

## A promising pioneer profession? Women in industrial chemistry in inter-war Britain

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**Abstract.** During the inter-war years women found employment for the first time in some of Britain's industrial laboratories, most of them concentrated in the food, pharmaceuticals, cosmetics, textiles and photographic industries. Drawing on a range of sources, including company archives and the technical press, this paper examines the emergence of these new positions for women and considers their workplace experiences, looking both at women with higher-level qualifications and at those who worked as laboratory assistants. It argues that although the entry of women into industrial chemistry represented an extension of their opportunities for scientific work, they tended to be employed as 'women chemists' to undertake routine tasks seen as especially suited to feminine skills and expertise and to have few opportunities for promotion. Their presence also appears to have changed the nature of men's work, helping to ensure that men could continue to be offered more challenging work and positions which retained the possibility of career advancement.

There are a number of miscellaneous jobs which a girl of 16 can secure, some of which give chances of rising. Girls who become laboratory assistants, if they are intelligent and hard working, can rise to positions where they will earn as much as £3 a week...

R. Strachey, *Careers and Opportunities for Women* (1934)<sup>1</sup>

In industry, and particularly in those industries where a large number of women are employed – such as food, margarine and jam factories – women are not infrequently engaged in analytical and research laboratories...

R. Pilcher, *The Profession of Chemistry* (3rd edn., 1935)<sup>2</sup>

By the mid-1930s industrial chemistry was increasingly being presented in careers advice literature aimed at middle-class British women as an area worthy of their serious consideration. Whereas prior to the First World War this had been exclusively a male preserve, now it was suggested that opportunities were available both for the female graduate and also for less well qualified young women who sought an alternative to those occupations such as clerical or shop work more commonly chosen by their peers. This enthusiasm was, however, tempered by a recognition of the limitations still faced by women chemists in industry. Strachey suggested that women were unlikely to be considered for research posts while Pilcher saw them as confined to a narrow range of industries and subordinate positions by their lack of experience in dealing with workmen.

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1 R. Strachey, *Careers and Opportunities for Women: A Survey of Women's Employment and a Guide for those Seeking Work*, London, 1934, 122.

2 R. Pilcher, *The Profession of Chemistry*, London, 3rd edn., 1935, 97.

Indeed, while women had apparently succeeded in entering a previously male domain they remained at the bottom of the career ladder, confined largely to those activities regarded as especially suited to their feminine characteristics: ‘manual dexterity, their delicacy of touch, their conscientiousness and their willingness to bear with a routine under which most men become impatient’.<sup>3</sup> Far from representing a triumph of feminist campaigns for equality, the entry of women into industrial science conformed instead to existing notions of what was appropriate work for women, reinforcing rather than challenging these boundaries.<sup>4</sup>

The picture of the nature of the opportunities available to women in industrial chemistry painted by these sources is strikingly similar to that which emerges from historians’ accounts of the working lives of female clerical workers and women in other ‘white-blouse’ occupations where women found a space in what had previously been exclusively male domains. Here it has been argued that although women came to carry out many of the tasks formerly assigned to men they did not strictly hold the same jobs as their male predecessors since they enjoyed neither the status, the opportunities for career advancement nor the remuneration. They thus occupied a very different position in the labour market. Women were not direct replacements for men and developed distinctly separate career paths which meant that they were not in direct competition with men for promotion.<sup>5</sup> As one observer noted of the civil service in 1923,

there is...no competition...between women and male staffs. ...Certain classes of work, mainly of a routine and not very responsible character, are made over to the women staff; the only result of their employment on that work is that a great mass of clerical labour which would otherwise have been done by men is done by women.<sup>6</sup>

Here the employment of women clearly facilitated a reorganization of tasks along gender lines so that the creation of a sphere of ‘women’s work’ also led to the redefinition of ‘men’s work’. In the case of clerical work it has also been suggested that this process enabled employers to maintain the possibility of career advancement for young males at a time when they were finding this increasingly difficult to sustain. Far from damaging the prospects of men the employment of women enhanced the position of those that remained.<sup>7</sup>

This study draws on these insights and a range of sources including company archives and the technical press to consider women’s employment as industrial chemists in Britain after 1914 and the extent to which the emergence of ‘women’s work’ in this field led also

<sup>3</sup> ‘Prospects for employment of women science graduates’, Part III, *Journal of Careers* (1938), 17, 289–96.

<sup>4</sup> Strachey, op. cit. (1); Pilcher, op. cit. (2); V. Brittain, *Women’s Work in Modern England*, London, 1928; D. W. Hughes, *Careers for our Daughters*, London, 1936 and the *Journal of Careers*, especially ‘Prospects for employment of women science graduates’ Parts I and III, *Journal of Careers* (1938), 17, 88–93 and 289–96.

<sup>5</sup> On ‘white-blouse’ work see G. Anderson (ed.), *The White Blouse Revolution*, Manchester, 1988; M. Savage ‘Career mobility and class formation: British banking workers and the lower middle classes’ in *Building European Society* (ed. A. Miles and D. Vincent), Manchester, 1993, 196–216 and E. Jordan, ‘The lady clerks at the Prudential: the beginnings of vertical segregation by sex in clerical work in nineteenth-century Britain’, *Gender and History* (1996), 8, 65–81, which includes a useful review of the literature. On women’s work in Britain more generally see J. Lewis, *Women in England, 1870–1950*, Brighton, 1984; E. Roberts, *Women’s Work, 1840–1940*, Basingstoke, 1988 and H. Bradley, *Men’s Work, Women’s Work*, Cambridge, 1989.

<sup>6</sup> E. R. Long in *Journal of the Institute of Bankers*, 1923, 116, quoted by Savage, op. cit. (5), 207.

