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How to cite:

Mackie, Robin and Roberts, Gerrylynn (2020). Consultancy as a Career in Late Nineteenth and Twentieth Century Britain. *Ambix*, 67(3) pp. 214–233.

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Version: Accepted Manuscript

Link(s) to article on publisher's website:

<http://dx.doi.org/doi:10.1080/00026980.2020.1794699>

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CONSULTANCY AS A CAREER IN LATE NINETEENTH AND TWENTIETH CENTURY BRITAIN

ROBIN MACKIE AND GERRYLYNN ROBERTS

The Open University, UK

This paper examines the continuing role of consultants within the profession of chemistry in the late nineteenth and twentieth centuries. Consultants were a prominent part of the profession in the late nineteenth century, but were overtaken in numerical terms by chemists working in academia, government and industry in the first half of the twentieth century. The paper demonstrates, however, that numbers later stabilised and then goes on to examine the characteristics of those chemists who worked as consultants as compared to the wider chemical community. It argues that the survival of consultancy is best explained in terms of a number of differing models of consultancy work. Whilst for some chemists, consultancy was their main occupation, for others it was a phase in their careers or a secondary occupation alongside another post. The continuing value of consultancy work was related to its very versatility.

Introduction

As a profession of chemistry emerged in the nineteenth century, one important group of practitioners were consultants – chemists, that is, who provided chemical services for a fee. The role played by chemists who made a living from such independent practice is highlighted in two key studies of how the profession of chemistry was defined in Britain in the middle decades of the nineteenth century and its institutions established.¹ Biographies of prominent chemists have also discussed their work as consultants.² For the twentieth century, however, consultants as a group and periods of consultancy work in chemical careers have received rather less attention. One reason for this is quite simply numbers: the rapid expansion of chemical employment in universities, government service, and above all in industry, has rendered consultancy less conspicuous to historians. Yet it is perhaps also to do with the nature of consultancy work: compared to the advances in chemical knowledge made in academia or the application of chemistry in industry, the services provided by consultants have often had a lower profile. As Robert Bud recently suggested,

¹ Robert F. Bud and Gerrylynn K. Roberts, *Science Versus Practice. Chemistry in Victorian Britain* (Manchester: Manchester University Press, 1984); Colin A. Russell, Noel G. Coley and Gerrylynn K. Robert, *Chemists by Profession. The Origins and Rise of the Royal Institute of Chemistry* (Milton Keynes: Open University Press, 1977).

² Colin A. Russell, *Edward Frankland: Chemistry, Controversy and Conspiracy in Victorian England* (Cambridge: Cambridge University Press, 1996); Katherine Watson, "The Chemist as Expert: the Consulting Career of Sir William Ramsay," *Ambix*, 42, 3, (1995): 143-159; William H. Brock, *William Crookes (1832-1919) and the Commercialization of Science* (Aldershot: Ashgate, 2008).

consultants are often “invisible in the history of science,” since the very process of selling expertise and know-how to individual clients meant that it remained confidential and unpublished.³

This paper is an attempt to address this imbalance. To do so, it explores the role that periods of consultancy work played in the careers of British chemists in the late nineteenth and twentieth centuries rather than focus on what consultants did. It is divided into four sections. The first looks at the sources and methods used. The second explores the proportion of the chemical community that worked as chemical consultants and how this changed over time. In the third section, we compare chemists who worked as consultants for some or all of their careers with this wider community. In the final section, we seek to place consultancy work within career paths in order to understand the different ways that the role continued to be relevant.

Methodology: Chemists Joining the Three Principal Chemical Societies, 1881-1971

The paper draws on a prosopographical database of British chemists, which includes representative samples of chemists joining the three principal British chemical societies over the period 1877-1971, the Chemical Society (CS, founded 1841), the Institute of Chemistry (IC, founded 1877), and the Society of Chemical Industry (SCI, founded 1881).⁴ The professional lives of sample members were charted using a range of sources, many of them, such as application forms, directories, and obituaries, created within the chemical societies; these were supplemented by public sources, such as the census, business directories, and biographical databases in a process of record linkage. Occupational titles were therefore largely based on self-descriptions or those of peers. [Therefore,](#) [for this paper,](#) we consider chemists' roles to be [roles of](#) consultancy [when](#) they were so described in contemporary sources, but it is important to note that during the course of a career, a chemist might fill other roles either sequentially or simultaneously, such that any individual might appear in our database in more than one occupational category.⁵

The three societies fulfilled different roles. The CS was a learned society and its journal, the *Journal of the Chemical Society*, was the premier chemical journal in the UK, whilst the IC was created to defend the interests of professional chemists, and the SCI was primarily a networking society for

³ Quoted in Jonathan Aylen, Viviane Quirke and Peter Reed, “Hireling Shepherds or Knowledge Brokers? The Changing Role of Consultants in Industry, 1850-2000,” *Newcomen Links* 250 (June 2019): 16-19.

⁴ This database was part of the “Studies of the British Chemical Community, 1881-1971” project funded by the Leverhulme Trust and the Open University. It includes data on all the Council Members of the three named chemical societies between 1881 and 1971, plus systematic samples of their ordinary members. These samples total around 4200 individuals.

⁵ For more information on the sources used in the database (referred to here as the ‘OU Chemists Database’), please contact Robin Mackie (see Notes on Contributors).

chemists with industrial interests, which also produced the *Journal of the Society of Chemical Industry*, focusing on applied chemistry. Reasons for joining the three societies therefore might differ, with the IC the only one with formal entry requirements. Nevertheless, there was considerable overlap between the societies especially at the level of their Councils: indeed, in many ways they did not so much compete as complement each other. Taken together, they represent a wide span of chemical activity in Britain, although membership in any of them was never compulsory for any post, so not all active chemists joined.⁶

FIGURE 1
Membership of three principal British chemical societies, 1881-1971

Source: membership data from the Annual Reports of the CS, the IC, and the SCI.

⁶ For more details on why individuals chose to join the three societies, see Robin Mackie, "Great Britain: Chemical Societies and the Demarcation of the British Chemical Community, 1870-1914," in *Creating Networks in Chemistry. The Founding and Early History of Chemical Societies in Europe*, ed. A. Kildebaek Nielsen and S. Štrbáňová (Cambridge: RSC Publishing, 2008): 139-160. This paper also discusses chemists who chose not to join the societies and the ways that their careers differed from those who did.

