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**‘American Plastic’ in Europe?**

**TITLE:** *Leo Baekeland’s Transatlantic Strategy for Bakelite*

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## Introduction

The Belgian-born scientist-entrepreneur Leo H. Baekeland (1863-1944) had had been living in America for almost twenty years and acquired the American nationality when he, in June 1907, made crucial breakthroughs in his private laboratory and filed his first patent applications on a material called 'Bakelite'. Baekeland and his American peers, particularly the industrial chemists who 'crusaded' for public recognition and government protection,[1] were eager to argue that the phenolic plastics industry, initiated by the commercialization of Bakelite, had been 'American in its conception and origin'.[2] Pushed by the outbreak of the First World War and the accompanying scarcities, they aimed to demonstrate their independence from the German chemical concerns which had dominated international markets.[3] Moreover, their success in plastics arguably showed the ability of American chemists, chemical engineers and businessmen to pioneer a 'science-based' industry of their own.[4]

Nevertheless, the Belgian newspaper *De Standaard* was not entirely wrong in including the invention of Bakelite in a list of European achievements.[5] Reflecting the scientific internationalism and economic interconnectedness of the years preceding the First World War,[6] the commercialization of Bakelite embodied influences of various origins. Based on Baekeland's intellectual property rights, the industry was established approximately simultaneously on both sides of the Atlantic. As the protagonists were aware of each other's work and agreed to collaborate, an investigation of its formation and early years asks for a comparative, transnational analysis.[7]

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[1] Cf. D.J. RHEES, *The Chemists' Crusade: The Rise of an Industrial Science in Modern America, 1907-1922*, Ph.D. dissertation, University of Pennsylvania, 1987 and K. STEEN, *Wartime Catalyst and Postwar Reaction: The Making of the United States Synthetic Organic Chemicals Industry, 1910-1930*, Ph.D. dissertation, University of Delaware, 1995.

[2] E.g. A. BROWN, 'Bakelite – What It is', *Plastics*, 1, 1 (Oct., 1925), p. 17.

[3] German corporations were particularly dominant in organic chemistry. British inorganic chemistry concerns were even larger than Bayer, BASF or Hoechst, but not nearly as research-intensive and therefore less appealing to industrial chemists such as Baekeland (cf. U. MARSCH, *Zwischen Wissenschaft und Wirtschaft: Industrieforschung in Deutschland und Grossbritannien 1880–1936* (Publications of the German Historical Institute, London, Volume 47), Paderborn, 2000, p. 206 and 209.

[4] In a narrow sense, the synthetic plastics industry was much less science-based than the dyestuff industry, the standard example. Whereas theoretical breakthroughs spurred economic growth in the latter case, they only followed belatedly on practical successes in the former. On the dyestuff industry, see J.P. MURMANN, *Knowledge and Competitive Advantage. The Coevolution of Firms, Technology, and National Institutions*, Cambridge, 2003 and E. HOMBURG, 'The Emergence of Research Laboratories in the Dyestuffs Industry, 1870-1900', *The British Journal for the History of Science*, 25, 1 (March, 1992), pp. 91-111.

[5] cf. 'Hoe Slim is Europa?', p. 7, in *De Standaard* (March 13, 2009).

[6] Cf. P. FORMAN, 'Scientific Internationalism and the Weimar Physicists: The Ideology and Its Manipulation in Germany after World War I', *Isis,* 64, 2 (June, 1973), pp. 151-180 and G. JONES, *Multinationals and Global Capitalism. From the Nineteenth to the Twenty-first Century*, New York, 2005.

[7] Such an analysis has not yet been made. On the invention of Bakelite and the material's meanings see W.E. BIJKER, *Of Bicycles, Bakelites, and Bulbs. Toward a Theory of Sociotechnical Change*, Cambridge, Mass, 1995, pp. 101-97 and J.L. MEIKLE, *American Plastic. A Cultural History*, New Brunswick, NJ, 1995, pp. 31-62; on the history of the British Bakelite company P. REBOUL, 'Britain and the Bakelite Revolution', in S.T.I. MOSSMAN and P.J.T. MORRIS eds., *The Development of Plastics*, Cambridge, 1994, pp. 26-37 and T.J. FIELDING, *History of Bakelite Limited*, London, 1949. References to the German Bakelite Gesellschaft are included in Gerd Collin's history of Rütgerswerke AG, its controlling stakeholders (cf. G. COLLIN, *Geschichte der Steinkohlenteerchemie: am Beispiel der*

By elaborating such an account, I aim to contribute to the methodological debate on merits and disadvantages of comparative history and transfer studies and ways to combine both approaches. The debate has mainly been conducted by German and French scholars, driven by a desire to go beyond national(ist) accounts of their countries' histories, and eager to study the history of Europe and European integration in relation to the outside world.[8] Some of the participants, for instance the social historian Hartmut Kaelble, have pointed out that the predominantly theoretical discussion would greatly benefit from empirical case-studies.[9] Particularly relying on the so-called *histoire croisée* or 'crossed history' approach of Michael Werner and Bénédicte Zimmermann, I aim to contribute to the fulfillment of that goal. Central to histoire croisée are the concepts of reflexivity and 'pragmatic induction'. Werner and Zimmermann suggest to readjust the points of view from which a research topic is approached continuously throughout the investigation. They underline, moreover, that the researcher has to acknowledge biases resulting from his/her position, personal interests and background, as categories of analysis can rarely be based entirely on the characteristics of the research objects. The relations and interactions between inquirer and object, in other words, have to be made explicit.[10]

Taking these considerations into account, I argue In the second and core section of the paper that the years until 1917, when America and Germany declared war on each other, should be analyzed as the 'German phase' in the development of the Bakelite business – both for what was happening internationally and to understand the evolution in the United States. As I relate the categorization to Baekeland's entrepreneurial strategies, the point of view of 'the Father of Modern Plastics' will be elaborated previously. In particular, I take Baekeland's preference for industrial applications rather than consumer goods as point of departure, and indicate his options for directing the development of the industry. The decision to search for German influences, however, was also a consequence of this author's interest in international technology transfers in a broad sense, i.e. not just movements of (knowledgeable and/or skilled) people and artifacts but also of related models and ideas.

