridge, MA: MIT Press, 1998), 361–399; Henry Etzkowitz and Lois Peters, 'Profiting from Knowledge: Organisational Innovations and Normative Change in American Universities', *Minerva*, 29 (2), (1991), 133–166; Henry Etzkowitz and Loet Leydesdorff (eds.), *Universities and the Global Knowledge Economy* (London: Pinter, 1997); Irwin Feller, 'Universities as Engines of R&D-based Economic Growth: They Think They Can', *Research Policy*, 19 (4), (1990), 335–348; Roger Geiger, *Research and Relevant Knowledge* (New York: Oxford University Press, 1993); Young S. Lee, 'University-industry collaboration on Technology Transfer', *Research Policy*, 26 (1), (1998), 69–84; and Dianne Rahm, 'Academic Perceptions of University-Firm Technology Transfer', *Policy Studies Journal*, 22 (2), (1994), 267–278.

[6] See, for example, Susan Rosegrant and David R. Lampe, *Route 128: Lessons from Boston's High-Tech Community* (New York: Basic Books, 1986); Everett B. Roberts, *Entrepreneurs in High Technology* (New York: Oxford University Press, 1991); and Stuart Leslie and Robert Kargon, 'Selling Silicon Valley: Frederick Terman's Model for Regional Advantage', *Business History Review*, 70 (4), (1986), 435–472.

[7] Robert K. Merton, *The Sociology of Science: An Episodic Memoir* (Carbondale: Southern Illinois University Press, 1979).

[8] For example, heparin, a drug used to prevent blood coagulation, which is now widely used in the treatment of thrombosis and in cardiac surgery, was discovered in a series of experiments between 1916 and 1918. Merbromin, discovered in 1919 at the

suggests an alternative role for the University in the national system of innovation.

ACADEMIC CULTURE AND UNIVERSITY-INDUSTRY INTERACTION

Today, Johns Hopkins University ranks as the single largest recipient of Federal R&D funds in the US – annually receiving almost twice as much as MIT or Stanford University.[9] Despite this prominence, the University lags behind other universities in measures of technology transfer performance, such as numbers of patents granted, licensing revenues, and university-based spin-offs.[10] While academic productivity is difficult to quantify, public statements support the idea that Hopkins' culture has not encouraged direct involvement with industry.

At Hopkins, the Vice-Provost for Research is responsible for technology transfer. Jared Cohon, who held this position from 1988 to 1992 (and who is now President of Carnegie Mellon University), once said, 'There's just been a different kind of culture here. I can't explain why it happened that way, but I accept it as real. We've always been a basic research, individual-investigator, Federally-funded institution, the kind of place that emphasizes the creation of knowledge for its own sake'.[11] Reflecting more than forty years experience, Theodore Poehler – currently, Vice-Provost for Research – has said, 'Historically, Hopkins has eschewed turning inventions into commercial ventures. Hopkins was a place where you would come to be an academic person and do research, and that's that. Most people here today are still here for that reason'.[12]

Recent remarks by William Brody, Hopkins' President, echo this sentiment and highlight the tensions involved in the university-industry

School of Medicine was developed and marketed as Mercurochrome by the Baltimore firm of Hynson, Westcott & Dunning. Similarly, research at the School of Hygiene and Public Health led to the discovery of vitamin D in 1922 and set the stage for an effective polio vaccine in the 1930s and 1940s. A list of Hopkins research breakthroughs may be found at www.jhu.edu/news/news_info/research.html; and, hopkins.med.jhu.edu/BasicFacts/discovery.html.

[9] See National Science Board, *Science and Engineering Indicators* (Washington, DC: National Science Foundation, 2001), Table 6-4. The University includes research expenditures at the Applied Physics Lab when calculating total R&D expenditures.

[10] Maryann P. Feldman, 'Post Bayh-Dole University-Industry Relationships', in Charles Wessner (ed.), *Government – Industry Partnerships in Biotechnology and Information Technologies: New Needs and New Opportunities* (Washington, DC: National Academy Press, forthcoming).

[11] Joe Levine, 'Technology Tales', *Johns Hopkins Magazine*, 42 (4), (1990), 26.

[12] Joanne Cavanaugh Simpson, 'Golden Opportunity – or Overwhelming Obstacle?' *Johns Hopkins Magazine*, 53 (1), (2001), 16.

relationship. In a speech entitled 'From Minds to Minefields: Negotiating the Demilitarized Zone between Industry and Academia', Brody described such relationships as tentative and uneasy, a 'minefield of potential conflicts, claims and counterclaims'. He identified four contentious issues: (1) what can and should be patented; (2) whether universities should patent at all; (3) whether universities should license intellectual property; and (4) if the university is to license, whether it should be on an exclusive basis. He concluded on a cautionary note:

> Our scientists are by nature explorers – they are off sailing uncharted seas in search of discoveries. Asking them to become managers, marketers and accountants is unrealistic and ultimately inimical to the research enterprise. Time spent in the boardroom is time away from the laboratory, making them less productive and less likely to achieve the things most suited to their abilities . . . . When Hopkins scientists discovered restriction enzymes, one of the bases of the biotechnology industry, we put the discovery in the public domain – losing millions and millions in potential royalties. Foolish? Perhaps. But I know we didn't slow science down or diminish the leading role [that] American industry plays in this field.[13]

These contemporary statements have deep resonance – notably, in the founding mission of the university, and in the history of fundamental research in nineteenth-century America.

Culture is an attribute of organizations that brings underlying values into focus, and influences patterns of behaviour and performance.[14] Culture, once defined, is also remarkably persistent and resistant to change. Thus, in examining the performance of Italian regional governments, Robert Putnam concluded that, 'social patterns plainly traceable from early medieval Italy to today turn out to be decisive in explaining why, on the verge of the twenty-first century, some communities are better able than others to manage collective life and sustain effective institutions'.[15] Even after other attributes are accounted for, cultural traditions powerfully influence performance and the ability to embrace new initiatives.

