

Chapter 15

Career Patterns in the British Chemical Profession during the Twentieth Century

Robin Mackie and Gerrylynn K. Roberts

Introduction

The obituaries carried by the major British chemical journals are an important source of information on chemical careers. Indeed, careers stand at the centre of their narratives. The following three are typical:

HAROLD ALBERT GOLDSBROUGH died at Hurstmonceaux, Sussex, on 12th March, in his 54th year. He received his early training under the late A. Chaston Chapman, F.R.S., with whom he worked for three years, and from 1906 continued at Finsbury Technical College, London. Thereafter he became Chief Assistant and later Associate Partner with Dr. Philip Schidrowitz, with whom he published various papers in the *Journal of the Society of Chemical Industry* and the *India Rubber Journal*. In 1915 he enlisted as a Corporal in the Special Brigade of the Royal Engineers, later receiving a Commission in the same Brigade and being promoted to the rank of Captain. He returned to Dr Schidrowitz, but was subsequently engaged with Messrs. J. B. Keeble & Co., and then with Hedge Sherriff Paper Co., in Canada, until 1932, when he returned to England and engaged in poultry farming. He passed the Intermediate Examination for the Associateship in 1908 and the Final Examination in 1910. He was elected a Fellow in 1913 (*Proceedings of the Institute of Chemistry*, 1937, 61, p. 191).

FRANCIS HENRY NEWAY LANE died at Coventry, on 26th August, in his 55th year. Educated at Portsmouth Grammar School and Plymouth College, he studied chemistry at Birkbeck College, and graduated B.Sc. (Lond.) in 1910. In September of that year he obtained an appointment as assistant analyst in the laboratory of the Admiralty Chemist, then the late Arnold Philip, Fellow, with whom he remained until December 1915, when he was appointed as assistant research chemist at the Imperial Institute. In 1917 he became works chemist with the Rover Company, at Coventry, where he also held a lectureship at the Technical Institute. He left the Rover Co. in 1925 and practised in Coventry until 1935, when he joined the staff of Modern Machine Tools Ltd. From 1938 he was chief metallurgist at Daimler Co.'s Factory until he was obliged to cease work owing to ill-health in October, 1939. He was elected an Associate of the Institute in 1919 (*Proceedings of the Institute of Chemistry*, 1940, 64, p. 340).

PERCY PARRISH died on 30 May, 1947, in his 63rd year. He received his scientific training at Dewsbury Technical School, Huddersfield Technical College and the University of Leeds. In 1900 he became Chemist to J. Brown & Co., Ltd., of Dewsbury, and in 1914 was appointed General Manager and Chemist to the Eaglescliffe Chemical Company's Works in County Durham. The following year he joined the South

Metropolitan Gas Company, becoming manager of the ammonia and acid works at East Greenwich, a position that he held at the time of his death. He was the author of *The Design and Working of Ammonia Stills, Sulphuric Acid Reaction Chambers, Sulphuric Acid Concentration* and [jointly] *Artificial Fertilisers, their Chemistry, Manufacture and Application*, in addition to numerous papers contributed to the technical press. He was the inventor of several processes, for which he held patent rights. He was elected an Associate of the Institute in 1918 and a Fellow in 1931 (*Proceedings of the Institute of Chemistry*, 1947, p. 190).

While the focus on careers gives such obituaries a common format, the careers described often vary enormously. Harold Goldsbrough began his working life as an apprentice with a leading consultant. Later he worked for another consultant, before taking posts with two industrial companies, the second in Canada. He died back in England, as a poultry farmer. Francis Lane began his career in 1910 working for the Admiralty. In 1915 he moved to the Imperial Institute, a government-funded research establishment that sought to further the economic development of the Empire through applied science. Two years later, he moved to Coventry and a post with the Rover car company, whilst at the same time teaching at the local technical college. In 1925 he set up as an independent consultant. Ten years later, he returned to industry, holding jobs with two separate firms in the four years before his retirement. Finally, Percy Parrish spent most of his working life with just two companies: J. Brown & Co. Ltd. and the South Metropolitan Gas Co. For 32 years, apparently, he served as manager of the latter's East Greenwich ammonia and acid works.

The varied work-life histories of these three chemists were not unusual. There were other career trajectories too: for example, progression through the ranks of a single institution. As the demand for chemists grew in late-nineteenth and twentieth-century Britain, chemists found roles across academia, industry and government. Some worked all their lives for a single company or university, for others, independent practice was always the goal; yet others pursued mobile careers, shifting location, employer and sector. If professions can be seen as 'knowledge-based groups' (Torstendahl, 1990), the expertise possessed by chemists proved highly transferable.

This versatility makes chemists an interesting case study for exploring the development of professional careers. From the end of the nineteenth century, an increasing range of applications for chemical knowledge came to be identified. Not only did the chemical industry itself develop rapidly, but also chemical skills were essential for a host of other industries (Homburg, Travis and Schröter, 1998; Travis, Schröter, Homburg and Morris, 1998; Russell, 2000). Government, from public health to armaments, also required chemical expertise; the rapid development of chemical education both reflected and further stimulated the demand for chemists. Turning this diversity to advantage, leading chemists highlighted the adaptability of their discipline: chemistry was a 'universal' and a 'useful' science, with a wide range of applications. Throughout the nineteenth century and well into the twentieth, chemists were Britain's largest scientific community. They were also one of the first of the new scientific or technical

professions to establish themselves in Britain at the end of the nineteenth century. In doing so, it was versatility that was emphasized. Andrew Abbott argues that professions establish themselves by defining a 'claim of jurisdiction' where society recognizes their exclusive rights (Abbott, 1988): in the rhetoric of the developing chemical profession, the wide utility of their discipline was always at the centre.