<sup>7</sup> This is stressed in Jordan, op. cit. (5).

to a redefinition of 'men's work'. It suggests that there were indeed close parallels between women's employment in industrial chemistry and other occupations, locating this activity firmly within the broader picture of women's work. This means that while many of the findings presented here will appear unsurprising to those familiar with the historiography of women's work this study reveals their presence in this specific context for the first time. This focus also sheds light more generally on the experiences of industrial chemists, who formed a significant, but largely unexplored and often difficult to trace, part of the scientific community during the inter-war years.<sup>8</sup> To do this it looks first at the emergence of positions for women with higher-level qualifications in chemistry in industrial laboratories and then at the work which they did. These two sections reveal the strategies adopted by women to secure space for themselves in the industrial chemistry laboratory and the extent to which they followed career paths which differed considerably from those available to men with similar educational backgrounds. The third section examines the experiences of women with few or no prior qualifications in chemistry, a group which has left even fewer traces in the historical record. Drawing primarily on the records of the laboratories of cocoa and chocolate manufacturers Cadbury Bros. of Bournville we can, however, learn something of the factors which led employers to offer laboratory work to this group for the first time. Here it appears that the employment of women provided a convenient solution to problems of labour management and contributed to the general effort to reduce costs undertaken by the firm during this period.

#### Finding space for women in industrial chemistry

Prior to the First World War few, if any of the chemists working in industry were women. Although some women who did research in university laboratories may have worked on problems connected with industry, this did not lead them to take up permanent posts in the laboratories of industrial enterprises as it did for many of their male colleagues.<sup>9</sup> Employment in industrial laboratories was regarded as both men's work and manly work, as a task done by men as well as one which was particularly suited to masculine attributes.<sup>10</sup> Since this position was regarded as 'natural' it was rarely articulated or discussed at length, although later debates and the more frequently discussed strictures against women's participation in science more generally indicate its basis. It was argued

8 The work of J. Donnelly has explored the work and career experiences of industrial chemists prior to the First World War. See his 'Industrial recruitment of chemists from English universities: a reevaluation of its early importance', *BJHS* (1991), 24, 3–20 and 'Consultants, managers, testing slaves: changing roles for chemists in the British alkali industry, 1850–1920', *Technology and Culture* (1994), 35, 100–28.

9 Donnelly op. cit. (8), which does not specifically discuss women students, demonstrates the direct links between universities and firms which led to employment in industry. On the opportunities for British women science graduates see J. Stevenson, 'A neglected issue in the history of education and training: women students of University College London and the polytechnic at Regent Street', unpublished Ph.D. thesis, Thames Valley University, 1996. M. Rayner-Canham and G. Rayner-Canham discuss the specific case of chemistry in *Women in Chemistry: Their Changing Roles from Alchemical Times to the Mid-Twentieth Century*, Philadelphia, 1998. M. Sanderson, *The Universities and British Industry, 1850–1970*, London, 1972, 314–38 discusses the general recruitment of women graduates into industry.

10 A useful discussion of this point can be found in M. Benjamin, 'Introduction' in *Science and Sensibility: Gender and Scientific Enquiry. 1780–1945* (ed. M. Benjamin), Oxford, 1991, 1–23.

that women lacked the intellectual capacity and staying power for scientific work, particularly for original work, and that expensive training would be wasted when they left to marry. In addition they could not work directly alongside men because of the possibility that men might be distracted from their work by the presence of female colleagues, nor could they be placed in positions of authority over men.<sup>11</sup> Additional restrictions applied to scientific work in an industrial context, which made it an even less suitable working environment for middle-class women. In the first place positions in manufacturing industry, especially heavy industry, were regarded as incompatible with both their femininity and gentility. Industrial science was doubly discounted since it often led to works management and other posts which involved interaction with men working on the shop floor.<sup>12</sup> For the increasing number of women who gained a scientific training as a result of the expansion of higher education and who sought to use their expertise to earn a living, the options were limited to schoolteaching and the other caring professions, although a small number managed to exist as researchers and teachers in higher education.<sup>13</sup>

It was during the First World War that women with a scientific training were first employed in industrial laboratories. Here, as elsewhere, wartime expediencies broke down existing constraints and industrial enterprises and government laboratories employed women to undertake scientific work across a range of disciplines for the first time. Among the tasks undertaken by women were metallurgical analysis, gunnery computing, aerodynamics research, materials testing and chemical work connected with munitions production.<sup>14</sup> Some women even rose to positions of responsibility. May Sybil Leslie, for example, became chemist in charge of the laboratory at the munitions factory where she worked and was awarded a D.Sc. by Leeds University for her portfolio of research work which included confidential wartime investigations.<sup>15</sup>

Their employment during wartime did not mean, however, that women had come to be regarded as an integral or permanent part of the workforce in industrial science. In common with many other women, those employed as industrial chemists frequently lost

11 These points have been widely discussed. See for example Benjamin *op. cit.* (10); M. Rossiter, *Women Scientists in America: Strategies and Struggles to 1940*, Baltimore, 1982; P. Abir-Am and D. Outram, *Uneasy Careers and Intimate Lives: Women in Science 1789–1979*, New Brunswick, 1987 and H. J. Mozans, *Women in Science*, London, 1913. For a fictional account of the perils of studying science see H. G. Wells, *Ann Veronica*, London, 1909, reprinted by Penguin Books, 1960.

12 Sanderson, *op. cit.* (9), 314–38, discusses these restrictions. The extent to which women's workplace opportunities relied on assumptions about what was compatible with their gender and class is discussed extensively in the literature on clerical work. See especially Jordan, *op. cit.* (5), 75–9 and A. Woollacott, 'Maternalism, professionalism and industrial welfare supervisors in World War I Britain', *Women's History Review* (1994), 3, 29–56.

13 Stevenson (*op. cit.* (9)) emphasizes the vocational motivations which underpinned women's participation in higher and further education as well as discussing their subsequent occupations. For details of women's involvement in higher education more generally see C. Dyhouse, *No Distinction of Sex? Women in British Universities, 1870–1939*, London, 1995, which has an extensive bibliography.

14 Rayner-Canham and Rayner-Canham, *op. cit.* (9) 165–6 and 'situations wanted' advertisements in *Scientific Worker* (1922), 3, which listed the experience of women who described their current situation as 'disengaged'.

