Chemical Careers in Postwar Britain: Centrifugal Discipline /Centripetal Profession?

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At the start of the twentieth century, chemistry was, arguably, widely perceived as the most fundamental science, but it was definitely perceived as the most useful science; chemists were the largest group of scientists in Britain, finding occupations right across the economy –in industry, government, academia and a range of other fields. They had been the first British professional group to be organised around a scientific discipline and chemists served as a model for other emerging British scientific and technical professions. After the Second World War, university provision for science in Britain increased rapidly and chemists continued to be the largest group of scientists, certainly on the criterion of being the largest number of graduates in any pure science subject, at least into the early 1970s. Chemists and chemical research were at the heart of a vigorous industry, which would also continue to expand into the 1970s. In the final decade of the twentieth century, however, there was a perception of 'decline'. Using an anthropomorphic metaphor for the trajectory of the discipline of chemistry, David Knight described it as having become 'middle-aged' during the first half of the century.[1] With the reputation of chemistry both enhanced and tarnished by participation in two world wars, its intellectual status appeared to be changing as, on the one hand, physics came to be seen as the most fundamental science while, on the other, biological sciences became the exciting frontier.

Knight's volume was one of a clutch of general histories of chemistry published in Britain at about this time; another was W.H. Brock's now standard volume.[2] Not only did the more or less simultaneous appearance of these works signify a maturing of the sub-discipline of the history of chemistry, they also signified the historical importance of the discipline of chemistry itself at a time, certainly in the UK, of, as we now know, peak enrolments,[3] coupled with financial stringency in academia, external pressures on the academy towards mission-oriented research arising from concern about an alleged lack of engagement between industry, academia and government, and talk –which would become reality early in the

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twenty-first century– of departmental closures and amalgamations. On the continent, in their history of chemistry also published in the early 1990s, Bernadette Bensaude-Vincent and Isabelle Stengers argued that there had been a dilution of disciplinary identity with an intellectual shift from 'chemistry' to a range of 'chemistries' with adjectival prefixes, perhaps even a return to the handmaid status from which the discipline had emerged two centuries previously.[4] The image of a centrifugal discipline captures this perception –a perception which analyses the discipline primarily in terms of research activity. Our approach, however, is to look at the discipline not in terms of research alone, but as a profession, from the perspectives of education and employment. That is, we examine who the chemists were.[5] Looking at the education and careers of chemists who joined the profession between 1944 and 1971, we can see on the one hand precisely the centrifugal tendency of the emergence of 'adjectival chemistries', but on the other hand we can also see a simultaneous centripetal pull of a still potent core identity for chemistry –on the educational side in terms of knowledge and skills and on the employment side in terms of a professional orientation defined in relation to that knowledge and those skills.

Consequent on government policy, the post-Second-World-War period was one of rapid growth in undergraduate numbers in Britain. From under 400 per year during most of the 1930s, the annual number of chemistry degrees doubled from 1948 to 1956 and tripled by 1966. 1969, when 2679 BScs in chemistry were awarded, was the peak year for undergraduate degrees in the period 1944-1971 on which we shall focus here. Although, the number of degrees awarded in other sciences also increased, what is striking in comparative terms is the continuing prominence of chemistry. Over the entire period to 1971, chemistry was the largest pure science degree cohort in Britain. It accounted consistently for roughly a quarter of all honours degrees awarded in pure science. By the early 1960s, some 55% of all those earning bachelors degrees in chemistry in Britain also went on to gain a PhD.[6]

What was officially counted under the heading of 'chemistry' in 1971 by the University Grants Committee, the administrative body for higher education at the time, included degrees in nine sub-disciplines: applied chemistry, colour chemistry, industrial chemistry, inorganic chemistry, organic chemistry, physical chemistry, polymer chemistry, technical chemistry, and textile chemistry. Chemical technology, agricultural, biological, clinical and physiological chemistry were counted under other subject headings, while biochemistry and chemical engineering were separate subjects.[7] Thus, the UGC considered as 'chemistry', not only the three major branches, but also a range of applied 'chemistries'. Under

the UGC's definition, what we might call the 'biological' chemistries were, by this time, seen as being distinct from chemistry. An even more fragmented image emerged from the 1971 Census of Population of Great Britain. It grouped under the subject heading 'chemistry' some 56 different 'disciplines of first qualification' listed by members of the population at large.[8] Whereas the UGC's list demonstrated an academic, administrative understanding of the shape of the field for a particular year, the census figures reflected individuals' perceptions of what the subject of their education had been. The UGC figures were a snapshot for a particular year, whereas the census reported the qualifications of individuals aged from 18 to 70; that is, over a long period. Despite individuals' declaration of such diversity, the Stone Report on the Future of University Chemistry, commissioned by the UGC in the 1980s, recorded that the vast majority of graduates still took their degrees in the three classic branches of inorganic, organic and physical chemistry.[9]