Career Paths of Professionals

Much of the literature on professions in Britain highlights a peculiar British pattern to professionalization. The classic works emphasized features common to many professional occupations – qualifying institutions, entrance exams, self-regulating codes of conduct – and used them to construct models of how professions developed (Carr-Saunders and Wilson, 1964; Millerson, 1964). This approach stressed the role played by the self-governing 'liberal professions' – particularly law and medicine – in shaping how professions developed in Britain (for elsewhere see Gispin, 1988; Fox, 1984). There can be no doubt that the success of the traditional professions served as an ideal for many of the occupational groups that organized in the final decades of the nineteenth century and the first half of the twentieth. When chemists first began to organize in the 1870s, engineering and especially medicine were frequently cited models (Russell, Coley and Roberts, 1977). More recent historical studies have argued that the growth of professions should be viewed as a central theme in explaining the development of British society in the twentieth century (Perkin, 1989; Savage, Barlow, Dickens and Fielding, 1992). Both approaches focus on similarities between professions; however, this can hide important differences among the experiences of the many knowledge-based groups that developed in the UK (Mackie, 2000; Mackie and Roberts, forthcoming).

Many of these differences relate to careers. This becomes evident when the related typologies developed by David Vincent and Andrew Miles to examine the work histories of people in Britain in the nineteenth and early twentieth centuries are used to examine the careers of professional groups. Vincent talks of four basic models of career development; Miles uses three categories with similar titles (Vincent, 1993; Miles, 1993; Miles, 1999). Both use a category of 'professional careers', which Vincent describes as 'organised on the basis of the largely non-hierarchical exploitation of a specific craft or skill' (1993, p. 224). This might seem the obvious category for most chemists and other professional workers. Yet, all three of Vincent's other categories, the bureaucratic, the entrepreneurial, and the dynastic, contain elements central to the career paths of many professional groups including chemists.

For many professionals, independent practice was – and indeed remains – an aspiration. Interestingly, in the first half of the twentieth century, this was the standard destination for many in the liberal professions of medicine and law. General practitioners followed a career path with little mobility. A successful practice depended on good local contacts and many returned to their place of origin, perhaps to take over an existing practice (Crowther and Dupree, 1996).

Success was not related to moving up a career ladder but to the growth of the practice and perhaps such external measures as status in the local community. As such, the career paths share some of the characteristics of the entrepreneurial model identified by Vincent and Miles, although, as Crowther and Dupree emphasize, there might be a dynastic element too, since independent practitioners often developed an inherited practice (1996). Some chemists followed career paths similar to doctors, either opening independent practices or working as public analysts for boroughs or counties. Indeed, as with medical practitioners, such posts were often combined, thus bridging the public/private divide. In addition, a few chemists entered entrepreneurial careers in business, either launching or inheriting companies that manufactured chemicals.

Other professions followed career paths much closer to the bureaucratic careers that both Vincent and Miles identify. Anglican clergy or army officers typically had only one possible employer and advancement depended on success within the institution. Savage points to the importance of loyalty to the firm in the careers of bank clerks (Savage, 1993; see also Stovel, Savage and Bearman, 1996). For chemists entering central government service, or large companies, or the major universities, progress might also mean a succession of jobs up a more or less clearly defined career ladder. ICI was notorious for preferring its own men to outsiders when it came to top appointments (Reader, 1975).

For a third group of professional or semi-professional workers, switching employers at irregular intervals was a normal part of career progression. British metal mining engineers gained experience by working for different companies in different countries (Harvey and Press, 1989); merchant navy captains held a series of renewable contracts. Such careers were 'based on and defined by possession of a recognised skill' that the professional could transfer to a new setting (Miles, 1999, p. 112). Again, many chemists had careers which conformed to this format, switching during their working lives between similar institutions: chemistry masters often taught at a number of schools, whilst smaller companies which employed few chemists might offer few prospects of advancement so that moving up a grade meant changing firm. In other cases, job changes involved greater shifts. Even leading chemical academics or industrialists might have spent part of their career in a completely different sector, or like Frederick Donnan, professor of chemistry at University College London from 1913 to 1937, might hold important industrial consultancies whilst pursuing an active academic career (Roberts, 1997).

The career paths of professionals, in short, varied enormously. What is interesting about chemists is that this diversity was contained within a single profession. The wide utility of chemistry meant that different professional avenues, with widely diverging career patterns, were open to them. This paper focuses on how individual chemists constructed careers from the options available. A central issue is the tension between career stability (staying in the same job, or with the same employer) and career mobility (shifting between employers or between sectors). Which was more common and did this change over time? Can we identify trends in the career patterns of chemists? Miles suggests that the end of the nineteenth century saw the beginnings of a shift towards career patterns defined by formal and external structures (1999, pp. 113-4). Is such a framework helpful in

understanding the development of careers in chemistry? A further set of questions relates to the relationship between stability, mobility and success. Were mobile or stable careers more likely to lead to the top? Did this change over time? Although our data describes behaviour rather than motivation, pathways to success may also raise questions about how we understand work-life histories. Exploring the patterns of chemists working lives may help us to understand why they – and other knowledge-based groups – moved or stayed put.

The Profession of Chemistry

To explore these issues, we use collective biography methods to analyze the careers of successive cohorts of the members of the Institute of Chemistry (IC), which was established in 1877 as a self-consciously professional body for chemists. Its background lay in conflicts within the learned Chemical Society [CS] (founded 1841) over how it should respond to external demands for clear membership criteria. From its beginning (and in contrast to the Chemical Society), the Institute required both evidence of practical experience and academic qualifications for admission and it rapidly created an entry route based on examinations (Russell, Coley and Roberts, 1977). In this it preceded many other professional bodies, including the engineering institutions, and as such was a pioneer of a new style professional body which saw certification as crucial. During the two World Wars, qualification routes were revised to take account of the growing number of chemists with qualifications from academic institutions.