To understand the culture of Hopkins, this essay begins by examining the founding vision, and the conflicting views of industrial relationships held by its early leaders and trustees. It then turns to the discovery of saccharin to examine how one influential scholar – Ira Remsen, second president of the University – strengthened the institution's culture. Next,

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[13] William Brody, 'From Minds to Minefields: Negotiating the Demilitarised Zone Between Industry and Academia', Remarks to the Biomedical Engineering Lectures Series, Johns Hopkins University, 6 April 1999.

[14] Lawrence J. Smircich, 'Concepts of Culture and Organisational Analysis', *Administrative Science Quarterly*, 28 (3), (1983), 339–358.

[15] Robert D. Putnam, *Making Democracy Work: Civic Traditions in Modern Italy* (Princeton: Princeton University Press, 1993), 121.

we briefly examine the University's first 'spin-off' firm, the Rowland Telegraph Company. Motivated by Henry Rowland, this venture failed, and its failure reinforced the view that direct commercial activity was inappropriate to the University. In the wake of these experiments, a School of Engineering was founded, which came to represent an uneasy compromise between commerce and culture. Paradoxically, the school's success in the industrial realm led to its demise and absorption into a new, but more traditional, School of Arts and Sciences.

THE FOUNDING MISSION

The University was founded by Johns Hopkins, a Quaker railroad magnate who, in 1870, gave $7 million to endow a university and hospital bearing his name.[16] At the time, this was the largest gift ever made to a college or university in the United States, and was twice the endowment of Harvard University.[17] Precisely what the word 'university' meant to Hopkins was a subject of debate long after his death, owing to an ambiguity in his will. The task of defining the mission and form of the University fell to a board of twelve trustees whom Hopkins named.[18] These were all 'friends and acquaintances', 'resident[s] of Baltimore, in middle life, independent, and acquainted with affairs', and people whom Hopkins 'believed to be free from a desire to promote, in their official action, the special tenets of any

[16] The endowment would be worth more than $130 billion in 2003 dollars. The amount was divided equally between the University and the medical school. This paper focuses on the University, but the history of the medical school is equally rich.

[17] 'Death of Johns Hopkins', *Baltimore Sun*, 25 December 1873. However, the Hopkins endowment was not as significant as might have been first thought, because the University's annual revenues and property holdings were not comparable to those of older colleges. For example, the property of Harvard was at the time worth more than $5 million, while that of Yale was thought to equal the University's endowment. Furthermore, the income-yielding funds of Harvard in 1875 amounted to more than $3 million, while Yale had $1.5 million. The JHU funds yielded revenue of slightly less than $200,000. By comparison, Harvard received in 1874–1875, $168,541.72 in tuition and $218,715.30 from property, the total of which was about twice the income of Hopkins, as reported by Daniel Coit Gilman, *The Launching of a University* (New York: Dodd, Mead & Company, 1906), 4–5.

[18] Seven of the twelve trustees were Baltimore businessmen. Four were lawyers (two, members of the city's high court), and the twelfth was Hopkins' personal physician. At least 10 trustees had some college or university training and one had studied abroad. Four were already on the Board of Trustees of another educational institution in Baltimore, the Peabody Institute (a music conservatory), which became part of Johns Hopkins University in 1976.

denomination or the platform of any political party'.[19] At a time when most privately endowed American colleges were associated with religious denominations – and while most of Hopkins' trustees belonged to the Society of Friends – it was decided that the new University would be non-sectarian. As Daniel Coit Gilman, its first president, said in his inaugural address: 'In a land where almost every strong institution of learning is either "a child of the church" or "a child of the state", and is thus liable to political or ecclesiastical control, [Johns Hopkins] has planted the germ of a university which will doubtless serve both church and state the better because it is free from the guardianship of either'.[20] The decision to be non-sectarian was controversial, but it served to create a climate favourable to scientific inquiry.[21]

Above all, the trustees of Hopkins wanted an institution that would be different from the 400 other American colleges and universities already in existence. Counsel was sought from President Charles W. Eliot of Harvard, President Andrew D. White of Cornell, and President James B. Angell of the University of Michigan.[22] Together, these three advised the trustees to move slowly in shaping their academic programme, to take a local focus, and to orient their new institution towards practical applications. Eliot argued that the new University should 'build up and improve the school system of Maryland. If you could improve the schools through the actions of the university you could do a good work for a much larger number of children than you would ever bring under your direct influence'.[23] Angell added, 'It seems to me in the present state of science and knowledge [that] you should hold steadily in view the practical application to science and arts – the practical application of chemistry, for instance, to the useful arts, such as working in metals, dyes, etc'.[24] White agreed, 'In establishing your course of instruction, permit me to suggest that you give great weight to the technical side, that is, to science in its application to the various industries'.[25] All three were unanimous in nominating Gilman as the first president.

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[19] Daniel Coit Gilman, *University Problems in the United States* (New York: Century, 1898), 7.

[20] *Ibid*., 7–8.

[21] J. Vernon Jensen, 'Thomas Henry Huxley's Address at the Opening of the Johns Hopkins University in September 1876', *Notes and Records of the Royal Society of London*, 47 (2), (1993), 257–269.

[22] Abraham J. Flexner, *Daniel Coit Gilman: Creator of the American Type of University* (New York: Harcourt, Brace and Company, 1946), 38–52.

[23] *Ibid*., 42.

[24] *Ibid*., 45.

[25] *Ibid*., 46.

Gilman greatly influenced the development of Hopkins. Formerly President of the University of California, Gilman had resigned following disagreements with the California legislature.[26] Now, he articulated a vision that at least some of his trustees shared – a vision that differed significantly from the practical orientation of the Land Grant colleges and the liberal arts tradition of the Ivy League.

