Pierre Desrochers

Victorian Pioneers of Corporate Sustainability

Historical scholarship on business–environment interactions has largely sidestepped the study of corporate innovations that had both economic and environmental benefits. This issue is examined through late-nineteenth-century initiatives sponsored by the British Society for the Encouragement of Arts, Manufactures and Commerce, whose aim was to document and promote the creation of profitable by-products out of polluting industrial waste and emissions. A case is made that the individuals involved in this effort not only anticipated concepts and debates now at the heart of the modern sustainable development literature, but also that their work questions some fundamental premises of this discourse.

A growing number of scholarly contributions situated at the junction of business, technology, and environmental history are devoted to attempts to address pollution problems during the industrial age.[1] Few of these, however, discuss the primary example of corporate self-interest in this context: the creation of valuable by-products from polluting industrial waste and emissions. Although neglected by historians

PIERRE DESROCHERS is associate professor of geography at the University of Toronto.

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[1]Most of these contributions deal with rubbish (domestic waste), sewage and, to a lesser extent, air pollution (caused by both industrial activities and domestic heating and lighting). On domestic waste recovery, see, among others, Susan Strasser, *Waste and Want* (New York, 1999); and Martin O'Brien, *Crisis of Waste* (New York, 2008). On air and water pollution, recent additions include Debora Spar and Krysztof Bebenek, "To the Tap: Public versus Private Water Provision at the Turn of the Twentieth Century," in this issue of the *Review*; Christine Garwood, "Green Crusaders or Captives of Industry? The British Alkali Inspectorate and the Ethics of Environmental Decision Making, 1864–1895," *Annals of Science* 61, no. 1 (2004): 99–117; Christopher Hamlin, "The City as a Chemical System? The Chemist as Urban Environmental Professional in France and Britain, 1780–1880," *Journal of Urban History* 33, no. 5 (2007): 702–28; Ben Pontin, "Integrated Pollution Control in Victorian Britain: Rethinking Progress within the History of Environmental Law," *Journal of Environmental Law* 19, no. 2 (2007): 173–99; and Peter Thorsheim, *Inventing Pollution: Coal, Smoke and Culture in Britain since 1800* (Columbus, Oh., 2006).

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until very recently, a case can be made that this activity was, overall, more successful, profitable, and significant than the creation of wealth from sewage or domestic waste because of the greater volume and uniformity of manufacturing residuals.[2]

Perhaps no institution ever did more to promote the discussion of by-product development than the British Society for the Encouragement of Arts, Manufactures and Commerce (henceforth, Society of Arts) in the second half of the nineteenth century. Through regular meetings, publications, and the creation of a detailed museum exhibit, the two individuals most closely associated with this effort, the chemist and politician Lyon Playfair and the journalist and publisher Peter Lund Simmonds, argued that increased profitability and a cleaner environment often went hand in hand. In doing so, they not only anticipated concepts and debates that now occupy a prominent place in contemporary literatures on corporate social responsibility, environmental management, and sustainable development, but they also ended up by challenging some of the fundamental premises of modern-day theorists.

Of course, other writers had paved the way for Playfair and Simmonds, perhaps most prominently the polymath Charles Babbage. After reviewing his work and influence, I shall attempt to summarize Playfair's and Simmonds's contributions and to assess their impact through an examination of archival records and third-party comments. Further, I shall offer some lessons and insights derived from their work.

Laying the Foundations: Charles Babbage (1791–1871)

The idea that waste products can be the source of new wealth is at least as old as the practice of deriving valuable products from the nonedible portions of animals or plants. Clothing from skins, tools from bones, and fuel from residual matter are among the countless examples. As economies developed and became more complex, the increasing diversification of human skills and materials resulted in ever more sophisticated advances in this respect. Not surprisingly, some early modern writers penned a few words on the issue. Among those in the English-speaking world, Charles Babbage was perhaps the most influential.

Now mostly remembered as a mathematician and computer pioneer, Babbage was better known in his time for his 1832 best seller *On the Economy of Machinery and Manufacture*, written after he had visited

[2] This does not imply, of course, that domestic waste recovery was not widespread and economically significant at the time. Recent historical work on industrial by-product development can be found in special issues of *Progress in Industrial Ecology* 3, no. 4 (2006) and *Enterprise and Society* 8, no. 2 (2007).

numerous factories while researching possible ways of building his calculating engine. Among other topics discussed, Babbage explained how competition between firms spontaneously resulted in a more efficient use of resources, particularly since one of its main results was "the care which is taken to prevent the absolute waste of any part of the raw material" in order to create as much value as possible out of inputs.[3]

Babbage illustrated this principle with a few examples, the most striking of which were the various products then derived from cattle horns. The lower portion was made into combs, and the remaining clippings of this process were sold for manure. The middle portion was split into thin layers used as a substitute for glass in cheap lanterns, and some leftover material was "cut into figures, painted, and used as toys" while the rest was sold for manure. The tip was turned into knife handles, tops of whips, and other such related articles. The core of the horn was then boiled in water. The resulting fat was used by yellow-soap producers, and the remaining liquid was purchased by cloth dressers for stiffening. The insoluble substance was then ground down and sold as manure.

One could infer from this example that the efficient use of by-products could be achieved through complex interfirm arrangements, but Babbage argued that the possibilities for effectively using waste were generally greater in larger plants, and that this circumstance often led to "the union of two trades in one factory, which otherwise might have been separated." This viewpoint probably stemmed from his belief that large-scale production was generally more efficient. Indeed, he discussed industrial by-products in his chapter "On the Causes and Consequences of Large Factories."

Babbage's analysis of by-product development was quoted and further illustrated with new examples in a wide range of publications during the following decades. Among the more influential were Francis Wayland's (1796–1865) *Elements of Political Economy*, the most influential mid-nineteenth-century American economics textbook; Alfred Marshall's (1842–1924) *Principles of Economics*—the most influential book of its genre in the English-speaking world at the turn of the twentieth century—and *Industry and Trade*; and the entries on "Residual and Waste Products" in various editions of the *Palgrave's Dictionary of Political Economy*. Other discussions of Babbage's insights appear in the *Fourth Book of Lessons for the Use of School* published by the Commissioners of National Education in Ireland (but distributed throughout the British Empire) and a special twenty-four-page U.S. *Census*

[3]Charles Babbage, *On the Economy of Machinery and Manufactures* (London, 1835), 217.

Bulletin devoted to "The Utilization of Wastes and By-Products," published in 1902.[4] As will now be illustrated, perhaps no other writers added more substance to Babbage's insights than Playfair and Simmonds.

Lyon Playfair and Peter Lund Simmonds on the Scope of By-Product Development

Lyon Playfair (1818–1898). While mostly remembered for his interventions in public health and education, the Scottish chemist Lyon Playfair also wrote much on the circumstances conducive to by-product development.[5] Unlike Babbage's emphasis on "mechanical science," Playfair's discussion focused mostly, as one could expect, on advances in chemical knowledge which had resulted in the development of "methods of utilizing products apparently worthless, or of endowing bodies with properties which render them of increased value to industry."[6] His interest in the topic can be traced at least as far back as his employment as a manager in the Primrose calico (a coarse cotton fabric) printworks in Clitheroe (Lancashire) in 1841 and 1842, where he dealt with daily operations and was also instrumental in gathering groups of around thirty persons interested in industrial chemistry problems for monthly meetings, first at his home and later at a local pub.

One major problem facing this industry was the root leftovers of the madder plant from which coloring had been extracted. This residual matter was not valuable enough to be sold as manure and was therefore typically disposed of in rivers, where it caused considerable damage. In time, however, a simple treatment with a hot acid was devised that recovered profitably the one-third of the coloring matter lost in the process. As Playfair would later observe, "The dyer no longer poisons the rivers with spent madder, but carefully collects it in order that the chemist may make it again fit for his use."[7] What role Playfair may have

[4] Francis Wayland, *The Elements of Political Economy* (Boston, Mass., 1854), 371–73; Alfred Marshall, *Principles of Economics*, 8th ed. (New York, 1920): 129n; Alfred Marshall, *Industry and Trade* (New York, 1932): 239; Robert Harry Inglis and Henry Higgs, *Palgrave's Dictionary of Political Economy*, vol. 3 (London, 1910); Commission of National Education of Ireland, *Fourth Book of Lesson for the Use of Schools* (Dublin, 1851): 279–80; and Henry G. Kittredge, "The Utilization of Wastes and By-Products," *Census Bulletin* 190 (16 June 1902).