By easing access for chemists with a university degree, the IC was able to keep abreast of the growth in numbers of trained chemists. Both revisions led to a surge in membership and, once this fell back, still left admissions on a higher level than before. A comparison can be made with admissions to the other principal chemical organizations, the Chemical Society and the Society of Chemical Industry (SCI), neither of which acted as a certifying body. Both had higher admissions in most years than the Institute of Chemistry (see Figure 15.1). Nevertheless, the higher retention rates of the Institute meant that it grew much faster especially after 1918. Before the First World War the Institute of Chemistry, was always the smallest of the three organizations. However, it overtook both the Chemical Society and the Society of Chemical Industry during the 1920s and by 1956, was twice the size of the SCI and fifty percent larger than the Chemical Society (see Figure 15.2).

The members of the IC were, therefore, by their own definition, professional chemists. They were entitled to use the designation AIC (Associate) or FIC (Fellow). Unlike a university qualification, since the membership was the qualification, if members wished to continue using the title, they needed to retain their membership by paying an annual fee. Fees were set at a high level – two guineas per annum in 1934. That retention rates were nevertheless so high was not because membership of the Institute was formally required for any office. In contrast to the position of some other professional bodies, and despite the occasional efforts of the Institute's leaders, government did not make membership of the Institute a condition for holding any post.

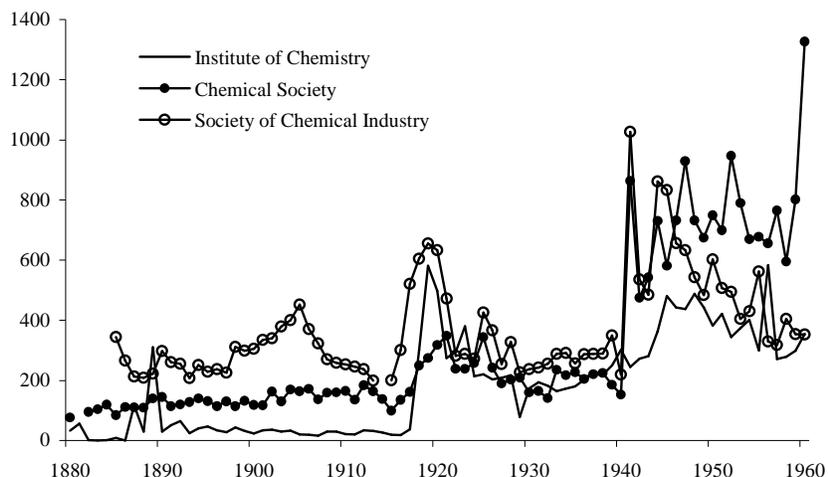


Figure 15.1 Annual admissions to the three principal British chemical societies

Source: Annual Reports of Council of the three societies.

It was also quite possible to keep abreast of scientific knowledge without IC membership. Both the Chemical Society and the Society of Chemical Industry produced prestigious learned chemical journals, and large numbers of chemists, including leading academics, joined those societies and not the Institute. Membership of the Institute was therefore a conscious decision taken either because of perceived advantages in terms of career advancement or because applicants wished to align themselves with a particular form of professional identity. The rapid increase in the membership of the Institute in the twentieth century was a vindication of the insistence of its founders on establishing a professional association based on qualifications: the steep upward curve in Figure 15.2 is evidence of the increasing importance of academic credentials. During the twentieth century, certification became important in a wide range of fields; among scientific and technical professions, chemistry was one of the earliest to engage in this process.

This study of the careers of members of the Institute of Chemistry draws on collective biography data from a larger project on the British chemical community in the twentieth century (Mackie and Roberts, 2000).¹ All tables below deal with samples of ordinary members of the Institute, representative of those who joined in the periods 1887-1917, 1918-1943 and 1944-1956 respectively. The three periods were defined by when the Institute's membership criteria changed, so that

¹ We are grateful to the Leverhulme Foundation for support for this work.

members of each sample were admitted under the same criteria, though the criteria differed from sample to sample.

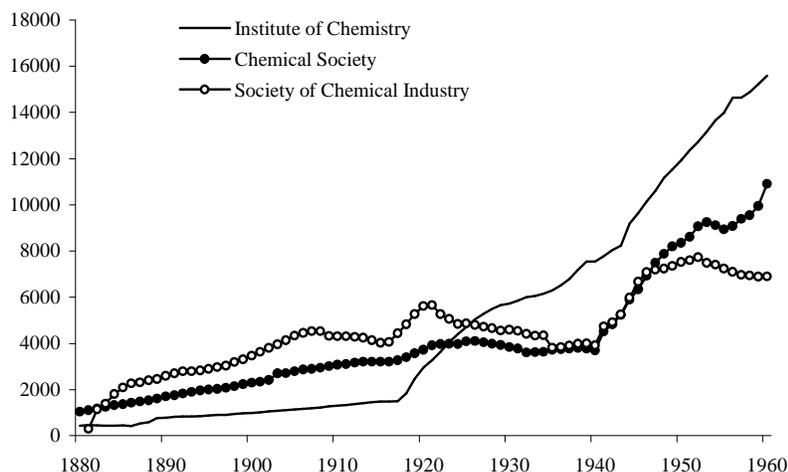


Figure 15.2 Annual membership of the three principal British chemical societies

Source: Annual Reports of Council of the three societies.

1717 members joined in the period 1887-1917, 9024 joined from 1918 to 1943 and 7862 joined from 1944-1956 (see Figure 15.1). Systematic samples with a random start were drawn from lists of all chemists entering the Institute organized by date of first entry to corporate membership.

Career Mobility

One type of mobility displayed by chemists was movement across fields of employment – here described as sectors (see Table 15.1). Chemists found posts in five main sectors: academia, including both universities and technical colleges, school teaching, ‘consultancy’, by which we mean independent practice, government, both central and local, and industry. Posts that fit in none of these, such as chemists working as medical practitioners or for public utilities, we designated as ‘Other’.

Among the patterns highlighted by Table 15.1 is a striking consistency among the three cohorts, showing both stability and mobility across sectors. Just over half spent their careers only in one sector, while more than 40 percent worked in at least two sectors. However, in this latter group, there was a decline in the percentage working in three sectors or more over time so that for the post-war cohort, this was

true of fewer than ten percent, although this was balanced by a rise in the percentage having careers in two sectors. From this perspective, the experience of Francis Lane, the subject of our second specimen obituary, was becoming increasingly rare.

