Mark Pendleton, University College London

'A Place of Teaching and Research': University College London and the Origins of the Research University in Britain 1890-1914

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Abstract

The principal aim of this thesis is to investigate the origins of the research university in Britain, focussing in particular on University College London in the period 1890-1914. This account demonstrates that this period witnessed a series of pioneering attempts to establish research schools in various departments of the College, and the emergence of an institutional commitment to both teaching and research. It is argued that - contrary to the assumptions implicit within much of the existing literature on this subject - government money and initiatives were of secondary importance, and the role of the state was merely to consolidate the effects of various developments that were taking place within the College. This thesis therefore highlights the significance of the role played by a handful of pioneering professors in certain key departments of the College - notably Karl Pearson (Applied Mathematics and Statistics), Sir William Ramsay (Chemistry) and A.F. Pollard (History). These remarkable individuals managed to pursue successful research careers and pioneered the development of research training for students. Moreover, through their efforts to secure the necessary financial support for their work (principally from private sources) and involvement in the campaign to reform the University of London, the College Council and University authorities were slowly forced to accept an expanded conception of the role and function of the College in this period, and in 1905 UCL was formally reconstituted as 'a place of teaching and research'. In the absence of a satisfactory secondary literature on Britain's universities and the rise of research, it is hoped that this thesis will act as a pilot study, suggesting a possible strategy for investigating the origins of the research university in this country based on local studies of individual universities, colleges and departments.

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1. Introduction: 'A Place of Teaching and Research'

It should be said that by the 1890s all the universities and young university colleges in Britain were broadly agreed on the character and contents of a university education and, to a somewhat lesser extent, on the importance of original research in the life and work of a professional scholar . . . . The existence of this area of common ground, and its delineation, owed a great deal to the way in which London had acted as a pioneer and pace-setter.

F.M.L.Thompson, 1986.[1]

It is a truth (almost) universally acknowledged that the modern British university is 'a place of teaching and research',[2] its twin objectives the advancement and dissemination of knowledge. Some universities are even beginning to see themselves exclusively, or at least primarily, as research institutions.[3] Historically, however, Britain's universities were conceived of (simply) as teaching institutions. To be sure, 'there has never been a period in the[ir] history . . . when they have not housed scholars of world renown, . . . when learning has not been illuminated by deep and original thought',[4] but until relatively recently university staff were not paid to conduct their own research, their students were not given any formal research training, and there was little opportunity or incentive for them to conduct their own experiments and investigations. When University College London was established - as the original London University - in 1826 the principal aim of its founders was simply to afford 'young men . . . adequate opportunities for obtaining literary and scientific education at moderate expense',[5] and the aims and objectives of the College did not come to include a dual commitment to teaching and research until the early years of the twentieth century.

The principal aim of this thesis is to investigate the origins and development of the modern conception of the British university as *a place of teaching and research*, focussing, in particular, on UCL and the period 1890-1914. It will be argued that this period witnessed a series of pioneering attempts to establish 'research schools' in

[1] F.M.L.Thompson, ed., The University of London and the World of Learning, 1836-1986 (London: The Hambledon Press, 1990), p.xix.
[2] As UCL was described under the terms of the University College, London, (Transfer) Act, 1905, University of London: The Historical Record (1836-1912) (London: University of London Press, 1912), pp.114-26.
[3] According to the 1996 University College London Graduate School Prospectus, for example, UCL is 'primarily a research-orientated university'. University College London Graduate School Prospectus, 1996/97(London: University College London, 1996).
[4] V.H.H.Green, The Universities (Harmondsworth: Penguin, 1969), p.189.
[5] Statement by the Council of the University of London Explanatory of the Nature and Objects of the Institution (London: Longman, Rees, Orme, Brown and Green, 1827), pp. 31-41.

certain departments of the College, and the emergence of a formal, institutional commitment to 'teaching and research'. One should not exaggerate the speed, scale and significance of these developments. It would be several decades before UCL could legitimately claim to be a 'research university', but the origins of the modern *conception* of the role and function of the College are nevertheless to be found in this period - in the efforts of the pioneering professors and their pupils who sought to establish embryonic research schools in the libraries and laboratories of UCL, strove to secure the necessary institutional and financial support for their work (primarily from private sources), and lead the campaign to reform the University of London as a 'teaching' or 'professorial' university.

UCL and the Rise of Research c.1890-1914

When Karl Pearson was appointed to the Goldsmid Chair of Applied Mathematics and Mechanics at UCL in 1884, he secured the right to deliver a regular course of lectures on geometry and mechanics to engineering students at the College, and to receive in return a proportion of the fees paid by the students who attended his lectures. He was not provided with a laboratory, nor any instruments or apparatus, and there was no requirement (or expectation) that he would conduct his own experiments and research.[6] At this point all the departments of the College were concentrated on the central Gower Street site. The South Wing of the main College building was occupied by University College School (which also had the use of more than an acre of College land as a playground), and the North Wing was dominated by the Slade School of Fine Art. Most departments were presided over by a single professor - or more junior member of staff - who derived his income entirely from the fees paid by the students who attended his lectures. Few of the undergraduates enrolled at UCL were reading for bachelor's degrees;[7] the postgraduate population of the College was dominated by volunteers and 'amateur devotees', and there was little opportunity or incentive for them to learn the methods of research and to conduct their own experiments and investigations. As Michael Thompson explains:

[6] Karl Pearson, [Application] 'To the Electors of the Savilian Professorship of Geometry', 10 July 1897, p.4. Among the correspondence and papers of Karl Pearson held in the Manuscripts Room at University College London Library, Box 233 [hereafter KP/UCL/233, etc].
[7] H.Hale Bellot, University College London, 1826-1926 (London: University of London Press, 1929), p.400.