[5] Playfair's most extensive biographical treatment is by T. Wemyss Reid, *Memoirs and Correspondence of Lyon Playfair, First Lord Playfair of St. Andrews* (New York, 1899). Discussions of his early professional years can be found in Edward Walford, *Men of the Time* (London, 1862), 625; and Robert Hugh Kargon, *Science in Victorian Manchester* (Manchester, U.K., 1977).

[6] Lyon Playfair, "On the Chemical Principles Involved in the Manufactures of the Exhibition as Indicating the Necessity of Industrial Instruction," in Royal Society of Arts Great Britain, *Lectures on the Results of the Great Exhibition of 1851* (London, 1852), 147–208.

[7] Ibid., 173–74.

played in these developments is unknown, but his private-sector employment certainly taught him much.

The chemist gave further thought to wasteful production processes when he was approached in 1846 by the British Association for the Advancement of Science to report, along with Professor Robert Wilhelm Bunsen (1811–99) of Heidelberg, on the chemistry of blast furnaces. Both researchers noticed not only that more than four-fifths of the fuel escaped through smokestacks, but also that nothing was done with the ammonia produced in the process, a substance that could be a valuable manure if recovered properly.[8]

In 1847, Playfair's attention was drawn to a "thick, dark, oily fluid" on a Derbyshire colliery belonging to one of his brothers-in-law, and he rapidly came to the conclusion that it might have some potential uses if treated properly. He brought it to the attention of his long-time friend, the chemist and entrepreneur James Young. After distilling and refining the substance, Young asked Playfair's opinion about what the solid crystals floating on top of his oil might be and received the answer, "Paraffin." Playfair then asked his friend to give him enough of the substance to prepare two candles, which were lit on a lecture table of the Royal Institution of Great Britain (henceforth, Royal Institution) during one of his presentations, in which he predicted that, despite what was then a prohibitive price, such candles would eventually take over the market. This soon turned out to be the case, as various ventures headed by Young and others capitalized on this discovery. In time, the main input of this industry would be the bituminous shale found in Scottish coal, a material long considered "worse than valueless, as it had to be taken along with the coal, separated, and thrown on the waste heap."[9]

Soon afterward, Playfair became a major organizer on behalf of the Society of Arts in what would become the Exhibition of the Works of Industry of All Nations, popularly known as the Crystal Palace or Great Exhibition, which opened in London in 1851. Apart from his administrative role, Playfair was also put in charge of visiting British manufacturing districts in order to solicit and advise manufacturers on their possible contributions to the event, a task that undoubtedly gave him the opportunity to familiarize himself with a wide range of industrial processes. Unlike subsequent events of this nature, it was a major financial

[8] Lyon Playfair, *Subjects of Social Welfare* (London, 1889).

[9] E. D. Price, ed., "Utilization of 'Waste Materials,'" in *Hazell's Annual Cyclopedia* (London, 1888), 464. See also David Bremner, *The Industries of Scotland: Their Rise, Progress and Present Condition* (Edinburgh, 1869); Lyon Playfair, *Subjects of Social Welfare* (London, U. K., 1889); and Kargon, *Science in Victorian Manchester*. Young obtained his key patent to produce paraffin in 1850 and showed a single paraffin candle at the Great Exhibition of 1851 (William Crookes, "Chemical Products—The Application of Waste," *Popular Science Review* 2, no. 5 [1862]: 58–70, and Price, "Utilization").

success, leaving Playfair and other commissioners with the happy problem of devising ways to spend the large surplus. After considerable discussion, a portion of this money was used to purchase land in South Kensington on which a museum of industrial arts was to be erected to support the instruction of British design teachers and students. The remaining sums were to be used to support the creation or expansion of several educational institutions and endeavors.[10]

Playfair's first lengthy discussion of by-product development was probably published in an 1852 essay titled "The Chemical Principles Involved in the Manufactures of the [1851] Exhibition."[11] His paper was part of a widely disseminated series of lectures on this subject delivered before the Society of Arts.[12] His other significant article on the topic, "Waste Products made Useful," was published four decades later in the *North American Review*, a publication aimed at a broad readership of academics and sophisticated lay audiences.[13] Despite the time lag, a substantial overlap can be observed between these pieces. In both, Playfair mentioned the "particularly foetid" fusel oil formed in the preparation of brandy and whisky. When mixed with compounds ranging from acetate and bichromate of potash to sulfuric acid, it was the main ingredient in the preparation of the oils of pears, apples, grapes, and cognac. "Many a fair forehead," he added, was "damped with eau de millefleurs, without knowing that its essential ingredient is derived from the drainage of cowhouses."[14]

The advances made in the profitable recovery of coal-gas residuals provided another striking illustration.[15] Playfair reminded his readers that it had been no mean feat to replace tallow candles and oil lamps by air streaming through pipes, especially in the light of the original diffi-

[10] See, among others, Anthony Burton, *Vision and Accident: The Story of the Victoria and Albert Museum* (London, 1999); and Bruce Robertson, "The South Kensington Museum in Context: An Alternative History," *Museum and Society* 2, no. 1 (2004): 1–14.

[11] Striking similarities in terms of tone, style, and content suggest that the Scottish chemist might have authored two earlier, much shorter, pieces on the topic "Nothing is Useless," *Chambers' Edinburgh Journal* 132 (1846): 19–21; and "The Value of Rubbish," *Chambers' Edinburgh Journal* 385 (1851): 310–14.

[12] Royal Society of Arts, *Lectures on the Results of the Great Exhibition of 1851* (London, 1852). This essay was reprinted several times in the following years in both the United Kingdom and the United States.

[13] Lyon Playfair, "Waste Products Made Useful," *North American Review* 155, no. 432 (1892): 560–68.

[14] Lyon Playfair, "On the Chemical Principles Involved in the Manufactures of the Exhibition as Indicating the Necessity of Industrial Instruction," in Royal Society of Arts, *Lectures on the Results of the Great Exhibition of 1851* (London, 1852), 181–82.

[15] Different types of coal gas were obtained as the result of processes that converted coal into combustible gases and other substances. It was mostly used as a fuel and illuminant until the advent of electric lighting and natural gas led to its demise, while coal-gas residuals would later be mostly replaced by petroleum-refining residues.

culties in removing a number of substances that were invariably mixed with it. Not only did the gas originally have an intolerably stale odor, but it was also noxious when burned, discolored the curtains, tarnished the metals, ate through the covers of books, and covered everything with its fuming smoke. Even more problematic was the tarry residual that destroyed the surrounding vegetation when buried. Nothing was left to be done except to burn it or to mix it with coal dust to create a more convenient fuel. And yet, even though the "waste and badly-smelling products of gas-making appeared almost too bad and foetid for utilization," they had all in time been made "almost indispensable to human progress."[16]

Despite the fact that many industrial pollution problems remained to be solved, Playfair was confident that many "still useless" residuals would in time "be converted into a practical utility." Indeed, the "whole history of manufactures" was a "commentary on this text," and it had been seen on more than one occasion that the "refuse of the produce of to-day" had become "the chief source of profit to-morrow."[17]

Playfair later addressed the issue in some detail in the course of six lectures given in 1862 at the Royal Institution on "Some of the Chemical Arts, with Reference to their Progress between the Two Great Exhibitions of 1851 and 1862." Again, he observed that useful purposes had been found for numerous formerly wasted products and that "substances which to-day are the most useless, to-morrow become embraced within the circle of industrial utilities." Coal-tar residuals remained his favorite example, but he could by then point out that chemists had found "sulphide of ammonium and carbonate of ammonia" in the "badly-smelling, black, ugly gas water of the gas-works" and that the agricultural value of ammonia salts was already well known. Indeed, ammonia derived its name from "Jupiter Ammon," near whose Egyptian temple ammonia had long been manufactured from the refuse of camels.[18]

Playfair also discussed by-product recovery incidentally in various essays and publications. For example, in an 1884 essay on "Petroleum—The Light of the Poor," he pointed out that very little use was made of the benzene, naphthalene, and anthracene found in some fractions of Caucasian petroleum then "barbarously rejected as useless." And yet, similar substances were extracted profitably from coal tar to prepare synthetic dyes and other commodities, leading him to predict that petroleum residuals would eventually form the basis of "a very important

[16] Playfair, "Waste Products Made Useful," 566.

[17] Playfair, "On the Chemical Principles Involved in the Manufactures of the Exhibition," 162.