There were relatively few changes in the purpose or entry requirements of the three societies during the period discussed;⁷ nevertheless, their rates of expansion varied. At the turn of the century, the SCI was the largest of the three, but its membership stagnated in the inter-war years, and later peaked in 1952. From around 1920 on, it was the IC that expanded fastest, reflecting greater emphasis on certification. The CS grew more slowly until around 1940 but grew rapidly thereafter. Figure 1 also includes a line representing the total membership of the three societies once the considerable overlap has been removed. Even if, as noted above, not all chemists joined the societies, the samples used to construct the cohorts represent very large numbers of chemists: as Figure 1 shows, the total membership of the three societies, once dual or triple membership is excluded, rose from around 4,500 in 1900 to over 36,000 in 1971.

For this paper, the samples of the membership of the three societies have been merged, taking into account their differing sizes and removing their overlap. As will be seen in Table 1, our data has been organised in five successive cohorts of members joining the three societies between specified dates, making it possible to explore change over time. Individuals have been assigned to a cohort by the date they first joined any one of the societies. This was in most cases around the time they obtained their qualifications, so at the beginning of careers that might last a further forty years; Cohort 1 (1881-1887), for example, included individuals who were still working in the 1920s.

Sectors of Employment

Table 1 shows the percentage of all chemists working in each of the four main sectors of employment (academia, consultancy, government and industry) for five successive cohorts of our chemists. As can be seen, for all cohorts the main sector where chemists worked was industry, and this by a considerable margin. The percentage working in industry is indeed remarkably stable, varying only between 69% and 74%. Employment in academia (which includes schools) and government (both central and local) rose over time, academia rising by over 50% and employment in government more than doubling.⁸ The percentage in consultancy, which includes in our database not only those working full-time as or for independent practitioners, but also those who performed consultancy work alongside employment elsewhere, took a very different path from the three other main sectors of employment. For members of Cohort 1, the percentage working in consultancy was

⁷ The most significant changes were to the entry requirements for the IC, which were progressively altered to take account of changing entry routes into the profession. The dates of these changes were used to establish our cohort dates.

⁸ Chemists, in addition, worked in a number of other sectors, including finance and trade. As a percentage of all chemists, this was most important for Cohort 1, where 11% of chemists worked in these sectors. By Cohort 5, this had dwindled to almost nothing.

similar to that in academia and more than double that working for government. Thereafter, however, it fell rapidly, virtually halving among members of Cohort 3, and remaining from then on by far the smallest of the four major sectors of employment.

TABLE 1
PERCENTAGE OF CHEMISTS WORKING IN EACH SECTOR

	Cohort 1 (1881-1886)	Cohort 2 (1887-1917)	Cohort 3 (1918-1943)	Cohort 4 (1944-1956)	Cohort 5 (1957-1971)
<i>N</i>	3,480	9,070	16,200	15,000	22,650
<i>n</i>	3,300	8,800	14,800	13,400	18,800
<i>n as% of N</i>	94	97	92	90	83
Academia (A)	29	28	36	40	44
Consultancy (C)	30	24	15	11	12
Government (G)	14	18	27	33	29
Industry (I)	72	74	69	72	71

Source: OU Chemists Database (see footnote 4).

Notes: N is the approximate number in each cohort once the samples have been merged and those with no link to the UK are excluded; n is the number remaining once those for whom we have no career data are excluded. This is only significant in Cohort 5, where there were gaps in the data on the SCI. Percentages in lower half of table are as a proportion of n. In addition to the four main sectors of employment, chemists worked in a number of other areas, including finance and trade. As a percentage of all chemists, this was most important for Cohort 1, where 11% of chemists worked in these sectors. By Cohort 5, this had dwindled to almost nothing.

The decline in the proportion of the profession working as consultants was recognised by contemporaries, and was largely explained in terms of external factors, and, in particular, changing demand from industry. An increasing number of firms, it was argued, came to perform in-house the type of work previously done by consultants. In 1927, for instance, a leading independent consultant, Alfred Chaston Chapman, lamenting the decline in consultancy, argued that this was down partly to the cost of setting up an independent laboratory, but above all because so many leading companies now employed their own resident works chemists.⁹ Historians have demonstrated that Chapman was right to highlight the trend towards in-house laboratories. James Donnelly has charted the earliest steps in this direction in the alkali industry, as major producers started to employ their own “chemists” to do their analytical work in the 1870s. By the turn of the century, some of these firms were establishing research laboratories, even if these laboratories

⁹ “The Birth of A Profession”, *The British Medical Journal*, 1, 3466 (1927): 1067-1068. The full paper was published as a separate pamphlet by the IC: A. Chaston Chapman, “The Growth of the Profession of Chemistry During the Past Half Century, 1877-1927” (1927): 1-23.

undertook a wide variety of work.¹⁰ Outside the chemical industry, John Hudson has investigated the move from employing independent consultants to the establishment of in-house chemical laboratories in the railway industry.¹¹ These developments certainly helped create a perception of an important shift in the location of chemical work from independent to in-house laboratories.

There can be no doubt that the number of chemists employed by industrial firms did rise in the first decades of the twentieth century. Donnelly suggests a figure of around 3,500 “chemists (loosely defined) working in British firms in the early twentieth century;” just before the First World War, it is estimated that around 75 qualified chemists were employed in industry in Scotland, and a further 130 without qualifications.¹² Most of these chemists were doing analytical work, which continued to be important, but some firms were already running research laboratories before 1914 and many others opened them between the wars. Michael Sanderson quotes a Federation of British Industry report in 1946 which gives a figure of 231 firms with industrial research laboratories, of which the largest number were in the chemical industry; David Edgerton and Sally Horrocks also argue that the chemical industry was the major investor in industrial research in the inter-war years. They highlight, in particular, the role of ICI, “easily the largest spender on R&D in Britain” with around 1,000 chemists and 615 “qualified research staff.”¹³ If Ulrich Marsch is slightly more cautious in his figures for research expenditure and number of scientists employed in industry, he too sees the chemical industry, especially in the inter-war years, as the leading industry for the application of science.¹⁴

Similar trends can be identified in government and academia in the first half of the twentieth century. One way to chart this is by comparing editions of *Official Chemical Appointments* (OCA), the “list of official appointments which are held by professional chemists, including professors of

¹⁰ James Donnelly, “Consultants, Managers, Testing Slaves: Changing Roles for Chemists in the British Alkali Industry, 1850-1920,” *Technology and Culture*, 35, 1 (1994): 100-128; James Donnelly, “Structural Locations for Chemists in the British Alkali Industry, 1850-1920,” in *The Chemical Industry in Europe, 1850-1914: Industrial Growth, Pollution and Professionalization*, ed. E. Homburg and H.G. Schröter (Dordrecht: Kluwer, 1998): 203-219.