Calling chemistry a 'central discipline' both, in its interactions with its neighbours, physics and the biological sciences more generally, and in its economic role, the Stone Report was fundamentally concerned with what we might term a 'pedagogic discipline' of chemistry –how this resource-intensive subject should best be organized nationally for teaching. 'The community, the chemical industry, and nearly all other industries need graduates who know the basis of their subject, who can find their way quickly through the maze of known facts, who know what methods might be used to solve new problems, and, above all, who are prepared to go on learning throughout their working lives'.[10] Therefore, the report concluded, university chemical education should consist of a broad-based study of the principles of chemistry, with ancillary physics. With such foundations, any necessary specific training could be readily gained on the job –a much better route, it argued, than vocationally oriented higher education. Elsewhere, we have called this model a 'liberal education' in chemistry. This argument on the basis of 'pedagogical efficiency' was remarkably congruent with the principles laid down in Britain in the 1840s, when the discipline was articulated there in institutional terms.[11]

A great deal is thus known about the supply of qualified chemists available to the labour market, and the picture is by no means as negative as has at times been suggested. However, it is much harder to find data about chemists' behaviour in the labour market. The evidence used tends to be either university enquiries into the first destinations of their graduates, or one-off surveys in particular years –both of which focus on individuals at particular points in time. Our methodology is to study collectively the whole careers of successive cohorts of individuals who

defined themselves as chemists by joining one or more of the three principal British chemical organizations over the period 1880-1971: the [Royal] Institute of Chemistry[12] (f. 1877), the Chemical Society[13] (f. 1841) and the Society of Chemical Industry[14] (f. 1881). In this paper, we offer some preliminary reflections based on our analysis of those who joined in the post-war period from 1944-1971.[15] Over that period the total membership of the three societies, adjusted for overlap, increased from roughly 14,700 to 36,700. Allowing for deaths, resignations and lapsed members, this increase of 22,000 in annual membership means in fact that some 37,000 individuals joined one or more of the societies over the period. That amounts to an average of about 1050 chemists joining each year during 1944-1956, increasing to 1500 per year during 1957-1971.[16] These are the chemists whom we profile in this paper; we have information on the careers of about 90% of them.[17]

Employment Sectors (%)

	1944-1956 N = 13354 n = 647		1957-1971 N = 20729 n = 711	
	All	*Sector*	*All*	*Sector*
Academia: Total	**38**	**100**	**38**	**100**
Only	11	30	13	35
& Industry	15	38	12	33
& Government	7	19	7	17
All 3	5	13	6	15
Government: Total	**33**	**100**	**25**	**100**
Only	8	24	4	18
& Industry	13	39	9	34
& Academia	7	22	7	26
All 3	5	16	6	22
Industry: Total	**71**	**100**	**64**	**100**
Only	38	54	37	58
& Government	13	18	9	14
& Academia	15	21	12	19
All 3	5	7	6	9

Note: N is the calculated number on whom we have employment information; n is the number in the sample on whom we have employment information.

A particularly striking feature of chemists' employment, which is revealed by a whole-career rather than snapshot approach, is the extent to which they worked across sectors of the economy. The table, 'Employment Sectors (%)', shows the principal employment sectors in which our two post-war cohorts worked, as a percentage of the cohorts as a whole (columns headed 'All') and also as a percentage of those employed in each sector (columns headed 'Sector').[18] The pattern is fairly consistent between the cohorts. Multi-sector working explains why the 'Totals' rows in the columns headed 'All' in the table add up to more than 100%. In both periods, just over 20% worked in 3 or more sectors during the course of their careers, while the percentage working in two different sectors of the economy fell slightly from 34% to 27%.