[18] Lyon Playfair, "Lecture II (Thursday, May 15, 1862)," *Chemical News* (1862): 327–32.

branch of production," perhaps even the "largest source of profit" for producers in some not too distant future. He further added that the "Russian oil king," the Swedish-born Ludwig Nobel, had not only built steam fleets to carry refined products, but that his steamers were "propelled by the refuse of the distillation."[19]

In his Presidential Address at the 1885 meeting of the British Association for the Advancement of Science, Playfair identified one of the three conditions of progress in the useful arts as the "methods of utilizing waste products, or of endowing them with properties which render them of increased value to industry." He went on to cite some examples: "Waste scrap iron and the galls on the oak are converted into ink . . . the badly-smelling waste of gasworks is transformed into fragrant essences, brilliant dyes, and fertilizing manure . . . the effete matter of animals or old bones is changed into Lucifer-matches."[20]

Playfair, however, never had the inclination to become a full-time popularizer and was apparently happy to leave this task to the Danish-born journalist Peter Lund Simmonds.

Peter Lund Simmonds (1814–1897). Simmonds was the individual with perhaps the broadest outlook on by-product development in the second half of the nineteenth century. He is mostly remembered as the author of the "first serious global study of what foods have been eaten, and where, by human beings," but his main contributions were essays, pamphlets, and extensive works of synthesis on natural resources already valuable or potentially so.[21] He occupied a segment of the publishing world "where scholarship and journalism overlap."[22]

Simmonds acquired his knowledge of the world of industry and agricultural production in various manners. In addition to his own reporting activities, he drew upon several correspondents for the magazines he owned and/or edited. He also read parliamentary and consular reports in great detail, "ephemeral but useful" publications and books of all kinds.[23] It may be, however, that he learned most through his various roles as organizer, curator, judge, and consultant for numerous trade and technological museums and international exhibitions, includ-

[19] Lyon Playfair, *Subjects of Social Welfare* (London, 1889), 269.

[20] Ibid., 250.

[21] Alan Davidson, "Introduction," in Peter Lund Simmonds, *The Curiosity of Food: Or the Dainties and Delicacies of Different Nations Obtained from the Animal Kingdom* (London, 1859; repr. Berkeley, Calif., 2001). Simmonds's publications include *The Dictionary of Trade Products* (London, 1858); *The Commercial Products of the Vegetable Kingdom* (London, 1854); *Tropical Agriculture* (New York, 1877); *The Commercial Products of the Sea* (New York, 1879); and *The Animal Food Resources of Different Nations* (New York, 1885).

[22] David Greysmith, "The Empire as Infinite Resource: The Work of P. L. Simmonds (1814–1897)," *Journal of Newspaper and Periodical History* 6, no. 1 (1990): 6.

[23] Simmonds, *The Commercial Products of the Vegetable Kingdom*, xi.

ing distant travels to Australia and Japan, where he was involved in the creation of technical museums.[24]

Simmonds's early association with the Society of Arts is unclear. While he might have had at best a peripheral role in the organization of the Great Exhibition, his work in the aftermath would be significant.[25] Initially, he was hired by the South Kensington Museum to help with an exhibit on "trade products and objects of natural history." In 1855, he joined the Society of Arts and was made an "honorary life member without payment" in 1862, under a special provision for individuals considered to be "eminent in the application of abstract science to the Arts, Manufactures and Commerce," although his extensive work for the organization was perhaps even more important in getting him this distinction.[26] Between 1854 and his death in 1897, Simmonds presented nineteen major papers at the Society's meetings, contributed thirty-three substantial articles to the Society's *Journal*, and was awarded three silver medals for particularly excellent papers. He also wrote many pieces that didn't bear his name for this publication.[27]

The origins of Simmonds's sustained interest in by-product development are unknown, even though the topic was a logical extension of his work on economically valuable resources. He was familiar with the work of Babbage, and, actually, he reproduced Babbage's discussion of horn products without acknowledging the source, thereby proving the point of a critic who had earlier opined that Simmonds "might be taught the use of inverted commas with advantage."[28] It seems certain, however, that individuals associated with the Society of Arts gave him the early means and incentives to write detailed articles on the topic. Indeed, the foundations of the first of three editions of his landmark treatise *Waste Products and Undeveloped Substances* (1862) can be found in two lengthy essays first published in the *Journal of the Society of Arts*. Some of the remaining material in *Waste Products* was derived

[24] Simmonds was involved as organizer or judge in all the major international exhibitions from the 1850s to the early 1880s, and in most (if not all, according to Jul Morel, *Les richesses de la nature: Le règne animal* [Gand, Belgium, 1876]) of the smaller international industrial exhibitions of the period. A preliminary list compiled from his writings suggests that he was a judge in at least fifteen of these smaller events held between 1855 and 1873, such as the Fishery Exhibition of Bergen (1865) and the Maritime International Exhibition of Le Havre (1868). He was also in charge of various topical exhibitions dealing with products such as wool and silk.

[25] Greysmith, "The Empire as Infinite Resource," 8.

[26] Peter Lund Simmonds, "The Production and Uses of Cotton-Seed Oil," *American Journal of Pharmacy* (May 1895): 249.

[27] Anonymous, "Peter Lund Simmonds FLS," *Journal of the Society of Arts* (1898): 1150.

[28] Peter Lund Simmonds, *Waste Products and Undeveloped Substances*, 3rd ed. (London, 1876), 19–20; Anonymous, Review of "Coffee and Chicory," *Athenaeum* 1927 (1854): 429.

from other papers presented at the Society, either by himself or others.[29] It also seems plausible that he benefited from a premium offered by the Society for "an account of the means at present employed in the utilization of 'refuse products' generally."[30]

Simmonds reciprocated for whatever support he may have been given by dedicating that first edition of *Waste Products*, which was 430 pages long, to the Council of the Society of Arts.[31] In it, he aimed "to condense into a brief compass such desultory notes and descriptions as would lead to reflection and investigation, and probably induce many to utilize more generally products now neglected or overlooked."[32] He took under consideration residuals without any profitable use or "wasted substances" and others that had already become by-products, as well as natural substances not utilized on a large scale. A few general remarks regarding Simmonds' material are in order.

The first is that much by-product development was going on in Victorian England by the time the first edition of *Waste Products* was published, for it was then the "province of [numerous] others following after the original manufacturer to collect and utilize" residual materials. This was done to some degree in virtually all British manufactures, but especially in several of the most important ones, including iron, wool, silk, cotton, and leather.[33] New industries were nonetheless constantly appearing, along with new problematic wastes from which commercial wealth had yet to be extracted. Simmonds clearly was part of a bigger picture.

He acknowledged the superficiality of his treatment, at least inasmuch as the topic was "too extensive in its scope to be discussed successfully in detail" in his thirty-five chapters.[34] Furthermore, his discussion is for the most part limited to organic substances. This focus not only reflects both his main area of expertise and the state of manufacturing activities at the time, but also perhaps the fact that, because of other engagements, his book, as he would later write, "commanded more notice

[29] The papers are "On Some Undeveloped and Unappreciated Articles of Raw Produce from Different Parts of the World," *Journal of the Society of Arts* 2, no. 106 (1854): 33–42; and "On the Utilization of Waste Substances," *Journal of the Society of Arts* 7, no. 325 (1859): 175–88. See also *Waste Products and Undeveloped Substances*, v.

[30] *Waste Products*, 6. It is unclear whether Simmonds had been awarded this premium to write his 1859 article or the first edition of *Waste Products*.

[31] Ibid., iii. Simmonds's remarks read as follows: "To the Council of the Society of Arts, before whom the subject treated of in this work has been frequently discussed, and who have awarded the author the Society's medal for his paper on undeveloped products, and more recently elected him an honorary life member, this work is gratefully dedicated by their obliged and obedient servant."

[32] Ibid., vi.

[33] Ibid., 2.

[34] Ibid., v.

than its merits deserved, because it was hastily and badly arranged" and therefore perhaps not as thoroughly researched as it might have been.[35]

Simmonds revisited the topic in 1869 in the Society's journal, focusing, as one would expect, on some recent advances.[36] Soon afterward, he was given the means to rectify the main deficiencies of his earlier work when the authorities of the Vienna International Exhibition of 1873 decided to devote a significant portion of their event to by-product development. The great American ecologist of the time, George P. Marsh, summarized the thinking of the Viennese organizers as follows: "On the one hand will be shown the waste products in all the industrial processes included in the forthcoming Exhibition; on the other hand, the useful products which have been obtained from such wastes since 1851. This is intended to serve as an incentive to further researches in the same important direction."[37]

The Austrian organizers asked Simmonds to form a representative collection to be shown in the British section of the exhibition, prompting him to request from British manufacturers "any specimens illustrative of such processes, and communication and statistics from manufacturers and others."[38] This endeavor also gave him the opportunity to begin developing an even larger exhibit on behalf of the Science and Art Department, which would eventually be displayed at the Bethnal Green Branch of the South Kensington Museum.