¹¹ John Hudson, “Chemistry and the British Railway Industry, 1836-1923,” Open University PhD Dissertation (2005). See also Colin Russell and John Hudson, *Early Railway Chemistry and its Legacy* (Cambridge: Royal Society of Chemistry, 2011).

¹² James Donnelly, “Defining the Industrial Chemist in the United Kingdom, 1850-1921,” *Journal of Social History*, 29 (1996): 775-95; Robin Mackie, “Counting Chemists: the Distribution of Chemical Expertise in Scotland in the First Half of the Twentieth Century,” *Journal of Scottish Historical Studies*, 27, 1 (2007): 48-74 (on 68).

¹³ Michael Sanderson, “Research and the Firm in British Industry, 1919-39,” *Science Studies*, 2, 2 (1972): 107-51 (on 119); D.E.H. Edgerton and S.M. Horrocks, “British Industrial Research and Development before 1945,” *Economic History Review*, 47, 2 (1994): 213-38.

¹⁴ Ulrich Marsch, *Zwischen Wissenschaft und Wirtschaft. Industrieforschung in Deutschland und Großbritannien, 1880-1936* (Paderborn: Schöningh, 2000): esp. 205-44, 501-512.

chemistry” published by the IC.¹⁵ The 4th edition produced in 1912, on the eve of the First World War, does list some large clusters of chemists such as at the Admiralty with 24 chemists and a further 7 in the Victualling Departments in the dockyards, the Government Laboratory with 62 chemists, and the War Office with 45 chemists at the Royal Arsenal at Woolwich, the Royal Ordnance Factory, and the Royal Gunpowder Factory.¹⁶ But the 9th edition, which came out 25 years later in 1937 has many more. In line with Edgerton’s emphasis on the defensive capabilities of the British “warfare state,” the Admiralty now employed 54 chemists, and the War Office 190, with a further 76 chemists in the Chemical Research Establishment including its Experimental Station at Porton Down.¹⁷ Other central offices had also grown, but the largest increase in employment had been in non-military institutions for applied research. In 1912, the only such establishment listed was the National Physical Laboratory (NPL) in Teddington; in 1937, the NPL was joined by the many other Research Stations of the Department of Scientific and Industrial Research, and over 20 Industrial Research Associations (RAs). Around 400 chemists are listed at these establishments.¹⁸ Marsch emphasizes the importance of the RAs in promoting research in industries that were not dominated by large companies.¹⁹

The OCA lists also reveal growth in academic employment. The chemistry departments of some of the UK’s leading universities and higher educational establishments were already quite large in 1912 and did not grow enormously between the two dates. Thus the 1912 OCA lists 23 chemists at Cambridge University, and that for 1937 has 26, whilst numbers listed at the Royal Technical College in Glasgow rose from 17 to 30.²⁰ But other universities, particularly in centres of industry, grew rather more rapidly: Leeds University was up from 19 to 49, Sheffield from 13 to 33, and Manchester from 15 to 34. Many of the newer University Colleges still had very small staffs, while the technical colleges in the same cities were often much larger: thus Hull University College had just 3 chemists but Hull Technical College had 18, and the University College of Wales in Swansea just 4, with 12 at the local Technical College.²¹

There is thus no doubt that the number of institutions employing large numbers of chemists grew rapidly in the twentieth century. As research departments from ICI’s Explosives Division in Ardeer to

¹⁵ OCA, 4th edn. (1912): 9.

¹⁶ OCA (1912): 15-6, 29, 32 and 67-8.

¹⁷ David Edgerton, *Warfare State, Britain, 1920-1970* (Cambridge: Cambridge University Press, 2006): 15-58; OCA, 9th edn. (1937): 13-15, 97-103.

¹⁸ OCA, (1912): 62; OCA (1937): 83-94.

¹⁹ Marsch, *Zwischen Wissenschaft und Wirtschaft*, 260-85.

²⁰ OCA, (1912): 81-2, 87; OCA (1937): 120, 124.

²¹ OCA, (1912): 90-1, 99, 104; OCA (1937): 126-8, 137, 142-3.

the Cotton Industry's Shirley Institute in Didsbury expanded, the capacity to do work in-house will have reduced the need to turn to external consultants for analyses and experimentation. There is also some evidence in the early twentieth century of a new caution surrounding the combination of private consultancy work with paid employment. As Christine Macleod charts, some academic scientists became increasingly reluctant to engage in the litigation that might surround defending private work and patents, preferring instead to campaign for state support for public research.²² Some employers also became more wary of their employees taking on external consultancy work. Anna Guagnini argues that "the attitude of university administrative bodies towards the extra-academic occupation of their employees began to change" and cites, for instance new regulations at Owens College in 1901.²³

Yet the assumption that the increase in salaried posts for chemists led to an inevitable shift away from consultancy work needs to be qualified. Returning to Table 1, it can be noted that the rate of decline in the percentage of chemists who engaged in consultancy work was much smaller between Cohort 3 and Cohort 4, and then stabilised. It should also be noted that the growth in the size of the cohorts over time meant that the total number of such chemists probably continued to rise from cohort to cohort: our figures suggest that the numbers entering the chemical community each year who spent part of their careers as consultants more than doubled between cohorts 2 and 5, even if these numbers were overtaken by the far larger numbers working in industry, academia and government. Furthermore, notwithstanding this levelling off in numbers, chemists working as consultants continued to play a significant role within the profession in the twentieth century. Not only were they prominent among the first cohorts of council members of the three societies, they continued to be over-represented, with their percentage in the councils more than double that in the wider membership joining in Cohorts 4 and 5.

The importance of consultancy among the members of Cohort 1 for both the ordinary and council members of the chemical societies was partly a reflection of occupations at a time when relatively few chemists had full-time posts, and many, such as Robert Warington and George E. Davis, discussed elsewhere in this volume, enjoyed "portfolio" careers which included some periods of full-

²² Christine MacLeod, "Reluctant Entrepreneurs: Patents and State Patronage in New Technosciences, circa 1870-1930," *Isis*, 103 (2012): 328-339.

²³ Anna Guagnini "Ivory Towers? The Commercial Activity of British Professors of Engineering and Physics, 1880-1914", *History and Technology*, 33, 1 (2017): 70-108 (on 95).

time employment, but more where part-time contracts were combined with consultancy work.²⁴ None the less self-employment was the professional ideal for many chemists. In the discussions leading up to the foundation of the professional body, the IC, parallels were made to medicine and engineering, where independent practice was the standard destination. The key issue was whether academic qualifications alone were sufficient preparation for becoming a practitioner; with the outcome that the IC developed its own qualifications requiring a combination of academic study and practical experience.²⁵ Subsequent revisions to the entry requirements in 1918 and 1956 also turned on the question of how practical experience should be recognised, and university study never became the only route into the profession.²⁶ Thus the IC, in a similar way to other professional bodies in the UK, aimed to retain some control over entry into the profession and used this to valorise practice as well as academic training.