Table 15.1 Mobility: number of sectors worked in (percent)

	1887-1917 N = 225	1918-43 N = 193	1944-56 N = 208
One only	50	51	52
Two	28	29	36
Three or more	17	12	7
Insufficient data	4	8	4

Source: R.L. Mackie and G.K. Roberts have constructed a 'Chemists database' at The Open University. Data were assembled from a wide range of sources including obituaries, a range of standard biographical sources, and the membership records of the major chemical institutions, which have been preserved by the Royal Society of Chemistry and the Institution of Chemical Engineers. We are grateful to these organizations for generous access to their membership archives. These essentially biographical sources were complemented by others that more closely approximate census data, such as the lists of members of the IC, CS, SCI and IChemE, and directories of the holders of chemical positions. Abbreviated records of some 3700 individuals, about 40 percent of the full database, can be viewed on our website: (<http://www5.open.ac.uk/Arts/chemists/index.htm>).

Note: In all tables, figures are for careers as a whole, rather than just within the sample period. Most IC members joined the Institute in their youth (average age of those for whom we have a date of birth was just over 28 years) and working lives may have lasted for approximately 40 years. Therefore, the careers of the first cohort may have lasted into the 1950s, whilst some in the final cohort may have retired only relatively recently. We have data on at least one post for all but 5.4 percent of the individuals in the three samples and have careers stretching over 30 years for more than half of them.

Table 15.2 disaggregates by sector the data in Table 15.1. 'All' gives the percentage of the entire sample who worked in a particular sector; 'Only', the percentage of the sample who – as far as we know – worked exclusively in that sector. That the 'All' column for each sample totals more than 100 percent is a consequence of individuals' working in more than one sector. For all three cohorts, the figures for industry stand out, with half, rising to three-quarters, of all chemists working for at least part of their career in industry.

Between a quarter and a third of chemists spent part of their careers in academia, government and – for the first sample – consultancy. By contrast, only small numbers of school teachers seem to have joined the IC.² These results

² It has been argued that school teaching was the destination of most science graduates at the turn of the century (Cardwell, 1972; but see also Donnelly, 1991). Our figures do not necessarily imply that chemistry graduates did not enter teaching, but rather that those who did apparently saw little reason to join the Institute. Although women were admitted to the Institute from 1892, only 0.4 percent, 3 percent and 5 percent respectively of our three

provide an interesting perspective on debates about the destination of graduates in the years immediately preceding the First World War. At the time there was widespread concern that industrialists showed too little interest in employing chemists. Table 15.2, however, suggests that even though the Institute had been set up primarily to serve chemists in independent practice, industry was already becoming a major career destination from the turn of the century (see also Roberts 1998). Over time, this became even more markedly the case. The percentage with industrial experience rose from cohort to cohort, whilst that working in academia and government was largely static, and the percentage working as consultants declined precipitously. This can be explained partly by changes in how industry 'bought' expertise in Britain. In the pre-1914 era, independent consultants were often used, whereas, from the First World War on, it became increasingly common for firms to employ their own chemists. As a result, independent practitioners, the group closest to the traditional ideal of a profession, gradually became a minority among Institute members.

Table 15.2 Mobility: distribution of chemists' posts among sectors (percent)

Sector	1887-1917 N = 225		1918-43 N = 193		1944-56 N = 208	
	All	Only	All	Only	All	Only
Academia	32	9	30	5	26	5
School	8	2	7	4	4	1
Consulting	30	3	12	1	5	0
Government	32	12	30	6	28	9
Industry	54	25	59	33	73	37
Other	4	0	8	2	10	1

Source: Mackie and Roberts, 'Chemists database'.

If industry was increasingly dominant, it was, however, never an exclusive employer. In virtually every case fewer than half those who worked in a sector spent their entire career there. Perhaps surprisingly, this is particularly true of academia and government where it might be expected that large institutions would have developed exclusive recruitment patterns. Even in industry, where the proportion of chemists who had no experience of other sectors was higher, around half worked outside their sector at some point in their career. This remained true over time, despite the rising percentage working in industry. In this sense at least, chemistry remained a unified profession with transferable skills, for which barriers between sectors never became insurmountable.

samples were women, possibly because the majority of women chemists became school teachers.

Career Stability

Turning to career stability, we have taken twenty years – approximately half a working life – as the unit of measurement. Table 15.3 shows the percentage in each sample who spent at least twenty years with the same employer in the same post and the percentage who worked for twenty years for the same employer – company, academic institution, or government department – but in more than one post. It also shows the percentage of those whose careers included no period of stability as long as twenty years.

Table 15.3 Stability: employment patterns of chemists with stable careers (percent)

Pattern	1887-1917 N = 225	1918-43 N = 193	1944-56 N = 208
20 years with 1 employer: 1 post	36	19	6
20 years with 1 employer: >1 post	18	29	24
< 20 years with 1 employer	17	19	37
Unallocated	28	33	33

Source: Mackie and Roberts, 'Chemists database'.

Note: 'Unallocated' refers to those for whom our data cover a period of less than 20 years. In the case of the 1887-1917 sample, early death was a factor with at least five percent of the sample dying before the age of 40, many during the First World War. Furthermore, because we have sought data widely within but to a lesser extent without the chemical literature, we are less likely to have data on those who dropped their membership of the Institute and the other chemical societies. It is therefore possible that many of the 'Unallocated' abandoned chemistry for some other occupation.

