From Chemistry for the People to the Wonders of Technology

The Popularization of Chemistry in the Netherlands during the Nineteenth Century

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Abstract: This article analyzes phases in the production of popular Dutch chemistry books in terms of their audiences and the character of the texts. While the first popular chemistry books (1809-1815), which were directed to women, youngsters, and common people, contained moralistic and physico-theological contemplations, these were absent in books that between 1830 and 1844 diffused 'useful knowledge' among the working classes. The next period (1845-1864) was a hey-day, which also marked the end of the old style of popularization of chemistry. After 1865 the number of popular chemistry books dropped considerably, as a result of (a) the professionalization of chemistry; (b) the introduction of chemistry as a school subject; and (c) the separation between science and religion. Until 1900 chemical technology became almost the exclusive focus of popular chemistry texts.

Keywords: *popularization of chemistry, popular chemistry books, Netherlands, 19th century, Gerrit Jan Mulder, Jan Willem Gunning.*

1. Introduction

In August 1965, when half of the Dutch population was on holiday, a number of men gathered in The Hague, in the office of the Society of the Dutch Chemical Industry (Vereniging van de Nederlandse Chemische Industrie, VNCI).[1] They were public relations officers from several large chemical companies and were faced with a problem. Since the publication of Rachel Carson's *Silent Spring* in May of 1962 and a large fire at a fertilizer plant near Rotterdam in 1963, the public image of chemistry in the Netherlands had noticeably deteriorated. Articles in the Dutch press began to use headings such as 'The poisonous cocktail of technology' and 'Is the Netherlands still inhabitable?' Something had to be done to counter this negative publicity.

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The Dutch population had to be made aware that chemistry had become an integral part of their life and that they better accepted it as such. It was decided to hire a communications representative who would be in charge of maintaining public relations with both the press and the public (Hoefnagels 1993, pp. 11, 30-31; De Galan 1965). Eibert H. Bunte, the man who was appointed, hit the ground running. In 1968, the year of the VNCI's 50th anniversary, he wrote the jubilee book *Leven met chemie* ('Living with chemistry') (Bunte 1968a/b). Since then the VNCI, together with its sister organization the Royal Dutch Chemical Society (Koninklijke Nederlandse Chemische Vereniging, KNCV), has been engaged in a consistent effort to improve the image of chemistry through information and popularization. In the 1990s this led to the establishment of the C_3 Foundation (Communication Center Chemistry).

Over the past four decades, science communication and the popularization of chemistry in the Netherlands have clearly been marked by this struggle to regain the favor of the public at large. The effort to improve chemistry's public image through the field's popularization was even so substantial that the uninformed might consider the genre of popular writings about chemistry to date back no further than the 1960s. For over two centuries, however, books and articles have appeared with the explicit aim of disseminating chemical knowledge in society, as well as promoting chemistry as a useful science. At times this specifically involved enhancing its public image, but this was certainly not always the case. When the Haarlem chemist and apothecary Martinus Nicolaas Beets (1780-1869) published his *Volks-Scheikunde* ('Popular chemistry, or Chemistry for the People') in 1815, chemistry was rather a fashionable field, a *Lieblingswissenschaft* about which many Dutch wanted to have more knowledge.[2] The wealthy educated gentleman who in Beets' book teaches his gardener the basics of chemistry is fortunate to encounter quite an eager student. When the gentleman tells him that in as much as he busies himself "with fertilizing and improving my soil, [he] also engages in the work of a chemist", the gardener is swiftly won over: "Ay, ay, Sir! Now I see: I should say I learned many a thing again." (Beets 1815, pp. 4-5) Chemistry allows one, Beets argued, to avoid specific harm, do away with superstition, while it also "promotes a sensible worship of God and produces utility and benefit for health and home economics" (Beets 1815, p. viii). If today chemistry popularization mainly serves the interests of chemical science and industry, in the early 19th century it was still part of a much broader effort aimed at social progress and the spread of a Christian civilization.

This difference between chemistry popularization then and now is not just revealing with respect to the development of the popular chemistry book; it also provides major insights into the social position of chemistry. Its popularization involves a set of activities that directly pertain to the interplay of chemistry and society. This is why a consideration of the popular literature

about chemistry offers a surprising outlook on discipline formation, professionalization, and changing views of the function of chemistry education (*cf.* Meinel 1985, pp. 35-6). It is also from this angle that this article aims to provide a preliminary exploration of the relevant 19th-century popular chemistry literature.

Books devoted to popularizing chemistry come in many guises: textbooks, handbooks on doing experiments at home, texts devoted to spectacular new developments, apologetic books that promote the social significance of chemistry, popular chemistry histories (*e.g.* French 1937, Greiling 1938, Reichen 1964), novels and plays (*e.g.* Schenzinger 1937, see also Krätz 1991), and (auto)biographies of leading chemists (*e.g.* Curie 1938, Watson 1968). In this article I do not address the last three genres mentioned; while regarding the others my emphasis will be on their publication context rather than their content. During the 19th century some 57 popular chemistry books (second and later editions included) appeared in the Netherlands: 1800-1815, 9; 1816-1829, 0; 1830-1844, 8; 1845-1864, 30; and 1865-1899, about 10. My major objective is to present a historical account that explains these different phases and that shows how developments in popular literature on chemistry are linked up with changes in the various interrelationships among learned men, educators, chemists, publishers, and the general public.

2. Wonders of Nature

The first (text)books on chemistry for a broad audience appeared in the closing decades of the 18th century. Up to that time, chemistry was a subject that was taught only to physicians, apothecaries, and mining engineers – to professionals, in short, who dealt with chemicals directly. Yet for those interested among the well-to-do there were some alternative options to gain chemical knowledge. In the context of special societies, but also outside of them, it was possible to follow lectures and courses on the inquiry of nature in the broadest sense. Moreover, there were a number of accessibly written books with facts and insights about nature, some of which also treated chemistry topics. They had an evident physico-theological bent, just like other 18th-century 'popular' books on natural philosophy. Also the content's presentation in the first popular books on chemistry – namely in the form of dialogues, letters, or the catechism's question-and-answer structure – seems to be derived from older popular books on natural philosophy.

For the Netherlands, *Het regt gebruik der wereltbeschouwingen, ter overtuiginge van ongodisten en ongelovigen* ('The right use of the world view for the conviction of atheists and infidels', 1715) by Bernard Nieuwentijt (1654-1718) is the first in a long series of physico-theological books that appeared throughout the 18th and 19th centuries (Van Berkel 1985, pp. 78-9; Raichvarg

& Jacques 1991, p. 47). As well as fighting the views of Spinoza and his followers, Nieuwentijt also took it upon him to explain the wonders of God's creation to 'the untrained'. If God's existence had to be proven with the help of the 'wonders of nature', this argument would of course benefit from a clear and transparent presentation of these wonders.[3] Thus Nieuwentijt paved the way to those who followed in his wake. Many later 18th-century books on natural philosophy were based on the notion that the spread of knowledge of nature would contribute to respect for the Creator and thus to devotion and virtue. An example is the 'physico-theological bestseller' *Katechismus der Natuur* ('Catechism of nature', 1777-1779), written by the teacher, clergyman, and natural philosopher Johannes Florentius Martinet (1729-1795) (Paasman 1971, pp. 47-9). Like Nieuwentijt's book, Martinet's *Catechism* was reprinted many times and came out in an abbreviated version for children, which like the original edition was reprinted and translated into several languages. Between 1790 and 1850 as many as 24 editions of *The catechism of nature for the use of children* appeared in the English-speaking world alone. Martinet's physico-theological doctrine continued to be influential through the middle of the 19th century in the Netherlands. The new edition of J.A. Uilkens' *De volmaaktheden van den Schepper* ('God's flawless creations'), which was revised and updated between 1852 and 1857 and contained only a few physico-theological passages, marked the end of an epoch (Paasman 1971, pp. 9-13, 61-5, 100-2). After 1860 the dominant influence of the thought of Nieuwentijt, Martinet, and their followers was definitively a thing of the past.