The growth of employment in industry, government and academia did, however, set chemistry on a path that diverged from medicine and engineering. Even if many doctors and engineers found employment in hospitals and large companies, general practice in medicine and consultancy both there and in engineering remained major career destinations in those professions.²⁷ This was not the case in chemistry. Why this was so, can partly be explained in terms of the nature of the tasks to be performed: chemical analysis and research came increasingly to rely on sophisticated laboratories that were beyond the means of all but the most successful independent practices. It was also related to the nature of the demand for their work. John Garrard and Vivienne Parrott contrast the professional development of solicitors and gas engineers by highlighting their different relationship with their customers: for solicitors, they argue, this “was intensely personal. They serviced individuals, families, or companies;” gas engineers, on the other hand, were mostly employed by big, public sector bodies.²⁸ An alternative model for professional practice also developed in fields where

²⁴ Anna Simmons, “A Life of ‘Continuous and Honourable Usefulness’: Chemical Consulting and the Career of Robert Warrington (1807-1867);” Peter Reed, “George E. Davis (1850-1907): Transition from Industrial Consultancy to Chemical Engineering.”

²⁵ Russell, Coley and Roberts, *Chemists by Profession*, 135-57.

²⁶ Russell, Coley and Roberts, *Chemists by Profession*, 180-2, 269-74.

²⁷ Anne Crowther and Marguerite Dupree, “The Invisible General Practitioner: the Careers of Scottish Medical Students in the Late Nineteenth Century,” *Bulletin of the History of Medicine*, 70 (1996): 387-413; Anne Crowther and Marguerite Dupree, *Medical Lives in the Age of the Surgical Revolution* (Cambridge: Cambridge University Press, 2007); Charles Harvey and Jon Press, “Overseas Investment and the Professional Advance of British Metal Mining Engineers, 1851-1914,” *Economic History Review*, 42, 1 (1989): 64-86. On the continuing role of external consultants in the railway industry, see Colin Divall, “Technological Networks and Industrial Research in Britain: the London, Midland and Scottish Railway, 1926-1947,” *Business History*, 48, 1 (2006): 43-68.

²⁸ John Garrard and Vivienne Parrott, “Craft, Professional and Middle-Class Identity: Solicitors and Gas Engineers, c.1850-1914,” in *The Making of the British Middle Class? Studies of Regional and Cultural Diversity since the Eighteenth Century*, ed. A. Kidd and D. Nicholls (Stroud: Sutton Publications, 1998): 148-168 (on 155).

what customers sought was not so much knowledge of one particular product as broad expertise: among mining engineers, for instance, international experience was linked to high status and salaries.²⁹ In trying to demarcate a new professional area of expertise, chemical engineers emphasized their expertise in “scaling-up” production methods that might be widely relevant across different industrial processes.³⁰

Looking at the nature of demand for independent chemical practitioners highlights some of the ways that consultancy might continue to flourish even as the overwhelming majority of chemists came to be employed in larger institutions. Edgerton and Horrocks, drawing on contemporary surveys, emphasize that in the inter-war years consultants continued “to play an important role, especially for the smaller firms and in the provision of specialist services ... consulting chemists specialized in work which related to the local industry, with a heavy concentration of expertise in London.”³¹ Niches might survive or emerge where demand was small or intermittent, or what was required was less in-depth knowledge of one process than expertise across the field. Certainly, the numbers still working in consultancy suggest that work was available for consultancy to remain a vital, if now smaller, portion of the profession.

To explore this continued demand for consultant chemists and how it was filled, we next compare chemists who worked as consultants for at least some of their lives with the wider chemical community so as to identify their distinctive characteristics. In the final section, we then investigate a number of models for consultancy activity to highlight the different and highly varied roles that it played in the careers of those chemists who undertook such work.

Consultants Compared

In the following three tables, we compare the experience of chemists whose careers included a period as a consultant to those in the chemical community as a whole. For these tables, we have focussed on those among our chemists for whom we have the most information: those where we have career data for 20 years or more, that is for over half of their careers. This varied between 50% and 70% across the cohorts; while for consultants the figures are between 70% and 80%.

²⁹ Harvey and Press, “Overseas Investment;” Roy Macleod, “‘Instructed Men’ and Mining Engineers: the Associates of the Royal School of Mines and British Imperial Science, 1851-1920,” *Minerva*, 32 (1994): 422-39.

³⁰ Colin Divall, James Donnelly and Sean F. Johnston, “Professional Identity and Organisation in a Technical Occupation: the Emergence of Chemical Engineering in Britain, c. 1915-30,” *Contemporary British History*, 13, 4 (1999): 56-81.

³¹ Edgerton and Horrocks, “British Industrial Research,” 229.

TABLE 2
QUALIFICATIONS OF CONSULTANTS COMPARED TO CHEMICAL COMMUNITY

	Cohort 1 (1881-1886)		Cohort 2 (1887-1917)		Cohort 3 (1918-1943)		Cohort 4 (1944-1956)		Cohort 5 (1957-1971)	
	% All	% C	% All	% C	% All	% C	% All	% C	% All	% C
PhD/DSc	28	31	26	33	30	29	43	57	54	63
UG degree	25	24	48	44	81	76	81	78	63	67
IC qual	45	56	47	56	82	85	82	87	75	76
IC + degree	20	22	31	31	72	68	69	82	53	61
IC only	25	34	16	25	11	17	13	5	23	15

Source: As Table 1.

Notes: Percentages are of chemists for whom we have information on qualifications: those labelled ‘% All’ is of the cohorts as a whole; ‘% C’ of those who worked as consultants. The bottom two rows are subsets of ‘IC qual’ disaggregated according to whether or not individuals also held a university degree.