> Teaching was geared to what was expected in examinations, and was naturally an exercise in imparting large volumes of information and sticking closely to a handful of text books or the familiar round of set passages from Homer, Plato, Thucydides, Cicero, Tacitus and Virgil . . . . Unsalaried Professors tended to work part-time, and if they did devote their lives to scholarship their devotions did not take place in College.[8]

Slowly, however, over the next thirty years - and more especially in the period 1890-1914 - a new conception of the College as a place of teaching and research began to emerge. By the eve of the First World War, almost a quarter of the students enrolled at UCL were registered as 'Postgraduate and Research Students'. The number of postgraduate degrees awarded to the students of the College had doubled over the previous decade, and almost 300 new books, journal articles and scientific memoirs were produced and published during the 1913-14 academic session.[9] Moreover, a number of major research projects were conducted within the precincts of the College in this period. Sir William Ramsay's Nobel Prize-winning researches on the gases of the atmosphere were carried out in the Chemistry Department between 1894 and 1902, and he had subsequently turned his attention to the study of radium and its emanation, which led on in turn to pioneering work on atomic structure and disintegration, the 'transmutation' of elements, and the use of radium in the treatment of cancer. Meanwhile, Ernest Starling and William Bayliss were investigating intestinal function and the regulation of the heartbeat in the Department of Physiology; and in the Department of Applied Mathematics Pearson and his colleagues were pursuing statistical investigations in various fields, increasingly focusing their attention on the analysis of biological and sociological data and the new 'science of national eugenics'.

Although they were paid to teach and not to do their own research, individual members of the staff of the College had always found time to conduct their own experiments and investigations. For example, in their illustrated history of UCL, John North and Negley Harte explain that men like Charles Bell, Anthony Todd Thompson, Edward Turner and William Sharpey all conducted important research in their respective fields during the early years of the College's history.[10] But the work carried out in the period 1890-1914 was of a different quality and character. Ramsay,

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[8] Thompson, University of London, pp.62-73.

[9] University College London Annual Report 1915 (London: University College London, 1915] [hereafter Reports 1915, etc], pp.13, 54-74. See below, Appendices 1-6.

[10] Negley Harte and John North, The World of UCL, 1828-1990 (London: University College London, 1991), pp.33-54.

Starling and Pearson instigated long term, self-sustaining *programmes* of research, which took several years to complete and involved the cooperative efforts of the professor, his junior colleagues and senior students. These remarkable men presided over successful *research schools* which were characterised by what is probably best described as a specific *culture* of teaching and research. The senior member of staff or director of the school would conduct his own experiments and investigations, integrate the results into his undergraduate teaching, train his senior students in the methods of research, encourage them to assist him in his researches, and also give them an opportunity to conduct their own independent experiments and investigations. Moreover, this was not an isolated phenomenon, witnessed in one or two individual departments of the College. The Departments of Chemistry, Physiology and Applied Mathematics were by far the most active in the area of original research in this period, but they only account for about a third of the original papers and other publications that emerged from within the College during the first decade of the twentieth century. By 1914 original work was being produced and published in almost every department - from Sanskrit, Hebrew, Pali and Buddhist Literature, through English, History and Geography, to Botany, Pharmacology and Mechanical Engineering.[11]

Initially, at least, this was a revolution from 'below', led by the individual members of staff, in certain key departments of the College, who struggled to pursue successful research careers in this period. However, the College Council and University authorities did begin to take more interest in - and responsibility for - advanced work of this nature during the last quarter of the nineteenth century, slowly transforming the institutional character of the College. By the turn of the century the Council was insistent that it 'attach[ed] the greatest importance to the original work done by the staff and students of the College', and in 1902 it was conceded that the 'academic rank and intellectual status' of University College would ultimately rest on its output of 'higher work' (i.e. 'independent work and research').[12] The arrangements for paying the professorial staff were subsequently revised in order to reward their 'higher and from the academical point of view their more valuable work'.[13] The Council also launched an 'Appeal for the Endowment of Advanced University

[11] Reports 1915, pp. 54-74.
[12] Reports 1903, pp.19-24.
[13] Reports 1913, p.13.