In the third part of the paper, I put the proposed categorization to the test by inquiring into the nature of early Bakelite applications developed in Europe and the United States. Contrary to the first two sections, which are mainly based on Baekeland's personal papers and records of two individual companies, that part of the text rests upon an analysis of trade journals of the plastics industry.[11] Interestingly, from the sectoral point of view the borders of Wilhelmine and Weimar Germany seem to have been relatively unimportant. As a matter of fact, a survey of the journals reveals

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*Rütgerswerke*, Hamburg et al., 2009). The most detailed account of Baekeland's life is C.B. KAUFMANN, *Grand Duke, Wizard and Bohemian. A biographical profile of Leo Hendrik Baekeland (1863-1944)*, M.A. thesis, University of Delaware, 1968.

[8] Cf. H. KAELBLE, 'Die Debatte über Vergleich und Transfer und was jetzt?', *History. Transnational*, http://geschichte-transnational.clio-online.net (February 8, 2005).

[9] Cf. *Ibidem*. See also E. VAN DER VLEUTEN, 'Toward a Transnational History of Technology: Meanings, Promises,Pitfalls', *Technology and Culture*, 49, 4 (Oct., 2008), pp. 974-994.

[10] Cf. W. WERNER and B. ZIMMERMANN, 'Beyond comparison: *Histoire croisée* and the challenge of reflexivity', *History and Theory*, 45 (February 2006), pp. 41-2, 47 and 49; M. MIDDELL, review of WERNER and ZIMMERMANN eds., *De la comparaison à l'histoire croisée*, Paris, 2004, in: *H-Soz-u-Kult*, April 29, 2005.

[11] The primary research has been made possible thanks to the support of the Smithsonian Institution (predoctoral fellowship at the National Museum of American History), the Hagley Museum and Library (grant-in-aid), and the Chemical Heritage Foundation (short-term Herbert D. Doan fellowship). I presented an earlier draft of the paper at the CHF on March 16, 2010.

Central Europe as 'the old world's hotbed of synthetic plastics and home region of American producers' most serious competitors. In the conclusion, I accordingly address the question whether transnational, national or local differences and peculiarities mattered most.

## 1. Baekeland's initial position

When the chemist-entrepreneur Leo Baekeland announced his invention of the synthetic resin 'Bakelite' on February 5, 1909, to an audience of scientists, businessmen and engineers, he was acutely aware of the commercial potential of the material. He maintained that his assistants and he were studying applications 'in more than forty different industries'.[12] Although not numerous enough to justify that claim, the examples he mentioned did span a remarkable range. He promised to overcome limitations of earlier, natural plastics, which could not satisfactorily respond to the rising demand for consumer goods and industrial applications in the expanding economies of the time. As luxury goods for the upper classes, they had mainly been confined to a small market segment. Celluloid, the semi synthetic plastic invented by John Wesley Hyatt in 1869, could be produced in much larger quantities and therefore opened new outlets to manufacturers. It posed challenges of its own, however, not in the least due to its flammability.[13]

On the one hand, Baekeland presented Bakelite as a substitute for celluloid and other plastics which had been used for manufacturing combs, buttons, and similar articles. On the other, he pointed out that Bakelite, because of its superior technical qualities compared with such earlier plastics, would be of great value for industrial applications as well. In this regard, Baekeland mentioned its use as strengthener of wood and insulating varnish for motors and dynamos, among other applications.

It must have been clear to the audience: the mentioned applications were too numerous and required expertise of natures too diverse to be pursued independently or at a single start-up. Baekeland, in any case, did not leave any doubt as to which uses he considered to be of the greatest interest. After having referred to possible Bakelite consumption goods, the 'Father of Modern Plastics' continued by saying that 'its use for such fancy articles has not much appealed to my efforts as long as there are so many more important applications for engineering purposes'.[14] To what extent could Baekeland, however, control 'his' technology? His legal position, to begin with, was anything but unfavorable. Having carefully filed American and international patent applications, Baekeland had already laid the basis for a global monopoly. He had taken detailed notes documenting the progress of the experiments at his laboratory, and showed samples to visitors, gathering evidence that would strengthen his case if there were to be legal battles about the validity of his property rights. At the same time, he had anxiously prevented the disclosure of technical details before having filed his patent applications.[15]

One of the applications would proof to be particularly important. U.S.P. 942,699 ('Method of making insoluble products of phenol and formaldehyde') described Baekeland's production process, particularly stressing the combined use of heat and pressure to control the reaction between phenol and formaldehyde. In addition to

[12] L.H. BAEKELAND, 'The Synthesis, Constitution, and Uses of Bakelite', *Journal of Industrial and Engineering Chemistry*, 1, 3 (March, 1909), p 158.
[13] Cf. R. FRIEDEL, *Pioneer Plastic. The Making & Selling of Cellulloid*, Madison, Wis., 1983 and BIJKER, *Of Bicycles*, p. 125.
[14] BAEKELAND, ‚Synthesis', p. 157.
[15] Cf. *Ibidem*, journals 1-3, Baekeland Papers, Central Archives, NMAH, Smithsonian Institution, Washington, D.C. (Series 4, Box 18, Folders 2-3).

such broad claims, Baekeland had filed patent applications to protect specific uses of Bakelite, such as a Bakelite varnish, packing material, container for food products and abrasive composition. Moreover, Baekeland had registered the trade name 'Bakelite' throughout the world and urged his customers to depict it clearly on their applications.