Simmonds used these opportunities to publish thoroughly updated versions of his book, first in 1873 and again, as an entirely new third edition, now 491 pages in length, three years later. In the latter, he reiterated the key point from his earlier writings that "one of the greatest benefits that Science can confer on man is the rendering useful those substances which being the refuse of manufactures are either got rid of at great expense, or when allowed to decompose produce disease and death."[39] Furthermore, he had done his best to "afford some information to experimenters and manufacturers . . . [and had been able] to accumulate much useful information, not generally accessible to the public, which [he had] endeavoured to classify and arrang[e] systematically."[40]

A few selected entries from the thirteen-page index will demonstrate the breadth of coverage: Albumen from fish spawn; Ammonia

[35] Ibid., iii.

[36] Peter Lund Simmonds, "On the Useful Application of Waste Products and Undeveloped Substances," *Journal of the Society of Arts* 17 (1869): 171–81.

[37] George Perkins Marsh, *The Earth as Modified by Human Action* (London, 1874), 37.

[38] Anonymous, "Vienna Exhibition—Use of Waste Materials and Their Products," *Journal of the Society of Arts* (20 Sept. 1872): 860. See also Peter Lund Simmonds, "The Production and Uses of Cotton-Seed Oil," *American Journal of Pharmacy* (May 1895): 249.

[39] Simmonds, *Waste Products and Undeveloped Substances*, 10.

[40] Ibid., preface, iii–iv.

from coal gas; Asparagus stems for paper; Bullocks' liver; Crab-shell manure; Dog's fat (use of); Furnace slag (uses for); Fossil flour; Hematite sand; Iodide of potassium; Martin's process for recovering tin; Naphta distillers in London; Papier-mâché from cocoanut-fibre dust; Petroleum (residuum from); Photographic waste (uses of); Port-wine dregs; Printers' rollers of glycerine; Rags (classification of); Railway grease (use of old); Sawdust; Ship-breakers in London; Slag (or scoriae of metal, uses of); Sulphur from coal gas; Tailings of mines; Tin clippings; Waste coal; Webster's process for utilizing spent flax from galvanizing works; and Yolks of eggs (uses for).

Among other improvements, Simmonds organized his material under the "ordinary divisions" of vegetable, animal, and mineral products. He had suggested this approach in an article published in 1859, but had not implemented it in the first edition of *Waste Products*.[41] His treatment of minerals was also much more detailed. He further described the universality of the topic by pointing out that if Britons were the first to develop by-products "on an extensive scale," their example was now being emulated in continental Europe, the United States, and even in resource-oriented economies such as Australia, Argentina, and Uruguay.[42] Simmonds concluded the last edition of *Waste Products* by observing that the topic was certainly not exhausted, "since every day furnishes new instances of what has become one of the most striking features of modern industry—to let nothing be lost, and to re-work with profit and advantage the residues of former manufactures," as well as pointing out that while he could further expand on the subject matter, he would undoubtedly "weary the reader with too ponderous a volume."[43]

Simmonds's Bethnal Green waste exhibit formally opened to the public in 1875 in the north basement of a building originally erected on the South Kensington grounds. In the seventy-nine-page catalog (originally priced at three pence), he observed that many ingenious individuals were busy devising "means by which [the] rubbish may be worked up into a useful product" and remarked that there were few "great manufactures which have not one or more of these dependent industries attached to them."[44] The number of substances displayed—in each case

[41] This broad classification permeates his work and can probably be traced back to both common sense and the Prince Consort and the 1851 Commissioners. See Anthony Burton, *Vision and Accident: The Story of the Victoria and Albert Museum* (London, 1999), 45.

[42] Science and Art Department of the Committee of Council on Education, *Descriptive Catalogue of the Collection Illustrating the Utilization of Waste Products* [Bethnal branch of the South Kensington Museum] (London, 1875), iii.

[43] Ibid., 477.

[44] Ibid., 4.

with an explanatory label written by Simmonds—was said to have been very large. The exhibit, however, seems to have grown very slowly in the years following its opening. No new additions were reported in 1877, 1881, and 1884, while thirty-three new items were added in 1880 and eleven in 1883.[45]

The collection was removed to the south basement of the Bethnal Green building in 1883. It was thoroughly rearranged and relabeled, and it benefited from better light, thus reportedly being more interesting to visitors.[46] Perhaps not coincidentally, what seems to have been Simmonds's last essay of significance on waste products was published that year, following a lecture he gave at the Society of Arts.[47]

Simmonds was retained by Bethnal Green on an ad-hoc basis until the fall of 1891, with the mandate to update the museum's food and waste exhibits. He might have been employed as much for his expertise as for charitable purposes by then, as he had fallen on hard times. Indeed, the available records suggest that his work was plagued by much delay and judged somewhat unsatisfactory, but that he was paid despite these problems. Simmonds died in 1897 at age eighty-three, but his waste exhibit continued to be displayed until its destruction in 1928.[48]

Precursors of Modern Scholarship on Sustainable Development

Playfair and Simmonds anticipated by almost a century and a half some of the most hotly contested debates and concepts in the current literature on sustainable development, corporate responsibility, environmental engineering, and environmental economics. I now turn to an examination of some of their most interesting insights.

Motivations for By-Product Development. One current debate pertains to the business case for improved environmental performance; arguments in its favor generally divide into two groups. The first group tends to view increased profitability and shareholder value from the standpoint of waste reduction, while the second views the increased purchases resulting from consumers' support of such initiatives as the

[45] Science and Art Department of the Committee of Council on Education, *Twenty-Fourth Report* (London, 1877), 503–4; *Twenty-Fifth Report* (London, 1878), 445; *Twenty-Sixth Report* (London 1879), 576; *Twenty-Eighth Report* (London, 1881), 506; *Thirtieth Report* (London, 1883), 532; *Thirty-First Report* (London, 1884), 254.

[46] Science and Art Department of the Committee of Council on Education, *Thirtieth Report* (London, 1883), 532.

[47] Peter Lund Simmonds, "The Savings of Science," *Popular Science Monthly* 33, no. 2 (1883): 798–811.

[48] From various memos, minutes, and letters written at the time, Victoria and Albert Museum's nominal file "Bethnal Green Museum, Waste Products Collection, 1874–1928."

main financial benefits of "being green."[49] Discussions by Playfair and Simmonds seem limited to the first issue, perhaps because pollution problems were then mostly viewed as local concerns of which consumers may have had little knowledge or interest, and because the most polluting industries were for the most part producers of intermediate inputs rather than final products.

By contrast, their insistence on the environmental benefits of competition was straightforward. For example, Playfair emphasized in 1884 that "as competition becomes keen, these waste products may become the largest source of profit."[50] Simmonds similarly wrote that "one of the characteristic and salient points of modern enterprise [is] not only to allow nothing to be wasted, but to recover and utilise with profit the residues from former working."[51] Perhaps his most candid passage on this topic is the following:

> As competition becomes sharper, manufacturers have to look more closely to those items which may make the slight difference between profit and loss, and convert useless products into those possessed of commercial value, which is the most apt illustration of Franklin's motto that "a penny saved is twopence earned . . . ."[52]

Simmonds cautioned, however, that large quantities of waste products, whose basic components were well known in commerce, were often a prerequisite in their successful commercialization.[53] After observing that the recovery and profitable utilization of residues typically led to a diminution of the price of the main articles, he added a cautionary note on the importance of the price system by writing that the transformation of waste into by-products should be guided by "their success as articles of commerce," and that if, "philosophically, nothing should be lost, commercially, much may be thrown away."[54] Indeed, philanthropic views, while undoubtedly morally serviceable, had little chance of surviving when they could no longer maintain a profitable establishment. Fortunately, in most instances "what pays is for the general good. The opposite may be equally as likely a scenario, since we should certainly hesitate before acting on any speculation undertaken solely on

[49] Support for the former perspective can be found in the work published by the World Business Council for Sustainable Development, while arguments in support of the latter are often expressed in the publications of the U.K. Department for Business, Enterprise and Regulatory Reform.

[50] Lyon Playfair, *Subject of Social Welfare* (London, 1889), 269.

[51] Simmonds, *Waste Products and Undeveloped Substances*, 4.

[52] Science and Art Department of the Committee of Council on Education, *Descriptive Catalogue of the Collection Illustrating the Utilization of Waste Products* (London, 1875), 4.

[53] Simmonds, *Waste Products and Undeveloped Substances*, 10.

[54] Ibid., 4.

the latter consideration."[55] Such speculations, however, were sometimes necessary in the context of actual or potential legal actions—as I shall now discuss.