Table 2 compares the level of qualification. Members of the chemical community, as we have defined it, were always highly qualified and the level of qualification generally rose from cohort to cohort until Cohort 5. The decline in the percentage for some qualifications from Cohort 4 to Cohort 5 was the result of the creation of a new category of membership in the IC, the Licentiate, which led to a large influx of new members.³² Turning to chemists who spent part of their careers working in consultancy, two major differences emerge. First, the percentage with IC qualifications was higher among members of the first three cohorts than among the community as a whole. This probably reflects a slightly greater emphasis on practical professional training rather than university study among such chemists, and also the effectiveness of the IC in providing a practice-based route to qualification. Second, among members of Cohorts 4 and 5, the percentage with higher degrees and that with both IC and university qualifications were both higher among those with consultancy experience than the community as a whole. These figures suggest that the stabilization in the percentage working as consultants in the later cohorts was accompanied by a rise in the level of their qualifications so that it was well above the equivalent figures for the wider chemical community. By the middle of the twentieth century, chemists who worked as consultants may have been rarer, but they were certainly well qualified.

Table 3 looks at where chemists worked, with the four regions where most chemists worked first, followed by two rows for all other parts of the British Isles and work overseas. Among all chemists, change is relatively slight. Chemists joining Cohort 1 were quite strongly concentrated in London, while those joining in later cohorts were more widely distributed across the British Isles with South-East England showing the largest long-term increase. Trends among chemists who spent part of their

³² Russell, Coley and Roberts, *Chemists by Profession*, 271-4.

careers as consultants were roughly similar but rather more marked. The early concentration in London was maintained for longer, but the later shift away from London towards the wider South-East was greater, reflecting probably the growth of science-based industries and especially research laboratories in the Home Counties and in Oxford and Cambridge. For members of four of the five cohorts, the percentage of consultants in North-West England was higher than among all chemists, and the difference was particularly large in Cohort 5, suggesting that the Manchester and Liverpool areas, long the home of major chemical plants, such as those of ICI and Unilever, continued to be a centre of chemical expertise. The bottom row of Table 3 shows that whilst the proportion of all chemists who worked overseas rose from cohort to cohort, this was less true of those who became consultants.³³

TABLE 3
REGIONS IN WHICH CHEMISTS WORKED

	Cohort 1 (1881-1886)		Cohort 2 (1887-1917)		Cohort 3 (1918-1943)		Cohort 4 (1944-1956)		Cohort 5 (1957-1971)	
	% All	% C	% All	% C	% All	% C	% All	% C	% All	% C
Greater London	76	76	71	82	66	76	60	78	48	37
SE England	17	21	24	36	28	32	38	39	38	63
NW England	13	15	20	20	17	20	20	6	19	45
Midlands	14	19	13	14	12	15	11	10	14	11
Rest British Isles	7	5	13	10	13	10	12	12	10	2
Overseas	2	3	7	4	7	9	8	10	13	5

Source: As Table 1.

Notes: For explanation of 'All' and 'C', see Note to Table 3. This table logs work in any of specified region, whether or not the work was in consultancy. Numbers add up to more than 100 because many chemists worked in more than one of the named regions. The regions used are based on standard UK economic regions, with SE England including both South-East England and East Anglia and Midlands including both East and West Midlands. All other parts of the British Isles, including Scotland, Wales and all Ireland are in Rest British Isles.

Table 4 explores the number of sectors in which chemists worked, in terms of the four main sectors described in Table 1. The top part of the table shows that consultants were always more mobile between sectors than the entirety of members in each cohort. In the chemical community as a whole, most chemists worked in just one sector, with very few indeed working in more than two. By contrast, the majority of chemists who worked as consultants worked in at least one other sector, with a substantial minority even from the first three cohorts working across three. In contrast to all

³³ All three societies included chemists who did not live in the United Kingdom, and those who never did have been excluded from this paper. "Overseas", therefore, includes chemists who spent just part of their careers abroad; note too that it excludes periods of study abroad, which was significant before the First World War and became common again after the Second. The careers of such chemists are explored in Gerrylynn K. Roberts and Anna E. Simmons, "British Chemists Abroad, 1887-1971: The Dynamics of Chemists' Careers," *Annals of Science*, 66, 1 (2009): 103-28.

chemists, moreover, there was a sharp upward trend in multi-sector working by consultants in the final two cohorts. Almost all Consultants had worked in at least one other sector, whilst 21% of them had experience of all four sectors. The lower parts of Table 4 explore the combinations of sectors that consultants worked in, first in terms of the percentage of all consultants who worked in each of the other sectors, and then, for each sector in turn, the percentage who had consultancy experience. Not surprisingly, in view of the relative size of the different sectors, many more consultants had experience of the other sectors than vice-versa. Experience of industry, in particular, remained prevalent. In terms of the other sectors, government was long much the smallest (see Table 1), so the overlap with consultancy figures particularly large. Over time, as the other sectors grew faster than consultancy, the percentage of those who had also worked as consultants fell. Cohort 5, however, shows a small rise in every row, suggesting a resurgence of consultancy work. This appears to have been particularly strong in government, perhaps reflecting a greater use of external expertise in the second half of the twentieth century.

TABLE 4
MULTI-SECTOR WORKING

	Cohort 1 (1881-1886)		Cohort 2 (1887-1917)		Cohort 3 (1918-1943)		Cohort 4 (1944-1956)		Cohort 5 (1957-1971)	
	% All	% C	% All	% C	% All	% C	% All	% C	% All	% C
Number of sectors worked										
1	58	11	50	4	47	2	42	1	43	1
2	29	54	36	58	37	63	45	38	33	17
3	12	31	12	34	12	28	12	51	20	61
4	1	4	1	4	1	6	1	9	4	21
Other sectors that consultants worked in: as % of C										
C and A	47		35		35		53		57	
C and G	30		31		31		40		67	
C and I	51		73		72		76		78	
Other sectors that consultants worked in: as % of those other sectors										
C and A	49		26		16		15		21	
C and G	62		34		18		13		33	
C and I	24		26		20		17		22	

Source: As Table 1.

Note: For explanation of 'All' and 'C', see Note to Table 2.

The Role of Consultancy within Careers in Chemistry

The picture that emerges from the above tables is of chemists who worked as consultants being distinct from other chemists in certain important respects. They tended to be more highly qualified, to be more concentrated in the most central locations, and to be more mobile between sectors. These tendencies became, if anything, more accentuated among members of Cohorts 4 and 5, when

the total percentage working in consultancy stabilised. The greater mobility of such chemists is the most striking difference: for consultants, more than for any other group of chemists, consultancy was frequently just one phase in a varied career.