The percentage staying in the same post for 20 years or more declined markedly over time. The figure for the 1887-1917 cohort may seem to clash with earlier evidence of high mobility. Very often, however, this represented different stages in the same career: high mobility in the first decade of employment was followed by later stability, perhaps because an independent practice had been opened or a desirable niche had been found. Over time, however, careers such as that of Percy Parrish, the third of our specimen obituary subjects, became increasingly uncommon. For the inter-war cohort, stability, as defined by remaining in a single post, was partly replaced by a rise in the percentage spending over twenty years with the same organization, presumably rising through the ranks. Such careers were apparently less common among the post-1944 cohort, although the difference is at the margin of statistical significance of our data. There is no doubt, however, that those starting their careers after 1945 were far more likely to work for a number of employers, the percentage in this group from the 1944-56 cohort being roughly double that in the 1887-1917 and 1918-43 cohorts.

There was a slightly different pattern of career stability in each employment sector (Table 15.4). For the pre-First World War cohort, the total percentage of stable careers with a single employer (28 percent) was lowest in academia, and such careers remained unusual in this sector.

Table 15.4 Stability: distribution of chemists working twenty years with one employer as percent of all chemists employed in sector

Sector	1887-1917		1918-43		1944-56	
	1 post	>1 post	1 post	>1 post	1 post	>1 post
Academia	18	10	7	9	7	11
Consulting	32	3	4	0	0	0
Government	33	21	9	24	5	25
Industry	21	13	19	32	3	18

Source: Mackie and Roberts, 'Chemists database'.

As Halsey demonstrates, the British university system in the first half of the twentieth century was an 'evolving hierarchy', and academic careers often included periods at different universities (Halsey, 1995). The percentage with stable careers in consultancy collapsed for the inter-war cohort, suggesting that the establishment of an independent practice was – as our subject Francis Lane may have found – an increasingly unrealistic career goal. Government employment saw an almost equally sharp decline in the percentage holding one job for twenty years, although the percentage holding a series of posts within the same department remained stable. Civil service restructuring and the inter-war development of government Research Associations may explain this (Varcoe, 1981). A similar trend can be identified in industry, but the shift away from 'a job for life' appears to have been later, whilst the percentage working only for one employer, peaked for the inter-war cohort. These trends in industry may be related to firm size, with individuals holding one post for twenty years more common among the many smaller firms, which were such a feature of British industry, and bureaucratic careers the norm in the large conglomerates which formed in the chemical and oil industries from the 1920s. After the Second World War, full employment may have reduced the ability of employers to demand firm loyalty from skilled workers.

Career Success

Turning next to career success, Tables 15.5 and 15.6 explore the achievements of chemists in terms of the highest ranking posts that they attained during their careers. For this purpose, we assign a 'rank' to individuals' posts based on their titles.³ A scale of 1 to 5 was created, with ranks 1 and 2 representing senior posts and rank 4 the standard grade. Table 15.5 gives figures for the cohorts as a whole; Table 15.6 shows the distribution across the four principal employment sectors of

³ These are the titles supplied to the Institute by members themselves for inclusion in its published *Register*. As such, they are a combination of official job titles and self-description. For example, in the industrial sector, rank 1 are owners and directors, rank 2 senior management, rank 3 middle management, rank 4 standard grade posts; in academia, rank 1 are high office holders (e.g. Dean), rank 2 professors, rank 3 senior lecturers, rank 4 lecturers. Roughly equivalent scales were constructed separately for each sector.

those who attained posts ranked in one of the top two bands as a percentage of those who held posts in that sector.

The main result emerging from the two tables is that the percentage attaining high ranks was lowest for the cohort joining in the inter-war period. The global figures in Table 15.5 and the figures for three of the four sectors analyzed in Table 15.6 dipped. The exception is consulting where the percentage for the inter-war cohort was the highest. As we know from Table 15.2, the numbers with consultancy careers dropped dramatically in this period. The percentage of the inter-war cohort in consulting in Table 15.6 suggests therefore that only the most successful remained in the sector.

Table 15.5 Career success: highest rank attained (percent)

Rank	1887-1917 N = 225	1918-43 N = 193	1944-56 N = 208
One	23	16	19
Two	31	23	29
Three	15	18	20
Four	13	18	10
Uncertain	18	26	23

Source: Mackie and Roberts, 'Chemists database'.

Note: Chemists were categorized according to the highest rank they obtained at any point in their lives. Where too little of an individual's career was known for us to be confident that the highest rank we noted was the highest rank achieved, the individual was classified as uncertain. The size of the uncertain category is due to the percentage for whom we know about less than 20 years of their career (see Table 15.3). Most of this group only attained careers ranked 4 in the period for which we have information, thus it is possible that our data reflect a career path out of chemistry.

Table 15.6 Career success: high ranks attained in sector (percent)

Sector	1887-1917	1918-43	1944-56
Academic	34	18	21
Consulting	57	75	55
Government	19	14	27
Industry	46	39	48

Source: Mackie and Roberts, 'Chemists database'.

Since the same ranking system was used for all three samples and the way the figures are constructed means that there was considerable chronological overlap between the careers analyzed in each case, it is unlikely that these trends are simply an artefact of the ranking system used. It is possible that the widening of the membership criteria by the Institute at the end of the First World War brought in many chemists who did not reach high office. This might explain the drop shown in Table 15.5 from 54 percent for ranks 1 and 2 in the pre-1917 cohort to 39 percent in the inter-war one. However, it is less helpful in accounting for the rise to 48 percent in the post-1944 cohort, after membership criteria were widened still further. Moreover, changes in IC membership criteria were not unrelated to wider

social trends: admission routes were simplified because the leaders of the Institute realized it would otherwise come to represent a declining proportion of a rapidly growing pool of university-qualified chemists (on numbers of science graduates, see Edgerton, 1996, pp. 18-24). Change in the percentage of chemists achieving high career ranks must therefore be at least partly explained in terms of supply and demand: compared to the pre-First World War cohort, chemists entering the profession in the inter-war years faced a situation where the supply of chemists was outpacing demand and access to top rank posts was more restricted. Interwar academics were certainly concerned that their students would face employment problems because of this (Roberts, 1996). After the Second World War, the demand for chemists grew rapidly (Sanderson, 1972, pp. 352-3) and our data suggests that prospects once again improved.