15 G. Rayner-Canham and M. Rayner-Canham, 'A chemist of some repute', *Chemistry in Britain* (1993), 29, 206–8.

their jobs after the conflict, as they were displaced by returning male employees or the positions they had occupied evaporated.<sup>16</sup> At the Cadbury laboratories, for example, the three lady assistants employed during wartime quickly disappeared from their benches as soon as men returned from active service.<sup>17</sup> In the light of these events one wonders what became of the recipients of the three scholarships of £50 each offered in 1916 to women who wished to qualify for positions as industrial chemists by the National Union of Women's Suffrage Societies through its journal *Common Cause*.<sup>18</sup> During the inter-war years it was suggested by R. B. Pilcher, secretary of the Royal Institute of Chemistry, that women had been encouraged by events during the First World War 'to take up chemistry with the hope of finding employment in industry', but their expectations of lucrative positions had proven unrealistic.<sup>19</sup>

Despite the widespread disappearance of those posts opened up directly by wartime events the conflict nonetheless had an important indirect impact on the possibilities for women's employment in industrial laboratories. It did so through the impetus which it gave to the development of industrial science more generally, which meant that many firms which already employed scientists expanded and reorganized their laboratories and others chose to employ their own scientists for the first time.<sup>20</sup> In the food industry, for example, only a few companies had extensive laboratories before 1914, but during and soon after the war several more, including the Co-operative Wholesale Society (CWS), Glaxo, Lyons and Colman's, established their own facilities.<sup>21</sup> This expansion of industrial science significantly increased the demand for industrial chemists as a whole and provided openings for women because many of the jobs emerged in the so-called 'new' industries which already employed large numbers of women in manufacturing. In addition, many of the posts also called for new types of expertise in fields such as bacteriology or biochemistry. Here, where there was no existing tradition of exclusively male employment and where concerns that they would have to deal with workmen were minimized, women were able to fashion careers for themselves.<sup>22</sup>

16 This means that here, as elsewhere, we need to be cautious about identifying the war itself as a decisive turning point. For a summary of the debates on this point see G. Braybon, 'Women and the War', in *The First World War in British History* (ed. S. Constantine, M. Kirby and M. Rose), London, 1995, 141–67. Wartime events do seem to have brought women greater access to the institutions of chemistry. In 1920 they were granted the right to join the Chemical Society after a debate which had lasted since the early 1890s. T. S. More and J. C. Philip, *The Chemical Society 1841–1941*, London, 1947, 85–97 and 185 and J. Mason, 'A forty years war', *Chemistry in Britain* (1991), 27, 233–8.

17 Cadbury Archives, Bournville (hereafter CA), Annual Reports of the Chief Chemist, 1919–20.

18 *Nature* (1916), 97, 394.

19 Pilcher, op. cit. (2), 96–7.

20 M. Sanderson, 'Research and the firm in British industry, 1919–39', *Science Studies* (1972), 2, 107–51 and K. Vernon, 'Science and technology', in Constantine *et al.*, op. cit. (16).

21 S. M. Horrocks, 'Consuming science: science, technology and food in Britain, 1870–1939', unpublished Ph.D. thesis, University of Manchester, 1993, Chapter 4.

22 A number of social historians have commented on the extent to which opportunities for women were generated by the emergence of new jobs which had yet to become gendered, although whether this was in fact the case was often dependent on the specific characteristics of the local labour market. See, for example, M. Savage, 'Trade unions, sex segregation and the state: women's employment in "new industries" in inter-war Britain', *Social History* (1988), 13, 209–29 and G. de Groot and M. Schrover, 'Between men and machines: women workers in new industries, 1870–1940', *Social History* (1995), 20, 279–96.

Firms in the food, pharmaceuticals and cosmetics, textiles and dyes and photographic industries most commonly employed qualified women chemists to work in their laboratories during this period. The food industry offered the largest proportion of posts, and in Lyons provided the firm employing the greatest number of women chemists. Many of them were graduates of King's College of Household and Social Science (KCHSS). Indeed, eighty-five KCHSS graduates were employed by eighteen different food firms and four analytical chemists' practices during the period 1910 to 1949. Over half of these – forty-four – worked for Lyons.<sup>23</sup> Other food manufacturers known to have employed women chemists included Glaxo, United Dairies, Chivers, CWS, Lever Brothers, Fullers, Peek Frean, Robertson's, Schweppes and Vitamins Ltd. Not all enterprises in this sector shared this willingness to employ women: those with a longer tradition of employing chemists were often the most reluctant to do so.

In the pharmaceutical industry the most scientifically advanced firms – Boots, May and Baker, British Drug Houses and Burroughs Wellcome – all employed women. Ilford and Kodak, the two premier enterprises in the photography industry, also adopted this policy. Textile and dyeing firms which employed women included the Calico Printers Association and Williams (Hounslow). Outside these sectors the number of women employed to work in laboratories appears to have been very small, although the evidence is far from complete.<sup>24</sup> Certainly the numbers increase significantly if we not only count those women who directly used their chemical expertise at the laboratory bench but also include those who did so less directly in their work as librarians, abstractors, translators or clerks. Few individuals identifiable as female were included among the research staff of laboratories listed in the published results of an Association of Scientific Workers survey in 1936, although this was far from comprehensive in its coverage.<sup>25</sup> ICI and its predecessors, by far the largest single employers of chemists in Britain, did not employ women in their laboratories, although a small number worked at the agricultural research station, Jealott's Hill. Several engineering firms, including Metropolitan-Vickers, British Thomson-Houston, LMS Railway and David Brown & Sons, employed women graduates intermittently during the inter-war years, mainly when there was a perceived shortage of suitable male candidates.<sup>26</sup>

Despite the emergence of employment opportunities for graduate women chemists within these firms, they constituted a relatively small minority of industrial chemists throughout the inter-war period, holding posts in only a small percentage of the 566 British firms who by 1938 undertook research and development. Opportunities to carry out

23 N. Blakestad, 'King's College of Household and Social Science and the Household Science Movement in English higher education c. 1908–1939', unpublished D.Phil thesis, Oxford University, 1994, (ASLIB, Thesis Abstracts, 45-9232), 244.