On 18 January 1875, *The Nation*, edited by the redoubtable Edwin L. Godkin,[27] announced that Gilman sought to promote scholarship by offering instruction to advanced students, rather than to undergraduates. The plan was to hire professors at the forefront of their fields, and to 'pay them well enough to leave them at their ease as regards the commoner and coarser cares'.[28] In return, Gilman 'would find them only students who were far enough advanced to keep them constantly stimulated to the highest point; and he would exact from them yearly proof of diligent and fruitful cultivation of their specialities by compelling them to print somewhere the results of their researches'.[29]

Against the advice of Eliot, White, and Angell, the trustees decided to follow Gilman, and to establish an institution devoted to advanced study and graduate training, along the lines of the so-called 'German model'. The universities of Germany, extolling the 'Humboldt tradition' made popular by Prussia, led the world in training scholars in research. An estimated 9000 Americans studied in Germany during the second half of the nineteenth century. The German model was seen to provide two features that the antebellum American university lacked – the principle of academic freedom, and a commitment to *Wissenschaft* – the idea of knowledge for its own sake.[30] In following the German example, Hopkins would become the first American university to offer a graduate programme.[31]

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[26] *Ibid*., 16–27; John Calvin French, *A History of the University Founded by Johns Hopkins* (Baltimore: Johns Hopkins University Press, 1946), 30–33.

[27] As recounted in Flexner, *op. cit.* note 22, 50–51.

[28] Adequate salaries were an important consideration. As Gilman observed, 'we could at this moment name twenty men, employed at small salaries in existing colleges, whose work in certain fields of research would be of inestimable value to science and literature of the world, but who are compelled, in order to earn their livelihood, to pass most of their time teaching the rudiments to boys or preparing schoolbooks ... [moreover], American graduates are compelled every year either to go abroad or content themselves with the necessarily imperfect aid which they can get in the post-graduate courses from overworked and half-paid professors'. *Ibid*., 50–51.

[29] *Ibid*., 50.

[30] Louis Menand, *The Metaphysical Club* (New York: Farrar, Straus and Giroux, 2001), 256.

[31] For the later adoption and diffusion of the 'Hopkins model' and its effect on the future of American research universities, see Geiger, *op. cit.* note 5, 7–9.

'What are we aiming at?' Gilman asked, in his inaugural address. 'The encouragement of research . . . and the advancement of individual scholars, who by their excellence will advance the sciences they pursue and the society where they dwell'.[32] Significantly, he added, 'Remote utility is quite as worthy to be thought of as immediate advantage. Those ventures are not always the most sagacious that expect a return on the morrow. It sometimes pays to send our argosies across the seas, to make investments with an eye to slow but sure returns. So is it always in the promotion of science'.[33]

During the next two decades, some trustees found Gilman's initial vision increasingly unsuited to the needs of an ambitious industrial economy. This could perhaps have been expected, given that seven of the twelve were businessmen of sufficient prominence to give time to public affairs. Notable among them was John Garrett, President of the Baltimore and Ohio (B&O) Railroad, a close friend and business associate of Hopkins himself.[34] Garrett wanted the University to take a more practical, commercial approach. In 1883, he publicly denounced the Board of Trustees for their conservatism,[35] and subsequently rarely appeared at trustees' meetings. Trustee Lewis N. Hopkins, nephew of the founder, agreed with Garrett, pronouncing that 'Great discoveries always came from those who were devoting themselves to practical applications'.[36] In 1887, Robert Garrett, who succeeded his father as both trustee and President of the B&O, tried again.[37] At his request, one of his assistants, W.T. Barnard, prepared a monograph, in which he demanded to know:

> Why should not the Johns Hopkins University sustain a department for higher technical training in industrial pursuits? . . . The present tendency of the Johns Hopkins University management savours too much of the classic and metaphysical scholasticism of the Middle Ages. . . . The Johns Hopkins University should be considered as a part of the Baltimore school system, and its crowning glory. To maintain this position it should afford instruction in applied as well as in pure science.[38]

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[32] Gilman, *op. cit.* note 17, 35.

[33] *Ibid*., 18.

[34] A large proportion of the University's initial endowment was invested in the B&O Railroad. To this day, the president and chairman of the finance committee of the B&O hold seats on the Board of Trustees.

[35] 'Address of John W. Garrett, delivered on 30 of January 1883, before the Young Men's Christian Association of Baltimore, on the Occasion of their Thirtieth Anniversary', as noted in Hugh Hawkins, *Pioneer: A History of the Johns Hopkins University, 1874–1889* (Ithaca: Cornell University Press, 1960), 5.

[36] *Ibid*., 305.

[37] *Ibid*., 318.

[38] W.T. Barnard, *Technical Education in Industrial Pursuits with Special Reference to Railroad Service* (Baltimore: Isaac Friedenwald, 1887), as quoted in Robert A. Rosenberg,

In this spirit, the Garrett family offered to endow a scientific school similar to the Sheffield School at Yale and the Lawrence School at Harvard. After due consideration, however, the University's administration turned the offer down.[39] It was not a good omen.