Education and Research' in order to raise the necessary funds to erect a school of advanced medical studies and new chemical laboratories, 'particularly for research',[14] and over the next decade impressive new buildings, housing modern laboratories, 'seminar libraries' and sophisticated facilities for teaching and research, extended the Gower Street site in every direction. A special postgraduate prospectus, highlighting the opportunities for students to learn the proper methods of research and conduct their own original investigations at UCL was produced for the first time in 1901,[15] and in 1906 new 'General Regulations as to Research Work' were drawn up, the College Council insisting that:

> On the recommendation of the Professor of any Department, any student may be admitted to the College for the purpose of undertaking such work.[16]

The regulations governing the administration of postgraduate degrees were revised in order to recognise 'Original Research as a qualification for the higher degrees of the University', and by the end of our period the London M.A. included a major research component and doctoral degrees were only awarded on the basis of the submission of a thesis 'embodying the result of independent research'.[17]

Crucially, the promotion of original research also came to be listed among the official aims and objectives of the College in this period. So while the 1869 Act of Parliament which reconstituted University College reminds us that its principal aim was 'to afford at a moderate expense the means of education in literature, science, and the fine arts',[18] by the time of the next Act of Parliament pertaining to UCL, the University College London (Transfer) Act of 1905, the College was described as 'a place of teaching and research', its principal aim:

> to hold forth to all classes and denominations in the United Kingdom and elsewhere . . . an encouragement for pursuing a regular and liberal course of education . . . *[and] to promote research and the advancement of science and learning* (my italics).[19]

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[14] The Needs of University College London (London: University College London, 1902), pp.2-4; Reports 1902, pp.17-18, 35.

[15] 'Post-Graduate Courses of Lectures and Laboratory Work Carried on at University College, London', Reports 1901, pp.13-16.

[16] University College London Calendar 1905-6 (London: University College London, 1905) [hereafter Calendar 1905-6, etc], p.20.

[17] University of London Calendar 1890-91 (London: University of London, 1890), pp.91-3; University of London Calendar 1902-03. Volume II. Regulations for Internal Students (London: University of London, 1902), p.138; University of London Regulations and Courses for Internal Students (September 1907) (London: University of London, 1907), pp.95-6, 202-1.

[18] University College London Supplementary Charter, 1867, Historical Record, pp.58-9.

[19] UCL (Transfer) Act, Ibid, p.114.

Historiography

The history of University College London has been fairly well documented. Negley Harte and John North's recent illustrated history provides a good general overview of its origins and development,[20] but the most authoritative account remains Hugh Hale Bellot's centenary history which was based on extensive and exhaustive research in the archives of the College and University of London.[21] Sections of Bellot's later history of the University of London, and some of the essays collected together in F.M.L. Thompson's sesquicentennial volume on *The University of London and the Word of Learning*, consider particular aspects of the history of the College in a more general or comparative University of London context.[22] More recently there have also been some good local studies which have looked more closely at the life and work of individual members of the academic and administrative staff of the College.[23] Certain topics and themes - notably UCL's pioneering role in the higher education of women and the relationship between the College and University of London - have been discussed and debated at length.[24] But there has

[20] Harte and North, World of UCL.

[21] Bellot, UCL.

[22] H.Hale Bellot, The University of London: A History (London: University of London Press, 1969); Thompson, University of London. See also Joshua Fitch, The University of London: A Sketch of Its Work and History From Its Foundation in 1837 to the Present Time (London: HMSO, 1900); Augustus D.Waller, A Short Account of the Origins of the University of London (London: University of London, 1912); University of London, 1836-1936 (London: University of London, 1936); Douglas Logan, The University of London: An Introduction (London: University of London, 1955), and Negley Harte, The University of London, 1836-1986: An Illustrated History (London: The Athlone Press, 1986).

[23] Examples that are particularly relevant to this study include Katherine D.Watson, 'Aspects of a Career in Science: Sir William Ramsay and the Chemical Community, 1890-1915' (Unpublished D. Phil. Thesis, Oxford, 1994); Katherine D.Watson, 'The Chemist as Expert: The Consulting Career of Sir William Ramsay', Ambix, 42/3 (1995), 143-59; Eileen Magnello, 'Karl Pearson, Evolutionary Biology and the Emergence of a Modern Theory of Statistics, 1884-1936' (Unpublished D. Phil. Thesis, Oxford, 1993); Eileen Magnello, 'The Non-Correlation of Biometrics and Eugenics: Rival Forms of Laboratory Work in Karl Pearson's Career at University College London', History of Science, 37 (1999), 79-106 and 123-50, and N.B.Harte, One Hundred and Fifty Years of History Teaching at University College London(London: University College London, 1982).

[24] See, for example, Bellot, UCL, pp.367-73; Caroline Bingham, The History of Royal Holloway College 1886-1986 (London: Constable, 1987); N.B.Harte, The Admission of Women to University College London: A Centenary Lecture (London: University College London, 1979); Julie Stevenson, 'A Neglected Issue in the History of Education and Training: Women Students of University College London and the Polytechnic at Regent Street, c.1870-1930' (Unpublished Ph.D. Thesis, Thames Valley, 1996); William Allchin, An Account of the Reconstruction of the University of London. Volume I 1825-1888 (London: H.K.Lewis, 1905), Volume II 1888-1891 (London: HMSO, 1911), Volume III 1891-1892 (London: HMSO, 1912), and T.L.Humberstone, University Reform in London (London: Allen and Unwin, 1926).

been little consideration of the origins and development of the modern conception of the role and function of the College as a centre for teaching and research.