24 Many of these firms are listed in 'Prospects for employment', op. cit. (3). Additional evidence comes from D. E. H. Edgerton, 'Industrial research in the British photographic industry, 1879–1939', in *The Challenge of New Technology: Innovation in British Business since 1850* (ed. J. Liebenau), Aldershot, 1988, 106–34; Association of Scientific Workers, *Industrial Research Laboratories: A List*, London, 1936; University of Warwick, Modern Records Centre CBI predecessor archive, MSS 200/F/T2/7/2, reply from Vitamins Ltd.

25 The limitations of this survey are discussed in D. E. H. Edgerton and S. M. Horrocks, 'British industrial research and development before 1945', *Economic History Review* (1994), 47, 213–38, 217.

26 'Prospects for employment', op. cit. (3).

Table 1. *Women fellows and associates of the Royal Institute of Chemistry, 1914–38\**

	Fellows	Associates	Total
1914	4	1	5
1918	13	36	49
1935	27	174	201
1938	29	182	211

\* Pilcher, op. cit. (2), 96.

research were particularly limited and analytical and secretarial work accounted for a significant number of appointments. In the absence of reliable data on the total number of chemists employed in industry it is not surprising that providing an estimate of the number of women is problematic.<sup>27</sup> Strachey, whose figures were derived from the census and do not distinguish between different institutional contexts, gives figures for women analytical and research chemists of 519 in 1921 and 568 ten years later, with other scientific pursuits accounting for 220 in 1921 and 496 in 1931.<sup>28</sup> Figures are available for female membership of the Royal Institute of Chemistry, a body to which many qualified industrial chemists belonged, but these do not distinguish between different types of employment, nor do they tell us anything about the extent to which women with few or no qualifications were employed in industrial laboratories. Moreover, it is difficult to ascertain the proportion of female RIC members who worked in industry, although it seems likely that this was lower than the equivalent for men.<sup>29</sup> Very few women indeed belonged to the Society of Chemical Industry, a body which included many industrial scientists among its members.<sup>30</sup>

Several sources suggest that the number of women employed in industrial laboratories increased during the 1930s, particularly in the second half of the decade. Blakestad indicates a rise in the proportion of women graduates from KCHSS entering industrial laboratories from 2.2 per cent for 1910 to 1919 to 6.6 per cent for 1930 to 1939, with the figure for 1940 to 1949 reaching 21.7 per cent.<sup>31</sup> The frequency with which advertisements specifically seeking women for laboratory work appeared in *Chemistry and Industry* also rose, although their absolute number remained low and most posts were still not open to both sexes. An Institute of Chemistry survey of its appointments register during 1935 and 1936 revealed that of 963 posts notified to it in all fields, just eighty were open to women.<sup>32</sup>

<sup>27</sup> For a discussion of the figures relating to chemists in general, see Horrocks, op. cit. (21), 136–7.

<sup>28</sup> Strachey, op. cit. (1), 45.

<sup>29</sup> M. Olliver, 'Women in chemistry', *Journal of the Royal Institute of Chemistry* (1955), **79**, 413–20.

<sup>30</sup> Published membership lists from the Liverpool Branch of the Society during the inter-war period include only one 'Miss' – Muriel Roberts, a public analyst – at a time when it is usually possible to identify women easily from such publications. Women also had a very low profile in the society at a national level. The records of the Liverpool branch are held in the Liverpool Record Office, Accs 4090.

<sup>31</sup> Blakestad, op. cit. (23), 242.

<sup>32</sup> 'Salaries and employment in chemistry', *Journal of Careers* (1937), **16**, 169. See also F. Sherwood Taylor, 'Shall I go in for science? Part III, The process of training and finding employment', *Journal of Careers* (1939), **18**, 89–91.

**Sticking at it: women chemistry graduates in industry**

The limited openings in industry available to women chemistry graduates and the difficulties they experienced in their search for employment suggest clear differences between their career prospects and those of their male counterparts. This section considers these differences and suggests that what was taking place was the emergence of distinctly female career patterns which have remained remarkably persistent. These have been identified by modern sociologists as ‘practitioner careers’, and remain a feature of women’s employment in science and technology. This career pattern, which usually involves remaining at the laboratory bench, contrasts with the linear career patterns more frequently followed by men, which involve promotion upwards in a managerial hierarchy and increasing administrative work.<sup>33</sup> The practitioner career was regarded as particularly compatible with women’s ‘special abilities and characteristics’ which were seen as distinct from those of men.<sup>34</sup>

The gendered nature of career opportunities in industrial chemistry became apparent as soon as women began their search for employment. Initially, and for much of the 1920s, the search for employment demanded of women a tenacity and a willingness to accept any job, no matter how poorly paid, that were not required of men. Women chemists fared no better than other women graduates seeking industrial employment, of whom Sanderson suggested it ‘took a certain restless, abnormally enterprising spirit...to consider embarking on so hazardous a course’.<sup>35</sup> Certainly those who persisted seem to have possessed at least some of these attributes and like Frances Hamer, who worked for both Ilford and Kodak, to have been characters of ‘sturdy independence’.<sup>36</sup>

These pioneers resorted to a range of strategies in their efforts to secure employment. Some women signed letters of application with initials only in the hope of being considered, but this ruse was not open to those with degrees from women’s colleges, and in any case could not be sustained once an interview was offered. Another option was to improve their qualifications or gain additional practical experience. Often this was done on a voluntary basis. Women took advantage of the assistance offered directly through professional organizations such as the National Union (later Association) of Scientific Workers, whose journal *Scientific Worker* carried notices of ‘situations wanted’. The Institute of Chemistry operated an employment bureau as well as providing a forum in which women could make the contacts vital to securing employment in a job market where vacancies were often filled by personal recommendation and word of mouth rather than through formal advertisement and interview procedures. These strategies did not guarantee success, but they did help some women to secure posts, even if these sometimes offered salaries so low that men would not consider them.<sup>37</sup>

33 J. Evetts, *Gender and Career in Science and Engineering*, London, 1996.

34 ‘Women and executive responsibility’, *Journal of Careers* (1936), 15, 318.