The columns headed 'Sector' show that some 65-70% of academics, a category in which we have here included school teachers, spent at least part of their careers working in another sector. This was also the case for 75 to 80% of those employed in government. Even among chemists in industry, the majority employment sector throughout our work, more than 40% worked elsewhere at some point in their career. Of course, the length of posts in particular sectors varied enormously. Those in the overlap segments will include many who spent just a few years working in one sector before building their career in another. However, the whole-career behaviour of chemists thus indicates that inter-sector boundaries were not as rigid as sometimes suggested.

Equally important, but not illustrated in our table, are movements within each sector, across intra-sector boundaries. For example, within academia, there was movement between colleges and universities. Within the industry category, chemists moved between working in the chemical industry or in large firms, to working in other industries and/or in smaller firms. For example, about two-thirds of the firms in which chemists from both cohorts worked were in the chemical industry and roughly 60% in other industries. Even within the chemical industry, a very high proportion of chemists moved among branches –our industrial chemists worked in some 22 classes of the Standard Industrial Classification [1981].[19] They also moved between firms within and among the classes. Chemists in the 1944-1956 cohort worked in some 700 separate firms in the chemical industry. We suggest therefore that is essential to move away from seeing chemists' employment in discrete boxes to recognising the extent and significance of occupational mobility, transferring knowledge and expertise from one workplace to another.

Geographical mobility was also characteristic of chemists' careers. Across the two cohorts, roughly 40% worked abroad for some part of their careers.[20] This figure

includes chemists born elsewhere who studied or worked in Britain or countries of its Empire, as all the chemical societies had large overseas memberships. Only the Royal Institute of Chemistry (RIC) required British nationality of its members in our period. 17% of the 1944-1956 cohort and 22% of the 1957-1971 cohort of chemists in our RIC samples who were born in the UK worked abroad. Adding in the British nationals born in the Dominions or wider Empire gives a figure of about 30% working overseas for both RIC samples.[21] Almost 60% of chemists moved between regions in the UK, while roughly 30% moved more than once.[22] Close to a third of each of the cohorts worked in Greater London and approximately a further quarter worked in counties of the southeast. The only other regional figures larger than 10% are 21% falling to 16% in the northwest and 11% of the first cohort in the West Midlands and in Scotland, falling to 6% and 8% respectively.[23] To some extent, this is of course a reflection of the metropolitan focus of the societies from which we have drawn our samples, despite all three being national, indeed international, bodies. 18% of the first cohort and 26% of the second both moved geographically and changed sector.

This degree of occupational and geographical mobility is easier to describe than to explain. We are still working on the analysis, which is likely to be economic and as much to do with circumstances within the various sectors in which chemists worked as with the nature of their chemical activities. For example, the geographical pattern suggests that chemists were affected by shifts over time in the location of industry in Britain.[24] Furthermore, we noted for chemists from our previous cohort, 1918-1943, the reflection in their careers of a shift in the wider economy to more structured, hierarchical career ladders, which entailed mobility as individuals sought to move up them. For the 1957-1971 cohort, there has been a further shift to portfolio careers, which entail mobility for different reasons.[25] It should also be noted that, when we look at the careers of individuals, they were highly particular and varied, despite each being allocable to our categories. Individual agency remained important.

Given the degree of mobility which we have shown, what is of most interest to us for purposes of this paper is that chemists were in fact able to move in this manner. Despite the apparent centrifugal tendencies suggested by the multiplication of specialities, and the huge array of specialist fields in which they worked, there was a countervailing centripetal tendency as well. Chemists had and were seen to have –by virtue of their liberal education in chemistry– core transferable knowledge and skills which allowed them to move from sector to sector, as well as within a sector. These were the core values of the liberal independent practitioner.[26] Their professional identity was that of chemists, rather than 'adjectival chemists'.

Their experience of work, especially for those who moved between sectors must have been such that they could adapt readily, giving them a certain professional elasticity that employers must have recognized and valued. We would argue that, certainly chemists produced in the period up to 1971, some of whose careers are still ongoing, thus maintained a distinct professional disciplinary identity. Interestingly, this identity has been reinforced recently from the perspective of pedagogy. Following a period of disciplinary gloom as undergraduate chemistry enrolments fell and prominent British chemistry departments were closed down in the early years of the twenty-first century, chemistry has been described recently as 'experiencing a renaissance' in Britain, with increased government funding and the undergraduate intake once more on the increase.[27] Prestigious new teaching laboratories have been opened on the basis of the pedagogical efficiency of teaching core chemical skills and knowledge, essential to a wide range of research and employment.[28] Arguably, the pedagogical and the professional are jointly centripetal in effect.