This reflects a more general weakness in the secondary literature dealing with the history of university education in Great Britain. Although there is an extensive literature on the subject, historians have chiefly been concerned with the evolution of higher education policy and the institutional history of individual universities and colleges. There is no satisfactory account of the origins and development of the modern conception of the British university as a place of teaching and research. It is widely accepted that today 'there must be research carried on in a university if it is to be worthy of the name',[25] and generally agreed that the universities and colleges of the late-nineteenth century were, in the words of Raphael Meldola, 'distinct failures as centres of . . . research';[26] but surprisingly little has been written about this revolution in the official conception of the role and function of university education in Britain. There has been no serious attempt to explain precisely how, when and why the aims and objectives of Britain's universities came to include a dual commitment to teaching and research, and the existing literature on the subject is rife with speculation, generalisation and assumption.

There is, of course, an extensive literature on the history of university education in Britain, dealing in detail with the history of particular universities and colleges, and also looking at particular topics and themes in a more general or comparative context.[27] But, although the origins of the research university in Germany and the United States are fairly well documented,[28] there is no single book or article that deals specifically with the origins and development of the modern

[25] Sydney Caine, British Universities: Purpose and Prospects (London: Bodley Head, 1969), p.54.

[26] Raphael Meldola, 'The Position and Prospects of Chemical Research in Britain' (Abridged from Presidential Address at Annual General Meeting of the Chemical Society, 22 March 1907), Nature, 76 (1907), 231-5.

[27] See, for example, Green, Universities; Konrad H.Jarausch, ed., The Transformation of Higher Learning, 1860-1930 (Chicago: University of Chicago Press, 1983); Michael Sanderson, ed., The Universities in the Nineteenth Century (London: Routledge and Kegan Paul, 1975), and the introduction to Jack Simmons' New University (Leicester: Leicester University Press, 1958), pp.9-42.

[28] See, for example, Roger L.Geiger, To Advance Knowledge: The Growth of American Research Universities, 1900-1940 (New York and Oxford: Oxford University Press, 1986); R.Steven Turner, 'The Growth of Professorial Research in Prussia, 1818-1848: Causes and Context', Historical Studies in the Physical Sciences, 3 (1971), 137-82, and L.Veysey, The Origins of the American University (Chicago: University of Chicago Press, 1965).

conception of the British university as a centre for teaching and research. Donald Cardwell does address the question in a brief essay on 'The Development of Scientific Research in Modern Universities',[29] but this is little more than a postscript to his more generalised account of *The Organisation of Science in England*.[30] There are one or two accounts which investigate particular aspects of the story of the origins of the research university in this country in some detail, notably Renate Simpson's *How the Ph.D. Came to Britain*,[31] and the sections of Christine Shinn's book on the origins and development of the University Grants Committee which deal with the impact of government funding on Britain's various universities and university colleges.[32] But the literature dealing with the history of university education in Britain and the rise of research has been dominated by what Konrad Jarausch has described as the 'vagaries of anniversary tributes to . . . illustrious alma mater[s]',[33] and, perhaps even more problematically, by the debate over the causes of Britain's relative decline as a major economic and industrial power in the twentieth century.

Historians seeking to explain this phenomenon have noted the existence of 'Two Cultures' in Britain,[34] and blamed her economic and industrial 'decline' on the predominance of an 'anti-technological' culture among social, political and commercial elites in this country. It has been argued that as a result of this cultural bias, the British - and more especially the British government - have neglected science and research, and that this has, in turn, been responsible for Britain's long term economic and industrial malaise. The many historians who subscribe to this view have been highly critical of Britain's various universities and university colleges - especially the Oxbridge colleges - which, they insist, 'provided a common formative experience for much of the British elite', shaping their aristocratic, anti-industrial, anti-scientific

[29] D.S.L.Cardwell, 'The Development of Scientific Research in Modern Universities: A Comparative Study of Motives and Opportunities', in A.C.Crombie, Scientific Change: Historical Studies in the Intellectual, Social, and Technical Conditions for Scientific Discovery and Invention From Antiquity to the Present (London: Heinemann, 1963).

[30] D.S.L.Cardwell, The Organisation of Science in England (London: Heinemann, 1957).

[31] Renate Simpson, How the Ph.D. Came to Britain: A Century of Struggle for Postgraduate Education (Guilford: Society for Research into Higher Education, 1983).

[32] C.H.Shinn, Paying the Piper: The Development of the University Grants Committee, 1919-46 (Lewes: Falmer Press, 1986), especially pp.1-57.

[33] Jarausch, 'Higher Education and Social Change', p.11.