35 Sanderson op. cit. (9), 325.

36 *The Times*, 17 May 1980, 16.

37 R. Bramley, ‘Kathleen Culhane Lathbury’, *Chemistry in Britain* (1991), 27, 428–31 and the longer typescript of this article kindly supplied by its author; D. Smith, interview with M. Olliver, Histon, 1979; Blakestad, op. cit. (23), Pilcher, op. cit. (2), 96–7. The role of male mentors in securing women’s access to positions in science is discussed in Abir-Am and Outram, op. cit. (11).

Nor did finding a job mean the end of their struggles. Frequently women found that the posts they had worked so hard to secure involved little more than routine and repetitive work for which they were considered to be especially suited. Moreover, these were junior positions which gave them no access to the promotion and positions of authority available to men with the same qualifications.<sup>38</sup> Kathleen Culhane, who worked for British Drug Houses during the 1920s and early 1930s, summarized her experiences of this situation clearly in her notes for a talk on women in the chemical industry:

What is it that the male graduate is called upon to 'stick'? He is paid a reasonable salary and, however young, if his university qualifications are good, he is usually given quite a dignified position from the beginning. The girl who worked side by side with him at the university is hard up and constantly humiliated...even if her work is intellectually satisfying, she will be expected to attain results from the ground floor for which her male equivalent is given the help of a little altitude...She will be happier if she is not too enterprising because then her sense of frustration will be less.

She later concluded that 'for women in the chemical industry magnificent health and a thick skin are more important than a knowledge of chemistry'.<sup>39</sup>

Despite the constraints imposed upon them these women should not be seen only as passive victims of their circumstances. Instead, as Gould has suggested in a different context, we need to recognize the extent to which they actively sought to redefine and improve their roles and to secure better conditions of service, not by 'fighting tooth and nail to widen a prescribed sphere' but by adopting less confrontational strategies.<sup>40</sup> Both Kathleen Culhane and Mamie Olliver, who was employed by Chivers, sought to secure promotion by doing research in their own time, carefully ensuring that they avoided conflict as they did so. In Olliver's case this brought her recognition both inside and outside the firm, and eventually the post of chief chemist. For Culhane it was a less successful strategy, bringing external but not internal recognition.<sup>41</sup> Women also used both their personal contacts and the situations wanted columns in the technical press to seek new positions with improved prospects. In July 1927, for example, *Chemistry and Industry* carried the following advertisement:

Viscose chemist. Woman B.Sc. desires better appointment, laboratory or plant. Eight years in present post as Production Manager and Analytical Chemist in small viscose factory. First aid certificate and knowledge of welfare work.<sup>42</sup>

It is difficult given the available evidence to determine how successful these attempts were; clearly their success was by no means guaranteed and the outcome lay in the hands of men.

38 The continued prevalence of this practice is discussed in Evetts, *op. cit.* (33) and M. Savage, 'Women's expertise, men's authority: gendered organizations and the contemporary middle classes', in *Gender and Bureaucracy* (ed. M. Savage and A. Witz), Oxford, 1992, 124–51.

39 Bramley, *op. cit.* (37), 428.

40 P. Gould, 'Women and the culture of university physics in late nineteenth-century Cambridge', *BJHS* (1997), 30, 127–49.

41 Bramley, *op. cit.* (37), Smith, *op. cit.* (37).

42 *Chemistry and Industry* (1927), 46, 8 July, p. iv. These advertisements were part of the commercial information pages which were numbered with roman numerals, starting afresh for each weekly part. They have not usually been retained in bound volumes. The University of Leicester library has an incomplete run of unbound copies for the years 1923 to 1943.

That they frequently met with failure is suggested by Olliver's own assessment, published in 1955, that during this period women had been forced 'to adjust themselves...to passive acceptance of subordinate positions because of the fear of unemployment'.<sup>43</sup>

Not only did they frequently occupy positions for which they were over-qualified, but women chemists were also underpaid compared with men. Women almost invariably started on salaries lower than those paid to their male contemporaries, and fell further behind as their careers continued. Sanderson presents data relating to the starting salaries paid to graduates of Imperial College in the 1930s which suggests that even the highest starting salaries paid to women fell below the average level achieved by men with the same qualifications. The average salary of men with pass degrees was £218, while that paid to women in this category varied from a high of £200, achieved by a chemist working for United Dairies, to £156, paid to a woman employed by British Thomson Houston as a librarian, and £90, to another who worked as a typist.<sup>44</sup> Blakestad's evidence reveals that a few women were paid starting salaries substantially above the average, even in line with those paid to men, but they were exceptions. When one graduate of KCHSS found a job with MacFisheries and was paid £300 per year her contemporaries saw her as 'rich beyond the dreams of avarice'.<sup>45</sup> This was around the time that F. G. Donnan was suggesting in the *Journal of Careers* that the usual starting salaries for graduate chemists in industry were between £250 and £300.<sup>46</sup> Women persisted in their efforts to gain employment as chemists because these disparities mirrored those in other occupations, so that the salaries they were able to secure compared favourably with those available to women in other posts demanding a similar level of education.<sup>47</sup>

The differences in pay levels between male and female chemists were highlighted by a survey of women chemists carried out by the RIC during the 1950s. This contrasted the employment prospects of women in the 1950s with those during the inter-war years, when 'women stood very little chance of getting into industry and many were able to do so only by accepting the very low-paid jobs that the men would not consider'. The legacy of this was clear in the salary data collected for the survey, which revealed that women chemists in their mid-30s were receiving the same if not more than those women in their 40s and 50s, who were likely to have started their professional careers before the Second World War and had been unable to gain promotion to positions for which higher salaries were available.<sup>48</sup>

This distinction between the career paths of male and female chemists suggested above appears to have been further intensified as employers began to offer posts specifically aimed at women graduates. These increased the number of opportunities available to women and made it easier for them to find jobs, but it also circumscribed clearly the roles which they were expected to play. Women were more likely to be required for analytical or secretarial

43 Olliver, op. cit. (29).

44 Sanderson, op. cit. (9), 332.

45 Blakestad, op. cit. (23), 218.

46 F. G. Donnan, 'The chemist in industry', *Journal of Careers* (1936), 15, 73–7.

47 See Lewis, op. cit. (5), 162–205 and A. Oram, *Women Teachers and Feminist Politics 1900–39*, Manchester, 1996, 58–72.