His industrial property rights would offer the central means to manage the development of the technology. Baekeland could, for instance, be selective in the granting of licenses. To whom did he sell his industrial property rights, if he decided to do so? Which applications did the agreements cover? What were the terms?

Moreover, as Wiebe Bijker has pointed out, in 1909 a substantial 'interpretative flexibility' was left for determining what 'Bakelite' actually was.[16] Baekeland himself repeatedly stressed the long distance between a laboratory breakthrough and the large-scale adoption of a new technology, perhaps reminding students of entrepreneurship of Joseph Schumpeter's distinction between inventions and innovations.[17] He for instance stated that 'seemingly secondary conditions' such as engineering problems and financial requirements 'most of the time become the deciding factor of success or failure of an otherwise well-conceived chemical process'.[18] At the time of the public announcement of his invention, the core of the developmental and 'educational' work remained to be done. By focusing on specific applications, Baekeland and his collaborators could therefore attempt to push through their preferences. In any case, they were probably aware of the risks of spreading research, production and marketing efforts along many lines before a stable sales basis had been achieved.[19]

In determining his strategy, Baekeland had the additional advantage that his financial resources, gained by selling Eastman-Kodak the Nepera Chemical Company, the photographic enterprise he had formed in 1893, allowed him to take long-term prospects into account rather than opt for short-term profits. As he would state in 1916, 'in selecting business associates for my new industry I took less in consideration any money they were willing to introduce as stockholders, than their exceptional personal qualifications and business experience'.[20] In making his choices, he may have steered the development of the Bakelite business in specific directions. Interestingly, he would come to rely heavily on German and German-American associates.

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[16] Cf. BIJKER, *Of Bicycles*, pp. 151-2 and 156.

[17] Cf. J. SCHUMPETER, *Theorie der Wirtschaftlichen Entwicklung*, 1912, pp. 178-9. The validity of the distinction has been questioned, however (cf. N.R. LAMOREAUX and K.L. SOKOLOFF, 'Introduction: The Organization and Finance of Innovation in American History', in LAMOREAUX and SOKOLOFF eds., *Financing Innovation in the United States, 1870 to the Present*, Cambridge, Mass., 2007, pp. 29-30 (fn. 1)). Baekeland's approach to innovation also has interesting parallels to the strategies of the independent inventor-entrepreneurs analyzed by Thomas Hughes (cf. T.P. HUGHES, *American Genesis. A Century of Invention and Technological Enthusiasm, 1870-1970*, New York, 1989 and Ibidem, *Networks of Power: Electrification in Western Society, 1880-1930*, Baltimore, 1983.

[18] L.H. BAEKELAND, 'Some aspects of industrial chemistry', New York, 1914, p. 21.

[19] Cf. FRIEDEL, *Pioneer Plastic.*, pp. 47-8.

[20] L.H. BAEKELAND, *Practical life as a complement to a university education* (Perkin Medal address), 1916, p. 29.

Fig. 1.1. and 1.2.: Bakelite billiard ball on the left and gear shift, artifact collection, NMAH, Smithsonian Institution (image credit photo on the left: Donald Hurlbert, Smithsonian) Whereas the need for a substitute for ivory for manufacturing billiard balls would have inspired John W. Hyatt, the inventor of celluloid, Baekeland was more interested in applications for automobiles, among other technical uses.

## 2. The 'German' stage in the development of the industry

### *2.1. Internationally*

To secure protection of his industrial property rights, Baekeland had pursued a regional, language-based strategy. For instance, he had made use of the services of New York-based patent agents to prepare and file his applications in the United States, Canada, and Britain, of agents from Berlin for Germany, Austria and Hungary, and of native French speakers for Belgium and France. He did not, however, subsequently initiate the formation of national or regional companies exploiting the respective rights, but opted to sell licenses on all of his European patents (including the European colonies except for Canada) and the 'Bakelite' trademark to a single consortium, based in Berlin, and dominated by the chemical concern Rütgerswerke A.G.[21]

Why Germany? First, Baekeland was doubtlessly charmed by the interest which German scientists, journalists and entrepreneurs took in his work. The editor of the *Chemiker Zeitung,* for instance, had been eager to publish a German translation of his seminal paper on Bakelite. Rütgerswerke, moreover, had already made one of their chemists approach Baekeland in London, where Baekeland was attending the 7th International Congress of Applied Chemistry, to start contractual negotiations. Their attention had been drawn to Baekeland's work through the article in the *Chemiker-Zeitung*.[22]

The demand-factor, however, by itself does not satisfactorily explain Baekeland's choice for Berlin. For instance, while travelling to England, an employee of Hardman & Holden, Ltd., coal tar distillers from Manchester, had already pointed out to Baekeland how a collaboration with his firm would benefit both parties. In addition to the raw materials that Hardman & Holden proposed to provide, Baekeland may have been aware that most American corporations with international ambitions had used

[21] Cf. *Ibidem*, journals 1-4, Baekeland Papers (Series 4, Box 18, Folders 2-4)
[22] Cf. *Ibidem*, journal 60, Baekeland Papers, Series 4, Box 22, Folder 2, pp. 127-8 and journal 60A (Folder 3), pp. 185-7.