[34] C.P.Snow, The Two Cultures and the Scientific Revolution (Cambridge: Cambridge University Press, 1959).

values, and coming 'to represent a national way of life'.[35] According to Correlli Barnett, for example, 'Oxford and Cambridge were sunk in introspective torpor and pedantic cultivation of the classics and mathematics' in the nineteenth century. Their staff 'recoiled in horror from any suggestion that they should concern themselves with preparing students for careers and . . . had no conception of research in the modern sense of the word'.[36] The 'declinists' have been equally dismissive of the new 'civic' universities and university colleges that were established in provincial towns throughout Northern England, Wales and the Midlands in the second-half of the nineteenth century;[37] and, according to Roy MacLeod, even University College London, 'with its strong scientific tradition, offered very limited prospects for research'.[38]

In most cases the declinists have simply dismissed all Britain's universities and colleges as failures as centres of research on the basis of the complaints of a small group of nineteenth century critics of the Oxbridge colleges - assuming that what may, or may not, have been true of Oxford in 1830, was equally true of London in 1870 and Manchester in 1914. However, in some cases - notably in the work of Donald Cardwell, Roy MacLeod and Peter Alter - there has been some attempt to develop a more sophisticated analysis of the work of the universities and their contribution to the promotion and organisation of (scientific) research, usually in the context of a more general discussion about the 'movement for the endowment of research' and the development of public and government attitudes towards science and research in the period 1870-1920.[39] Cardwell, MacLeod and Alter argue that the British universities' neglect of science and research in the nineteenth century reflects a more general disregard for the scientist and researcher in the Victorian era, and insist

[35] Martin Wiener, English Culture and the Decline of the Industrial Spirit, 1850-1980 (Cambridge: Cambridge University Press, 1981), p.23.
[36] Correlli Barnett, 'Long-Term Industrial Performance in the UK: The Role of Education and Research, 1850-1939', in Derek Morris, ed., The Economic System in the UK (Oxford: Oxford University Press, 1985), p.671.
[37] See Ibid, p.680.
[38] Roy MacLeod, 'Resources of Science in Victorian England: The Endowment of Science Movement, 1868-1900', in Peter Mathias, ed., Science and Society, 1600-1900 (Cambridge: Cambridge University Press, 1972), p.122.
[39] See, for example, Peter Alter, The Reluctant Patron: Science and the State in Britain,1850-1920 (Oxford: Berg, 1987), especially pp.22-35; Cardwell, Organisation of Science; MacLeod, 'Resources of Science', and the various essays collected together in his Public Science and Public Policy in Victorian England (Brookfield: Variorum, 1996).

that the origins and development of the research university in this country can therefore only be understood in the context of the concurrent transformation in the attitude of the British people and government towards science and the promotion of research. According to this interpretation, the British government was, for much of the nineteenth century, a most 'reluctant patron' - taking little interest in the promotion and organisation of scientific research, and leaving the universities to exist in a state of semiautonomous independence. But, in the face of mounting evidence of Britain's relative economic and industrial decline - which appeared to give substance to the demands of an increasingly vociferous 'science lobby' - the state was slowly forced to abandon its traditional *laissez-faire* attitude towards science and the promotion of research during the last quarter of the nineteenth century and early years of the twentieth century.

As a result, Britain's universities and university colleges were subject to almost constant public investigation and 'cross-examination' by a series of Royal Commissions and official boards of inquiry from about 1850 onwards, and it was eventually decided that their work should include both teaching *and* the promotion of original research. In August 1873, for example, the Royal Commission on Scientific Instruction and the Advancement of Science (the Devonshire Commission) presented its third report (on Oxford and Cambridge), concluding that 'the first duty of new professors was to advance knowledge',[40] and three years later Lord Salisbury introduced a bill to reform the University of Oxford in the House of Lords, insisting:

> We are of the opinion that the mere duty of communicating knowledge to others does not fulfil all the functions of the universities, and that the best universities in former times have been those in which the instructors, in addition to imparting learning, were engaged in adding new stores to the already acquired accumulation of knowledge.[41]

The state's growing conviction that the aims and objectives of Britain's universities and university colleges should include both teaching and research is particularly significant because government influence over the universities was increasing all the time with the steady growth of Treasury expenditure on higher education. The launching of an annual Parliamentary Grant-in-Aid to University Colleges in Great

[40] 'The Report of the Science Committee on the Old Universities', Nature, 8 (1873), 337-41.
[41] Hansard, Parliamentary Debates (House of Lords), Third Series, Vol. 227, cols. 791-803 (14 February 1876).

Britain in 1889 therefore acted as an 'indirect endowment of research',[42] and most of Britain's leading universities and university colleges were subsequently reconstituted as centres of teaching and research. However, the declinists remain highly critical of their contribution to the promotion of original research, even in this period. According to MacLeod, for example, most British universities continued to give 'greater emphasis to education than to research training and "research schools" were not visible in many universities until the end of the First World War'.[43] Similarly, Cardwell insists that there were an 'astonishingly small' number of science students engaged in 'systematic post-graduate research' even as late as 1914,[44] and Alter's conclusion (based on a speech given by Raphael Meldola, the President of the Chemical Society, in 1907) is typical:

> The contribution made by Britain's universities to basic research was 'far below the standard, both of the quantity and quality, which might be expected and which we should like to [have seen] attained . . . . many of our universities [were] distinct failures as centres . . . of research'.[45]