In 1887, a voluble Colonel Thomas J. Scharf seized a public opportunity to attack the University for its failure 'to come down out of the scholastic clouds'.[40] Whether Scharf was party to Garrett's plan is not known, but in the end, attempts to introduce applied science failed.[41] On the contrary, Gilman was stirred to respond. His Commemoration Day speech of 1885, entitled 'The Benefits Which Society Derives from Universities', took up the disciplines taught at Hopkins, one by one, to prove their usefulness.[42] In later years, Gilman invoked the aphorism attributed to Faraday: 'There is nothing so prolific in utilities as abstractions'.[43] Gilman recalled that inventions such as the telegraph, the telephone, photography, the steam locomotive, and electric lighting were not the product of industrial research, of commercial corporations, or of private enterprise, but of university researchers, whose motives were not 'acquisition of wealth, but the ascertainment of fundamental laws'.[44]

Gilman's actions were as good as his word. Louis Menand notes that by 1880, only four years after the University opened, there were more than 100 graduate students at Hopkins, as compared with only forty-one at Harvard. Appointments stressed the importance of scholarly production. In four years, Hopkins faculty published almost as much research as had been published during the previous twenty years by all other American universities combined.[45] In 1878, Gilman inaugurated the Johns Hopkins Press, which is the oldest university press in continuous operation in America, underlining his conviction that publishing, along with teaching and research, is a primary obligation of a great university.

'Academic Physics and the Origins of Electrical Engineering in America' (Unpublished PhD dissertation, Johns Hopkins University, 1990), 209–210.

39 Hawkins, *op. cit.* note 35, 318–319 as quoted in *ibid*., 210.

40 French, *op. cit.* note 26.

41 Hawkins, *op. cit.* note 35, 318.

42 Gilman, *op. cit.* note 17, 94. In the preface to a new edition of his address, Gilman recalled: 'When the following address was delivered, the comments which had been made upon the work of the University seemed to call for a new exposition of its principles and aims'.

43 Gilman, *op. cit.* note 17, 117.

44 Christopher Lucas, *American Higher Education: A History* (New York: St. Martin's Griffin, 1994), 173.

45 Menand, *op. cit.* note 30, 257.

Assessing institutional culture is never a simple task, and academics never form a unified group. Still, at Hopkins, we find an almost universal emphasis on fundamental inquiry. Hugh Hawkins notes, 'If one had asked among the teachers and students of the early Johns Hopkins University what ideal they served, he would most often have been answered, Truth, or "Truth for its own sake". Truth was the theme presented as the ideology of the university'.[46] Many faculty members were hostile to direct applications of academic work.[47] The first professor, Basil L. Gildersleeve, a classicist, declared in his Commemoration Day Address of 1877, 'that the word "useful" should be banished from the university vocabulary'.[48] Colleagues in science expressed similar sentiments. Ira Remsen, the University's first professor of chemistry (and second president, 1901–1913), deplored what he called 'practicalism', and refused offers to consult for private industry as long as he occupied his university chair.[49] Furthermore, when a student suggested that private industry might help pay for new laboratories, and cited German precedents to support his case, Remsen responded that he 'could think of no worse fate for the university than such an invasion'.[50] His position became all the more conspicuous when, by contrast, the University of Virginia appointed an academic chemist, John W. Mallet, with the explicit objective of expanding practical knowledge, and encouraged him to devote his time to industrial and agricultural subjects.[51]

THE SACCHARIN STORY

That said, Hopkins could not completely avoid commercial entanglements. Among the earliest and most compelling examples of the American University's contribution to the commercialization of knowledge was the discovery of saccharin by Constantin Fahlberg, a European chemist who

46 Hawkins, *op. cit.* note 35, 293–295.

47 Rosenberg, *op. cit.* note 38, 185–195.

48 Hawkins, *op. cit.* note 35, 304.

49 *Ibid*., 140.

50 Hawkins, *op. cit.* note 35, 140, citing a letter from Judge Morris A. Soper, 13 March 1953. The student was Alfred R.L. Dohme, later President of Sharpe and Dohme, a prominent Baltimore pharmaceutical company that subsequently merged with Merck.

51 Hugh Miller Spencer, *The Life of John William Mallet, BA, PhD, LLD, Hon MD FRS; and the Four Distinguished Sons of Patrick Kerr (1776–1828) and Hannah Blythe Rogers (ca. 1775–1820)* (Charlottesville: Alumni Association of the University of Virginia, 1985). Mallet surveyed the 'Most Important Changes in the Industrial Applications of Chemistry within the Last Few Years' in the first three issues of the *American Chemical Journal*.

worked with Remsen as a postdoctoral fellow.[52] The discovery of saccharin is a story of unintended consequences. In 1879, Fahlberg was assisting Remsen in experiments on the oxidation of toluene, a coal tar derivative. During lunch in their laboratory, Fahlberg noticed an unaccountable sweetness in his food, which he traced to a substance that had spattered on his fingers. The researchers jointly published their discovery in two articles in the *American Chemical Journal* in 1879 and 1880, and in a German journal in 1879. Remsen then moved on to other projects, but Fahlberg saw commercial potential in low-cost sweetening agents. When he returned to Germany, he obtained financial backing, and perfected a process to manufacture what he called 'saccharin', from *saccharum*, the Latin for sugar. In 1884 and 1885, Fahlberg was granted American and European patents for the 'Manufacture of Saccharine Compounds' and 'Saccharine Compounds'. Remsen was not included in the patents as co-inventor, although the jointly authored American article was referenced.

The Hopkins culture seemingly made no impression on the unpaid Fahlberg, who in any case had filed other patents before making his serendipitous discovery.[53] Fahlberg became wealthy from the new sweetener, but neither Remsen nor the University ever received, or claimed, a royalty. Remsen did insist that the University's role be recognized, and was distressed when Fahlberg claimed full credit for the invention.[54] But Remsen never challenged Fahlberg's patents, despite an offer to pursue compensation when the University was in financial difficulties. One student recalled: 'I urged Remsen to accept Merck and Company's offer to undertake the contest, but he refused, saying that he would not

[52] Various, and sometimes conflicting, accounts of this episode are given in Mike Field, 'Technology Transfer's Bittersweet Beginnings', *The Johns Hopkins University Gazette*, 17 May 1993, 1 and 5; Christine A. Rowett, 'Smithsonian Revisits Remsen, Fahlberg Debate', *The Johns Hopkins University Gazette*, 22 August 1994 (available at http://www.jhu.edu/~gazette/1994/aug2294/remsen.html), James Stimpert, 'Ira Remsen: The Chemistry was Just Right', *The Johns Hopkins University Gazette Online'*, 11 September 2000 (available at http://www.jhu.edu/~gazette/1994/aug2294/remse n.html); and Douglas Birch and Gary Cohn, 'The Changing Creed of Hopkins Science', *The Baltimore Sun*, 25 June 2001, 1.