The Porter Hypothesis. Industrial concerns have long been held liable for their actions in market economies, although present-day critics often assume otherwise. In short, the old common-law maxim "Use your own property so as not to harm another's" provided the foundation for the resolution of disputes between industrialists and individuals harmed by their activities. Harmful activities tended to fall into one of three categories: trespass (any entry on the property of another); nuisance (intangible invasions such as odors and noises); and violation of riparian rights (altering the quality or quantity of the natural flow of water beside or through someone's property).

Playfair and Simmonds never wrote extensively on the details of actual court cases, but they did allude to the consequences of actual or potential legal actions, and provided illustrations of how these sometimes resulted in the development of innovations that had both economic and environmental benefits. In doing so, they anticipated and validated to some degree the "Porter Hypothesis," named for Harvard management scholar Michael Porter, according to which "well-designed" environmental standards can spur innovations that would not otherwise be developed, resulting in both the reduction of environmental harm and enhanced business competitiveness.[56] It would nonetheless seem reasonable to infer from their writings that such cases were the exception rather than the rule, inasmuch as the vast majority of the cases they described did not seem to have necessitated external pressures other than market competition.

Industrial Ecology Metaphor. Of Playfair's insights, perhaps none is more surprising to modern sustainable-development theorists than his anticipation of the now highly influential "industrial ecology" metaphor, according to which resources and materials used in industrial processes should mimic the cycling of residual matter in nature.[57] He

[55] Ibid., 10–11.

[56] See Pierre Desrochers, "Did the Invisible Hand Need a Regulatory Glove to Develop a Green Thumb? Some Historical Perspective on Market Incentives, Win-Win Innovations and the Porter Hypothesis," *Environmental and Resource Economics* 41, no. 4 (2008).

[57] Robert U. Ayres and Leslie W. Ayres, *A Handbook of Industrial Ecology* (Cheltenham, U.K., 2002). Of course, "nightsoil" and other urban wastes had long been collected profitably in many parts of the world, while trained chemists were by then thoroughly familiar with Antoine Lavoisier's notion that "Nothing is lost" and Justus von Liebig's "chemical metamorphosis" and "materials cycling." Playfair, however, was probably the first successful popularizer of the industrial-ecology metaphor to refer to interindustrial links. For some historical perspective on societal metabolism and von Liebig, see Marina Fischer-Kowalski, "Society's Metabolism: The Intellectual History of Materials Flow Analysis, Part I, 1860–1970," *Journal of Industrial Ecology* 2, no. 1 (1998): 61–78; Marina Fischer-Kowalski and Walter Hüttler,

might have first hinted at it if he was the writer of a paper published without attribution in 1846, in which it was observed that just as "nothing in nature [should be regarded] as worthless," so nothing should be thrown aside "until we have exhausted our ingenuity to turn it to advantage."[58] Be that as it may, Playfair was explicit about it in his 1852 essay: "This economy of the chemistry of art is only in imitation of what we observe in the chemistry of nature. Animals live and die; their dead bodies, passing into putridity, escape into the atmosphere, whence plants again mould them into forms of organic life; and these plants, actually consisting of a past generation of ancestors, form our present food."[59] He later restated this analogy by observing that as "nature does not admit the idea of waste matter, man, when under the guidance of knowledge, should not be inclined to deem anything as a waste product." Playfair also commented on the "happy definition," usually attributed to Lord Palmerston (1784–1865), that "dirt is merely matter in the wrong place," and he suggested that the object of his article was "to show that, as science advances, it sweeps up dirt from the wrong place and deposits it in the right place" and "when converted into an utility it is no longer dirt, for it has been purified." Again, "manufacturers [were] only imitating Nature in these transformations."[60]

Simmonds credited Playfair with being the originator of this analogy and borrowed it on several occasions. For example, he observed in the first edition of *Waste Products*: "When we perceive in nature how nothing is wasted, but that every substance is reconverted, and again made to do duty in a changed and beautified form, we have at least an example to stimulate us in economically applying the waste materials we make, or that lie around us in abundance, ready to be utilized."[61] Later renditions contained the following: "Nothing comes amiss to our ingenuity. We consume our smoke, write and print on the remnants of our ragged shirts, and triumph over decomposition and stenches. Utilisation is the great law of Nature, and we are only following her teaching."[62]

This analogy was also used by other Victorian writers. For example,

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"Society's Metabolism: The Intellectual History of Materials Flow Analysis, Part II, 1970–1998," *Journal of Industrial Ecology* 2, no. 4 (1998): 61–78; Erland Mårald, "Everything Circulates: Agricultural Chemistry and Recycling Theories in the Second Half of the Nineteenth Century," *Environment and History* 8, no. 1 (2002): 65–84; and Christopher Hamlin, "The City as a Chemical System? The Chemist as Urban Environmental Professional in France and Britain, 1780–1880," *Journal of Urban History* 33, no. 5 (2007): 702–28.

[58] Anonymous, "Nothing is Useless," *Chambers' Edinburgh Journal* 132 (1846): 21.

[59] Playfair, "On the Chemical Principles Involved in the Manufactures of the Exhibition," 165–66.

[60] Playfair, "Waste Products Made Useful," 560–61, 565.

[61] Simmonds, *Waste Products and Undeveloped Substances*, 1–2.

[62] Ibid., 10.

the physician and writer Andrew Wynter observed in an essay strongly influenced by Simmonds's book: "What the most learned of us know with respect to waste, is infinitesimal compared with our good mother Nature; she, indeed, has no such word in her universal dictionary, and this mankind is slowly finding out as knowledge progresses."[63] The vice-president of the [British] Society of Engineers, Perry Fairfax Nursey, similarly observed that it was certain that scientific progress, "in promoting economy of working," would in the course of time "lead to the utilization of substances for which at present no satisfactory use can be found," for all matter "was but so much waste before the creative faculty of man provided appliances for its utilization." In time, what was then the "veriest waste" would "assume a condition of value. Thus, will art be made to approximate to nature, in that she will know no waste."[64]

Impact of British Writers on Industrial Practices and Ethics

Playfair's and Simmonds's efforts, along with the sponsorship of their activities by the *Society of Arts*, were mentioned and commented upon in several publications. For example, one anonymous contributor to *Chambers's Journal* observed in 1869 that "Dr Lyon Playfair and Mr P. L. Simmonds have frequently drawn attention" to successful cases of by-product development and noted that "Mr Simmonds has recently collected a new budget of instances, which he has brought under the notice of the Society of Arts."[65] Not surprisingly, Simmonds hoped that this particular effort would help illustrate that "as man advances in scientific knowledge, he will discover means of utilizing everything now considered as waste, and we shall realize the fact that the Great Creator has made nothing in vain." As this was increasingly becoming the case, "the thanks of the community at large [were] due to the long labours of the Society of Arts in collecting, publishing, and discussing every subject and suggested improvement calculated to benefit the wide domains of Art, Manufactures, and Commerce."[66] I now turn to a survey of various assessments of their efforts.

[63] Andrew Wynter, "The Use of Waste Substances," in *Good Words for 1876*, ed. Donald McLeod (London, 1876), 155.

[64] Perry Fairfax Nursey, "The Economic Use of Blast-Furnace Slag," *Van Nostrand's Eclectic Engineering Magazine* 12 (1875): 401–9. See also Anonymous, Review of "*Waste Products and Undeveloped Substances* by Peter Lund Simmonds," *Popular Science Review* 2 (1863): 254–58; and Pierre Desrochers, "Learning from History or from Nature, or Both? Recycling Networks and their Metaphors in Early Industrialization," *Progress in Industrial Ecology* 2, no. 1 (2005): 19–34, for other contemporary uses of this metaphor.

[65] Anonymous, "Waste Not!" *Chambers's Journal of Popular Literature, Science and Arts* (18 Dec. 1869): 807.

[66] Simmonds, "On the Useful Application of Waste Products and Undeveloped Substances," 178.

Bethnal Green Waste Exhibit. Generations of the Victoria and Albert Museum employees have kept a "cuttings book" of press accounts of their various exhibits. No such effort, however, seems to have been devoted to the Bethnal Green permanent exhibit on waste products, but it is possible to get some idea of its impact from various sources.