The declinist thesis is based on the technocratic assumption that scientific research is the driving force behind economic growth and social change, and the Baconian belief that it is therefore the duty of the government to organise and support science and research. This interpretation originated in the complaints of a number of very prominent nineteenth-century scientists and their supporters, principal among them Charles Babbage, David Brewster, Lyon Playfair, John Lubbock, Edward Frankland, Norman Lockyer, George Gore, Alexander Strange and Richard Haldane.[46] They maintained that 'scientific discovery and research [was] national work' and argued that it was therefore 'the duty of the state to provide and pay for it'.[47] They were insistent, moreover, that the British

[42] MacLeod, 'Resources', p.161.
[43] Ibid, p.162.
[44] Cardwell, Organisation, p.215.
[45] Alter, Reluctant Patron, p.30; Meldola, 'Position and Prospects of Chemical Research', pp.231-5.
[46] See Barnett, 'Long-Term Industrial Performance', especially pp.76-98, 116-37, 177-90, J.G.Crowther, Statesmen of Science (London: The Cresset Press, 1965), MacLeod, 'Resources of Science', and Roy MacLeod, 'The X-Club: A Scientific Network in Late-Victorian England', Notes and Records of the Royal Society of London, XXIV (December 1970), 305-22.
[47] George Gore, 'On the Present Condition of Science in Relation to the British Government', Transactions of the Social Science Association (Plymouth, 1872), p.280, quoted in MacLeod, 'Resources of Science', p.129.

government was not doing enough to support and subsidise scientific research, and that as a result science was 'all but dead' in Britain.[48] These arguments have been accepted, uncritically, by generations of historians. They achieved a new prominence in the 1960s under the influence of Cardwell, MacLeod, C.P. Snow, Jacob Bronowski and David Landes,[49] and had come to be accepted almost as an article of faith among the disciples of Correlli Barnett and Martin Wiener by the late 1980s.[50]

However, despite the enduring influence of these arguments, the declinist thesis was successfully challenged by Michael Sanderson as long ago as 1972 in his seminal work on *The Universities and British Industry*.[51] More recently Sanderson and a number of revisionist historians, including Frank Turner, Sidney Pollard, David Edgerton, Donald McCloskey, W.D. Rubinstein, Bruce Collins and Keith Robbins,[52] have attacked the declinists' interpretation with renewed vigour, dismissing the

[48] 'A Voice From Cambridge', Nature, 8 (1873), 21-2.

[49] Snow, The Two Cultures; C.P.Snow, Science and Government (Oxford: Oxford University Press, 1961); Jacob Bronowski, Science and Human Values (London: Hutchinson, 1961); David Landes, The Unbound Prometheus: Technological Change and Industrial Change in Western Europe from 1750 to the Present (Cambridge: Cambridge University Press, 1969). MacLeod does have a rather more subtle approach to the question, but much of his work reflects the dominance of the declinist thesis, and, by his own admission, he takes a 'positive view of the state's acceptance of responsibility' for the promotion and organisation of science and scientific research in the late-Victorian and Edwardian era. MacLeod, Preface to Public Science and Public Policy,pp.viii-ix.

[50] Correlli Barnett, The Collapse of British Power (Gloucester: Sutton, 1984); Barnett, 'Long-Term Industrial Performance'; Correlli Barnett, The Audit of War: The Illusion and Reality of Britain as a Great Nation (London: Macmillan, 1986); Wiener, Decline of the Industrial Spirit; Bernard Elbaum and William Lazonick, eds., The Decline of the British Economy (Oxford: Clarendon, 1986); Keith Pavitt, ed., Technical Innovation and British Economic Performance (London: Macmillan, 1980); G.W.Roderick and M.D.Stephens, Education and Industry in the Nineteenth Century: The English Disease (London: Longman, 1978); G.W.Roderick and M.D.Stephens, Where Did We Go Wrong? Industrial Performance, Education and the Economy in Victorian Britain (Lewes: Falmer Press, 1987).

[51] Michael Sanderson, The Universities and British Industry,1850-1970 (London: Routledge, 1972).

[52] M.Sanderson, 'The English Civic Universities and the "Industrial Spirit", 1870-1914', Historical Research, 61 (1988), 90-104; Frank Turner, 'Public Science in Britain', Isis, 71 (1980), 589-608; Sidney Pollard, Britain's Prime and Britain's Decline: The British Economy, 1870-1914 (London: Edward Arnold, 1989), especially pp.115-213; D.Edgerton, England and the Aeroplane: An Essay on a Militant and Technological Nation (Basingstoke: Macmillan, 1991); D.Edgerton, 'The Prophet Militant and Industrial: The Peculiarities of Correlli Barnett', Twentieth Century British History, 2 (1991), 360-79; D.Edgerton, Science, Technology and the British Industrial 'Decline', 1870-1970 (Cambridge: Cambridge University Press, 1996); D.N.McCloskey, Essays on a Mature Economy: Britain after 1840 (London: Methuen, 1971); W.D.Rubinstein, Capitalism, Culture and Economic Decline in Britain,1750-1990 (London: Routledge, 1993); Bruce Collins and Keith Robbins, eds., British Culture and Economic Decline (London: Weidenfeld and Nicolson, 1990).