Notes

[1] David M. Knight, *Ideas in Chemistry* (London: Athlone, 1992), 179.
[2] William H. Brock, *The Fontana History of Chemistry* (London: Fontana Press, 1992).
[3] See Peter Morris, "Chemistry in the 21st Century: Death or Transformation?", elsewhere in this volume.
[4] Bernadette Bensaude Vincent and Isabelle Stengers, *Histoire de la Chimie* (Paris: Éditions la Découverte, 1993); trans. by D. van Dam, (Cambridge, MA: Harvard University Press, 1997).
[5] See Gabor Pallo, "Boundaries of Chemistry: Interest and Identity in Early Twentieth Century", elsewhere in this volume.
[6] Great Britain, University Grants Committee, [various series titles] (London: HMSO, 1944-1962); latterly, *First Destination of University Graduates* [1962-63 to 1970-71] (London: HMSO, 1954 to 1972).
[7] Great Britain, University Grants Committee, *First Destination of University Graduates,* 1970-71.
[8] Office of Population, Census and Surveys, *Persons with Qualifications in Engineering, Technology and Science,* Studies in Technological Manpower, No. 5 (London: HMSO, 1976), 15. The equivalent survey for 1961inculded 16 sub-disciplines in the chemistry count; General Register and General Register Office, Scotland, *Census 1961, Great Britain: Scientific and Technological Qualifications* (London: HMSO, 1962), xv.
[9] University Grants Committee, "The Future of University Chemistry: Report of the Chemistry Review" [The Stone Report], 1987, typescript of final draft copy, kindly provided by the then Head of the Department of Chemistry, The Open University. The review committee included 5 academics and a Deputy Chairman of ICI Pharmaceuticals.
[10] The Stone Report, 8.

[11] On the development of the 'liberal education' model of chemical pedagogy in Britain from the 1840s, see Robert F. Bud and Gerrylynn K. Roberts, *Science vs Practice: Chemistry in Victorian Britain* (Manchester: Manchester University Press, 1984).
[12] Colin A. Russell, Noel G. Coley and Gerrylynn K. Roberts, *Chemists by Profession. The Origins and Rise of the Royal Institute of Chemistry* (Milton Keynes: The Open University Press, 1977). It received the designation 'Royal' in 1944.
[13] R. L. Mackie, "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. Anita Kildebaek Nielson and Sona Strbanova (Cambridge: Royal Society of Chemistry, 2008), 140-61. 1971 is the terminal date for this study because there was a major institutional change on 1 January 1972, when the Royal Institute of Chemistry and the Chemical Society committed to amalgamation, with a view to subsequent unification.
[14] J. F. Donnelly, "Defining the Industrial Chemist in the United Kingdom, 1850-1921," *Journal of Social History,* 29 (1996): 779-96; Robin Mackie and Gerrylynn K. Roberts, "Un secteur à part? Les chimistes industriels et la Society of Chemical Industry dans le contexte de la communauté chimique britannique," in *Chimie et Industrie en Europe. L'apport des sociétés savantes industrielles du XIXe siècle à nos jours,* ed. U Fell (Paris: Editions des Archives Contemporaines, 2001), 127-47.
[15] This paper forms part of Robin Mackie's and Gerrylynn K. Roberts's project, 'Studies of the British Chemical Community, 1881-1972: The Three Principal Institutions', which was initiated with funding from the Leverhulme Trust. At the core of the project is the 'Chemists' Database' constructed at the Open University. This includes all Council members (*c.* 1900) plus systematic samples with a random start of members at large of the three societies drawn for five periods in their history determined by changes in Institute of Chemistry policies, totalling some 4.200 individuals. Biographical information was assembled by record linkage from a wide range of sources. Our data track individuals over the whole of their careers wherever possible. All data presented in this paper, which draws on two cohorts of members at large –those joining in the periods 1944-1956 and 1957-1971– are calculated from the 'Chemists' Database'. We have, however, eliminated those individuals whose connection with Britain was tenuous as they neither worked nor studied in the UK or its Empire. Our 'Biographical Database of the British Chemical Community', contains a full list of sources used and abbreviated records of, currently, *c.* 4.850 individuals; see *http://www5.open.ac.uk/ou5/Arts/chemists.*
[16] Not all graduates joined any of our societies. Preliminary calculations suggest that just over 50% of graduates in the period up to 1956 joined one or more of them –55% of male graduates and 30% of female graduates. Many graduates became school teachers –13% of all graduates, but 21% of female graduates– and are under-represented in the societies. Others not joining, who are harder to trace by our methods, may have left chemistry altogether, which seems to have been the case especially for women. Although some 9% of graduates over the period were women, they were not admitted to membership of the societies until late in the First World War. They comprised 4.8% of those for whom we have career information joining in the period 1944-1956 and 3.3% of those joining in the period 1957-1971. Despite these known 'missing' categories, we are aware that this still leaves a considerable percentage of graduates that did not join the societies at all. Nor did everyone who joined the societies have a degree. About 5% of those joining the societies across our period had neither a degree nor a professional qualification of the Royal Institute of Chemistry. Roughly 10% of joiners in our earlier period had no university degree but held an RIC qualification, defined as honours-degree equivalent at the time. In order to keep membership