England as their gateway to Europe.[23] During the Congress of Applied Chemistry, a delegation of Hardman & Holden traveled to London to learn more about Baekeland's invention and discuss prospects of collaboration.[24]

Manchester nor London, however, could match Berlin as regards the available expertise concerning perhaps the most promising market for Bakelite, and certainly one which Baekeland particularly valued: the material's use for electrical applications. Baekeland wanted to include Siemens & Halske and Allgemeine Elektrizitätsgesellschaft (AEG), the companies which were largely responsible for Berlin's status as 'the electrical metropolis' of the world, in his consortium.[25]

Furthermore, Baekeland probably anticipated that the fiercest competition would come from German scientists. To obtain peer recognition for his achievements and financial rewards as founder of a new industry, it would therefore be particularly important to establish his rights firmly in that country. After Baekeland's talk in New York, a local representative of Bayer had already expressed doubts as to the novelty of his work, and Baekeland would be confronted with additional challengers while in Germany. The chemist Hans Lebach of Knoll and Company, in particular, argued that his 'Resinit' was very similar to Bakelite, only 'somewhat earlier conceived'.[26] Baekeland, who received a draft of Lebach's article prior to its publication in the *Chemiker-Zeitung* thanks to his cordial relation with one of the journal's editors, refuted Lebach's claim in a text of his own. A heated discussion followed in the following weeks, until the Patent Office ruled in Baekeland's favor and the rivals agreed to start collaborating.[27]

An additional reason to explain Baekeland's choice for Berlin may have been his admiration for the German science-based industries. He used some of his dear time to study their business methods in more detail. On June 30 he admitted to Elon H. Hooker, for whose Development & Funding Company he was supposed to be doing consulting work, that: 'Involuntarily I have dilated on matters which have no relation to our own business, but I could not help doing so, impressed as I am with what constitutes German superiority in business enterprises based on scientific principles.'[28] In a previous paragraph of the same letter, he had already remarked that:

"I am surely sorry that you are not with me here in Germany, as I have no doubt that the direct and thorough business methods displayed here by big chemical and engineering concerns would open your eyes wide and would show you the secret of the tremendous success these people are achieving in these particular lines. Instead of having merely bankers or so called business men at the head of their enterprises

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[23] Cf. H. BONIN and F. DE GOEY, 'American companies in Europe: issues and perspectives', in: *Ibidem,* eds., *American Firms In Europe, 1880-1980: Strategy, Identity, Perception and Performance*, Geneva, 2009, pp. 18-9 and M. WILKINS, 'US Business in Europe: an American perspective', in: *Ibidem*, p. 51.
[24] Cf. *Ibidem*, journal 4, Baekeland papers, Series 4, Box 18, Folder 4.
[25] Cf. *Ibidem*, and J. OSTERHAMMEL, *Die Verwandlung der Welt*, Munich, 2009, p. 1029.
[26] Quoted in BIJKER, *Of Bicycle*s, p. 168.
[27] Cf. *Ibidem*, p. 169; BAEKELAND, journal 4, p. 194 and journal 60A, pp. 185-6; *Ibidem*, 'Bakelit, ein neues synthetiisches Harz', *Chemiker-Zeitung*, 35, 35 (March 23, 1909), p. 317; 36 (March 25), p. 326; 38 (March 30), p. 337 and 39 (April 1), p. 358; H. LEBACH, 'Bakelite and its applications', *Journal of the Society of Chemical Industry*, 32, 11 (June 16, 1913), pp. 559-64; F. RETZLAF, *Max Weger. Der Vater der Bakelite Gesellschaft* (http://www.chemieforum-erkner.de/chemie-geschichte/personen/weger.htm#lit), Feb. 26, 2010 (consulted on May 17, 2010).
[28] Letter from L.H. Baekeland to E.H. Hooker on June 30, 1909, Elmer A. Sperry Papers, Accession 1897, Box 17 (Electrochemistry Files), Soda House, Hagley Museum and Library, Wilmington, Delaware.

they have the most thoroughly technically and scientifically developed staff. In fact, the majority of the board of directors is made up of people who have achieved success through practical scientific men. This explains their tremendous daring in business enterprises based on scientific facts."[29]

According to the business historian Jeffrey Fear, the technically-oriented business culture Baekeland hints at was typical for German and French corporations. Fear argues that their managers, often scientists or engineers, expected that profits would naturally follow from delivering high-quality products, whereas their American counterparts would have focused on return-on-investment as central criterion to evaluate their companies' performances.[30]

Although Baekeland already held the German chemical and electrical industries in high opinion prior to the summer of 1907, it has to be stressed that he did not pursue a 'grand strategy'. His stay in Europe was considerably marked by contingencies and improvisations. Baekeland was repeatedly approached by chemists, lawyers, inventors and entrepreneurs of whom he had never heard before. His success partly depended on his capacity to make a fair judgment about their competencies and, perhaps more difficult, their characters. The final agreement, moreover, substantially deviated from Baekeland's initial preferences. Siemens and AEG, for example, were eventually left out of the consortium. Nevertheless, Baekeland was satisfied with the result and eager to start with what he called 'the real work': improving the technology.[31]