Regarding the relative overall success of the Bethnal Green Museum, the main drawback seems to have been its remote location.[67] As one American visitor put it in 1881: "Being intended especially for the benefit of the poorer class, it is situated in a somewhat out-of-the-way portion of the city, and is therefore rarely visited by tourists or even by the better class of Londoners themselves."[68] Indeed, from a West Ender's perspective, "Bethnal Green mark[ed] nearly the uttermost bound of metropolitan civilization," while "the upper end of the Hackney-road [was] almost the ultima Thule of the world of London."[69] In spite of its geographic location, however, more than nine million visits were recorded during the museum's first decade and a half, a number that hardly seems insignificant.[70]

While other exhibits were more popular, Simmonds, a man usually extremely modest in his writings, described his work as having attracted "much attention and interest," while an anonymous reviewer believed it to be "the first permanent public collection" of its kind.[71] As to its educational value, perhaps the most informative assessment can be found in Thomas Greenwood's 1888 survey of British museums and art galleries:

> In the lower part of the building there is, in a series of long wall-cases, a very comprehensive series of products illustrating the utilization of waste. These might be most interesting and useful, but in a dark corridor, and without a scrap of printed matter respecting them for the visitor to carry away, either by purchase or otherwise, their utility is considerably lessened. And yet there is no part of the whole Museum so calculated to produce solid lessons on the mind of the visitor as this section. Here in proper form there are specimens of products, arranged by that veteran in the utilization of waste products, Mr. P. L. Simmonds, of cotton, jute, nuts, straw, wood, barks, leaves, oil, silk, glass, metal and other substances.[72]

[67] Anthony Burton's verdict in his *Vision and Accident: The Story of the Victoria and Albert Museum* (London, 1999), 121–22, is generally negative, while a contemporary source like Anonymous, "Sight-seeing in Bethnal Green," *All the Year Round* (1872): 228–32, reports good attendance in the Museum on the day of his visit in the year of its opening.

[68] F. T. Aschmann, "Notes on the Bethnal Green Museum, London," *School of Mines Quarterly* 2 (1881): 72.

[69] Anonymous, "Sight-seeing in Bethnal Green," 228.

[70] Thomas Greenwood, *Museums and Art Galleries* (London, 1888): 266. See also Marcus B. Huish and David C. Thomson, *The Year's Art 1883*, 2nd rev. ed. (London, 1883), 30.

[71] Barbara J. Black, *On Exhibit: Victorians and Their Museums* (Charlottesville, Va., 2000), 33–34; Simmonds, *Waste Products and Undeveloped Substances*, iii; Anonymous, "Waste," *Warehousemen and Drapers' Trade Journal* (Feb. 12, 1876): 57.

[72] Greenwood, *Museums and Art Galleries*, 264.

A decade earlier, one anonymous reviewer had similarly remarked that "the utility of any museum is undoubtedly much increased by the publication of a catalog of its contents" that helps visitors remember exhibits in a more productive way, especially in terms of their value and commercial relations. Simmonds's "affordably priced" booklet was then available, and the reviewer pointed out that "even those who have not the opportunity of visiting Bethnal Green Museum may learn a good deal by [its] perusal, which we may unhesitatingly state is one of the most useful of its kind that we have seen."[73]

As another reviewer observed, since most of the inhabitants of the museum's vicinity were engaged in some branch of trade and were earning their daily bread by manipulating some of the very articles displayed, "the mere fact of seeing them elevated to a position of importance in a public exhibition will no doubt inspire [visitors] to seek further information on the sources of the materials which are constantly before their eyes, but of the origin of which they know but little."[74] The reviewer further suggested that this result would be considerably assisted by the *Descriptive Catalogue of the Collection*. According to the 1877 annual report of the Science and Art Department, the booklet was selling "moderately well," while the 1878 edition reported that 110 copies had been sold and the 1879 edition 46 copies.[75]

Writings. The impact of Playfair's and Simmonds's writings is easier to document than that of the waste exhibit, for some of these were reprinted on more than one occasion in different (typically American) periodicals and broadly discussed, sometimes jointly. For example, one joint review was published in 1859 in *Chambers's Journal*. It began with Palmerston's dictum on dirt being matter in the wrong place, and observed that "practical chemists have long known this; medical men not unfrequently impress the fact on their patients; patentees of new inventions often show an appreciation of it; and the world is getting wiser thereon every day."[76] Both authors were also quoted or referred to several times in a special 1902 U.S. Census Bureau bulletin, "The Utilization of Wastes and By-Products."[77] Perhaps most remarkable is a

[73] Anonymous, Review of "Descriptive Catalogue of the Collection Illustrating the Utilisation of Waste Products, in the Bethnal Green Branch of the South Kensington Museum," *Pharmaceutical Journal and Transactions*, 3rd ser., 6 (1876): 598.

[74] Anonymous, Review of "Descriptive Catalogue of the Collection Illustrating the Utilisation of Waste Products (Bethnal Green Museum)," *Gardeners' Chronicle* 4 (1875): 427. Another positive review is Anonymous, "Notes," *Nature* 12 (1875): 540–41.

[75] Science and Art Department of the Committee of Council on Education, *Twenty-Fourth Report, with Appendices*, 504 (London, 1877); *Twenty-Fifth, with Appendices*, 486 (London, 1878), *Twenty-Sixth Report, with Appendices*, 576 (London, 1879).

[76] Anonymous, "Nothing Lost," *Eclectic Magazine of Foreign Literature, Science and Art* 4 (1859): 563.

[77] Charles Kittredge, "The Utilization of Wastes and By-Products," *Census Bulletin* 190 (16 June 1902).

lengthy review essay published by Andrew Wynter in 1868 that discussed their contribution on by-product development, along with the work of Babbage and the Society of Arts (through its journal). As the author put it: "The absolute economy of Nature, which turns every scrap to some ultimate account, man has necessarily observed, and when compelled by circumstances . . . he has long put in practice." Although Wynter thought the Chinese more advanced than the British in this respect because of the "pressure of population," in Europe "thousands of materials are now turned to account, that not very long ago were utterly unutilized. And thriftiness begets thriftiness. There are scores of manufactures, which produce by-products that almost necessitate supplementary factories to use them up."[78] Anonymous references to Babbage's, Playfair's, and Simmonds's writings that were probably derived from Wynter's article could in turn be found a few years later in a book providing "one thousand domestic hints."[79]

Playfair's 1852 lecture also garnered interest, although much of its appeal seems attributable to the repulsive nature of some of his examples, which caught the attention of the popular press.[80] Among the most notable popular works and publications in which Playfair's lecture was quoted or discussed are C. L. Matéaux's classic *The Wonderland of Work* (in her chapter, "Things that are Done With") and an entry in the satirical magazine *Punch* on "the horrors of chemistry," in which one "Angelina" was dismayed by the "frightful things" described in the *Morning Post*'s account of a chemical lecture by the "horrid man" Dr. Lyon Playfair.[81] In later years, reviewers of Simmonds's *Waste Products* would not infrequently quote lengthy excerpts of Playfair's early essay directly from his book.[82]

[78] The view that the Chinese and Japanese were much better recyclers of organic waste, especially of sewage, seems to have been widespread among European writers at the time. See Mårald, "Everything Circulates," 65–84; Andrew Wynter, "The Use of Refuse" *Quarterly Review* 124 (1868): 335. This lengthy essay by Wynter was also printed in *Every Saturday* and the *London Quarterly Review* and later reprinted in Andrew Wynter, *Curiosities of Toil and Other Papers* (London, 1870).

[79] John Timbs, *One Thousand Domestic Hints* (London, 1871), 2–4.

[80] See, among others, Anonymous, "Penny Wisdom," *Household Words* 6, no. 134 (1852): 97–101; Anonymous, "Nothing Lost," *Eclectic Magazine of Foreign Literature, Science and Art* 48, no. 8 (1859): 563; Anonymous, "Chemical Appliances to Industry," *Journal of Education for Upper Canada* 5 (1852): 112; Anonymous, "Scraps and Refuse Economised," *New England Farmer* 9, no. 1 (1857): 23–24; Anonymous, "Curiosities of the Chemistry of Arts," *Illustrated Magazine of Art* 1, no. 6 (1853): 358–59; R. S. Bosworth, "Chemical Transformations," *Cincinnatus* 2, no. 1 (1857): 35–38; David. A. Wells, *Things not Generally Known* (New York, 1859; reprinted on several occasions in later years).

[81] Clara L. Matéaux, *The Wonderland of Work* (London, 1880), 306–7; Angelina [pseud.], "The Horrors of Chemistry," *Punch* 22 (Jan.–June 1852): 23.

[82] See Anonymous, "Waste Not!" 807–9; William Chambers, "Waste Materials," *Chambers's Journal of Popular Literature, Science and Art*, 4th ser., 546 (1874): 369; Wynter, "The Use of Waste Substances."