3. Science Popularization in the 18th Century

The 18th century, thanks to its flourishing societies and the proliferation of works like those by Nieuwentijt and Martinet, is often seen as an era of 'science popularization' (Van Berkel 1985, pp. 77-84; Snelders 1992, pp. 309-12). Measured by the broad interest for the natural sciences among the bourgeoisie at that time, this characterization is certainly valid. Yet the term 'popularization' has one drawback; today we tend to associate it with rendering esoteric knowledge of experts accessible to a lay audience. In the 18th century, however, the practitioners of the natural sciences did not yet constitute a sharply delineated social group. They were part of a single learned and literate social elite within which new knowledge and insights involving nature circulated freely, even though on an individual level there were substantial differences in understanding, of course. In these societies, interested amateurs might have been at once 'consumers' of scientific knowledge and 'producers' of new facts and phenomena (*cf.* Golinski 1992). Popularization in the 18th-century sense, then, should not be merely conceived as the diffusion of knowledge within

well-to-do male patrician circles, but primarily as the transfer of knowledge to social groups that because of their gender, age, or class did not belong to those circles: women, children and the common people.

From the mid-18th century onward, it was far from unusual for upper class women to display a warm interest in the latest accomplishments of natural philosophy. They joined their husbands in society lectures, discussed natural science topics in salons, embraced Martinet's *Catechism of Nature*, and in 1785 established their own Natural Science Ladies Society (Natuurkundig Gezelschap der Dames) in Middelburg (Sturkenboom 2004). Books like Francesco Algarotti's *Il Newtonianismo per le Dame* (1737) and works by the abbot Nollet (1743) and Émilie du Châtelet (1738) were in high demand.[4]

After about 1770, influenced by Enlightenment pedagogues such as J.C. Rousseau, J.B. Basedow, C.G. Salzmann, and, later, J.H. Pestalozzi, children's education and the training and civilizing of the 'lesser classes' gained significant attention. This led to plans for education reforms and the start of courses for craftsmen and manufacturers, whereby the diffusion of knowledge of nature was one of the objectives pursued.[5] Martinet's 1779 *Catechism of nature for the use of children* offers a good example of this new phase in science popularization; *a fortiori* this also counts for the establishment, five years later, of the Maatschappij tot Nut van 't Algemeen. This 'Society for the Common Good', which sought to combine the diffusion of useful skills and sciences with the promotion of piety and morals among the general population, played a major role in the Netherlands in the diffusion of scientific knowledge throughout the 19th century (Mijnhardt 1988, pp. 104-5, 259-94; Lenders 1988, pp. 32-6).

4. Half a Century Too Late?

Regarding the field of chemistry, the popularization effort was marked by basically the same publication pattern: at first accessible works for an unspecified readership, which were followed by books that specifically catered to women, children, and enterprising members of the general public. But there was a striking delay of several decades. Why did the popularization of natural philosophy and natural history take off about half a century earlier than that of chemistry? Is it simply because Lavoisier's 'Chemical Revolution' occurred nearly a century after Newton's 'Scientific Revolution'? This is not very plausible. It is true that the latest discoveries by chemists such as Lavoisier and Davy were not absent in the first popular books on chemistry, but they played no central role. The basic tenet of the first chemistry works for a large audience was that the field, including the chemistry before Lavoisier, was important and useful anyhow; it would make an indispensable contribution to

issues of health and disease, the growth of factories and production, and the advance of agriculture.

It seems more compelling, then, to assume that the popularization of chemistry took off comparatively late because the physico-theological genre and the nature of chemistry did not match very well. While the mechanics of planetary movements and the wondrous diversity of the three empires of nature could be linked up with God's creation in ways that were readily observable to everybody, chemical processes occurred in the laboratory's hidden world. This is why at that time chemistry was rarely counted as one of the *natural* sciences, but mostly as one of the *arts*, or technologies (Meinel 1983; Homburg 1993a, pp. 64-8; Roberts 1993). The phenomena and results of 18th-century chemistry ('schei-kunst' in Dutch, or 'the art of separation') were not so much exposed at the level of the divinely created cosmos or natural world, but in the industriousness of social life. For Beets, just like for Paracelsus three centuries earlier, chemistry revealed itself particularly in the work of bakers, gardeners, gin distillers, glass blowers, potters, water distillers, glue makers, and "so many others" (Beets 1815, p. 5; Homburg 1993a, pp. 58-61). This makes it understandable that the popularization of chemistry took off in the last four decades of the 18th century, when the Enlightenment got a more utilitarian character. In those years the need to improve agriculture and industry with the help of chemistry and mechanical engineering was emphasized again and again (*cf.* Lowood 1987). Furthermore, the integration of chemistry in the natural sciences opened up the possibility to interlace the subject matter's presentation with physico-theological lessons and considerations. The first popular scientific works on chemistry, however, did not denounce the field's separate character. If physico-theological considerations were rarely absent in the earliest popular chemistry literature, commonly their role was limited, at least in comparison to the repeated emphasis on the field's economic usefulness.

5. Chemistry for Women, Children, and the Common People

English and German authors took the lead in popularizing chemistry.[6] Starting in 1781, the *Chemical Essays* by the British bishop Richard Watson (1737-1816) conveyed "in a popular way, a general kind of knowledge" to "persons not so much versed in chemical inquiries". Apparently, this formula catered to a felt need because within 12 years six editions were published of this five-volume work, while it was soon translated in German as well (Watson 1793, preface).[7] Ten years later the prolific German author Jacob Andreas Weber (1737-1792) published *Leichtfassliche Chemie, für Handwerker und deren*

Lehrlinge, and in the ensuing years other textbooks by Scherer (1795), Parkinson (1799), Imhof (1802), and Wurzer (1806) came out. The wide distribution of these books in Germany gave the term 'populäre Chemie' a common ring (Weber 1791, Scherer 1795, Parkinson 1799, Imhof 1802, Wurzer 1806).

Soon all these titles were overshadowed by two English works that appeared in 1806, the *Chemical Catechism* by Samuel Parkes (1761-1825) and the initially anonymously published *Conversations on Chemistry* by Jane Marcet (1769-1858). That these works explained chemistry in simple terms was hardly new; the way in which they did so was new however. Strategies like dialogue and catechism, deployed successfully by earlier popularizers like Pluche and Martinet, were now applied to chemistry for the first time. Until after the middle of the 19th century both works were repeatedly translated and republished. Parkes' *Chemical Catechism* subscribed to physico-theological views much more explicitly than Marcet. The book by Parkes was intended as a tool for parents to teach their children chemistry at home, but in a popular fashion "a body of incontrovertible evidence of the wisdom and beneficence of the Deity" was equally imparted. Fully in the tradition of Baconianism, Parkes assumed that only uncompromising attention for the experimental fact would offer a safeguard against "insidious sophistry […] scepticism or superstition" (Parkes 1837, pp. vi-vii, 18-9; Knight 1986; *cf.* also Wurzer 1806, pp. vi-vii). Parkes' *Catechism*, then, had much more in common with Martinet's moralizing *Catechism of Nature* (which was very popular in England) than just the name and the didactic form.