Career Patterns

In order to address the relationship between career mobility or stability and career success, we used categories from Tables 15.1 and 15.3 to define a number of career patterns. Table 15.7 explores this for the samples as whole. 'Cross-sector mobile' represents the career of an individual who worked in three sectors or spent at least five years working in each of two sectors.

Table 15.7 Career patterns (percent)

Pattern		1887-1917 N = 225	1918-43 N = 193	1944-56 N = 208
Cross-sector mobile	Mobile	28	21	18
Stable in one job	Stable	23	16	4
Stable in one organization	Stable	15	23	19
Mobile within one sector	Mobile	5	8	22
None of the above		4	1	5
Insufficient data		25	32	33

Source: Mackie and Roberts, 'Chemists database'.

Note: In this table, allocation is additive and has been done in the order set out. That is, if an individual met the criteria for one career pattern, they were allocated to it and not considered for the next pattern, even if their career would also have matched its criteria. This order of allocation was chosen in order to reflect the likely level of impact different career patterns might have on an individual's professional identity. Thus if an individual had extensive experience of working in different sectors, we judged this as likely to have been highly significant for their professional identity, even if they also spent twenty years in the same post for part of their career. As well as the positive categories, the table also contains two negative categories: a small percentage of careers where we have adequate data, but the individual's career does not fit any of the defined patterns, and a group for which our data are insufficient to allow allocation. Most of these are, of course, the individuals for whom our data covers a span of less than twenty years (see Table 15.3).

'Stable in one job' describes the career of an individual who worked for only one employer in only one post for 20 or more years. 'Stable in one organization' refers

to the career of an individual who worked for only one employer for 20 or more years but in more than one post. 'Mobile within one sector' represents the career of individuals who worked for a number of employers, all within the same sector.

The result is a table with four positive categories, two each for stable and mobile careers. Each of the four positive categories moved differently over time. The proportion of cross-sector mobile careers declined gradually. The 'stable in one job' group dropped far more dramatically. The proportion of 'stable in one organization' peaked with the inter-war cohort before falling back slightly, whilst the 'mobile within one sector' group remained low until a sharp rise in the post-1944 cohort. If we amalgamate the two mobile categories, the percentages are 33 percent, 29 percent and 40 percent respectively, whilst the stable pair adds up to 38 percent, 39 percent and 23 percent, suggesting that the most significant change came after the Second World War. Inside both pairs there was a marked shift in the relative weight of the component categories between the first and the last cohort.

Clearly, such figures are underlain by complex and sometimes conflicting trends. The pre-First World War cohort combined high cross-sector mobility with stability in one job – indeed 13 percent of the cohort combined these features and had careers that could have been allocated to either category. However, both of these career patterns formed a declining proportion of later samples. Instead, a greater percentage of the inter-war cohort spent a large part of their career within one organization – men like Percy Parrish who enjoyed what Vincent describes as 'gold watch' careers (Vincent, 1993, p. 225). Finally, the post-Second-World-War cohort had a higher percentage of mobile careers within one sector.

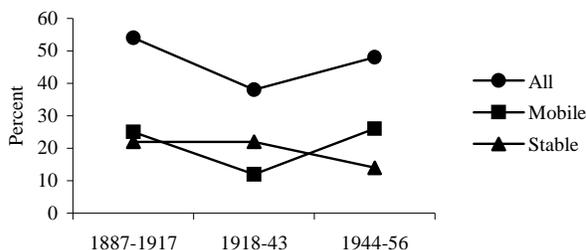


Figure 15.3 Career patterns related to career success

Source: Mackie and Roberts, 'Chemists database'.

Figure 15.3 analyzes mobility and stability in relation to career success. In this figure, the percentages of chemists achieving rank 1 or 2 have been amalgamated. 'Total' shows the trend for the cohort as a whole. 'Mobile' and 'stable' careers amalgamate the categories with these designations in Table 15.7. Thus both mobile and stable careers could lead to high ranked posts and this was indeed true for all the four categories used in Table 15.7: it was not the case that any single career pattern was consistently linked to ultimate career rank. The percentages for the entire sample reiterate the dip for the inter-war-years cohort noted in the section on career success. This is mirrored in the figures for mobile careers; indeed the rise in

mobile careers for the post-1944 cohort is even more marked than it is for 'All' careers. By contrast the figures for stable careers display a different pattern: unchanging for the first two cohorts and then declining. Two trends combined to produce this pattern. First there was a sharp rise in the success rates of those with 'stable in one organization' careers for those starting out in the inter-war years; for the post-1944 cohort, the combined figures are affected by the collapse of the percentage staying in one job for twenty years or more.

These trends are further elucidated when those with industrial, academic, and government careers are looked at separately in Figure 15.4, where the figures relating career pattern to career rank are disaggregated by sector.

The result is three sets of paired lines – a pair for each sector. In the case of both government and academia there was relatively little change over time. High rank was always harder to come by in government posts, with fewer attaining posts ranked 1 or 2. Stability (that is, long service in one government department) seems to have been somewhat more likely to lead to higher-ranked posts. Nevertheless, some chemists in government posts achieved success despite (or because of) mobility. By contrast, in academia, mobile patterns were more likely to lead to higher ranked posts. The data do not of course indicate what was cause and effect – in academia was it switching between universities that led to success or did success permit switching?