To understand the significance of this it is particularly enlightening to explore the pattern of the working lives of chemists who spent part of their careers as consultants. Here, a sociological and historical literature on careers is helpful. In a classic article on career paths, the American sociologist, Harold Wilensky, describes “orderly careers” as “a succession of related jobs, arranged in a hierarchy of prestige, through which persons move in an ordered (more-or-less predictable) sequence”.³⁴ Historians have identified the origins of such careers in a number of institutions and sectors, including large public and private organisations, such as the civil service, railway companies and banks, and also universities.³⁵ Yet it has also been recognised that Wilensky’s model of a career does not fit all careers, even among the middle class, where working lives in business, but also in liberal professions such as medicine and law, may depend on developing a business (including a medical or law practice) over a working life. In such careers, which have elements of the “entrepreneurial” or even the “dynastic” pathway as well as that of the “professional,” to use the definitions suggested by David Vincent, career success is not related to moving up a hierarchy of posts so much as the successful exploitation of assets.³⁶

These different models of career pathways are further illuminated by examining the career paths of some specific chemists who became consultants in the late nineteenth and twentieth centuries. Take, for instance, that of Alfred Chaston Chapman (1869-1932), whom we quoted earlier. After studying at Leeds Grammar School he studied at University College London (UCL) under Professors Alexander Williamson and Charles Graham, but left without taking a degree. Instead he sat the Institute of Chemistry exams, becoming an Associate in 1892 and a Fellow in 1895. He established himself in private practice as an Analytical and Consulting chemist in Aldgate in the heart of the City

³⁴ Harold L. Wilensky, “Orderly Careers and Social Participation: The Impact of Work History on Social Integration in the Middle Mass,” *American Sociological Review*, 26, 4 (1961): 521-39 (on 523). See also Joseph C. Hermanowicz, “Argument and Outline for the Sociology of Scientific (and Other) Careers,” *Social Studies of Science*, 37, 4 (2007): 625-46.

³⁵ Andrew Miles and Michael Savage, “Constructing the Modern Career” in *Origins of the Modern Career*, ed. David Mitch, John Brown and Marco H.D. van Leeuwen (Aldershot: Ashgate, 2004); Katherine Stovel and Mike Savage, “Mergers and Mobility: Organizational Growth and the Origins of Career Migration at Lloyd’s Bank,” *American Journal of Sociology*, 111, 4 (2006): 1080-1121; Cathelijn Waaijer, “The Coming of Age of the Academic Career: Differentiation and Professionalization of German Academic Positions from the 19th Century to the Present,” *Minerva*, 53 (2015): 43-67.

³⁶ David Vincent, “Mobility, Bureaucracy and Careers in Early Twentieth-Century Britain” in *Building European Society, Occupational Change and Social Mobility in Europe, 1840-1940*, ed. Andrew Miles and David Vincent (Manchester: Manchester University Press, 1993): 217-39.

of London when still in his twenties, and continued to practice from there until his death in 1932.³⁷ Chapman's focus was on chemical analysis, particularly in fermentation and brewing, where he was "the chief authority in the country."³⁸ As well as taking on many commercial contracts, he also took on government ones, acting, for instance, as Public Analyst for St Albans for over 20 years, and doing considerable work on water treatment. Active on various government committees related to food supply during the war, he later served on the Chemistry Research Board of DSIR, and was a member of the Board of Studies of the University of London. Not unlike his UCL teacher, Charles Graham,³⁹ Chapman was a strong advocate of closer links between academia and practice, calling for Chairs in Analytical Chemistry to "serve the very useful purpose of forming a much-needed link between the members of the chemical staff and chemical practitioners, one great advantage of this being that the Universities would be able to draw upon the vast accumulation of practical knowledge and experience which practising chemists have acquired in their professional work."⁴⁰ In this Chapman might be seen as promoting the link role that we have identified as one of the possible niches for consultants, providing a bridge between different sectors of practice. It is perhaps also relevant that Chapman was an active and eminent member of many chemical societies, particularly those related to chemical analysis and to professional practice. He was President of the Institute of Brewing from 1911-13, of the Institute of Chemistry from 1921-24, and of the Royal Microscopical Society from 1924-6. His main role, however, was in the Society of Public Analysts, where he was on the council from 1897, Secretary from 1899 to 1914, and President from 1914-16.⁴¹

Chapman's career fits well with the idea of 'entrepreneurial pathway,' using his base in the centre of London to build up a business, which relied on his expertise in analysis and spanned many different sectors of chemical activity. In this, his networks were central. Oswald John Silberrad (1878-1960), also followed an entrepreneurial career as a chemical consultant, although it was different from Chapman's in significant ways. After studying at Finsbury Technical College and at Würzburg University, where he obtained a PhD in 1900, he worked for a year as a research chemist in the Davy-Faraday Laboratory at the Royal Institution, followed by six years as a superintendent for the recently established Explosives Committee at the Royal Arsenal in Woolwich. In 1907, however, he left to set himself up as an independent chemist, later citing "the strangulating effect of red tape and

³⁷ Chapman also ran a brewing school. See Bernard Dyer, "Alfred Chaston Chapman" *Journal of the Chemical Society* (1932):2980-86.

³⁸ R. R., "Alfred Chaston Chapman, 1869-1932", in *Obituary Notices of Fellows of the Royal Society*, 1, 2 (1933): 146-148 (on 146).

³⁹ Yoshiyuki Kikuchi, *Anglo-American Connections in Japanese Chemistry: The Lab as Contact Zone* (New York: Palgrave-Macmillan, 2013): 15-26.

⁴⁰ "Chapman", *Obituary Notices*, 147.

⁴¹ OU Chemists Database; "Chapman", *Obituary Notices*.

officialdom” as one of his reasons.⁴² He established the Silberrad Research Laboratories, where he continued to work until 1953. Some of his work was for industry, including research on the chemical properties of ships’ propellers, and he became the director of a number of companies. He was an expert witness in court cases, but he also continued to work on explosives and so took on government contracts, particularly after the start of the First World War. Inevitably, much of this work was confidential and unpublished. Always keen on experimental research, Silberrad worked best independently and clashed with leading figures in chemistry, which appears to have stymied attempts to have him elected to the Royal Society. Although a member of the Chemical Society and the Society of Chemical Industry, Silberrad never served on the council of either.⁴³

Silberrad, therefore, preferred independent research to the networking that was so central to Chapman’s career – independence, indeed, seems to have been central to his career goals. Both men, however, built up a successful consulting practice. As such, both can be seen as following entrepreneurial careers, similar to that in many other businesses, where success is measured by the growth of a business, rather than by climbing a ladder of increasingly prestigious posts. For many consultant chemists, the possibility of developing an independent practice was facilitated by the opportunities to combine independent practice with official posts, such as Public Analyst or Official Agricultural Analyst. In a similar way, Anne Crowther and Marguerite Dupree have identified how important public roles such as Medical Officers of Health or work in local hospitals were to GPs in the late nineteenth and early twentieth centuries.⁴⁴

But there were other models of consultancy work. For John Frederick Briggs (1871-1963) a period in consultancy was a brief, if important, stage in a career that conforms more closely to Wilensky’s model of an “orderly career,” in that it involved a “succession of related jobs,” mostly in industry. After studies at the Central Technical Institution in Finchley, he spent five years in India working for two sugar refining companies first in Madras and later in Bengal. Back in England in 1898, he briefly joined the consulting firm of Cross & Bevan in London before a stint at sugar refiners W. & R. Balston, in Maidstone. In 1905, he returned to Cross & Bevan, who focused primarily on the paper trade and played a major role in the development of wood cellulose and the discovery of viscose.⁴⁵

⁴² Quoted in Robert Sharp, “Oswald Silberrad: the Work of a Forgotten Chemist,” *Ambix*, 50, 3, (2003): 302-309. This article draws on a collection of Silberrad’s papers that is held at the Science Museum in London.