Serious discussions of the Scottish chemist's essay included comments by the chairman presiding over a talk given by the chemist Crace Calvert in 1855 in the same room where Playfair had "declared that the great end in modern civilization was to effect an economy of time, or to make most refuse products conducive to the advantage of manufactures and arts."[83] The American economist Henry Charles Carey (1793–1879) similarly referred to a "recent writer" in his discussion of "the wonderful increase in the economy of human efforts resulting from increased economy of the gifts of nature" and reproduced large excerpts from Playfair's essay in his influential *Principles of Social Science*.[84]

Playfair's 1892 essay, written as it was for a somewhat specialized periodical, was obviously less influential. It was nonetheless reprinted in the journal *Review of Reviews* and was the primary reference used by John Atkinson Hobson, a prominent socialist historian and journalist, to argue that "new industrial arts owing their origin to scientific inventions and their practice to machinery arise for utilising waste products" could be observed in many trades and that "during the interval between great new inventions in machinery or in the application of power many of the principal improvements are of this order."[85] George Powell Perry, an American writer whose 1908 book *Wealth from Waste* suggests that he might have been a clergyman, similarly referred (without naming him) to the author of a piece in a magazine who, a few years earlier, had told of the peculiar Parisian practice of giving rats dead carcasses to feed on, in this way cleaning bones for further processing and providing raw materials for glove makers and meat exports for the Chinese market. Playfair used this example in his 1892 article (which he probably borrowed from Simmonds's *Waste Products*). Perry's description of gas tar by-products and several other illustrations similarly bear uncanny resemblances to various portions of Playfair's article.

Not surprisingly, Simmonds's more voluminous and numerous writings also attracted much attention. Actually, the various editions of *Waste Products* can probably be considered best sellers for works of this type at the time of publication—indeed, the second edition quickly sold out.[86] They were reviewed in a variety of outlets, ranging from daily papers, broad periodicals, and more specialized media.[87] Assessments of

[83] Frederick Crace Calvert, "On the Manufacture and Application of Various Products Obtained from Coal (Coal Gas Excepted)," *Mining Magazine* 5 (1855): 55.

[84] Henry Charles Carey, *Principles of Social Science* (Philadelphia, 1858), 385–86.

[85] John A. Hobson, *The Evolution of Modern Capitalism: A Study of Machine Production* (New York, 1917), 75.

[86] Jul Morel, *Les richesses de la nature: Le règne animal* (Gand, Belgium, 1876), vi.

[87] Daily papers include the *Daily News*, the *Observer*, and the *Standard*. Broad periodicals include *All the Year Round*, the *British Almanac*, the various iterations of the *Chambers's Journal*, *Good Words*, the *Quarterly Review*, and the *Saturday Review*. More specialized

Simmonds's efforts seem to have been overwhelmingly positive. For example, the reviewer of Charles Dickens's *All the Year Round* presented readers with several illustrations from the first edition of this "excellent work," such as a list of ninety-eight plants that were used in various countries as substitutes for tea or the fact that an immense number of German cigars were made of beet and turnip leaves.[88] As a reviewer for *Popular Science Review* further noted, *Waste Products* was "written in a pleasing style, and the circumstances relating to the transformations of refuse often read like a romance, rather than a dry detail of the uses of 'waste and undeveloped substances.'"[89] The editor of the *Manufacturer and Builder*, a monthly American trade journal, described the third edition as the most "instructive book [on the subject] for the ambitious technologist and the man of practice."[90] It was probably the case, however, that a *Nature* reviewer of the second edition spoke on behalf of more polite colleagues when he observed that "Mr Simmonds has been affected by the mass of subjects he has attempted, for the book very frequently displays a considerable lack of arrangement . . . [I]n a future edition . . . the book might be easily and advantageously condensed to a considerable extent."[91]

Waste Products was frequently cited. The 1873 edition was the only reference given in the "Residual and Waste Products" entry of *Palgrave's Dictionary of Political Economy*.[92] The electrochemist and educator George Gore used it as his evidence that "numerous substances which were formerly thrown away, destroyed, or neglected, are now utilized," and that a "long list of instances might be adduced if it were necessary, some of them of very great importance."[93] Gore's comments were later reproduced and paraphrased by the businessman and essayist James Platt, who similarly used Simmonds to support his claims.[94] The author of a medical article referred to Simmonds's book as proof

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outlets include the *Journal of the Society of Arts*, the *Manufacturer and Builder*, the *Mining Journal*, *Nature*, and the *Popular Science Review*. Perhaps the lengthiest and most detailed reviews of Simmonds's work are to be found in the *Popular Science Review* 2 (1863): 254–58; in Andrew Wynter's "The Use of Refuse," *Quarterly Review* 124 (1868): 334–57; and in the *Chambers's Journal* 546 (1874): 369–71. Andrew Wynter, "The Use of Waste Substances," *Good Words for 1876* (1876): 155–60, is a lengthy review essay of the third edition of *Waste Products*, which does not give Simmonds full credit for the information listed in the paper.

[88] Anonymous, "What's the Use of That?" *All the Year Round* 8 (1862): 186.

[89] Anonymous, Review of "*Waste Products and Undeveloped Substances* by Peter Lund Simmonds," *Popular Science Review* 2 (1863): 258.

[90] Anonymous, "Some Words to Inventors," *Manufacturer and Builder* 16, no. 5 (May 1884): 98.

[91] Anonymous, Review of "P. L. Simmonds's *Waste Products*," *Nature* (11 Dec. 1873): 101.

[92] Inglis and Higgs, *Palgrave's Dictionary of Political Economy*, vol. 3, 292.

[93] George Gore, *The Scientific Basis of National Progress* (London, 1882), 150–51.

[94] James Platt, *Platt's Essays, Vol. II, Life, Mortality, Progress* (London, 1884), 506–7.

that in France the value of blood as a food source was better understood and acted upon than in England.[95]

Of course, some of Simmonds's essays also drew the attention of other writers. For example, an anonymous 1869 entry in the *Chambers's Journal* summarizes Simmonds's latest *Journal of the Society of Arts* offering to illustrate that "many instances of substances recently transferred from the domain of waste to that of utility, and many suggestions for a similar transference in other quarters" present the same division of the animal, vegetable, and mineral kingdoms. [96]

The following excerpt from the preface of the last edition of *Waste Products* further demonstrates Simmonds's capacity to reach a broad audience—again keeping in mind the author's habitually modest tone:

> Having long given much attention to the diffusion of practical information on the Utilization of Waste and Refuse, and the accessory products from manufactures, by various essays and lectures, which have been widely circulated on the Continent and in America, I have had the satisfaction to find that many of the hints and suggestions thus thrown out have led to the establishment of great and profitable economic industries, and to the useful application of numerous formerly neglected natural products.[97]

Two years before his death in 1897, Simmonds further suggested that he had "reason to believe that the adoption of many of my suggestions has resulted in fortunes to some, and has utilized profitably much of the former waste in manufactures."[98] The obituaries and biographical entries published upon his death singled out *Waste Products* as his most influential book.[99] Also telling is the recognition that his work received in other countries. For example, the second edition was awarded a gold medal by the Académie nationale de Paris and was probably an important reason for his being accorded the Légion d'honneur in 1878. This edition was also translated into French, and the third into German.

The French adaptation was published in 1876 by the Belgian chemist Jul Morel, a professor at the École Industrielle de Gand and self-described close friend of the author. Morel's goal, however, was more

[95] Francis Vacher, "On Serum Sanguinis as a Therapeutic," *Liverpool and Manchester Medical and Surgical Reports* (1876): 190.

[96] Anonymous, "Waste Not!" 807–9.

[97] Simmonds, *Waste Products and Undeveloped Substances*, iii–iv. His 1869 article similarly discusses the influence of his earlier writings on the topic.

[98] Simmonds, "The Production and Uses of Cotton-Seed Oil," 249.

[99] Contemporary obituaries and biographical entries on Simmonds can be found in, among other outlets, the *American Journal of Pharmacy*, *A Supplement to Allibone's Critical Dictionary of English Literature*, the *Athenæum*, *Dansk Biografisk Lexikon*, *Dictionnaire universel des contemporains*, the *Freemason*, the *Journal of the Society of Art*, and *Men and Women of the Time*.

ambitious. *Les richesses de la nature: Le règne animal* (Nature's Wealth: The Animal Kingdom), although 392 pages long, covered only a fraction of the topics discussed in the 1873 English edition. According to the foreword, Morel originally planned to write three volumes using Simmonds's classification (animal, vegetable, and mineral) that would address all the uses of various natural products, but the remaining volumes were either never published or did not survive to the present time. Be that as it may, Morel pointed out in his introduction that his adaptation differed so much from the original that it actually amounted to a third edition of the book. He even wrote that the presentation had been more thoroughly rationalized, thus becoming "more suitable to the French spirit." In fairness to Simmonds, however, he had already or was about to cover the same material in his other books.