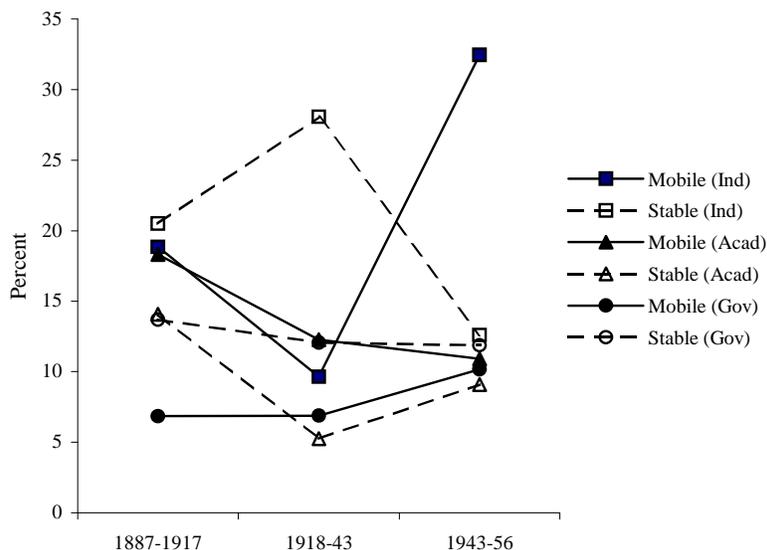


Figure 15.4 Career patterns related to career success disaggregated by sector
 Source: Mackie and Roberts, 'Chemists database'.

For both government and academia differences between mobile and stable career paths in the achievement of higher-ranked posts virtually disappeared for the final

cohort. Industry, however, shows a markedly different pattern, bringing out yet more sharply the changes over time visible in Figure 15.3.

For the cohort starting out before World War One, mobile and stable careers were similar in terms of highest rank achieved, in the inter-war years it was stable careers that were the route to the top as bureaucratic careers were rewarded. However, for the post-1944 cohort, the higher success rates of those with 'mobile within one sector' careers pushed up the overall success of mobile careers.

Conclusion

The trends highlighted are many and complex; however, perhaps the most important trend is the continued importance and changing nature of career mobility. The decline in the proportion of the sampled chemists who held one job for twenty years or more as outlined in Tables 15.3 and 15.7 is striking. Instead, there was a rise in the proportion both of careers that included long service to one employer in a series of posts rising in status, and of careers that included mobility between employers. In terms of the categories used by Miles and Vincent, one might talk of a shift away from 'entrepreneurial' (and perhaps 'dynastic') careers. Mobility of course was displayed throughout the period and, indeed, the earliest sample shows the highest percentage of chemists with experience of three or more sectors. However, mobility became more focussed. From a situation where individuals might apparently move randomly through a series of posts, there was a shift towards what appears to be more ordered movement - within one organization or between similar institutions. This might be seen in the context of the shift towards a more formal career process described by Miles (1999, p. 113). Furthermore, those who followed such career paths were more likely to achieve higher rank posts. If, in all periods, each of the four main career paths identified led to high-ranked posts for some, in the post-1944 period more such posts went to those who followed careers that displayed this 'ordered mobility' than to those who did not. Within the increasingly dominant industrial sector, there appear to have been few barriers to switching employers. This may reflect a decline in the significance of internal promotion within firms in the final decades of the twentieth century, as suggested by Savage and colleagues (Savage, Barlow, Dickens and Fielding, 1992, pp. 64-9).

For the founders of the Institute of Chemistry, the ideal type of a professional was an independent practitioner. However, careers that included long spells in independent practice declined dramatically as a percentage of all careers during the twentieth century. Yet, the ideal of professional independence remained central to the new career patterns that became increasingly common and increasingly successful. Mobility between employers required recognition – not least from employers themselves – that skills were transferable. For those starting out in the inter-war years, it seemed for a time that loyalty to one institution might become the key to success, but the rise in the percentage of 'mobile within one sector' careers for the post-Second-World-War cohort swung the pendulum back towards career mobility. Indeed, even 'cross-sector mobility' remained impressive: 43

percent of the post-1944 sample worked in more than one sector. With increasing numbers of chemists and increasing specialization in both university departments and company research, one might have expected chemical skills to become more narrowly focussed to the extent that mobility became problematic. That this was not the case is evidence of the success of the chemical community and its leaders in preserving the unity of the profession and the discipline. Chemical knowledge and skills remained a passport to many careers.

The continuing strength of this professional ideal is also highlighted when we focus on the percentage in each table that defied classification. When appearing as a figure in our tables, this group often seems to be awkwardly large. It was not possible to classify these careers because we only have data on part of them. There are good reasons for thinking that a major reason for this is that a large part of the working lives of these individuals was spent outside chemistry. The corollary is, of course, that for more than two thirds of every cohort, over 20 years (and in many cases far longer) was spent within the profession. In the absence of comparable data it is hard to judge whether seepage out of the chemical community was high or low, but, since the acquisition of professional qualifications was arduous, it is perhaps to be expected that professional qualifications, once acquired, were used. There can be little doubt that membership of the IC was of continuing importance to most of its members.

Job stability is often equated with security. Yet for chemists, and, we imagine, for many other professionals, success was most likely to be achieved by job mobility within their profession. If for many workers continuity of employment was a goal to strive for, for many professional or knowledge-based occupations, successful careers were built upon mobility as transferable expertise was demonstrated and progression achieved. Some might climb ladders within one organization, but for others, success was achieved by switching employers. In the case of chemists, it is interesting that those who entered the profession after World War Two in a period of expansion, when demand for scientists was high, were more likely to switch employers (and achieve high ranks by doing so) than those who entered the profession during the troubled inter-war decades. Where choices existed, mobility was preferred. In this, chemists were conforming to an ideal in which professional expertise and not organizational loyalty was seen as the key to success.

The emphasis in many of the obituaries of chemists on careers reflected professional priorities. The professional identity of chemists was closely bound up with the world of work. The close attention given by the writers of the obituaries to work titles and career moves reflects their importance in shaping the life histories of the deceased. The careers of men such as Harold Goldsbrough and Francis Lane may seem to consist of a series of random moves, yet, in staying put or moving on, chemists were following paths bounded by professional expectations. Over time, there were shifts in the patterns of these paths towards a more ordered mobility, but careers thus ordered entailed no loss of professional identity.