⁴³ OU Chemists Database; Sharp, “Silberrad,” *Proceedings of the Chemical Society*, 29 (1961); Godfrey Rotter, “Silberrad, Oswald John,” *Dictionary of National Biography*, <https://www-oxforddnb-com>. (accessed 17 April 2020)

⁴⁴ Crowther and Dupree, “The Invisible General Practitioner”.

⁴⁵ E. F. Armstrong, “Charles Frederick Cross, 1855-1935,” *Obituary Notices of the Royal Society*, 1, 4 (1935): 458-64.

This was presumably of significance in his next appointment as technical chemist at the Scottish papermaker, Tullis Russell & Co. Ltd. in Fife. According to the company history, he was the first chemist appointed by the firm and among his early duties was to set up a company laboratory and organise the new wax extraction plant, “the first of its kind in the esparto paper industry.”⁴⁶ Briggs stayed seven years in Fife, before moving to British Celanese Ltd. in Spondon, Derbyshire, where he took up again the work on cellulose started at Cross & Bevan. He stayed at Spondon until his retirement, rising to the rank of chief chemist.⁴⁷

For Briggs, therefore, his period with the consulting firm of Cross & Bevan was an important period in his life history, enabling his move into a successful career in paper and cellulose. Another chemist for whom consultancy was a career stage, albeit a very different one, was William Murdoch Cumming (1891-1976). He graduated in Chemistry from Glasgow University in 1915, and moved immediately to Huddersfield where his studies were put to good use in the manufacture of TNT at British Dyestuffs Ltd. After the war, he returned to Glasgow, taking up an appointment as a lecturer at the Royal Technical College, where he stayed until 1949, rising to the position of Young Professor of Technical Chemistry, and working on cyanides and naphthalene. But during the Second World War he was once again involved in explosives production, now as Director of Explosives Research in Scotland, work for which he was awarded an OBE in 1946. By this point in his career he was highly active in public life in Glasgow: a member of River Clyde Purification Board, and a director of the Glasgow Engineering Centre and the Glasgow Chamber of Commerce. In 1949 he left the Royal Technical College and became Technical Director of British Dyewoods Ltd., a company originally set up to import dyeing and tanning materials, but by the 1950s focussing on the production of tannic and other acids. He stayed there for seven years before establishing himself as a Technical Consultant in Glasgow, the city where he had made his career. Like Chapman, Cumming was very active in chemical societies, principally the Society of Chemical Industry and the Institute of Chemistry, where he was a Vice-President in 1951-2. But Cumming was also active in the Institution of Chemical Engineering which he joined in its infancy becoming a member in 1928.⁴⁸

Cumming’s career illustrates well the varied careers pursued by some chemists who worked as consultants, with periods in academia, government work and industry. Common too was the way the two World Wars created new opportunities for chemists with the right expertise and skills, to

⁴⁶ C.D.M. Ketelbey, *Tullis Russell. The History of R.Tullis and Company and Tullis Russell Ltd., 1809-1959* (Markinch: Tullis Russell, 1967): 189.

⁴⁷ OU Chemists Database; *Chemistry & Industry*, 23 (1963): 1869-70.

⁴⁸ OU Chemists Database; Grace’s Guide to British Industrial History, https://www.gracesguide.co.uk/British_Dyewood_Co (accessed 17 April 2020).

branch out in new directions which might be continued after the war. In Cumming's career, consultancy was a final stage, but based on his wide experience of applied chemistry. As with Chapman, Cumming's networks included his activities in the chemical societies. Location was important too, as it was for consultants in many professions: nearly all Cumming's activities were Glasgow-based, and it is clear that he was well known in relevant circles in his city.

Harry Emeléus (1903-1993), who spent nearly all his working life in academia provides a final model for consultancy within a career in chemistry. Emeléus studied at the Royal College of Science in London, by then affiliated with Imperial College, obtaining a First in 1923 and a PhD in 1926. He then worked with Alfred Stock in Karlsruhe and with Hugh Taylor at Princeton. In 1931, he returned to Imperial College as a lecturer and then a Reader, before moving to Cambridge, where he became Professor of Inorganic Chemistry in 1946, staying there until his retirement in 1970. In the war, Emeléus also spent time at the Ministry of Supply and a year working on uranium hexafluoride at the Oak Ridge Institute of Nuclear Studies as part of the Manhattan Project. But the focus of his career was academic: together with a colleague, J. S. Anderson, he wrote a key textbook, *Modern Aspects of Inorganic Chemistry* (1938), which was "to change the perception of the subject throughout the world."⁴⁹ In the post-war years, his focus was on halogen fluorides, and also the trifluoromethyl group. His research group at Cambridge was long prominent in the field of inorganic chemistry and Emeléus enjoyed great academic success, being awarded a series of prestigious prizes in the UK and Europe. Like Chapman, Emeléus was active in the chemical societies, serving as presidents of both the Chemical Society from 1958-60 and of the Institute of Chemistry from 1963-65.

Yet, though primarily an academic, Emeléus too had wider interests. Both during and after the Second World War he was a member of the Chemical Defence Advisory Board, including a stint as chairman; he was also a technical advisor in the development of Windscale, and a Trustee of the British Museum. Nor did his wider interests stop there. According to an obituary, "these activities inevitably brought him into contact with several sectors of the British chemical industry" and Emeléus "was a past master at developing new chemistry that was potentially of importance to both industry and academe." He was a consultant for over 20 years to the Mond and General Divisions at ICI and also worked with British Titan Products and Borax Consolidated, relationships that were "congenial and mutually beneficial."⁵⁰

⁴⁹ Norman Greenwood, "Harry Julius Emeléus, 1903-1993," *Biographical Memoirs of the Royal Society*, 42 (1996): 124-150 (on 133).