Jane Marcet's *Conversations* was specifically aimed at women, which is why the dialogue in the book is between a female instructor and two girls. This book gained enormous popularity among English and, especially, American women. Until after 1850 over 50 editions (including illegal ones) appeared in both countries that were used in girls' schools and for self-study (Marcet 1841, Knight 1986, Lindee 1991). At the beginning of the 19th century the popular chemistry textbook definitively established a solid footing in England, Germany, and France.

Dutch publishers, translators, and authors were not lagging. About a quarter century after chemistry became fashionable with Dutch physicians, apothecaries, and entrepreneurs (Snelders 1992, pp. 314-6, 319-22; Homburg 1993b, pp. 161-5), books came out that catered to youngsters, women, and the common people. In 1809 the Utrecht apothecary Pieter van Werkhoven (1772-1815) was the first with his translation of Wurzer's 1806 handbook. In 1810 the Dutch translation of Marcet's *Conversations* came out, followed the next year by a translation of Segur's *Lettres élémentaires sur la chimie* of 1803.[8] In contrast to other countries, these books appear to have been unsuccessful in the Netherlands. The books by Wurzer and Segur went through a second edition, but no more editions appeared. After the 1810s the interest in chemistry lost its momentum, efforts at educational reform lost strength, the na-

tional economy fell into a deep crisis, and, last but not least, the books were beyond reach to most people because of their high price (Homburg 1993b, pp. 165-6, 170, 173-4, 179; Verbong 1994, pp. 41-5, 47-9).[9] During this period, it seems, the Dutch popularization of chemistry was fueled not so much by public demand but rather by forces on the supply side.

The most prominent of these forces was the before mentioned Society for the Common Good, concerned with civilizing and educating the populace. According to this Society, the Dutch population's interest in modern natural science was poorly developed. "With regret" it noticed the "misunderstandings, prejudices, and superstitions that were still prevalent, and too much so, among those of little means", and therefore, in 1811, it published a textbook on natural knowledge written by Johannes Buijs "in the fashion of the very useful work by Helmuth published in Germany, *Naturlehre, zur Dämpfung des Aberglaubens*" (Buys 1811, preface). The same spirit also infused Beets' *Volks-Scheikunde*: the Society's prize competition explicitly asked for a chemistry book modeled after the example of Buijs (Beets 1815, pp. ix-xii). Supported by this influential Society with over 8,000 members, Beets' *Volks-Scheikunde* was much more widely distributed than the works by Wurzer, Marcet, and Segur. At the same time, though, it symbolizes the end of an era. The Society for the Common Good turned away from its earlier utilitarian, science-based thinking modeled on the French tradition. Although chemistry and the other sciences continued to play a role in the activities of this Society, they no longer had a strategic function in the new, national civilization that this organization promoted with ever more zeal after the accession of King William I. Disciplines such as (Dutch) history, geography, and languages now received much attention, at the expense of a reduced interest in the sciences and the arts (Mijnhardt 1988, pp. 289-94).

6. Evening Schools and Sunday Schools

The boom of newly published chemistry books for beginners between 1795 and 1815 went hand in hand with criticism of traditional education in Latin schools. Various authors of popularizing works on chemistry ardently argued for its inclusion as a subject of general education. Every educated civilized man or woman needed to have knowledge of this field on account of its huge social utility and the wholesome influence it wielded on the intellectual faculties of students (Wurzer 1806, pp. vi-ix; Parkes 1837, vol. 2, pp. 18-9; Parkes 1830, vol. 3, pp. 21-3). Yet apart from a few exceptions very little came of the subject's introduction in secondary education, both in the Netherlands and the rest of Europe (Homburg 1993a, pp. 100, 113-4, 118, 128-9, 458 note 73, 464 note 157). When after 1815 the Restoration mentality gained the upper hand throughout Europe and the classic gymnasium education became the

norm again, this killed all efforts to turn chemistry into a regular school subject. In the Netherlands it was introduced in the curriculum nationwide only after Thorbecke's Secondary Education Act of 1863. In the meantime, notably in the years before 1845, chemistry was taught exclusively for utilitarian reasons. Popularizing efforts regarding women and young people ceased for the time being. Only in combination with the training of craftsmen and manufacturers there continued to be a niche for popular chemistry books in the first few decades after 1815.

Although in the 18th century there were evening and Sunday courses for entrepreneurs and craftsmen (Homburg 1993a, pp. 107-12, 462 note 121), the breakthrough of this type of education occurred in England when between 1823 and 1826 the movement associated with the Mechanics' Institutes – under the banner of Bacon's 'knowledge is power' – achieved unprecedented successes (Russell 1983, pp. 139-46, 154-73; Shapin & Barnes 1977). The movement spread from England to the Continent. Henry Brougham's *Practical Observations upon the Education of the People, Addressed to the Working Classes and their Employers* (1825) was also very influential outside England.[10] In Germany, the *Polytechnische-* and *Gewerbe-Vereine* in various cities took charge of organizing evening and Sunday courses (Homburg 1993a, pp. 197, 233-6, 247, 400, 410, 414, 418), while in the Netherlands in 1825 King William I ordered the universities to deliver public lectures on the 'application of chemistry and mechanics to the useful arts' (Loschacoff-de Kanter 1970; Goudswaard 1981, pp. 33-5, 133-69). Shortly thereafter, on the initiative of the Society for the Common Good and the Maatschappij ter Bevordering van Nijverheid (Society for the Promotion of Industry), such education was also started up outside of university towns.[11]

In the second quarter of the 19th century, to serve those who attended evening and Sunday classes, various 'popular' chemistry instruction books were issued. In England this involved either practical guidelines for simple experiments with a 'portable laboratory' or 'chemistry chest', or traditional, not-too-difficult textbooks (Gee 1989, Homburg 1999). In 1836, under the direction of the Amsterdam professor of Mathematics, Physics and Chemistry W.S. Swart (1807-1847), who in 1830 had taught craftsmen and manufacturers, Erdmann's *Populäre Darstellung der neueren Chemie* was translated by two of his pupils. Eight years later a Dutch translation of Girardin's *Leçons de chimie élémentaire appliquée aux arts industriels* appeared (Erdmann 1836, Girardin 1851).[12] In addition, original Dutch instruction books for evening schools were published as well, such as Van der Boon Mesch's *Leerboek der scheikunde* (1831-35) and Meijlink's *Allereerste beginselen der scheikunde* (1836-38).

The differences between these new popular instruction books and those of the previous generation were substantial. Physico-theological considerations, for one, vanished altogether, to be replaced by fervent arguments that highlighted the social usefulness of chemistry. Manufacturers could free

themselves "from the old routine", and "a source of plenty for many" would come into being if one knew the basics of chemistry – this was the repeated message of the authors mentioned above (Girardin 1851, pp. i-ii). Didactically, too, there were striking differences to the popular chemistry books published between 1795 and 1815. Popularizing strategies such as the dialogue, the letter format, and the catechistic question-and-answer game were now absent. In their educational approach vis-à-vis industrialists and craftsmen all authors gave priority to the systematic nature of the science of chemistry. "Popularity, in the sense of comprehensibility for those without any education" was no longer the goal that had to be pursued at all cost (Erdmann 1836, pp. iii-iv). The treatment of the subject matter should avoid both overly systematic rigidity and overly indulgent popularity. In this respect, the popular chemistry books from that period were fairly conventional chemistry textbooks. Apart from a slightly larger concern for industry, their content hardly differed from the prominent standard work by Berzelius, which appeared in Dutch in that same period. But their approach was quite dissimilar, as is reflected in the use of language, the conciseness of the prose, and the emphasis on illustration and demonstration (Berzelius 1834-41; Verbong & Homburg 1994, pp. 248-9).[13]

7. Affordable and Illustrated Books for all Classes

The evening classes on technical chemistry in various Dutch towns and cities drew large crowds. An attendance of more than one hundred per evening was not unusual. Yet in view of the original aim of catering to craftsmen these courses were hardly successful. If manufacturers, officers, and other upper middle class members showed up regularly, it was much harder for workmen and craftsmen to have that same commitment because of their long working days and the cost of the books (Russell 1983, pp. 157-60). Prices of nearly three to seven guilders or more meant that the purchase of books such as those by Meijlink and Girardin took up a full week's salary.[14] These were simply out of reach for workers.