References

- Abbott, A. (1988), *The system of professions: an essay on the division of expert labor*, Chicago, University of Chicago Press.
- Cardwell, D.S.L. (1972), *The organization of science in England*, revised edition, London, Heinemann.
- Carr-Saunders, A.M. and Wilson, P.A. (1964), *The professions*, revised edition, London, Frank Cass.
- Crowther, A. and Dupree, M. (1996), 'The invisible general practitioner: the careers of Scottish medical students in the late nineteenth century', *Bulletin for the History of Medicine*, 70, pp. 387-413.
- Donnelly, J. (1991), 'Industrial recruitment of chemistry students from English universities: a reevaluation of its early importance', *British Journal for the History of Science*, 24, pp. 3-20.
- Edgerton, D. (1996), *Science, technology and the British industrial decline, 1870-1970*, Cambridge, Cambridge University Press.
- Fox, R. (1984), 'Science, the university and the state in nineteenth-century France', in Geison, G.L. ed. *Professions and the French State, 1700-1900*, Philadelphia, University of Pennsylvania Press, pp. 66-145.
- Gispén, C.W.R. (1988), 'German engineers and American social theory: historical perspectives on professionalization', *Comparative Studies in Social History*, 30, pp. 550-74.
- Halsey, A.H. (1995), *The decline of donnish dominion: the British academic profession in the twentieth century*, Oxford, Clarendon Press.
- Harvey, C. and Press, J. (1989), 'Overseas investment and the professional advance of British metal mining engineers, 1851-1914', *Economic History Review*, 42, pp. 64-86.
- Homburg, E., Travis, A.S. and Schröter, H.G. (1998), *The chemical industry in Europe, 1850-1914: industrial growth, pollution and professionalization*, Chemists and Chemistry Series, 17, Dordrecht, Kluwer Academic Publishers.
- Mackie, R.L. (2000), 'But what is a chemical engineer?': profiling the membership of the British Institution of Chemical Engineers, *Minerva*, 38, pp. 171-99.
- Mackie, R.L. and Roberts, G.K. (2000; last updated 28 August 2002), *Biographical database of the British chemical community, 1880-1970* [Internet], Milton Keynes, Open University, available from: <<http://www5.open.ac.uk/Arts/chemists/index.htm>> [Accessed 29 November, 2002].
- Mackie, R.L. and Roberts, G.K. (forthcoming), 'Chemical institutions: the professional chemist', in Knight, D. M. ed. *Storia della Scienza*, 6-7, *La Scienza dell'800, sez. E. Chemistry*, Roma, Istituto della Enciclopedia Italiana fondata da Giovanni Treccani.
- Miles, A. (1993), 'How open was nineteenth-century British society? Social mobility and equality of opportunity, 1839-1914', in Miles, A. and Vincent, D. eds. *Building European society. occupational change and social mobility in Europe*, Manchester, Manchester University Press, pp. 18-39.
- Miles, A. (1999), *Social mobility in nineteenth- and early twentieth-century England*, Basingstoke, Macmillan.
- Millerson, G. (1964), *The qualifying associations: a study in professionalization*, London, Routledge and Kegan Paul.
- Perkin, H. (1989), *The rise of professional society. England since 1880*, London, Routledge.
- Reader, W. J. (1975), *Imperial Chemical Industries. A history, Volume II, The first quarter-century, 1926-1952*, London, Oxford University Press.

- Roberts, G.K. (1996), 'C.K. Ingold at University College London: educator and department head', *British Journal for the History of Science*, 29, pp. 65-82, Reprinted in *Bulletin of the History of Chemistry*, 19, pp. 34-44.
- Roberts, G.K. (1997), 'Physical chemists for industry: the making of the chemist at University College London, 1914-1939', *Centaurus*, 39, pp. 291-310.
- Roberts, G.K. (1998), "'A plea for pure science": the ascendancy of academia in the making of the English chemist, 1841-1914', in Knight, D.M. and Kragh, H. eds. *The making of the chemist: the social history of chemistry in Europe, 1789-1914*, Cambridge, Cambridge University Press, pp. 107-19.
- Russell, C.A., Coley, N.G. and Roberts, G.K. (1977), *Chemists by profession: the origins and rise of the Royal Institute of Chemistry*, Milton Keynes, The Open University Press.
- Russell, C.A., ed. (2000), *Chemistry, society and environment: a new history of the British chemical industry*, Cambridge, Royal Society of Chemistry.
- Sanderson, M. (1972), *The universities and British industry, 1850-1970*, London, Routledge and Kegan Paul.
- Savage, M. (1993), 'Career mobility and class formation: British banking workers and the lower middle classes', in Miles, A. and Vincent, D. eds. *Building European society. occupational change and social mobility in Europe*, Manchester, Manchester University Press, pp. 196-216.
- Savage, M., Barlow, J., Dickens, P. and Fielding, T. (1992), *Property, bureaucracy and culture. middle-class formation in contemporary Britain*, London, Routledge.
- Stovel, K., Savage, M. and Bearman, P. (1996), 'Ascription into achievement: models of career systems at Lloyds Bank, 1890-1970', *American Journal of Sociology*, 102, pp. 358-99.
- Torstendahl, R. (1990), 'Essential properties, strategic aims and historical development: three approaches to theories of professionalism', in Burrage, M. and Torstendahl, R. eds. *Professions in theory and history: rethinking the study of the professions*, London, Sage, pp. 44-61.
- Travis, A.S., Schröter, H.G., Homburg, E. and Morris, P.J.T. (1998), *Determinants in the evolution of the European chemical industry, 1900-1939*, Chemists and Chemistry Series, 16. Dordrecht, Kluwer Academic Publishers.
- Varcoe, I. (1981), 'Co-operative Research Associations in British industry, 1918-1934', *Minerva*, 19, pp. 433-63.
- Vincent, D. (1993), 'Mobility, bureaucracy and careers in early-twentieth century Britain', in Miles, A. and Vincent, D. eds. *Building European society. occupational change and social mobility in Europe*, Manchester, Manchester University Press pp. 217-39.