### *2.2. In the United States*

Baekeland's original intention was to restrict himself to granting licenses and providing technical advice in America. In the months following his return to New York, however, he changed his mind and started to make plans to establish an American Bakelite company as well. The General Bakelite Company went into business on September 29, 1910. The firm was located on grounds of the Roessler and Hasslacher Chemical Company, an importer and manufacturer of a broad range of chemicals, and made use of its facilities. Executives of Roessler & Hasslacher were strongly represented on General Bakelite's board of directors and held almost half of the issued stock. Additionally, Bakelite contractually obliged itself to purchase its basic input formaldehyde exclusively from R & H.[32]

R&H was named after Franz Roessler and Jacob Hasslacher, who had been sent across the Atlantic in the 1880s to represent the interests of the Frankfurter concern Deutsche Gold- und Silber-Scheideanstalt, unofficially known as 'Degussa', in the United States, and formed a partnership to this purpose. The engineer Rupert Lowe, who started to work for Bakelite in 1923, was told that Baekeland greatly admired Hasslacher, R&H's president from the company's incorporation in 1889 until 1916. According to Lowe, moreover, General Bakelite was de facto run as a subsidiary of R&H in the years up to the outbreak of the First World War, when the scrutiny of the

[29] *Ibidem*.
[30] J.R. FEAR, 'Constructing Big Business: The cultural concept of the firm', in A. CHANDLER, Jr., F. AMATORI and T. HIKINO eds., *Big Business and the Wealth of Nations*, Cambridge, Mass., 1997, p. 562.
[31] Cf. BAEKELAND, journal 4 and supplement. Reference to 'the real work' on pp. 23-4 of supplement to #4.
[32] Cf. H.R. CARVETH, *Roessler & Hasslacher – Partners*, Soda House, Hagley Museum and Library, Wilmington, Delaware, Records of E.I. du Pont de Nemours & Company, Series II, Part I, Accession 500, Box 1658 (Records of absorbed companies), pp. 4-5.

U.S. Government and anti-German sentiments probably made Baekeland pursue a more independent course.[33]

To what extent did the close intertwinement between General Bakelite and R&H impact on the commercial development of phenol-formaldehyde resins? More specifically, were the features of German chemical concerns lauded by Baekeland reflected in General Bakelite's policies through its collaboration with R&H? Interestingly, company histories of R&H and internal documents of Du Pont, which would take over R&H in 1930, indicate how the firm's practices deviated from what was common in the American industry of the time. For instance, R&H was among the first American chemical firms to send out technicians to teach its customers how to use its products, a practice pioneered by Bayer in the German dyestuff industry and adopted by General Bakelite as well.[34] To pursue a business model which increased the mutual dependency of seller and buyer effectively, it was particularly important to gain the goodwill of the customers. A report by Du Pont indicates that R&H had been successful in this regard: among R&H's assets, it mentions its 'high standing in the chemical industry with connection with practically every branch in the industry'.[35]

The Du Pont committee, moreover, appreciated 'the strong technical organization and the aggressive research policy' of Roessler & Hasslacher.[36] Although R&H seriously expanded its research staff and facilities only in the late 1920s, the roots of its approach to R&D predate the outbreak of the First World War. Hector R. Carveth, who directed R&H's research in the 1920s until he was elected president in 1928, had for instance abandoned his teaching position at Cornell University to join the company in 1905.[37] Summarizing Carveth's career to the editors of the biographical dictionary *Who's Who in America*, whom he urged to include a profile of Carveth in their next volume, Baekeland commented that 'Unfortunately it does not happen often enough in the United States that large business enterprises here should have able scientists as their executive head.'[38] The boards of directors of the large German chemical concerns, to the contrary, were dominated by scientists and engineers.[39]

According to Du Pont vice-president Jasper Crane, furthermore, Carveth had a 'foreign and to us ... incorrect view about [employment] contracts'.[40] Crane's remark concerned the legal guarantees granted to R&H employees. Roessler and Hasslacher typically ensured them a minimum salary and term of employment. Crane, contrarily, argued that 'the feeling of a Du Pont salaried man that he is an

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[33] Cf. Interview with Rupert Lowe, Baekeland Papers, Smithsonian.

[34] Cf. MURMANN, *Knowledge and Competitive Advantage*, p. 147. For instance, Bakelite hired Lowe as 'sales engineer' rather than salesman (cf. Interview with Lowe, Baekeland Papers). Outside of the chemical industry, however, the model had already been adopted, for instance by the National Cash Register Company (cf. J.W. CORTADA, *Before the Computer: IBM, NCR, Burroughs, & Remington Rand and the Industry They Created, 1865- 1956,* Princeton, 1993, p. 68).

[35] Cf. F. SPARRE, *Roessler & Hasslacher Chemical Company* (*report of development department to executive committee, Feb. 24, 1930)*, Du Pont Records, Accession 1813, Box 5, Folder 15 (Willis F. Harrington Papers), p. 8; Ibidem, *Report on accomplishment of objectives* **(**June 30, 1932), Du Pont Records, Series II, Part I, Accession 500, Box 1658; Also CARVETH, *Roessler & Hasslacher,* p. 3.