⁵⁰ Greenwood, "Emeléus," 145; OU Chemists Database.

Academics who also worked as consultants or in industry were not uncommon before the First World War: Katherine Watson has charted the extensive business interests of William Ramsay as expert witness, industrial consultant, and as business promoter.⁵¹ Such a wide portfolio of outside interests became more difficult to manage alongside academic duties between the wars, but some attempts were made to formalise university-industry relations, as in ICI's Research Council, launched in 1927, which brought together a number of leading chemistry professors and ICI directors of research to "promote and direct research work in this country for the benefit of industry as a whole and to advise on the more promising lines of work to be undertaken."⁵² Academics undertook war-related during the Second World War, whilst after the war there was a continued demand for consultancy work in industry. For some, such as Emeléus, this was an extension of their academic work; for others, as for Cumming, independent consultancy was a role taken up after formal retirement.

Periods of work as a consultant therefore occupied very different places in the careers of the chemists we have studied. Some were consultants for most of their working lives, either, as was the case for Chapman, alongside work as a Public Analyst, or, as in the case of Silberrad, following employment elsewhere. For others, it was only a stage, either, as was the case for Briggs, in the early development phases of a career, or, as for Cumming, at its end. For others again, it took place alongside other work, perhaps, like Ramsay, as part of a wide portfolio of work, or, like Emeléus, as an interesting but clearly secondary spin-off.

The different ways that consultancy figured in careers are quite hard to quantify, but we have looked in more detail at the career paths of many of the consultant chemists for whom we have career data for 20 years or more. Where consultancy was combined with work in other sectors, we looked at the pattern of individuals' careers in two ways: first, we looked at how important a part of careers consultancy was and, second, when it occurred.⁵³ To explore the first, we attempted to draw a distinction between those for whom consultancy was either their main sector of employment or roughly equal to another and compared them to the numbers for whom consultancy was a secondary occupation, either because it only lasted a few years or because it was carried out alongside what clearly was the main employment. This analysis could not be done in a strictly quantitative manner, so our figures can only be indicative. However, it suggests that over time, and

⁵¹ Katherine Watson, "The Chemist as Expert."

⁵² Gerrylynn K. Roberts, "Dealing with Issues at the Academic-Industrial Interface in Inter-War Britain: University College London and Imperial Chemical Industries," *Science and Public Policy*, 24, 1 (1997): 29-35.

⁵³ See Table 5. Numbers are in some cases quite small and need to be treated with considerable caution.

quite sharply towards the end of our study, consultancy ceased to be the major element in careers which included it. For up to roughly two-thirds of the members of Cohorts 1 and 2 consultancy was the main occupation in their multi-sector careers, whilst this had dropped to about a third for members of Cohort 4, and into single figures for members of Cohort 5. Second, we looked at whether consultancy was performed alongside work in other sectors, or, if it only occupied part of a career, whether this stage came towards its beginning or its end. Just under half the members of Cohort 1 worked as a consultant alongside other work (in the way that, for instance, Chapman did), whilst the other half were roughly equally split between those for whom their period as a consultant came early in their career, and those for whom it came later. Over time, the percentage of chemists who combined it with other work fell, so that it was only about a fifth of members of Cohort 5, whilst those for whom it was an early phase varied but never rose much above a quarter. In contrast, for members of Cohorts 3 to 5, over half of the chemists who worked as consultants did so later in their career.

Combining these trends suggest that the role consultancy played in careers did change over time, if unevenly. Chemists for whom consultancy was the main occupation, such as Chapman and Silberrad, became rarer, and it became more common for consultancy to be a secondary occupation. For some, such as Briggs, this came early in their career, but, over time, chemists turned to consultancy later in their careers. Careers such as those of Cummings and Emeléus suggest too that there may have been a change in the services that consultants provided: what was sought increasingly was the knowledge and expertise gained from research and experience. One factor in this was the reorganisation of the chemical industry in the 1970s and 1980s, linked in the UK above all with the break-up of ICI.⁵⁴ Not only did this change the demand for chemical expertise, but the consequent changes in employment created a pool of senior chemists with time to take the plunge into consultancy at the end of their careers.

Conclusion

The dramatic growth in the number of chemists working in academia, government and industry, meant that by the early twentieth century consultants were a diminishing proportion of the chemical community. Yet there continued to be a space for them. The key to understanding this is the very versatility of the role. If, for some chemists, consultancy was an entrepreneurial opening, an

⁵⁴ Peter T.J. Morris and Anthony S. Travis, "Trade and Industry: The Growth, Diversification, and Dissolution of a Global Industry." in Peter J. T. Morris (ed.), *A Cultural History of Chemistry in the Modern Age, 1914-2019* (London: Bloomsbury, 2021). We are grateful to Dr Morris and Dr Travis for sharing with us a pre-publication version.

opportunity to exercise more independence than work as an employee allowed, for others it was part of a “portfolio career”. It might be a stage that facilitated progression towards a better post in a new institution or even sector, or the final part of a long and varied career. For others again, it was secondary occupation, arising from other interests and perhaps an opportunity to make money, but taking place alongside other work. Chemists who worked as consultants had unusually varied careers. Indeed, although we have not explored this, it is likely that the work itself was extraordinarily diverse, covering a broad range of fields from foodstuffs to metallurgy, and including routine analysis, pioneering research, and advisory work.

At the same time, it is possible to identify two features that chemical consultants shared. First, because it was done for others, it is likely that consultancy work was not high profile. Whilst work in industry might result in new industries or products, and academic research would lead to publications, consultancy work, by its very nature, was shared primarily with the client and therefore often remained, as Bud has suggested, invisible. Second, expertise and networks were, not surprisingly, important. Consultancy work attracted some of the most highly qualified chemists and flourished in larger centres. Consultants such as Chapman and Cumming were able to build networks that were based on both central locations and professional or scientific links. Even high-profile academics, such as Emeléus, found consultancy work through external contacts. But consultants may also have needed experience of different areas to understand the requirements of their clients. Silberrad’s experience at the Royal Arsenal developed his expertise in explosives; Cumming’s war work gave him an understanding of what would be of value to the organic chemical industry. Consultancy continued to flourish because there continued to be a need for external knowledge and expertise.

Acknowledgements

This paper was first presented in Oxford in May 2019 at a workshop entitled ‘The Changing Role of Chemists in Industry, 1850-2000’. We are very grateful for the invitation to the workshop and benefited greatly from the discussions there. We’d also like to thank two anonymous referees for their helpful comments.