technocratic assumptions upon which their case was built.[53] They have also condemned the naive and simplistic historiographical methods employed by the declinists - David Edgerton and Sally Horrocks insisting that there is 'no coherent body of literature' on any aspect of this subject, 'much less the sort of coherent debate that characterises mature historiographical traditions'.[54] As Sanderson explains, generations of historians have simply assumed that 'defects in education were a cause of economic retardation because Victorians believed and reiterated it'. But one should remember that this view was 'propagated by a lobby of notable figures' who were linked by common interests and personal friendship.[55] Frank Turner insists that this is a typical failing of the declinists. They have accepted the complaints and criticisms of the nineteenth-century champions of the endowment of research uncritically, simply repeating 'arguments and polemics that have long been in the public domain'. Turner insists that these lobbyists were 'public scientists', and describes the 'body of rhetoric, argument and polemic' they used to 'justify their activities to the political powers and other social institutions upon whose goodwill, patronage and cooperation they were dependent' as *public science*, explaining:

[53] This point is taken up by the biochemist Terence Kealey. He notes that though the government did not support science to any significant extent in the nineteenth century, the industrial revolution was born in *laissez faire* Britain (and not dirigiste France), and the government's neglect of science 'did not prevent Britain from growing into the richest and most industrialised country in the world' and producing scientists of the calibre of Davy, Kelvin, Maxwell and Darwin. He argues that there is a characteristic pattern of long-term economic growth in capitalist countries, and that richer countries generally spend more on R&D, but tend to have slower rates of growth (basically because poor countries enrich themselves by copying, and it is easier and quicker to copy). Britain has accorded closely to this pattern, and Kealey therefore concludes that 'Much of the criticism or praise that has been attached to various countries since 1870 has been misplaced . . . . It is generally claimed by commentators that Britain declined because it neglected R&D . . . [but] that is simply not true'. Terence Kealey, The Economic Laws of Scientific Research (London: Macmillan, 1996), pp.1-2, 70-3, 87-92,125-6.

[54] D.E.H.Edgerton and S.M.Horrocks, 'British Industrial Research and Development before 1945', Economic History Review, 47 (1994), 213-38, p.213. Edgerton has gone as far as to suggest that in studying this literature, one 'should be prepared to believe that the opposite of what is implied could be true. Could it be that in the twentieth century Britain has been the most scientific nation in Europe, and its relative economic 'decline' has been caused by too much R&D?'. D.Edgerton, 'British Industrial R & D, 1900-1970', Journal of European Economic History, 23 (1994), 49-67, p.65.

[55] Michael Sanderson, Education and Economic Decline in Britain, 1870 to the 1990s (Cambridge: Cambridge University Press, 1999), p.31.

> The major requirement is to recognise public science as such, that is to recognise that scientific writers were often formulating a polemic for science as a social and intellectual institution within British society and were devising a public ideology for workers in science. Virtually all of the historians of late nineteenth-century science . . . have generally accepted at face value the scientific community's own evaluation of their own predicament and their own characterisation of British scientific backwardness.[56]

The revisionists have also attacked the declinists' failure to make a distinction between relative economic decline and 'doing badly' or failure; the fact that they have taken contemporary complaints at face value; their preoccupation with state-sponsored activity (or rather the lack of it) and the civilian sector; their nationalistic treatment of science and technology; the poor quality of their international comparisons; and the arbitrary use of 'widely differing implicit definitions of science, technology, R&D, novelty, invention and innovation'.[57] David Edgerton has argued, moreover, that 'British higher education, the British state and British industry were, if anything, peculiarly scientific and technological', and dismissed the assumption that they have neglected science and research.[58] In order to support their case, the anti-declinists have highlighted the contribution made by British industry and the military. Sanderson insists that although the private sector has been 'ignore[d], belittle[d] or even slander[ed]' by generations of declinist historians, the 'vast bulk of industrial research . . . was carried out privately within the firm' in this period,[59] and Edgerton and Horrocks have shown that many British firms, in many sectors, were actively engaged in funding and performing research in the early years of the twentieth century.[60] Edgerton and others have also highlighted the significance of the role played by the Admiralty and naval shipbuilding firms which stood at the centre of a scientific and industrial complex of 'unprecedented power', and benefited civilian industries - and the economy - through the process of 'spin-off', particularly in the period 1870-1914.[61]

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[56] Turner, 'Public Science', pp.589-90, 607-8. Similarly, Sidney Pollard insists: 'The agitation was clearly self interested, it came from a lobby of scientists who wanted more status and more resources, and must on that account be suspect'. Pollard, Britain's Prime and Britain's Decline, p.122.

[57] Edgerton, British Industrial 'Decline', pp.11-13.

[58] Ibid, pp.68-9.

[59] Michael Sanderson, 'Research and the Firm in British Industry, 1919-39', Science Studies, 2 (1972), 107-51, p.108.

[60] Edgerton and Horrocks, 'British Industrial Research', pp.219-20.

[61] Edgerton, 'British Industrial R&D', pp.52-3; R.C.Trebilcock, '"Spin-off" in British Economic History: Armaments and Industry, 1760-1914', Economic History Review, 22 (1969), 474-90.