[53] Fahlberg's earlier American patents were for an 'Improvement in processes for utilising zinc sulphate' (1878), for a 'Method of removing iron from ferroginous saline solutions' (1882), and for the 'Recovery of plumbic dioxide from ferroginous solutions' (1882). Fahlberg obtained his first German patent in 1886. See Tomas Szmercsanyi, 'Review of Christopher Maria Merki, *Zucker gegen Saccharine: zur Geschichte der Kuslichen Sussstoffe*, in *World Sugar History Newsletter*, 24 June 1997 (http:www.chass.utoronto.ca/epc/wshn/number24.html).

[54] Johns Hopkins University, Ferdinand Hamburg Archives, Records of the Office of the President, 02.001 Box 116 #274, Ira Remsen to Dr Goodnow, 26 February 1918.

sully his hands with industry'.[55] What Remsen sought was recognition – not remuneration.

Remsen's expression of commercial disinterest is consistent with David Hounshell's description of that early moment in America when academics pursued pure science rather than profit.[56] As in many intellectual circles in Europe, applied science and science-for-profit were considered occupations less prestigious than science for 'its own sake'.[57] As told and re-told, the 'saccharin story' became standard fare in introductory chemistry classes at Hopkins and throughout the country, and provided a moral tale that helped socialize students into the expectations of an academic career. The same sentiments were echoed as recently as 1990 by Professor Robert Massof, who characterized the attitude of his medical school colleagues at Hopkins as revolving around the idea that 'money from business is tainted [and] dealing with business [was] a form of prostitution'.[58]

Local representatives of industry and commerce in the Baltimore community formed a corresponding impression of the University as remote from everyday concerns. A former student of Remsen recalled that his teacher's

> . . . attitude toward American chemical industry in that day was unfortunate. The intimate association which existed between the German universities and German industry and the mutual advantages that grew out of the association was a theme not infrequently touched upon in his lectures. Yet there was little attempt made by him to direct any of his students into industry: all his encouragement appeared to steer them into teaching. I suspect he may have had some unfortunate experiences with industrialists. He used to speak ironically of those who were boastful about operations 'on the large scale' and I have heard him speak of being refused an entry into some of the Baltimore works. I daresay there may have been as much prejudice on the other side toward the school, but if he had been a more tactful man, prejudices might have been swept away and new opportunities for students might have been opened as well as new avenues of influence for a man so really practical as himself.[59]

To present readers, Remsen's views seem to complement Vannevar Bush's description of the 'linear' model of innovation, in which basic

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55 Field, *op. cit.* note 52, 1, notes: 'This has often been attributed to the fact that Fahlberg eventually claimed that the discovery was his alone, leading to Remsen's comment in a letter to English chemist William Ramsey: "Fahlberg is a scoundrel. It nauseates me to hear my name mentioned in the same breath with him" '.

56 David Hounshell, 'The Evolution of Industrial Research in the US', in Richard S. Rosenbloom and William J. Spencer (eds.), *Engines of Innovation: US Industrial Research at the End of an Era* (Cambridge, MA: Harvard Business School, 1996), 13–86.

57 Rosenberg, *op. cit.* note 38, 186–187.

58 Quoted by Levine, *op. cit.* note 11, 26.

59 E.T. Allen, 'Reflections on Ira Remsen', *Johns Hopkins Alumni Magazine*, XVI, (1927), 222–223.

research produces discoveries, which are then disseminated by publication and education, and subsequently developed and marketed by industry.[60] According to this model, now largely discredited, knowledge flows in one direction, from the university to industry.[61] To the extent in which Hopkins adhered to the model, its contacts with industry were inevitably limited, and their outcomes, frustrated. Two cases well illustrate the point.

THE FAILURE OF EARLY COMMERCIALIZATION

From time to time, special circumstances led the University to make an exception to its general rule, and to support commercial activities. However, these forays demonstrated the difficulty of bringing about successful technology transfers. Hopkins' first 'spin-off' company was the Rowland Telegraphic Company (RTC), established in 1898. Henry A. Rowland, among the first professors hired by Gilman, founded the Hopkins' physics department, and set up a Physical Laboratory widely regarded as the most complete and extensive facility of its kind in the world.[62] Rowland also designed an innovative curriculum in applied electricity and applied mechanics.[63] The University's Department of Physics and Astronomy still bears his name. Rowland's views were thoroughly consistent with Gilman's views and Hopkins' culture. In a speech entitled, 'A Plea for Pure Science', delivered as a Vice President of the American Association for the Advancement of Science in 1883, Rowland echoed Gilman's vision of the University:

> The proper course of one in my position is to consider what must be done to create a science of physics in this country, rather than to call telegraphs, electric lights, and such conveniences, by the name of science . . . . When the average tone of the [nation's scientific] society is low, when the highest honours are given to the mediocre, when third-class men are held up as examples, and when trifling inventions are magnified into scientific discoveries, then the influence of such societies is prejudicial.[64]

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60 Claude Barfield, *Science for the Twenty-First Century: The Bush Report Revisited* (Washington, DC: American Enterprise Institute Press, 1997), gives a retrospective examination.

61 Stephen J. Kline and Nathan Rosenberg, 'An Overview of Innovation', in Richard Landau and Nathan Rosenberg (eds.), *The Positive Sum Society* (Washington, DC: National Academy Press, 1987), 275–306. A more fashionable alternative is the 'chain-link' model, which incorporates university-industry collaboration in problem definition and development activities.