Between 1845 and 1865 that situation changed dramatically, though. The popularization of chemistry entered a new phase, in which scientists, educators, and publishers sought to reach the common working man with new means and also broadened their effort (again) towards young people. Furthermore, as a by-product of the increasing professionalization of science, various scientists felt the need to legitimate their field vis-à-vis the public.

In this reemergence and broadening of science popularization, publishers played a major role.[15] From about 1830 enterprising publishers entered the stage, trying to open up a mass market by offering books at low prices and filling them with attractive illustrations. Thereby in innovative ways they

combined the possibilities of a number of recent technical breakthroughs – such as the technique of wood engraving (ca. 1790), cheaper machine-made paper (ca. 1800), stereotype (ca. 1800), and the steam press (1811) – into the commercially successful product of the illustrated, affordable book.[16] French publishers, with their reasonably priced book series (ca. 1825), and their British colleagues, who first applied woodcuts on a large scale (ca. 1832), led the way (Simons 1915, pp. 15-8; Van Lente & De Wit 1993, pp. 190, 257-8). The launching of *Penny Magazine* in March 1832 by the English publisher Charles Knight, in collaboration with the Society for the Diffusion of Useful Knowledge, marked a definitive breakthrough. This magazine's success was overwhelming. Within a year its circulation rose to 200,000 copies, an unprecedented number. For the first time there was a magazine that was also widely read – and seen – by workers. If the popularization of science and technology was certainly a main aspect of the formula of Knight's magazine, its notion of *useful knowledge* had a much broader purport, referring to the total of the various knowledge areas dubbed *Realwissen* in Germany. It comprised science, technology, history, manufacturing, geography, modern languages, and, in particular, knowledge about the crafts – or basically all areas of knowledge except classic languages, pure mathematics, and religion.[17]

Innovative Dutch publishers such as Diederichs Brothers (Amsterdam), K. Fuhri (The Hague), A.C. Kruseman (Haarlem), and A.W. Sijthoff (Leiden), followed the British example (Van Lente & De Wit 1993, pp. 189-90, 232-3, 268-9, 271). They also belonged to the first Dutch publishers who marketed inexpensive popular books and magazines on chemistry and the other natural sciences. For instance, Diederichs, with its *Nederlandsch magazijn ter verspreiding van algemeene en nuttige kundigheden* ('Dutch magazine for the diffusion of general and useful skills') that appeared since 1834 and was modeled after a British example, also published Millard's cheap and illustrated *Scheikunde ten algemeene nutte* ('Chemistry for general use', 1842) and popular booklets on physics and physiology (Van Lente & De Wit 1993, pp. 264-5; Hemels & Vegt 1993, pp. 309-11).

More important for the popularization of the natural sciences in the Netherlands was the Haarlem apothecary son A.C. Kruseman (1818-1894), who in 1844 published a Dutch version of Liebig's *Familiar Letters on Chemistry*, and this was followed in 1852 by the first annual volume of the well-known popular science magazine *Album der natuur*.[18] Within a year 3,080 copies were sold, which suggests that the editors were right when in their preface of the first volume they posited that a fair and equal social distribution of knowledge of nature and its phenomena is "one of the basic needs of our times" (*Album der natuur*, **1** [1852], p. v). Although later on its circulation would drop, for years the *Album* was by far the main popular science magazine in the Netherlands (Enschedé 1898, vol. 1, pp. 209-13; Coffeng 1994).[19] Still, this was not yet the end of Kruseman's science popularization efforts. In particular between 1853 and 1856, stimulated by the success of his magazine,

he started publishing the *Practische volks-almanak* (1853-1862), an annual for the diffusion of "knowledge of the applied sciences among all social classes", and inexpensive magazines and book series for workers, farmers, and industrialists (Enschedé 1898, vol. 1, pp. 254-9, 264-6, 307-13, 320-9; Simons 1915, pp. 18-9; Van Lente & De Wit 1993, pp. 269-70; Hemels & Vegt 1993, pp. 154-5). These series included popular booklets on chemistry, but despite their moderate price (30 to 60 cents) the series was short-lived; probably, because Kruseman's competitors became more active in the same market and because, in terms of their content, Kruseman's books tended to be too popular for manufacturers and too difficult for workers (Enschedé 1898, vol. 1, p. 254).[20] By 1857 Kruseman in fact discontinued his activities in this area. He changed some of his popular science journals into family magazines and sold the others (Enschedé 1898, vol. 1, pp. 212, 258, 308-10, 325-6).

The publisher A.W. Sijthoff managed to have more lasting success. After having entered Kruseman's market in 1855 with his *Geïllustreerde almanak* (1855-65), which was supposed to compete with the *Practische volks-almanak*, in 1857 he began the popular science journal *Geïllustreerde familie-bibliotheek tot verspreiding van nuttige kennis* ('Illustrated family library for the diffusion of useful knowledge'). Strictly speaking this serial publication, which appeared in issues of 35 cents each, was no periodical, but a string of translated and adapted popular science books. For this series the enterprising publisher from Leiden had signed a contract with the German publisher Otto Spamer, who also supplied him with the indispensable plates for the illustrations. The quality of illustrations greatly influenced a series' commercial viability and Sijthoff had a nose for such details. With a circulation of 2,000, the *Boek der uitvindingen* ('Book of Inventions'), which comprised the first 48 issues of the new series, proved an extraordinary success. Before 1865 Sijthoff also published the series the *Boek der Natuur* ('Book of Nature') and the *Boek der Reizen* ('Book of Travels') (Van der Meulen 1891, pp. 56-9; Van der Meulen 1876, pp. 15-6; Enschedé 1898, vol. 1, pp. 257-8; Van Lente & De Wit 1993, pp. 269, 271). From 1868 onward Sijthoff successfully tapped the market with his *Algemeene bibliotheek* ('General Library') (Van der Meulen 1891, pp. 59-70; Van der Meulen 1876, p. 14; Van Lente & De Wit 1993, p. 190; Simons 1915, p. 21). Prior to 1875 as many as 90 volumes appeared, priced from 15 to 30 cents, in which also some chemistry-related topics were addressed (*e.g.* De Loos 1872).