48 Olliver, op. cit. (29); and *idem*, 'Women in technology', *Journal of the Royal Institute of Chemistry* (1957), 81, 715–21.

work than they were for research posts<sup>49</sup> and to find themselves employed to work alongside other women doing tasks which were considered particularly suitable to their feminine as well as their scientific skills.<sup>50</sup> This was clearly the case at Cadbury Bros., which in 1936 established laboratories at its four milk-condensing factories. These were located away from its existing main laboratory facilities at Bournville, where all the qualified chemists were male. The new laboratories were designed to relieve the pressure on central facilities by reducing the volume of their analytical work. The staff recruited to carry out this work were exclusively female – a ‘Dairy College trained milk tester’ and a female assistant for each factory. At the same time the firm advertised in *Chemistry and Industry* for a chemist to carry out research work at Bournville on ‘plant handling large quantities of milk’. It called for a ‘young chemist, male, qualified with dairy training’.<sup>51</sup> Here women with chemical qualifications were sought for positions which confined them to routine testing, isolated them from the possibility of involvement in more prestigious research work and gave them authority only over other women. They remained apart from the main administrative hierarchy, which was an exclusively male domain. How widespread this practice was is unclear, but it certainly seems to have been common in dairying where United Dairies, the CWS and individual district co-operative societies all employed women to test milk samples in their laboratories.<sup>52</sup> In all of these cases opportunities emerged for women with a limited training as well as for those with more expertise and experience.

The most numerous positions for women with chemical qualifications were to be found in those areas which made use of their expertise but did not place them at the laboratory bench. Such posts described by Rossiter as falling into the ‘interstices of scientific employment’<sup>53</sup> included advertising, library and abstracting work, secretarial work and scientific journalism. Women were frequently advised that the best possibilities for using their scientific skills lay in combining them with a secretarial training because of the demand for this combination of expertise. H. Bassett, chief chemist of the Egyptian State Railway, for example, indicated a preference for typists with some chemical knowledge in order to avoid ‘silly mistakes’ in producing technical documents.<sup>54</sup> Women advertising their services in the situations wanted columns of *Scientific Worker* and *Chemistry and Industry* frequently indicated their willingness to take on such jobs, and listed an

49 The situations vacant column of *Chemistry and Industry* during the 1930s shows this distinction clearly and it was widely discussed in the careers literature. See especially ‘Prospects of employment for women science graduates, Part IV, Careers in which science is useful though not the main subject’, *Journal of Careers*, 1938, 17, 421–5.

50 The emergence of exclusively female scientific spaces is discussed in the academic context in M. L. Richmond, ‘“A lab of one’s own”: the Balfour biological laboratory for women at Cambridge University, 1884–1914’, *Isis*, (1997), 88, 422–55.

51 *Chemistry and Industry* (1936), 55, 22 May, p. iv.

52 S. Williams, ‘Scientific control in the milk industry’, *Journal of Careers* (1932), 11, 23–5 and ‘Prospects for employment’, op. cit. (3). The general limits placed on women’s responsibilities are discussed in ‘Educated women’s employment: its extent and variety’, *Journal of Careers* (1934), 13, 239–43.

53 Rossiter, op. cit. (11), 265; and *idem*, ‘Chemical librarianship: a kind of “women’s work” in America’, *Ambix* (1996), 43, 46–58; Pilcher, op. cit. (2), 96–7.

54 Pilcher, op. cit. (2), 97; H. Bassett, ‘The organisation of a works laboratory and its relationship to the plant’, *Industrial Chemist* (1934), 9, 330–2.

impressive array of qualifications in addition to their scientific training to support their search for employment. The following, which appeared in *Chemistry and Industry* in 1933, is typical of this type of advertisement:

Woman Graduate, Hons. Nat. Sci. Tripos, Cambridge, experienced secretary, 5 years' unique experience with well-known combine, classifying and abstracting technical documents, seeks responsible work. Good French, Technical German, short hand typist. Excellent testimonials.<sup>55</sup>

There are no figures which indicate the number of women who took up employment of this type, but the evidence from the job advertisements indicates that there was a steady level of demand. Moreover, the majority of advertisements for library and abstracting work specifically called for female applicants.

The relative ease with which women chemistry graduates were able to secure these posts draws attention to the extent to which their employment was restricted to those jobs regarded as suitable for them as women. As the careers advice literature suggested, they did not enter the workforce on equal terms with men, despite holding the same qualifications, and instead found themselves pursuing careers as women chemists rather than simply as chemists. As women chemists, they were paid less than men, confined to a limited range of industrial sectors or to jobs outside the laboratory, given fewer opportunities for research or managerial responsibility and frequently expected to end their employment when they married. Women did actively seek to improve their status and opportunities, challenging the implicit assumptions which often served to circumscribe their roles, but they met with only limited success. Where they did reach positions of authority it was often only in relation to other women, so that while some areas of industrial chemistry were predominantly the province of women the image of the profession as a whole remained resolutely masculine. This ensured that when wartime mobilization began their skills were often ignored and commentators writing after the Second World War tended to discuss the problem of 'scientific manpower' without reference to the potential contribution of women.<sup>56</sup> Others felt justified in suggesting that a 'willingness to employ women in professional and technical posts' was a result of opportunities which became available during that conflict, ignoring the extent to which graduate women scientists had been employed in industry during the inter-war years.<sup>57</sup>

### Women laboratory assistants

The employment of women chemistry graduates was only one aspect of women's employment in industrial laboratories. From the mid-1920s onwards a number of firms began to recruit women with few or no qualifications to carry out routine work, and by the mid-1930s the availability of posts as laboratory assistants was actively promoted in the careers literature aimed at those girls who had studied science at school to matriculation level.<sup>58</sup> Such posts were also available to boys with similar qualifications, but the expectations concerning the long-term career aspirations of men and women entering this type of employment were distinctly different. For men it was regarded as a stepping stone

55 *Chemistry and Industry* (1933), 52, 10 February, p. iv.