62 Gilman, *op. cit.* note 17, 14–15.

63 Rosenberg, *op. cit.* note 38, 195–211.

64 Henry Augustus Rowland, *The Physical Papers of Henry Augustus Rowland, Johns Hopkins University, 1876–1901* (Baltimore: Johns Hopkins University Press, 1902).

However, as Robert Rosenberg has shown, Rowland was no 'scientific aristocrat', and did not think it a disgrace to make money from inventions, or by doing commercial work.[65] When a routine medical examination for an insurance policy revealed that he had diabetes, then an incurable illness with a limited life expectancy, Rowland saw the world of commercial application in a more positive light. As he wrote in his diary: 'The certainty of my death in a few years entirely changed my life and I work for money for wife and (3) children as I never expected to'.[66] He began research in telegraphy and hydroelectric power, which led to consulting arrangements with Baltimore businesses, to the invention of new telegraphic devices, and to the creation of the RTC. President Gilman, and subsequently President Remsen, supported his commercial turn. The Physical Laboratory was placed at his disposal, and he was given great latitude in the disposition of his time.[67]

The early results were predictable. As the President of the RTC chronicled in his company's annual report for 1907:

> The work thus went forward with the combined advantage of laboratory and field experience. It grew upon our hands into an undertaking far greater than we had foreseen. We soon found that it was not enough to demonstrate the working principles of Professor Rowland's invention, and that only a fully commercial machine would (or could) prove the availability of the invention in commercial use.[68]

It was necessary to perfect each part of the machine, to standardize all the components, to make special tools and to integrate the machine in existing systems, which meant dealing with the diversity of the telegraph system.

However, the report ended cautiously: 'This elaborate work was wholly unexpected. It led to repeated remodelling, but progressive successes always justified the continuance of our work'. In the event, difficulties mounted, and in 1910, after Rowland's death, the RTC went out of business. The experiment of a university-industry link, for all its promise, had failed, and the experience made little impression upon either Hopkins' culture or Baltimore's economy.

It seemed that the case was merely an exception dictated by circumstances. We may speculate that if the experiment had proved successful, it might have encouraged Hopkins to reconsider its position. As it was,

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65 Rosenberg, *op. cit.* note 38, 202.

66 Stephen May, 'One Summer in Seal Harbor', *Johns Hopkins Magazine*, June 1995 (available at http://www.jhu.edu/~news_info/jhmag/695web/eakins.html).

67 Anonymous, 'The Rowland Multiplex Printing Telegraph System', *The Electrical Age*, 29 (9), (1902), 540–557.

68 Rowland Telegraphic Company, *The Rowland Telegraphic Company. Report of the President* (Baltimore: Rowland Telegraphic Company, 1907).

Remsen's disdain of saccharin's commercial success, coupled with the difficulties of commercializing Rowland's inventions, served to reinforce Gilman's definition of academic culture. However, another opportunity was soon to arise, in the establishment of a School of Engineering, which appeared to offer the University a workable compromise between culture and commerce.

THE COMPROMISE: ENGINEERING SCIENCE

Among nineteenth-century academic disciplines, the fields of chemistry and engineering typically enjoyed the closest relations with manufacturing industry. In the United States, engineering often led the way. Despite (or perhaps, because of) the influence of British and French practice in many institutions of higher education – including West Point – practical engineering education was deemed to lie outside Hopkins' mission. According to Yoe, 'a few faculty members felt strongly that formal instruction in an essentially pragmatic field was inconsistent with the University's role and ideals'.[69] In his inaugural address in 1876, Gilman provided an assessment of departments that were part of existing institutions and their place at Hopkins:

> There is a department of engineering, which may also receive special attention here. ... But in forming all these plans we must beware lest we are led away form our foundations; least we make our schools technical instead of liberal; and impart a knowledge of methods than that of principles. If we make that mistake, we may have an excellent Polytechnicum but not a university.[70]

This principle was to change in 1912, when the state legislature passed the Maryland Technical School Act, which gave Hopkins $600,000 to launch an engineering programme. Because Maryland did not have an engineering school, some 300 young men annually left home to attend northern institutes of technology; while many others, who could not afford to study away from home, were denied an engineering education.[71] This Act also created 129 scholarships for state residents to attend Hopkins to study for degrees in applied science and technology. Funds for a new building and laboratory were also included.

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[69] Mary Ruth Yoe, *Hopkins: Engineering at the University* (Baltimore: Johns Hopkins University Press, 1989), 5.

[70] *Ibid*., 39.

[71] Daniel Coit Gilman, 'Inaugural Address', 22 February 1876, http://milton-real.mse.jhu.edu/text.html.

The state's offer came at a time when Hopkins was in financial difficulties.[72] The plan was that 'the work of the school was to be primarily undergraduate with advanced work for adequately prepared college graduates'.[73] However, the University insisted on retaining control, and insisted that the new funds also be used for advanced study and research. To define a new curriculum, John Whitehead, Professor of Applied Electricity and a student of Henry Rowland, visited fourteen East Coast engineering schools and sought practical advice from industry. He concluded that what Hopkins needed was a programme rooted not in applied engineering, but in fundamental scientific principles.