Apart from these trailblazers in the area of illustrated books and magazines, there were countless other publishers in the period 1850-1865 who issued popular science works.[21] It is hardly relevant to name all of them, but two publishers of chemistry books deserve special mention. Between 1854 and 1861 the Amsterdam publisher Weytingh & Van der Haart published its *Volks-bibliotheek* that "addresses all branches of art and science, crafts and professions", which was designed to comprise as many as 103 booklets ("with woodcuts") of some 25-50 cents. Whether or not all volumes indeed appeared

cannot be established with certainty here, but in the area of chemistry and its applications alone at least nine books were published (Van Moorsel 1855b; Van Moorsel 1855c; Jacobson 1859; see also Van der Meulen 1876, pp. 175-6). In 1854 the Sneek-based publisher Van Druten & Bleeker started its *Goedkoope bibliotheek voor alle standen* ('Cheap Library for All Classes'). This series, which would appear until after 1887, contained several fairly successful popularizing works on chemistry. Both J.W. Gunning's translation of J.F.W. Johnston's *Chemistry of Common Life* and Th.A.J. Abeleven's translation of Emil Postel's *Laien-Chemie* were reprinted at least once (Johnston 1855-56, Postel 1864). Contrary to the very practice-oriented *Volks-bibliotheek* of Weytingh & Van der Haart, Van Druten & Bleekers *Goedkope bibliotheek* contained marked physico-theological elements though.[22] It would be the last time that these two styles of popularization of chemistry existed side by side as equal (Homburg 1994, pp. 451, 456-60, 465-6). The new era of professional science was dawning – an era in which the relationships between science practitioners and laypersons, between science and religion, and between scientific knowledge and social utility were substantially revised and redefined.

8. 1845-1865: Period of Flowering and Transition

The 1850s and early 1860s were unmistakably the heyday of the popular science book. Rarely so many different initiatives were undertaken in such a short time span, and various motives and social groups played a role. Precisely because so many dissimilar developments overlapped, the third quarter of the 19th century was a decisive and exciting episode in the history of science popularization.

Apart from the role played by publishers, changes in the social position of science practitioners influenced the popularizing of scientific insights and research results. A single class of learned scholars dissolved into numerous discipline-based communities of specialists who earned their living by practicing their discipline. For chemists and other professional scientists the popularization of their field fulfilled an essential role in their striving for social prestige. Publications by Justus Liebig (1803-1873), notably his *Chemische Briefe*, provide a perfect example, but the *Nut der scheikunde voor den industrieel* ('Usefulness of chemistry for the manufacturer'), written by the Amsterdam chemistry professor E.H. von Baumhauer, fits this pattern as well (Liebig 1840; Liebig 1844-46; Bayertz 1985, pp. 214-5; Zott 1993). In addition, the professionalization of science, because of the growing specialization that accompanied it, exerted great influence on the relationship between scientists and laypersons. Everyone who did not belong to the small particular field involved was now a layperson. In this respect it is interesting to observe

that around 1850 for the first time a group of authors emerged who became active in the intersecting knowledge domain of the disciplinary specialist and the layperson. Basically these new professional popularizers devoted their life to translating the results of science to a large audience. In France this involved well-known popularizers such as the abbot François Moigno (1804-1884), Victor Meunier (1817-1903), Louis Figuier (1819-1894), and, later on, Camille Flammarion (1842-1925) and Gaston Tissandier (1843-1899) (Raichvarg & Jacques 1991, pp. 41-4, 59-65, 68-76), while for the Netherlands one might think of W.H. Logeman and Douwe Lubach, two of the editors of the *Album der natuur* and of many other works.

The professionalization of science had major consequences for the nature of science popularization, yet it was not the main driving force behind the new wave of publications at that time. The science popularization of the early 1850s was still too much bound up with the tradition of both the old physico-theology and, in particular, the philanthropist and moralizing approach – aimed at education and enlightening the public – as embraced by the Dutch Society for the Common Good and the English Society for the Diffusion of Useful Knowledge. This is why it is perhaps more correct to view the flourishing of science popularization in the years immediately after 1845 as a final twitching of the late-18th and early-19th-century way of science popularization. Stimulated by the new post-1848 political realities – that brought liberal professionals and industrialist to power – a major publishing offensive was realized one more time, geared toward educating the youth and elevating the workers. When its demands were realized in part, as reflected in the Dutch school acts of 1857 and 1863 and the establishment of technical schools, it dwindled again. Chemistry and the other natural sciences were integrated into the regular school curricula, and normal textbooks took over the function that hitherto had been fulfilled by the popular science books. First, however, the popularization of chemistry would flourish as never before.

Farmers and the rural youth were among the first to receive attention from the 'knowledge diffusers'. Already from the mid-1840s books were published especially for them in which agricultural chemistry was explained in simple terms. These books promulgated the view that chemistry might well be the most useful and interesting subject to learn more about (*e.g.* Johnston 1847, Enklaar 1851, Stöckhardt 1854; see also Snelders 1981 and Layton 1973, pp. 48, 51-3).

Not much later the education of the lower classes in the cities gained attention as well. In more cities and on a much larger scale than in the 1830s, industrial schools, evening courses for workers, and reading cabinets were established. They were initiated not only by the Society for the Common Good and the Society for the Promotion of Industry, but also by many new organizations, several of which were set up – in the wake of the revolutionary events of 1848 – in order to assuage the polarization of capital and labor through the spread of useful knowledge. Science for the people was largely

meant to serve political pacification and the stabilization of social relations, as was the case with the British Society for the Diffusion of Useful Knowledge.[23] Specific Dutch examples are the Utrecht Vereeniging ter Bevordering van Nuttige Kennis (Association for Promoting Useful Knowledge [1848]), the Maatschappij ter Bevordering van Wetenschap tot Volksgeluk (Society for the Promotion of Popular Happiness by Means of Science [1849]) established in Amsterdam, and several similar societies founded in the years 1849-1854 (Mulder 1881, vol. 1, pp. 195-8; Goudswaard 1981, pp. 94-5, 100-1, 131-2, 176-85, 198-214; Van Lente 1988, pp. 96-105; Simons 1915, pp. 19-20; De Vries 1963, pp. 11-20; Van Lente & De Wit 1993, pp. 189-90). In addition, several local scientific societies – the Genootschap Physica in Zaandijk, the Natuur- en Scheikundig Genootschap (Society for Natural Knowledge and Chemistry) in Deventer, and the Genootschap Tot Nut en Vergenoegen (Society for Usefulness and Enjoyment) in Arnhem – began to organize popular lectures on physics and chemistry.[24] Although some doubted the usefulness of "making available popular scientific writings at low prices" in addition to these lectures because "those of the lesser classes" often "do neither read such writings nor understand them", a number of accessible chemistry books were still published in this period.[25] These included, besides the books by Girardin and Van Moorsel mentioned above, J.W. Gunning's translation of Stöckhardt's *Schule der Chemie*, which in Germany was one of the most successful self-study chemistry books, and the *Voorlezingen over elementaire scheikunde* ('Lectures on Elementary Chemistry') by E.A. van der Burg. The Utrecht-based educational facility for workers (Inrigting tot Onderwijs voor den Arbeidenden Stand), for instance, used Stöckhardt's textbook in its chemistry teaching (Stöckhardt 1848).[26]

In addition, popularizing works on chemistry appeared that had to serve as 'reading books' for primary schools. These books were part of initiatives aimed at a radical reform of primary education. The reading instruction on the basis of the Bible was meant to be replaced by instruction on the basis of books on topics of which the children of workers and farmers would have direct practical benefit in their later professional life. Physics and, especially, chemistry were supposed to play a prominent role in these new reading books. Their content needed to be presented in such way that the direct connection with the child's daily 'lifeworld' was immediately clear. In England, the cradle of many of these ideas, the "movement for teaching the science of common things" was very successful after 1853 (Layton 1973, pp. 35-54, 95-117). There, within a few years more than 200 different science schoolbooks for primary education were published, including 28 on chemistry alone (Layton 1973, p. 111). Given the large influence of church organizations on primary education some caution was called for, though. At all cost it had to be prevented that people would think that the Bible was replaced by godless, materialist readings. This also explains why precisely in this popular science genre, in the period 1845-1865, books still regularly contained physico-

theological formulations, while education reformers argued that "the teaching of science [is] essential for the moral and religious salvation of the children of the poor" (Layton 1973, pp. 96-7, 112-3). Thus these books were unmistakably in the tradition of the children editions of the books by Martinet and Uilkens, but there was one major difference: if in Martinet and Uilkens the divinely created surrounding world was center-stage, now also the objects of the technical-industrial society were considered part and parcel of everyday life. Besides the sky, water, soil, and flora, issues such as human food, housing, clothing, health care, and hygiene were extensively addressed. In much smaller editions than in England such books were also published in the Netherlands, with the main example of Johnston's several times reprinted *Scheikunde in het dagelijks leven* ('The Chemistry of Common Life'), which, in the words of its translator and editor Gunning, might also serve as "a suitable reading book in the higher grades of our public schools" (Johnston 1855-56).[27]