[36] Cf. SPARRE, *Report on accomplishment of objectives,* pp. 6-7.

[37] The other presidents in the 1920s, Franz Roessler and Wm. A. Hamann, had been associated with the firm since its formation.

[38] Letter of L.H. Baekeland to Messrs. A.N. Marquis Company on Sept. 10, 1929, Baekeland Papers, Series 3, Box 8, Folder 14.

[39] Cf. FEAR, 'Constructing Big Business', p. 552 and 562

[40] Letter of J. Crane to W. Harrington on Nov. 1, 1930, Du Pont Records, Series II, Part 2, Box 1051 (Jasper Crane Vice-Presidential Papers), File 42 (1).

integral part of the whole show is infinitely better than to attempt to tie him up with a contract.'[41]

A comparison between Roessler & Hasslacher and Bakelite on the one hand, and Du Pont on the other provides additional insights as to the nature of the former enterprises. To Du Pont's negotiators, used to the relatively transparent bookkeeping of their own concern, it proved to be a challenge to quantify the value of Roessler & Hasslacher, a closed corporation which had tried to maintain the spirit and practices of its partnership days.[42] For instance, the company's top managers-employees generously divided profits among themselves rather than distributing them more broadly among the stockholders.[43] As to the amount of money: the committee which had studied the matter reported that 'In no instance have we been able to find a bonus policy as liberal as the one pursued for a number of years by our Company'.[44] However, it conceded that, taking the high profitability into account, the practice may have been justifiable.

In this instance, once again, the similarities between Roessler & Hasslacher and General Bakelite are striking. It was an open secret in the industry that Bakelite's directors were being compensated royally for their pioneering work. Even Lawrence Byck, who had joined the company in 1910 and documented its history in 1952, could however not retrieve any record of profits concerning the early years.[45] Tellingly, R&H official Philip Schleussner mentioned to Du Pont executive Willis Harrington, whose company had indirectly acquired Bakelite stock by merging with Schleussner's, that he had suggested to Leo Baekeland's son George that Bakelite should start to issue annual statements to its stockholders.[46] Hindered by a lack of inside information, Du Pont treasurer Eliason's valuation of Bakelite's stock would proof to be far too optimistic.[47]

Additionally, Roessler & Hasslacher's technical director D.O. Notman remarked around 1944 that one of the aspects in which his company used to be 'very different from the average American company of that time' [the late 19th and early 20th century, JM] was its strict reliance on secrecy.[48] For instance, Fritz Roessler would have concealed the liquid bright gold formulas which had carefully been passed on by Roessler fathers to their sons for several generations, and made sure that his laboratory was closely guarded. Baekeland's impression in 1909 was that German manufacturers were (even) more secretive about their production methods than their American counterparts. He had relied on secrecy himself during the 1890s, while

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[41] *Ibidem*. The Du Pont committee which studied the matter, however, concluded that it would be preferable to stick to R&H's methods (cf. report Committee on contracts, submitted by L.M. White on July 28, 1930, Jasper Crane Vice Presidential Papers, File 42 (1)).

[42] Cf. Letter of Eliason to W. Harrington on June 6, 1930, Du Pont Records, Accession 1813, Box 5, Folder 12 (Harrington Papers); SPARRE, *Roessler & Hasslacher Chemical Company,* pp. 2-3; CARVETH, *Roessler & Hasslacher*.

[43] Until 1916 Roessler & Hasslacher was financially controlled by the Gold- und Silber-Scheideanstalt.

[44] L. HAYES, R. PAUL and G.E. WARREN, *The Roessler & Hasslacher Chemical Company. Report of Committee on Bonus Distribution for the Year 1929*, Harrington Papers, Box 5, Folder 13.

[45] Cf. L.C. BYCK, *A Survey of the Bakelite Thermosetting Business – 1910 through 1951*, Baekeland papers, p. 6.

[46] Cf. Letter of H. Carveth to W. Harrington on June 25, 1931, Harrington Papers, Box 10, Folder 3.

[47] The impact of the Great Depression probably contributed to Eliason's misjudgment as well.

[48] D.O. NOTMAN, *Elchem – Past, present and future*, Du Pont Records, Accession 1676, Box 6 (Records of Absorbed Companies), p. 1.

developing photographic papers which he had not patented, and would do so again in the years following on 1909, in addition to his use of the patent system.[49]

R&H's officers' practice of corresponding in German with one another, finally, had probably less to do with secrecy than with convenience.[50] Nevertheless, it is another indication of the 'foreign' character of their company.

In general, it can be concluded that Baekeland's perception of German models of innovation most likely made him, in collaboration with his associates of Roessler & Hasslacher, pursue business strategies which were uncommon in the American chemical industry of the time. In particular, General Bakelite's model of offering engineering services would become the norm in the plastics industry. After the Second World War, when so-called specialized engineering firms started to diversify their activities, it would be adopted even more widely.[51] Although no 'hard' evidence could be found thus far, Baekeland's experiences in Europe and his reliance on German-Americans with 'foreign' conceptions make it plausible that the model was inspired by practices in the German science-based industries. If true, the findings would suggest a new, transatlantic interpretation of a significant transition in corporate America.