The Engineering Department opened in 1912. With Whitehead, the other founding professors were Charles J. Tilden (civil engineering) and Carl C. Thomas (mechanical engineering). Their expectation was that Hopkins would set new standards for engineering education, analogous to those set in medicine by Hopkins' Medical School.[74] It was an expectation widely shared. One of the first students in the new four-year programme was J. Trueman Thompson, who described himself and his classmates as, 'guinea pigs in an experiment in engineering education. . . . The teachers in the Faculty of Philosophy looked at us with suspicions and doubt but decided that if we were determined to be plumbers and other varieties of mechanics, we would at least be better educated than the artisans whom they had thus far encountered'.[75]

The term 'plumbers', certainly meant to be pejorative, could easily be traced to the doubts surrounding the establishment of the engineering programme in the first place.[76] Some of these doubts gradually dissipated. When the US went to war in 1917, some Hopkins' engineers became involved in military work, and after the war, turned to commercial activities, some of which had vast importance. For example, William B. Kouwenhoven, an assistant professor, was a captain in the country's first Reserve Officers Training Corps (ROTC) unit. During the war, he worked on methods of quality control in the manufacture of rifle stocks; afterwards, he became interested in preventing the accidental deaths of elec-

72 French, *op. cit.* note 26, 166.

73 *Ibid.*, 168.

74 *Ibid.*, 169.

75 Johns Hopkins University, Milton S. Eisenhower Library, Special Collections, MS 114. J. Trueman Thompson Papers, 'Homewood, 1913–1963: An Autobiographical Sketch'. Mimeograph.

76 John Boswell Whitehead, later first Dean of the School of Engineering, is recalled to have said, 'They thought I meant plumbers', when explaining why some Hopkins' faculty opposed the introduction of engineering. See Yoe, *op. cit.* note 69, 19.

tricity utility linemen. Ultimately, in 1960, his work led to the innovation of cardio-pulmonary resuscitation (CPR).

In 1919, the Engineering Department became a School of Engineering, and as such enjoyed local political and corporate support.[77] Its early emphasis on basic science was gradually abandoned in favour of the more practical approach that was common in other technical colleges.[78] Night courses for technical workers were begun, together with short courses at the request of local industries. The school also entered into cooperative agreements with firms to give students hands-on experience.[79] Many staff consulted with industry and government on matters ranging from electrical insulation to highway construction and steam turbine design.[80] John Whitehead, Dean of the School, once said that a technical school within a university had to be 'in proper adjustment with, and feeding the needs of, the surrounding community, but at the same time setting its standards high and providing opportunity in the field of the applications of science for the most advanced types of study and education'. Given this practical orientation, Hopkins engineering graduates were highly regarded and sought after. In 1937, in the depths of the Depression, the *Baltimore Sun* reported that thirty-five corporations had made campus visits, and that every graduate in mechanical engineering had been offered at least three jobs.[81] The University's success in engineering appeared to exemplify a rapprochement with commerce.

However, not all in the Hopkins community viewed these successes with equal enthusiasm. A 1944 report commissioned by President Bowman recommended that methods courses be dropped in favour of an increased emphasis on basic principles, and on coursework in social studies, the humanities, and oral and written expression. The School's course on Heat Engines was replaced by a course on Thermodynamics,

[77] J. Trueman Thompson, 'An Experiment from the Beginning', *Johns Hopkins Magazine*, XIV (6), (1962), 6–9.

[78] Yoe, *op. cit.* note 69, 33–37.

[79] *Ibid*., 26.

[80] Details of the Engineering School's interactions with industry are found in the list of 'professional services', in each *Annual Report of the President of the Johns Hopkins University*. Following the First World War, foundations and associations interested in the applications of scientific discoveries in electricity gave Hopkins $120,000 for research in Electrical Engineering. In 1924, the member companies of the Southern Gas Association offered $8,000 a year for five years for graduate and undergraduate work. The work was so successful that additional grants came from the gas companies of four large cities and from the American Gas Association. In later years, this work was merged with chemistry to create a Department of Gas and Chemical Engineering. See French, *op. cit.* note 26, 175.

[81] *Ibid*., 24.

while to reflect a more scientific orientation, Circuit Analysis replaced Electrical Machinery.[82] As coursework became less applied, graduates were awarded degrees in 'Engineering Science'. In 1946, a similar story unfolded in aeronautics, when, in his inaugural address, the newly appointed department head, Francis Clauser, upheld Hopkins' tradition. 'I am not here to establish a trade school', he said, 'but to set up a training course for the type of men who have always pushed back the frontiers of flight knowledge'.[83] Even so, the pace was slow. Despite the prominence of aviation, it took Hopkins seventeen years to create a department in the field.

Following the Second World War, the School of Engineering pioneered developments in 'engineering science'.[84] The graduate programme was reoriented towards the training of university academics and researchers. As a result, more staff had training in the sciences than in engineering. In 1961, the school completed the transition by changing its name to the 'School of Engineering Sciences'. However, much of its programme had become redundant, and its courses were increasingly similar to those offered by the science departments of the university. Accordingly, in 1966, the School of Engineering was merged with the School of Philosophy,

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82 Yoe, *op. cit.* note 69, 41.

83 Quoted in *ibid.*, 39.

84 See Eugene S. Ferguson, *Engineering and the Mind's Eye* (Cambridge, MA: MIT Press, 1992). Ferguson summarizes these developments in the following terms: 'The final report [of the Committee of the American Society for Engineering Education [published in the early 1950s] contained two significant recommendations that were promptly followed by those schools that had received or hoped to receive large research grants. First, "those courses having a high vocational and skill content" should be eliminated, as should "those primarily attempting to convey engineering art and practice". Thus, shop courses – intended to give students a visual and tactile appreciation of materials and basic processes, such as the welding, casting, and machining of metals – were rapidly dispensed with. Engineering drawing lingered a bit, primarily because many drawing instructors held academic rank and were difficult to fire, but the diminished status of courses in drawing and descriptive geometry was clear to all concerned. The "art and practice" courses – which described the individual components of engineering systems such as steam power plants, electrical networks, and chemical process plants and explained how the components were co-ordinated in practice, thus providing training in the way engineering had been and was being done – survived only until the committee's second recommendation could be put in place. That second recommendation called for courses in "six engineering sciences – mechanics of solids, fluid mechanics, thermodynamics, transfer and rate mechanisms (heat, mass, momentum), electrical theory, and nature and properties of materials". By no means were all engineering curricula changed immediately, but the gospel of change was unambiguous for the research-oriented engineering schools and for the schools that aspired to join the prosperous group' [160–161].