Although books on the 'chemistry of everyday life' outside the context of primary education would continue to be published way into the 20th century, the heyday of this genre was over after 1865 (*cf.* Wijnand 1918, Bokhorst 1933, Römpp 1944, Schouten 1967). The same holds true for popular chemistry books that catered to workers and farmers. While between 1845 and 1864 about 30 popular chemistry books appeared in the Netherlands (including reprints), in the period 1865-1899 their total was not even ten, of which five were between 1865 and 1869.[28] As indicated above, the inclusion of chemistry in regular school curricula seriously lowered the need for specific lectures and courses aimed at popularization. A striking example of the effects of this are the textbooks used by Gunning in his teaching. After first having lectured for years in evening schools for workers on the basis of Stöckhardt's popular chemistry book, after its third edition he decided to write his own chemistry book. He was meanwhile teaching at a technical school, with a regular curriculum and daily classes, for which he deemed Stöckhardt's book and its "aphoristic form" unsuitable (Gunning 1858, vol. 1, p. vi). After 1863 textbooks similar to the one by Gunning were issued in large quantities to serve advanced secondary schools (*hogere burgerscholen*). But also for basic education – technical schools and general evening schools – regular textbooks appeared that no longer were framed as popularizing books, even though their didactics deviated from the books used in the advanced secondary schools (List 1862-64; Huizinga 1869).[29] This is a reflection of profound changes in the general understanding of the nature of popular books. Popularization shifted from an activity geared toward the diffusion of knowledge to women, children, and the lower classes to knowledge transfer between researchers and laypersons.

9. Mulder and Gunning

Between 1860 and 1870, not only a quantitative break in chemistry's popularization took place, as illustrated by the numbers mentioned above, but also, and above all, a qualitative one. Views on the use, function, and content of popularization changed drastically. Thereby a role was played by the professionalization of chemistry and the gradual growing apart – for many reasons – of natural scientists and the common people, as well as by the 'educational struggle' in the Netherlands that caused moral and religious education to be disconnected from the transfer of useful knowledge.[30] The nature of the changing insights in popularization can be demonstrated preeminently on the basis of the views of two major Dutch popularizers of chemistry: Gerrit Jan Mulder (1802-1880) and his student Jan Willem Gunning (1827-1900).

In the history of Dutch chemistry Mulder holds a prominent place, but not just in chemistry.[31] Despite his unmistakable shortcomings, especially on a personal level, he literally and figuratively dwarfed most of his contemporaries. There are few areas in Dutch society with which he did not engage. Medicine and public health care, pharmacy, chemistry, secondary and higher education, national and colonial agriculture, tax politics and trade, technology, and local and national politics – on all these areas he has left his mark. Also in the area of science popularization Mulder played a leading role, which, strangely, has not received the attention from those in the history of science that it deserves.[32] In the late 1840s in the field of chemistry he stood at the heart of the then emerging popularization movement.

Just like his teacher Gerrit Moll (1785-1838), Mulder had great admiration for English science and its prevailing utilitarian view. Moll was the leading example of a science popularizer for Mulder (Mulder 1881, vol. 1, p. 188). The English influence on Mulder's views is appropriately reflected in the fact that he preferred to use the English term *useful knowledge* where others would simply refer to its Dutch equivalent (Mulder 1881, vol. 1, pp. 182, 195).[33] Not surprisingly, we encounter many of the views promoted by the *Society for the Diffusion of Knowledge* and the *Penny Magazine* also in his writings almost word for word. Mulder considered "thou shall be useful to others" as the highest command citizens had to live by. Scientists, therefore, should not be men of learning but "men of *useful knowledge*". They should gear their research toward socially useful matters and be fully committed to passing on their knowledge to workers, women, boys, and other members of society. Much as in his English examples, this knowledge diffusion served a major moral goal, according to Mulder, because it would make an essential contribution to the "moral and material happiness of the people". Knowledge of nature would encourage young people to admire "the Creator of all things". Our 'knowing', he felt, determined our 'action', which is why all knowledge had direct ethical relevancy (Mulder 1881, vol. 1, pp. 31, 38, 182, 193-8, 294; Mulder 1850, pp. 8, 11, 30-3; Mulder, 'Voorrede', in Stöckhardt,

De scheikunde (1848), cited after De Vrijer 1946, p. 45; Gunning 1882, pp. 153-7; *cf.* also Anderson 1994, pp. 53-4, 67, 79). For Mulder, therefore, science popularization was hardly a marginal activity; it was to him an essential and integral part of his identity as a scientist. Energetically, he dedicated himself to the popularization of chemistry, notably in the years between 1845 and 1851. He was involved in nearly all the kinds of popularization activities discussed above. For example, in the 1840s he gave popular lectures on chemistry for the Society Physica in Utrecht, he gave evening classes to boys between 12 and 16, he was one of the founders of the technical school in Utrecht, he was an initiator and for years the chairman of the Vereeniging ter Bevordering van Nuttige Kennis, and he was secretary and co-founder of the Maatschappij Wetenschap tot Volksgeluk, an organization that set up so-called *consultatiebureaux*, a sort of precursor to the late-20th century 'science shops' (Mulder 1881, vol. 1, pp. 188, 193-8; Mulder 1849; Mulder 1850).

In addition, Mulder played a stimulating role in the publication of two popular chemistry books that marked the beginning of the 1850s hype. In 1847 he had his student J.R.E. van Laer translate Johnston's *Catechism for Agricultural Chemistry* and one year later he pushed his student Gunning to translate Stöckhardt's chemistry book. Moreover, it was he who in 1853 convinced King William III to organize public, popular lectures on the agricultural sciences, which resulted in a lecture series published by Kruseman (Mulder 1847; Mulder 1881, vol. 1, p. 261).