56 Bramley, op. cit. (37), 430–1.

57 G. L. Payne, *Britain's Scientific and Technological Manpower*, Stanford, 1960, 373.

58 Strachey, op. cit. (1); Hughes, op. cit. (3); 'Educated women's employment', op. cit. (52).

to more responsible posts either in the laboratory or the works itself. The ‘secondary-school boy’ starting work as a laboratory assistant was expected to continue his education through part-time study directed towards recognized professional qualifications, usually either the Associateship of the Institute of Chemistry or an external London B.Sc.<sup>59</sup> For the ‘secondary-school girl’ the prospects were generally very different, with only limited opportunities or expectation of advancement. Few women were encouraged to undertake study part time, while their lack of advanced qualifications prevented them from securing promotion. Firms appear to have been reluctant to invest resources in employees who were expected to leave after only a few years’ service when they married and women were discouraged from embarking on further study because they themselves anticipated that their tenure would be limited.<sup>60</sup> These expectations, which restricted women’s prospects whether they eventually chose to marry or not, have been labelled by Rossiter as ‘planned obsolescence’. She comments that ‘managers expected women to leave, planned for it, and then blamed them for the turnover’.<sup>61</sup> It is also possible that women may have been aware of the limited rewards available to them even if they did successfully continue their education.

Although evidence concerning the employment of women as laboratory assistants is very limited, that which is available suggests a close correlation with the picture painted in the careers literature. Here the focus will be on the experiences of laboratory staff working for Cadbury Bros., along with more limited evidence from Colman’s, who produced a wide range of foodstuffs including mustard and relishes, baby food and fruit drinks. Colman’s first employed analysts in its mustard mill during the 1890s and in 1924 expanded scientific activities to include a research programme as well as testing and control work. From the outset of this expansion at least one and at times two female laboratory assistants were employed. When they left they were replaced with other women and although female staff remained a permanent feature of the laboratory they stayed firmly at the bottom of the hierarchy. Moreover, while women left to get married or for jobs elsewhere in the firm they never did so to pursue their studies, a common reason for departure among the male laboratory assistants.<sup>62</sup> Women’s employment in the Colman’s laboratory was characterized by short tenure, limited responsibility, little opportunity for advancement and concentration on tasks assigned primarily or exclusively to women.

Similar features can be identified in the Cadbury laboratories, but here more extensive evidence permits a more detailed analysis. This firm appointed its first chief chemist, Norman Booth, in 1901.<sup>63</sup> He rapidly established a secure place for science within the firm,

59 A. E. Findley, ‘Openings in science for secondary school boys: does the industrial laboratory afford a career?’, *Journal of Careers* (1935), 14, 555–8; L. H. Callendar, ‘The laboratory technician in industry: a consideration of his prospects for promotion’, *Journal of Careers* (1939), 18, 618–21; R. Brightman, ‘Registration and the laboratory assistant’, *Industrial Chemist* (1931), 6, 122–4.

60 ‘Prospects for employment’, op. cit. (3).

61 M. Rossiter, *Women Scientists in America Before Affirmative Action*, Baltimore, 1995, 256.

62 Colman’s Archives, J. W. Corran, ‘The Research Department, Carrow Works, 1924–49’, typescript, 1949, with subsequent amendments. For a more detailed account of the work of the department see Horrocks, op. cit. (21), 162–4.

63 The section is based on CA, Annual Reports of the Chief Chemist, 1901–39, supplemented by the Minutes of the Research Committee. A fuller account of the development and activities of the laboratories is found in Horrocks, op. cit. (21), 176–222.

Table 2. *The scientific staff of the Bournville Laboratories, 1927 and 1935\**

	1927		1935	
	male	female	male	female
Chemically qualified staff				
Staff A	2		2	
Staff B	1		2	
Technical staff	6		3	
Other chemists	16		16	1
Staff with no chemical qualifications				
Girl assistants		2		5
Microscopists and samplers			2	
Manual assistants (including residimeter operators)	3		3	3
Total	28	2	28	9

\* CA, Annual Reports of the Chief Chemist, 1935.

The job categories used here are those which appeared in the Annual Reports. Staff 'A' and staff 'B' were the most senior categories, followed by 'technical staff' and then 'other chemists'. The category 'other chemists' included people studying for further qualifications.

and laboratory staff and facilities grew steadily, checked only by the events of the First World War. After Booth left in 1923 to head the firm's Australian operations<sup>64</sup> he was succeeded by Arthur Knapp, whose Annual Reports provide a detailed account of staffing in the Cadbury laboratories. These make clear that by this stage their smooth organization depended on a clear division of labour, with individual staff members developing specific expertise. Senior staff tended to be recruited from outside but laboratory assistants were encouraged to study for external examinations and their success in doing so was recorded from 1924 onwards.

Throughout the inter-war period the total number of staff in the laboratories at Bournville grew steadily, but beginning in 1927 and continuing up to the outbreak of the Second World War there was a significant shift in the composition of the workforce. In contrast to the earlier period, when expansion had been through the recruitment of qualified chemists and the retention of those who had undertaken their training while working for the firm, now growth occurred by increasing the number of employees engaged primarily or exclusively on routine tasks. Indeed some of them had job descriptions which suggest that they were designated exclusively to the operation of an individual testing procedure or piece of apparatus. 'Microscopist and sampler' and 'residimeter operator' (a specific task under the general heading of manual assistant) were new job titles which first appeared during this period. This meant that whereas in 1927 out of the thirty scientific staff, twenty-five held qualifications in chemistry; by 1935 the figure was just twenty-four out of a total of thirty-seven.