to create a School of Arts and Sciences. Following the merger, the word 'engineering' almost disappeared from the campus.[85]

In 1975, the University convened a blue-ribbon committee, chaired by L. R. Hafstad (a retired vice president and research director of General Motors), to review the future of engineering at Hopkins. Its report, issued in the autumn of 1976, came to the following, perhaps predictable, conclusion:

> In the industrial world, Hopkins is considered to have lost all interest in practical engineering activities. Individual professors may be known and even acclaimed, but there is no 'School of Engineering' to attract students interested in working in industry. There is little incentive for industry to support an institution not sensitive to its needs for broadly trained leaders capable of managing major engineering projects.[86]

In 1979, as a result of controversy aroused by the Hafstad report, the School of Engineering was re-invented. It could be argued, however, that at Hopkins, engineering continued to struggle with culture. In 1990, Jared Cohon, Vice-Provost for Research, argued that most of the engineering staff worked on relatively abstract problems, and received most of their funding from Federal agencies that supported fundamental research, such as the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the Department of Defense (DOD).[87] To date, there has been little industry funding or sponsored research, and Hopkins' engineering staff do relatively little consulting for private industry. At the close of the 1990s, while Hopkins ranked in the highest category in research income among American universities, its percentage of industry-sponsored research as a proportion of total research expenditure ranked second to lowest among the top twenty American universities. As such, the position of Hopkins was in sharp contrast to that of comparable American institutions – including MIT, Penn State, and the University of Washington.[88]

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85 Yoe, *op. cit.* note 69, 52.

86 As reported in John C. Schmidt, *Johns Hopkins: Portrait of a University* (Baltimore: Johns Hopkins University Press, 1986), 132.

87 Levine, *op. cit.* note 11, 26.

88 In the fiscal year 1994–1995, the percentage of industry-sponsored research, as a proportion of total research funds, was, at MIT, 15.25%; at Penn State, 14.99%; and at the University of Washington, 9.65%. By contrast, at Hopkins, industry provided only 1.33% of the University's research funding. See H. Norman Abramson, José Encarnaçao, Proctor P. Reid, and Ulrich Schmoch (eds.), *Technology Transfer Systems in the United States and Germany: Lessons and Perspectives* (Washington, DC: National Academy Press, 1997).

CONCLUSION

Culture is an illusive attribute that, while impossible to quantify, is nevertheless real and persistent. The University's founding mission, and commitment to 'Truth for its own Sake', defined a role radically different to the prevailing traditions in liberal arts and technical education, and over time, generated a powerful mystique. This paper has explored the institutional context of a university that provides a counterfactual case in sharp contrast to the economic extension orientation of the Morrell Act Land Grant institutions, or the decidedly more commercial orientation of MIT, or the economic development mission put forward by Leland Stanford. Hopkins' mission and academic culture institutionalized the norms of open science regarding what constitutes appropriate activity for academics.

Johns Hopkins' experience illuminates three points that are relevant to the contemporary debate about university-industry interaction. First, Gilman's view that the best academic science practices are truly 'argosies' created a culture that yielded great social benefit. Top-ranked scientists were encouraged to engage in curious science. While it is true that this type of work does not yield immediate commercial profit, it nevertheless had value. The second insight is that the expectation that there are numerous untapped sources of wealth locked within universities may also be unrealistic. As Rowland's case illustrates, even the brightest people, working at the frontier of knowledge, are typically too remote from the marketplace to come up with commercially successful products. There are, of course, exceptions; however, it is probably fair to say that most academic scientists make poor business people. Finally, the idea of 'Truth for its own Sake' needs to be seen in perspective. Some disciplines benefit more than others from industrial expertise and marketplace exposure. As illustrated in the history of the engineering school, losing touch with applied work made the School redundant.

Since the passage of the Bayh-Dole Act in 1980, incentives have encouraged American universities to patent and license ideas to industry. In consequence, many universities have taken an active interest in the business of technology transfer. Hopkins has been no exception.[89] As one

[89] Hopkins did not have a dedicated technology transfer office until 1986, making it a late entrant into this activity. See David Mowery and Arvid Ziedonis, 'The Effects of the Bayh-Dole Act on US University Research and Technology Transfer: Analyzing Data from Entrants and Incumbents', Science and Technology Group, NBER Summer Institute (Cambridge, MA: National Bureau of Economic Research, 1999). The Association of University Technology Managers (AUTM) reports that Hopkins created an Office of Technology Transfer in 1973. We prefer 1986 as a more realistic date, owing to policy changes that gave incentives for faculty to disclose inventions.

university officer put it, 'Changing a university's culture takes time, like turning a tanker takes time, there's a lot of inertia to overcome'.[90] Yet, we may question if academic institutions should adopt similar institutional missions and cultures.

One of the strengths of the American system of innovation lies in the institutional diversity of its universities. Given its diverse sources of public, private and industrial sponsorship, American universities have taken many different forms, and have served many different missions. Johns Hopkins chose to specialize in pure science. Today, however, the search for money, talent and students increasingly obliges universities to be innovative, and competitive with each other. We may well wonder whether the current emphasis on academic-industry interaction – in its zeal for the managed application of new knowledge – may undermine and destroy that very strength and diversity that have distinguished America's academic culture for more than 130 years.

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[90] As quoted by Heather Lynch, 'The Age of Invention: Hopkins Cranks up Wheel of Free Enterprise', *The Daily Record*, 12 December 1998, 1a and 10a.

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