Gunning was the most active of Mulder's students in the field of science popularization, with the possible exception of Mulder's own son Louis (1828-1897). Especially at the beginning of his career, he adored his teacher and closely followed in his footsteps. In 1849 he became Mulder's assistant and still before earning his doctorate in 1853 he translated Stöckhardt's chemistry book and *Schoedler's boek der natuur* (with J.J. Altheer). He taught, most likely, at the Inrigting tot Onderwijs voor den Arbeidenden Stand in Utrecht, and from 1854 also at the technical school, co-founded by Mulder. Besides his role as translator of *Scheikunde der dagelijkse dingen* for Van Druten & Bleekers' *Goedkoope bibliotheek* (1855-56) and as author of *Wat men uit zeewater maken kan* ('What can be made from sea water') for Kruseman's *Nijverheidsbibliotheek* (1857), he was active – together with other leaders of the Vereeniging ter Bevordering van Nuttige Kennis as editor of the 25 cents magazine *Pantheon: tijdschrift ter verspreiding van nuttige kennis* (1853-1858) (Gunning & Altheer 1850-52; Simons 1915, p. 18; Mulder 1881, vol. 1, pp. 195-6; De Vrijer 1946, pp. 36-75, 216-64, esp. 37, 43-5, 65-6, 225).[34]

After a personal conflict in 1857, Mulder radically broke with his student. Thereafter Gunning went his own way. The break with his teacher not only meant a watershed in his social career, but also in his thinking on science popularization. From about 1860 he developed his views on the social role of science and the relationship between science and religion that sharply deviated from those of Mulder. His marriage to Petronella Adriana Pierson in 1858

not only brought him into contact with circles associated with the orthodox Protestant movement 'Reveil', but also with the movement of emerging Modernist theology, led by his brother-in-law Allard Pierson and the then famous Dutch author Conrad Busken Huet. Without ever subscribing to the Modernist direction, Gunning showed himself to be in the remainder of his life a fierce proponent of a strict dualism between religion and science, which was professed by both Modernists and orthodox (!). This dualism radically broke with more than a century of physico-theology, Enlightenment didactics, and the diffusion of 'useful knowledge'. For Gunning the Bible, and the figure of Christ in particular, was the foundation of religion, while science had to be practiced experimentally and objectively, unrelated to any philosophical-moral or religious ideology. As a child of the professionalizing science of his time he demanded full freedom for scientific research "for its own sake", regardless of whatever social usefulness (Gunning 1865; Gunning 1882; De Vrijer 1946, pp. 38-42, 47-61, 222-3, 251-60). From this perspective, in 1882 Gunning looked back on the work of his teacher and criticized his views with singular sharpness. Mulder, Gunning argued, did not know the "autonomy of science in the modern sense"; he valued "science only […] to the extent it could elevate humanity morally [and] not for its own sake". Such "fatal" views had troublesome consequences for both science and ethics. "To attribute a morally edifying character to science, by asking it to be subservient to objectives that as such – no matter how lofty and honorable – are foreign to it, is to make it unfree." Which knowledge will become useful could not be determined in advance, according to Gunning, notwithstanding Mulder's self-reliant view on this issue (Gunning 1882, pp. 155-7, 171-2, 185-7). While Mulder saw himself as a transitional figure, in between the traditional scholar and the 'man of useful knowledge', he failed to recognize that, as he grew older, the 'train of chemistry', influenced by Liebig and his followers, had already moved on to the next station: the 'man of useful knowledge' was replaced by the professional chemist who transferred his knowledge to the next generation of professional chemists rather than to the public (Mulder 1881, vol. 1, p. 182, 257-9; *cf.* Homburg 1993a, pp. 287-373). A new generation of chemists opted to give low priority to educating the people and put their knowledge in the service of science itself, the government, and the victors of the liberal revolution of 1848, the industrialists (Homburg 1993c, pp. 266-70; Verbong & Homburg 1994).

This is why Mulder, regardless of his major role in the establishment of Dutch education in chemistry, cannot be characterized as an early professional chemist. He belonged to an earlier phase of the cultivation of science. His entire life he remained faithful to views articulated around 1830 within organizations such as the Society for the Common Good and the Society for the Diffusion of Useful Knowledge – views he first embraced during and right after his college years (*cf.* Homburg 1987; Homburg 1993a, pp. 223-51, 313-28, 341-50).

10. Wonders of Technology

These new views, such as Gunning's, had obvious consequences for the popularization of science. After all, the old justification of spreading social virtues through knowledge of nature was no longer accepted. By 1855 Kruseman, who in Haarlem had intensive contact with Busken Huet, became painfully aware of this. Consequently, he altered the subtitle of *Familie-magazijn* from 'reading-matter for entertainment and the diffusion of useful skills' to 'moral reading-matter for entertainment and also for the diffusion of useful skills'. A subtle change that was meant to express that the moral and the scientific were separate worlds (Enschedé 1898, vol. 1, pp. 320-6). Some time thereafter he gave up nearly all his popular science activities.

In the vacuum that emerged in the area of popularization on account of the rise of regular chemical education and the more limited appeal of the useful knowledge diffusion movement only a small niche remained for the popular chemistry book: showing the wonders of technology. Whereas astronomers, paleontologists, biologists, and other earth scientists in popular, lavishly illustrated works managed to entertain the public at large with the results of their science, the chemist's test-tubes proved to be no attention-grabbers. More promising were spectacular, or mysterious, images of factories, or of mineral, vegetable, and animal materials used and produced by them. It was this road that was taken by the popularizers of chemistry after about 1865.

The *Boek der uitvindingen* ('Book of Inventions'), published by Sijthoff, is the best example of the new popular genre that came into being at that time. Between 1852 and 1893 eight German editions were published, each one revised to such extent that the size of the book gradually expanded from two to nine volumes (Thomas 1852, Reuleaux 1889-93). Between 1857 and 1892 as many as five Dutch adapted versions appeared, the last one in seven volumes. In this series chemistry took up a prominent place. The last edition devoted a full volume, called *Organic chemistry in everyday life*, to organic chemical technology (sugar, vinegar, soap, gaslight, *etc.*) as well as a volume to inorganic chemical technology, entitled *Chemistry and technology* (iron and steel, porcelain, gun powder, paint, *etc.*) (Bosscha 1892ff.). We encounter the same technology-colored vision on chemistry in works such as Figuier's *Wonderen der wetenschap*, and in the six-volume series *De wonderen der techniek*, with one entire volume devoted to chemistry (Figuier 1867-72, Borgerhof van den Berg et al. 1906-10; *cf.* Deherrypon 1872). If popularization before was about the wonders of God's divine creation, the new books that catered to the general public emphatically put mankind's wondrous scientific and technological creations center-stage.

11. Conclusion and Outlook

There are four main reasons, I think, for the dramatic change in the popularization of chemistry after about 1860: (1) first and foremost, the introduction of chemistry as a regular subject at secondary schools, which greatly reduced the need for popular chemistry books for self-instruction; (2) the professionalization of chemistry, which shifted the role of popularization from an emphasis on the great works of the Creator and on the general usefulness of science to roles linked to legitimation and recrutement strategies of the chemical profession; (3) changing views on the relation between science and religion that emphasized the separation of the two; and (4) last but not least the changing nature of the genre of the popular book, which increasingly dictated the use of illustrations. The rise of a visual culture during the second half of the 19th century was in my view, next to the expansion of the industry itself, one of the major causes of the increasing role of chemical technology and chemical industry in popular books on chemistry.

In the 20th century the emphasis on technical chemistry would continue to play a decisive role, not in the last place because of the then emerging direct involvement of chemical corporations in the popularization of chemistry. In contrast to the years 1865-1899, in which in the Netherlands all popular chemistry books had a technological outlook, after 1900 new styles of popular chemistry books would (re)emerge: books completely devoted to simple experiments that boys could perform at home, in order to prepare their minds (and hands) for becoming a chemists; and books on new developments, such as new theories of atoms and molecules, the world of radioactive rays, and the discoveries in biochemistry, which also resulted partly from attempts to enhance the recruitment into chemistry. Yet these books on chemical science and chemical experimentation were outnumbered – at least in the Netherlands, and probably elsewhere as well – by books in which the chemical industry was treated in a popular way. Starting approximately in 1865, the popularization of chemistry and the promotion of the chemical industry became so strongly entwined that one cannot blame the general public for not always being capable of keeping the two apart. In my view, the long lasting emphasis in popular chemistry books on utility, technology, and industry has made the science of chemistry particularly vulnerable with respect to criticism of social, political, and environmental behavior of the chemical industry.