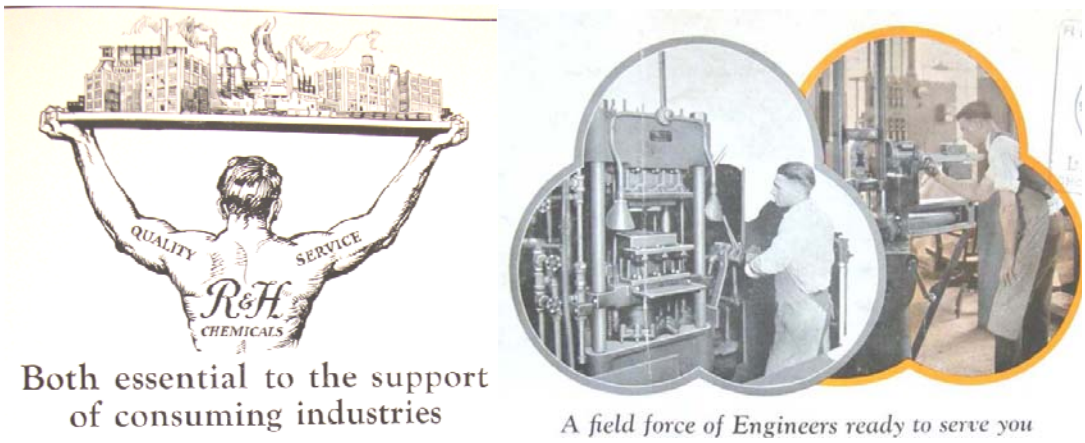


Fig. 2.1 and 2.2: fragment of R&H advertisement from 1925 (Du Pont Records, Hagley Museum and Library, Accession 500, Box 1658) and of Bakelite Corporation ad from October 1927 (*Plastics,* 3, 10). Both R&H and Bakelite offered their customers knowledge on how to use their products

[49] Cf. BAEKELAND, journal 2, pp. 36-8, journal 5, p. 41, journal 9, pp. 52-3, and journal 31, pp. 17-8 and 50-1.
[50] Knowledge of German was required from chemistry students at American universities and the language was spoken frequently at the Chemists' Club in New York City, until its use was prohibited during the First World War (cf. D.H. KILLEFER, *Six Decades of The Chemists' Club*, New York, 1957, pp. 43-4). Baekeland may have come to know Hasslacher through the Chemists' Club, as both of them were active members.
[51] Cf. A. ARORA and A. GAMBARDELLA, 'Evolution of Industry Structure in the Chemical Industry', in A. ARORA, R. LANDAU and N. ROSENBERG eds., *Chemicals and Long-Term Economic Growth: Insights from the Chemical Industry*, New York, 1998, p. 393. See also above, fn. 35.

### 3. Central European strengths

Did Baekeland's preference for industrial applications and the engineering culture of General Bakelite and R&H determine what kind of products were developed and sold? Did the proclaimed focus on technical uses, furthermore, prove to be financially rewarding? According to one observer, tellingly, Baekeland 'knew that the commercial success of the substance [Bakelite, JM] depended on its introduction into industrial uses' and therefore concentrated his efforts on improving its qualities in order to make it more suitable to this end.[52] As mentioned, Roessler & Hasslacher had established a track-record of being profitable as well.

In any case, laminating varnishes were General Bakelite's most important application in the first decade.[53] The firm mainly sold them to Westinghouse, which used them on insulating sheets and boards for electrical applications.[54] A technical use indeed. Bakelite Gesselschaft, to the contrary, pioneered the development of Bakelite buttons. They were manufactured at three factories, two of them located in Germany and one in Russia. According to Baekeland, the company derived most of its sales from the button business. In the same diary entry of January 1912, he noted that his German colleagues were lagging behind in all other branches.[55] After having visited the Gardelegen plant of Siemens-Schuckert-Werke in the subsequent year, he confirmed that 'They all seemed to apology that they are using so little bakelite'.[56]

More generally, European manufacturers seem to have had a competitive advantage in producing fancy goods. In the early 1920s, for example, American Bakelite decided, on the initiative of three of its employees, to form a subsidiary to produce Bakelite jewelry, novelties and gifts. They could not, however, compete with cheaper imports from Central Europe and had to abandon the enterprise.[57] Perhaps as a consequence of that experience, Bakelite took legal steps to prevent further imports of such products. In a heavily contested case, the company was eventually granted protection by Presidents Coolidge and Hoover, who followed the advice of the U.S. Tariff Commission.[58]

The threat to American producers partly stemmed from economic conditions in Germany, Austria and Czecho-Slovakia. The American trade journals which covered the case, generally supporting Bakelite's demand for additional protection, above all pointed to the considerably lower production costs in Central Europe, where small firms relied on cheap hand labor.[59]

Articles about the general evolution and conditions of the plastics industry per country, however, point as well to qualitative strengths related to specific districts. A