increasing and to better reflect the reality of industrial employment, the Institute added a new grade of professional membership in our final period, admitting individuals who did not have an honours degree level qualification. This resulted in some 30% of joiners of all the societies in our final period with a professional qualification, which, depending on grade, was not necessarily honours-degree equivalent. A fairly consistent 45% held higher degrees. The figure for those who had both a degree and a professional qualification fell from 60% to 42%.

[17] It should be noted that our data on the 1957-1971 cohort is less complete. The average age of joining the societies was 25, so many members of this cohort are only now reaching the end of their careers. Furthermore, by definition, obituary material, on which we rely heavily for information, is less available for this cohort. We are none the less reasonably confident that we have captured accurately the experience of a significant portion of this group.

[18] Our full data contains two further, numerically less important categories of chemists: independent consultants who were an important group in the early twentieth century, but of declining numerical importance (only 10% of chemists after the Second World War) and a small miscellaneous group of 'Others', whom we are ignoring for now. On independent consultants, see Anna E. Simmons, "Working in a Transitional Territory? Chemical Consultants in The United Kingdom, 1870-1914", elsewhere in this volume.

[19] Great Britain, Central Statistical Office, *Standard Industrial Classification* (London: HMSO, 1981).

[20] Gerrylynn K. Roberts and Anna E. Simmons, "The Overseas Dimensions of British Chemical Societies, 1890-1950,"*Historia Scientiarum*, 16 (2007): 224-43.

[21] Gerrylynn K. Roberts and Anna E Simmons, "British chemists abroad, 1887-1971: the dynamics of chemists' careers," *Annals of Science,* forthcoming.

[22] We have designated Northern Ireland, Scotland and Wales as separate regions and divided England into 10 regions, with Greater London being one of them.

[23] On Scotland for an earlier period, see R. L. Mackie, "Counting Chemists: The Distribution of Chemical Expertise in Scotland in the First Half of the Twentieth Century," *Journal of Scottish Historical Studies*, 27 (2007): 48-74.

[24] See for example, R. J. Buswell and E. W. Lewis, "The Geographical Distribution of Industrial Research Activity in the United Kingdom," *Regional Studies*, 4 (1970): 297-306.

[25] Robin Mackie and Gerrylynn K. Roberts, "Career Patterns in the British Chemical Profession during the Twentieth Century," in Origins of the Modern Career, *ed.* D. Mitch, J. Brown and M.H.D. van Leeuwen (Aldershot, England: Ashgate, 2004), 317-36.

[26] Robin Mackie and Gerrylynn K. Roberts, "Career Patterns".

[27] Royal Society of Chemistry, "Digest of Statistics of Chemistry Education, 2007," *http:www.rsc.org/Education/Statistics*, accessed 28 April 2008.

[28] Steve McCormack, "Chemistry returns to its element in universities," *The Independent*, 25 January 2007; online edition *(http://education.independent.co. uk/higher/article2181876.ece)*, accessed 1 February 2007.