64 G. Jones, 'Multinational chocolate: Cadbury overseas, 1918–39', *Business History* (1984), 26, 59–76.

As Table 2 indicates, the majority of these new jobs were held by women, so that the emergence of these new positions provided them with sustained employment at the laboratory bench in this firm for the first time. A total of ten different women were employed in the Bournville laboratories between 1927 and 1939, all but one of them remaining in the general laboratory throughout their time with the firm. The exception was D. M. Lowe, who joined in 1931 as an analytical assistant and followed the path more usually taken by male assistants in studying for further qualifications, in her case a B.Sc. degree at Birmingham University. On her return to the firm she moved to the research department, although unlike many of her male colleagues she does not appear to have published the results of her work prior to 1939. None of the other women appear to have pursued their studies.

Soon after women were first recruited as laboratory assistants, the job of controlling the cocoa-grinding process through repeated microscopic analysis was transferred from youths to 'older and disabled men', two of whom worked in the general laboratory. A few years later, in 1936, responsibility for milk testing moved from the general laboratory at Bournville to special laboratories staffed entirely by women at each of the firm's milk condensing factories. These changes ensured that an increasing volume of routine work could be undertaken by the Cadbury laboratories for the minimum increase in costs and, as Arthur Knapp noted in his annual report for 1935, that 'trained chemists now do a greater amount of responsible work', leaving their assistants to focus on more routine operations. They also meant that this routine work was increasingly concentrated in the hands of two groups of workers – women and elderly and disabled men – who were perceived to be unlikely candidates for promotion to higher status positions for which they would have received more remuneration. This suggests that the employment of women in this case may well have been motivated not only by the desire to reduce costs but also by the perceived need to do so while sustaining the possibility of career advancement for men.

This interpretation is supported by evidence pointing to the departure during the early 1930s, for senior posts elsewhere, of several qualified male chemists who had been with the firm for some time. Previously the growth in staff numbers had been largely cumulative, with very few recorded as leaving. In 1930, however, T. H. Cooke found a post with Michelin as an efficiency manager and L. H. M. Holden joined a metallurgical firm. Three years later R. J. Phillips moved to Kemps, a London biscuit manufacturer, as chief chemist after nearly twenty years at Bournville. W. T. Field left in 1935 to become chemist and assistant works manager to confectioners Payne's. Most of these men had studied for their qualifications after joining Cadbury's and it is indeed possible that their departure was precipitated by the perceived lack of opportunities for advancement available within the firm. Few staff seem to have moved from the laboratories into production and by the early 1930s a static hierarchy had become established, with the tendency to recruit new senior and research staff from outside the firm, which left few openings for those already in post. As the expansion of routine work outpaced the growth of positions higher up the bureaucratic hierarchy, the possibilities for promotion remained limited, but highly skilled staff were still in demand for routine work. By employing women and other unpromotable categories of labour to undertake this work the firm was able to reduce, if not eliminate,

this dilemma. Further support for this interpretation of events comes from R. Brightman, writing in *Industrial Chemist* in 1931, who suggested that girls were being recruited as laboratory assistants for precisely this reason. He claimed that ‘the embarrassment caused by the fact that most boys entering laboratories as assistants wish finally to become chemists, has induced some firms to recruit certain sections of their laboratory staff, particularly for analytical duties, from girls’.<sup>65</sup>

Here the emergence of a new field of work for women appears to have helped to preserve some of the existing features of men’s work at the same time as redefining the nature of some of the tasks which they undertook. Distinct but complementary patterns of employment for men and women became established in at least some industrial laboratories. Men retained career positions which offered the possibility for advancement and were responsible for research work and the management of routine testing. Where they were themselves involved in routine work it tended to be regarded as part of their training for more senior posts. Women were generally regarded as a temporary part of the workforce, content to carry out routine work without the possibility of promotion. In this way the employment patterns observed to be emerging during the late 1920s and 1930s in the context of industrial chemistry appear to parallel closely much earlier events in clerical work where the employment of women served to improve the opportunities available to men.<sup>66</sup>

### Conclusion

This study confirms that a gender division of labour similar to that which has been documented in other contexts also emerged in British industrial chemistry during the inter-war period. The assimilation of women into this part of the scientific labour force was based on the emergence of jobs which were regarded as particularly suitable for them as women, whether they were graduates or not. Women did not compete directly with men, instead their position in the labour market facilitated an increased division of labour within industrial laboratories. They were employed because they could be offered conditions of service very different from those which were regarded as the norm for men, and because the nature of the work which they undertook could be readily associated with established notions of female skill and expertise. This combination of circumstances enabled firms to solve at least some of the difficulties of recruiting labour to do routine work when few prospects of promotion could be offered. The emergence of women’s work served to preserve for men those tasks and career opportunities which accorded with expected notions of men’s work. These conclusions echo those which have been reached by scholars who have examined the development of women’s careers in other skilled and professional occupations, especially clerical work and the medical professions, as well as recent research on women’s careers in science and engineering.<sup>67</sup> They also highlight the significance of

<sup>65</sup> Brightman, op. cit. (59).

<sup>66</sup> Jordan, op. cit. (5).

<sup>67</sup> See the literature cited in (5) and J. Evetts, op. cit. (33).

women to the development of male careers, suggesting that an appreciation of the 'gendered patterns of exclusion and segregation' which operated here are as relevant to understanding the process of occupational formation and professionalization in industrial science as they have been shown to be in other areas of employment.<sup>68</sup>

<sup>68</sup> A. Witz, in *Professions and Patriarchy* (London, 1992), discusses the significance of gender in medical professionalization. On the profession of chemistry during the inter-war years see C. Russell, N. Coley and G. Roberts, *Chemists by Profession*, Milton Keynes, 1977, 236–83.