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[52] Cf. H.H. STEIDLE, 'Manufacture and Uses of Wood Flour', *Plastics*, 2, 11 (Nov., 1926), pp. 405-406.
[53] Cf. BYCK, *Survey of Bakelite Thermosetting Business,* p. 9.
[54] Cf. BAEKELAND, journal 20, p. 45 and MEIKLE, *American Plastic*, p. 53.
[55] Cf. BAEKELAND, journal 10, pp. 101-3.
[56] *Ibidem*, journal 12, pp. 100-1. To be fair, Baekeland added that they were using more Bakelite than he had expected and that their applications were of good quality.
[57] Cf. BYCK, *Survey of Bakelite Thermosetting Business*, p. 13.
[58] Cf. 'Government Prohibits the Importation of Bakelite', *Plastics*, 2, 6 (June, 1926), p. 196; 'Tariff Board Denies Motions To Dismiss Phenolic Resin Case', *ibidem*, 2, 7 (July, 1926), p. 247; 'Embargo on Bakelite "C"', *ibidem*, 2, 8 (Aug., 1926), p. 268; 'Bakelite Tariff New Hearing', *ibidem*, 3, 2 (Feb., 1927), p. 78; 'Final Briefs Filed in Bakelite Tariff Case', *ibidem*, 3, 3 (March, 1927), p. 122; 'Phenomenol Use of Resinoids', *ibidem*, 3, 10 (Oct., 1927), pp. 560-7; 'Appeal from Bakelite Decision', *ibidem,* 4, 10 (Oct., 1928), p. 553; 'The Moulder and the Fancy Goods Trade', *British Plastics and Moulded Products Trader*, 2, 20 (Jan., 1931), p. 335.
[59] They were estimated to be less than half of the costs in America (cf. 'Phenomenol Use of Resinoids', p. 566 and 'Embargo on Bakelite "C"', p. 268).

world-renowned jewelry industry, for instance, was located in Jablonec nad Nisou (*Gablonz an der Neise*).

Jablonec, together with relatively nearby Teplice, had developed into internationally competitive centers of synthetic plastics. Besides jewelry, the Czech cities also exported bracelets, buttons, piano keys and toys. Building on established strengths, local companies predominantly used plastics in the production of small consumption items.[60]

In the case of the Bakelite buttons, the presence of specific skills and infrastructures may have been decisive as well. The company Sylbe & Pondorf of Schmölln, according to an expert 'the 'Button Capital' of Germany, if not of the world', was the leading producer of button machinery. Sylbe & Pondorf would employ more than 1,000 workers to that purpose by the mid-1920s and have equipped manufacturers across the continent.[61] Schmölln's relative vicinity to Berlin might therefore explain Bakelite Gesellschaft's interest in the button business.

If it had not been for the details of America's industrial policy, however, even Central European manufacturers of plastic novelties would have experienced great difficulties in having their products enter the American market. Only objects made from pure phenol-formaldehyde resin were exempted from the high tariffs which effectively held back other variants of Bakelite. Because of its amber-like color, the pure form of Bakelite was well-suited for decorative purposes. It did not, however, have the technical qualities which made the typically black or brown phenol-formaldehyde molding materials so valuable for industrial uses. Whether purposefully or not, the American government had thus been favoring domestic producers of technical applications of Bakelite.[62]

## 4. Concluding remarks

Has it proved to be feasible to write a 'crossed history' of the formation and early years of the phenolic plastics industry? Has the attempt, at least, been rewarding? At this stage of my research, I will limit myself to two comments.[63]

By switching the points of view throughout the investigation, firstly, the paper has indirectly showed risks of sticking to previously defined units of comparison. Rather than Europe in its entirety - however that may be defined - Germany, the German chemical industry, and what would nowadays be described as a German 'national innovation system' were frequent points of comparison to Baekeland and his American peers. Baekeland's choice of associates, additionally, probably resulted not only in Europe but also in the United States in the adoption of German-inspired models and practices. If the scale of the analysis had been limited to Wilhelmine or Weimar Germany, however, important factors precipitating or hindering the adoption of a profoundly new material might have remained disguised. From the sectoral perspective, Germany's Central European neighbors appear to have been equally innovative manufacturers of plastic consumption goods. A closer reading of the trade journals, moreover, leaves the impression that local, industry-specific capabilities mattered more than national or supranational differences. Although more research

[60] Cf. 'European Toilet-ware Industry Suffers Depression', *Plastics*, 3, 4 (April, 1927), p. 184; 'The World Trade in Plastics, II. Czechoslovakia', *Ibidem*, 4, 1 (Jan., 1928), p. 30

[61] Cf. F.P. PONDORF, 'Remarkable Rise of the Button Industry', *Plastics*, 3, 5 (May, 1927), p. 210.

[62] I plan to include details on the politics of the trade legislation, including lobbying by the American chemical industry, in the next draft of the paper.

[63] I will explore the opportunities of the histoire croisée approach more comprehensively in my Ph.D. dissertation.

needs to be done before firm conclusions may be drawn, the preliminary results support the view that innovation students and policymakers would do well by looking more thoroughly at industrial sectors and transnational knowledge flows rather than national innovation systems.[64]

The comparative, transnational approach, secondly, makes possible a relative assessment of American and European economic and technological trajectories. The immigrant-inventor's 'American dream', getting rich while contributing to technical progress, may indeed not have been realizable in the old continent - at least not to the same extent. Baekeland's preference for industrial applications probably was economically rational, as the electrical and automotive industries, which quickly became important customers of General Bakelite, achieved disproportionally high growth rates in the decade following on the public announcement of his invention.[65] The electrical corporations of Berlin, interestingly enough, apparently needed more time for switching to phenol-formaldehyde resins. The economics behind the development of plastic consumer goods in Central European cities such as Jablonec, moreover, clearly did not include American-style rationalization and mechanization efforts. In my Ph.D. dissertation, I will address such contrasts more systematically.

[64] Cf. A. VAN ROOIJ et. al., 'National innovation systems and international knowledge flows: an exploratory investigation with the case of the Netherlands', *Technology Analysis & Strategic Management*, 20, 2 (March, 2008), pp. 149–168.
[65] Cf. BYCK, *Survey of Bakelite Thermosetting Business*, p. 6.