When in August 1965 several worried public relations officers from the Dutch chemical industry gathered in The Hague to consider the deteriorated public image of chemistry, their concern was not without precedent. Perhaps without realizing it, they tackled an issue the historical foundation of which was put in place a full century before. As we all know now, the results of their publicity campaigns have been rather futile, or even counter-productive. In Eibert Bunte's *Leven met chemie* ('Living with Chemistry') of 1968, the old story of the utility and necessity of chemistry was repeated for the ump-

teenth time. Not much later student numbers in chemistry started to drop dramatically, and they have never really recovered until today (Homburg & Palm 2004, pp. 6-9). It is only recently that communication between chemical science, the chemical industry, the environmental movement, and the public at large has begun to improve. The replacement of popularization and public relations campaigns by dialogue is crucial here. In that respect, perhaps, we are now witnessing the final days of traditional approaches to the popularization of chemistry. How the new approaches will influence the public image of chemistry, can only be known in the future.

Notes

[1] A longer version of this paper appeared in Dutch (Homburg 1995). I thank the publisher of *Gewina* for permission to use parts of that article. I thank Ton Brouwers for translating those parts.

[2] On chemistry as '*Lieblingswissenschaft*', and on the successful lectures by Humphrey Davy in London, see: Hufbauer 1982, pp. 13, 28-9, 145, 149; Golinski 1992, pp. 193-4.

[3] Cf. the French title of Nieuwentijt's work: *L'Existence de Dieu démontrée par les merveilles de la nature* (1725). On Nieuwentijt, see Vermij 1991.

[4] Marie Meurdrac's *Chymie charitable et facile en faveur des dames* from 1666 does not belong in this list, because it was not related to the socio-cultural movement from which the works of Algarotti and Du Châtelet emerged. It was a very practical book with home recipes (Raichvarg & Jacques 1991, pp. 31-4, 55-7; Van Berkel 1985, pp. 82, 87; Paasman 1971, pp. 41-2).

[5] In France things occurred somewhat earlier. Pluche's *Le spectacle de la nature* (1732) was already specifically written for children (Homburg 1993a, pp. 100-13; Lenders 1988, pp. 21, 32-6, 132-48; Raichvarg & Jacques 1991, pp. 34-40).

[6] Apart from translations, the only French popular chemistry books I managed to track down are Segur 1803 and Martin 1810 that aimed at female readers. That fewer popular works on chemistry appeared in France is probably caused by this country's more developed *regular* chemistry education that made such books less relevant. Parkes (1830, p. 3) explicitly refers to the French lead in this area.

[7] Watson's book was based on lectures he gave in Cambridge between 1764-1782 to students of all faculties; *cf.* Golinski 1992, p. 53.

[8] Wurzer 1809 (2nd Dutch edn. 1815), Marcet 1810, Segur 1811 (2nd edn. 1817).

[9] Wurzer's book came out in 1809; its price went up from 2.50 to 4 guilders by 1815. Marcet's book was priced at 3 guilders and Segur's two-volume work at 5.50 (Holtrop 1842, pp. 326, 396, 412).

[10] There is also a Dutch translation, Brougham 1826.

[11] Physics and mechanical engineering were commonly the main subjects. Chemistry courses were given in Leiden (1826), Groningen (1826), Utrecht (1829), Amsterdam (1829, 1846), Maastricht (1838), Delft (1841) and, probably, Haarlem and Deventer (MacLean 1977; Goudswaard 1981, pp. 54-60, 93-5, 169-85).

[12] The first edition of Girardin appeared 1844-45, later editions in 1862-63 and 1867.

[13] Some 'popular' authors explicitly compared their undertaking with the textbook by Berzelius (W.S. Swart, 'Voorrede', in: Erdmann 1836, pp. vi-vii).

[14] The book by Van der Boon Mesch was priced at approx. 4.80 guilders per volume (so 14.40 for the three volumes!), Erdmann at 3 (1 volume in 2 parts), Meijlink at 2.75, and Girardin at 7. For these prices, see Van der Meulen 1876.

[15] In the case of Liebig, see his fascinating correspondence with his publisher Vieweg (Schneider 1986).

[16] These innovations were introduced slightly later in the Netherlands: wood engraving approx. 1834, machine-made paper approx. 1834-38, and the fast press approx. 1828 (steam only after approx. 1850) (Van Lente & De Wit 1993, pp. 188-91, 205-10, 228-32, 256-60, 263-5, 276-81; Anderson 1994, pp. 2-3, 10-2, 72).

[17] On the *Penny Magazine* and Knight's view on educating the people voiced in it, see Anderson 1994, pp. 50-83.

[18] *Album der natuur* (Haarlem, 1852-1909); on Kruseman, see Enschedé 1898.

[19] Chemistry topics first played a modest role in the *Album*. This changed only after the Amsterdam chemistry teacher G. Doyer van Cleeff joined the editorial board in 1886; see *Chemisch Weekblad*, **13** (1916), 856-8.

[20] Examples of chemistry related works are Liebig 1855, Von Baumhauer 1855, Van Moorsel 1855a, Gunning 1857. For prices, see Van der Meulen 1876, p. 107.

[21] For an, incomplete, enumeration, see Simons 1915, pp. 18-23, 34.

[22] The series, for instance, opened with a book by H. Thiele on the history of the Christian church and by H. Burmeister on the history of creation. See also the preface by Gunning in Johnston 1855-56 and that by P. van der Burg in Postel 1864.

[23] For a careful treatment of this subject, see Russell 1983, pp. 165-71; and Anderson 1994, pp. 4-7, 53, 67, 77-79.

[24] *Statistisch Jaarboekje*, 2 (1852), 166; *Statistisch Jaarboekje*, 7 (1858), 166-8; *Berigten over het Fabrijkwezen in het Jaar 1857* (Haarlem 1859), pp. 1, 5.

[25] *Verslag eerste Nederlandsche Nijverheids*, Congres, Haarlem, 1857, pp. 15, 83.

[26] Later editions appeared in 1850 and 1855. See also *Verslag aangaande den toestand der Inrigting van Onderwijs voor den Arbeidenden Stand te Utrecht over den cursus van 1853-54*, Utrecht, n.d., p. 4; Van der Burg 1860. The books by Girardin and Van der Burg were quite expensive. The one by Van den Burg did cost 3.90 guilders (Van der Meulen 1876, p. 23).

[27] See also Meijlink & Jacobson 1863, Augustijn 1851, Duflos 1854-55, Enklaar 1857.

[28] The estimate is based on extensive bibliographical study, using the bibliographies mentioned above (Holtrop, Van der Meulen) and all titles found with the help of the on-line national Dutch library catalogue NCC, when using keywords such as 'scheikunde', 'scheikundig', 'chemie', and 'chemisch'.

[29] Huizinga emphasized in his preface that advanced secondary education (HBS) textbooks moved from the general to the specific, while he himself tried to start from 'everyday ... phenomena'. On Huizinga as popularizer, see Van Berkel 1991.

[30] After the controversial act of 1857, public primary schools first retained their general Christian character, but after more private schools had been founded, public

schools grew much more neutral. In private schools religious education was obviously tied to the school's specific denomination (*cf*. Idenburg 1960, pp. 82-119).

[31] On Mulder, see Snelders 1993, pp. 93-108; Wels 1985; Van Raak 2001.

[32] A recent exception is Theunissen 2000, pp. 80-97.

[33] See also his correspondence with the Ministry of the Colonies (personal information from Margaret Leidelmeijer).

[34] See also *Verslag Inrigting voor den Arbeidende Stand*; 'Otto van Rees', *NNBW* III, 1046-7.

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