The first German treatise on industrial waste recovery was similarly a more than three-hundred-page translation and adaptation of the last edition of *Waste Products* published in 1879 by a government inspector.[100] In his preamble, the author pointed out that since Simmonds's book had obtained high acceptance by appearing in print already for the third time since 1873, he had thought it useful to provide easy access to its content to the German public. He had tried to do so in the most compact and clear way possible, which involved summing up and shortening as far as necessary the original content, and by adding information on the latest experiences and progresses in this area.

Victorian Attitude toward Waste. It is difficult to weigh the specific contributions of Playfair and Simmonds with any sort of precision, but it seems certain that the idea of creating "wealth from waste" was well ingrained in Victorian minds. Perhaps the spirit of the age was best captured in 1881 by the popular author and theologian William Garden Blaikie (1820–99): "All of us have an instinctive dislike of waste, and an instinctive satisfaction in the recovery of lost or waste material, of whatever kind, and its application to useful purposes."[101] In the preface to a 1928 survey of by-product development authored by the chemical engineer John B. C. Kershaw, a past president of the Federation of British Industries, Max Muspratt (1872–1934), observed that in the days of his childhood "Waste not, want not" was a lesson inculcated in all young people. [102] While he couldn't remember if there had been a suitable response in the nursery, he wrote that "the same wise saying has had the

[100] Otto Suessengut, *Die Industrie der Abfallstoffe* (Leipzig, Germany, 1879).

[101] William Garden Blaikie, *Better Days for Working People* (London, 1881), 130.

[102] Muspratt was a chemist by training and one of the heirs of a then prominent Liverpool family. See Michael D. Stephens and Gordon W. Roderick, "The Muspratts of Liverpool," *Annals of Science* 29, no. 3 (1972): 282–311.

constant consideration of every progressive manufacturer for at least a century."[103]

This perspective was also shared by some of the most important economists of the time. For example, British resident Karl Marx (1818–83) pointed out, in the third volume of his *Capital*, that with "the advance of capitalist production the utilisation of the excrements of production is extended" and commented that "so-called waste plays an important role in almost every industry." Interestingly, Marx gave credit to the search for increased profitability. "These excrements," he wrote," "reduce the cost of the raw material to the extent that they are saleable. For a normal loss is always calculated as a part of the cost of raw material, namely, the quantity ordinarily wasted in its consumption. The reduction of the cost of this portion of constant capital increases to that extent the rate of profit." Indeed, Marx went so far as to write that industrial waste recovery was "the second great branch of economies in the conditions of production," after economies of scale.[104] While Marx did not refer to Playfair or Simmonds in his work, he was strongly influenced by Babbage and became a member of the Society of Arts at the invitation of Simmonds.[105]

In the end, however, while the Bethnal Green waste exhibit might have played an important role in educating a broad audience, it is doubtful that it was absolutely crucial in promoting waste recovery among industrialists, for, as both Playfair and Simmonds commented, such behavior predated their writings. Indeed, as the editor of the *Chemical News* observed soon after the publication of the first edition of *Waste Products*: "The progress of our great chemical manufactures during the last ten years, as exemplified in the International Exhibition of 1862, appears chiefly to have been directed towards the utilization of waste substances."[106] Besides, by-product development was simultaneously becoming widespread in locations where people had never heard of these British writers and did not benefit from a permanent by-product display. This is not to say, of course, that specific individuals did not benefit or draw inspiration from the waste exhibit or from the written work on the subject.

The fact that resource recovery was still going strong after the deaths of Playfair and Simmonds is attested to by, among other facts,

[103] John B. C. Kershaw, *The Recovery and Use of Industrial and Other Waste* (London, 1928), vii.

[104] Karl Marx, *Capital, A Critique of Political Economy*, vol. 3: *The Process of Capitalist Production as a Whole* (Chicago, 1909), 96, 95, 120–1.

[105] Greysmith, "The Empire as Infinite Resource," 3–15. Simmonds's letter was part of a mass-mailing effort, but it seems likely that Marx visited Simmonds's waste exhibit.

[106] William Crookes, "Chemical Products," 58.

the launch of *Waste Trade World: The Journal of the Metal, Cotton, Woollen, Paper, Rubber, and other Waste Trades* in 1912. It was the first British periodical devoted to the business of scrap and waste products in all their forms. In 1918, when one of the editors of this publication was contemplating the creation of a detailed bibliography on waste recovery, he came across a reference to the 1875 Bethnal Green Waste Exhibit catalog in an edition of William Stanley Jevons's *Principles of Economics*.[107] Upon contacting the museum, T. A. Lehfeldt—the employee then in charge of the exhibit—informed the editor that the catalog had long been out of print, but that a copy could be found in the Science Library of South Kensington.[108]

Another indication of the importance of by-product recovery in the early decades of the twentieth century is that compendiums similar to Simmonds's were published and updated in Germany, France, the United Kingdom, and the United States.[109] These books failed to mention his pioneering work and essentially conveyed the same message while drawing on later technological developments. Assuming no bad faith, these volumes provide further evidence that market incentives were much more compatible with "win-win" innovations than is now often believed to have been the case.

Reflective Conclusion

Much current thinking on corporate social responsibility and sustainable development is based on a perceived trade-off between economic growth and environmental protection. Indeed, it is typically argued that the corporate search for increased profitability resulted in increasingly unmanageable pollution problems, the depletion of nonrenewable resources, habitat and species destruction, and a regulatory race to the bottom among competing jurisdictions.[110] At the roots of this perspective is the belief that, in the words of one public health historian, "Historically business has tended to look on the pollution costs of

[107] The original reference is in William Stanley Jevons, *The Principles of Economics* (London, 1905), 28–9, in a subsection on "successive utilization."

[108] The original query (6 June 1918) and Lehfeldt's reply (12 June 1918) can be found in the Victoria and Albert Museum Registry's "Bethnal Green Museum, Waste Products Collection, 1874–1928" file.

[109] Theodor Koller, *The Utilization of Waste Products*, 3rd rev. ed., transl. from the 2nd rev. German ed. (New York, 1918); Paul Razous, *Les déchets et sous-produits industriels* (Paris, 1905); Kershaw, *The Recovery and Use of Industrial and Other Waste*; Charles H. Lipsett, *Industrial Waste and Salvage: Conservation and Utilization* (New York, 1951).

[110] Bruce L. Hay, Robert N. Stavens, and Richard H. K. Vietor, eds., *Environmental Protection and the Social Responsibility of Firms: Perspectives from Law, Economics, and Business* (Washington, D.C., 2005).

production as an external cost to be born [*sic*] by society in the form of dirtier water or air or depleted natural resources." This externalization of environmental costs, in turn, is said to have "encouraged economic expansion and employment by reducing costs to the manufacturer."[111]

The evidence collected by Playfair, Simmonds, and others nonetheless suggests that a rethinking of some foundations of the now dominant "sustainable development" perspective is perhaps required. Is it not ironic that the Royal Society of Arts' recent manifesto includes "Moving towards a Zero Waste Society," a challenge that seems to have been devised without any knowledge of their predecessors' initiatives and findings.[112] Admittedly, by-product development was never able to eliminate pollution problems completely, but it seems undeniable that such activities were triggered on a large scale by profitability considerations and very often resulted in drastically reduced environmental impact.

All this is not to say, of course, that Playfair, Simmonds, and some of their contemporaries were denying the severity of environmental problems created by profit-seeking businesses in various locations. It is, instead, to say simply that their contribution is better understood as an attempt to promote the development of win-win practices through creative problem-solving, rather than through the reduction of manufacturing output and living standards. In a world where widespread poverty and hunger were still the norm for most of the human race, and where people were much less sheltered from the vicissitudes of nature than they would later become, these authors were surely better able to appreciate the trade-offs between the economy and the environment of their day than are the twenty-first century writers so often prone to indict Victorians for their lack of environmental concern. Several hundred examples from the height of the industrial age suggest that the rational interest of business has never been as opposed to the environmental interest of society as many academics, activists, and regulators currently believe. A more detailed examination of past successes and failures in terms of "win-win" economic and environmental innovations is long overdue.

[111] John T. Cumbler, "Conflict, Accommodation and Compromise: Connecticut's Attempt to Control Industrial Waste in the Progressive Era," *Environmental History* 5, no. 3 (2000): 314. Pierre Desrochers, "Industrial Ecology and the Rediscovery of Inter-Firm Recycling Linkages: Some Historical Perspective and Policy Implications," *Industrial and Corporate Change* 11, no. 5 (2002), documents how widespread this belief is in a wide variety of academic disciplines.

[112] Part of the RSA's 2005 manifesto states that its goal is to "develop mutually reinforcing policies, products, technologies behaviours and lifestyle that reduce waste of all kinds, with zero waste as the long term ideal."