The revisionists have also taken issue with the traditional picture of Britain's universities and challenged the assumption that they were failures as centres of research, insisting that their contribution was 'never more vital' than in the period 1890-1914.[62] The anti-declinists have highlighted the significance of the role played by the new 'civic' universities and colleges,[63] which put much more emphasis on scientific and technological subjects than Oxford or Cambridge,[64] and were closely associated with local industry. As Michael Sanderson explains, 'the circumstances of their founding, the thrust of their studies . . . , the background and careers of their students, their whole ethos was rooted in the industrial culture from which they derived their purpose and which they served'. The civics therefore constitute something of a 'problem' for Martin Wiener's analysis of the decline of the industrial spirit:

> The University system can not be blamed for the decline of the industrial spirit, even if there was such a thing and even if it was declining, on the contrary the largest part of the university sector, the civic universities, were a prime expression of the industrial spirit, closely linked with industry, drawing their lifeblood and finance from it, and pumping back research and students to it.

Sanderson has therefore argued that 'the very real achievements of the British universities and their contribution and service to industry have tended to be masked', noting the existence of a 'symbiotic' relationship between the civic universities and industry, and highlighting numerous examples of the interaction between the universities and industry, in both teaching and research.[65]

Similarly, James Donnelly has argued that 'industrial recruitment was a pivotal force in the growth of higher education in chemistry' in the period 1850-1914.[66] Colin Divall has demonstrated that engineering firms and the universities reached a 'measure of agreement' in the development of undergraduate teaching in

[62] Sanderson, 'Civic Universities', pp.99-100.

[63] The origins and development of the civic universities are discussed in W.H.G.Armytage, Civic Universities: Aspects of a British Tradition (London: Benn, 1955), and David R.Jones, The Origins of the Civic Universities: Manchester, Leeds and Liverpool (London: Routledge, 1988). On Manchester see Robert H.Kargon, Science in Victorian Manchester: Enterprise and Expertise (Manchester: Manchester University Press, 1977), pp.153-237.

[64] Indeed three of the new institutions - Newcastle, Leeds and Birmingham - styled themselves 'colleges of science', and it is 'clear that the fostering of science studies was their principal aim: in order to achieve university status, arts faculties had to be grafted on to the original science colleges'. G.Roderick and M.Stephens, 'Scientific Studies and Scientific Manpower in the English Civic Universities, 1870-1914', Science Studies, 4 (1974), 41-63, p.41.

[65] Sanderson, 'Civic Universities', pp.90-2. See also Elizabeth J.Morse, 'English Civic Universities and the Myth of Decline', History of Universities, XI (1992), 177-204.

[66] James Donnelly, 'Industrial Recruitment of Chemists from English Universities: A Reevaluation of Its Early Importance', British Journal for the History of Science, 24 (1991), 3-20.

engineering (at least up until 1914), and Graham Gooday has discussed William Ayrton's pioneering efforts to establish the academic physics laboratory as a legitimate space for the training of electrical engineers between 1873 and 1884.[67] There is also a good deal of evidence to suggest that the staff of the civic universities often carried out consultative work and applied research in connection with the demands of (local) industry in this period. For example, Sanderson has demonstrated that university science professors often did consultancy work on behalf of local firms, highlighting the example of Oliver Arnold, Professor of Metallurgy at Sir Frederick Mappin's Technical School (which was affiliated to Firth College, Sheffield), and his work on behalf of the British steel industry in the early years of the twentieth century.[68] According to Robert Kargon, Edward Frankland, the first Professor of Chemistry at Owens College, Manchester, also built up 'a vast clientele in industry and local government' as a chemical consultant,[69] and Geoffrey Tweedale has investigated Sir William Boyd Dawkins' work in South Africa, Australia and the Kent coalfields, stressing that he regarded his consultancy work as being inextricably linked with his teaching and research in Manchester.[70] Michael Sanderson has demonstrated that a great deal of work was also undertaken by the London colleges in connection with the demands of local industry, insisting that the University of London was 'actually the chief centre of higher education and research relating to British industry before 1914'. He argues that London professors not only did a 'vast amount' of routine consultancy work, but also did much to help create new industries and new techniques, noting, in particular, their contribution in the fields of aeronautics, dyestuffs, electrical engineering and mechanical engineering.[71] Sanderson even

[67] Colin Divall, 'A Measure of Agreement: Employers and Engineering Studies in the Universities of England and Wales, 1897-1939', Social Studies of Science, 20 (1990), 65-112; Graeme Gooday, 'Teaching Telegraphy and Electrotechnics in the Physics Laboratory: William Ayrton and the Creation of an Academic Space for Electrical Engineering in Britain 1873-1884', History of Technology, 13 (1991), 73-111.

[68] Arnold served as a consultant to various local iron and steel firms, the vast conglomerate Sheffield Steel Makers Ltd., the Admiralty, and the Lloyds Shipping Register. He also carried out pioneering work on the development of high-speed steels, the electric furnace and scientific methods of testing and measurement. Michael Sanderson, 'The Professor as Industrial Consultant: Oliver Arnold and the British Steel Industry, 1900-14', Economic History Review, 31 (1978), 585-606.

[69] Kargon, Science, pp.157-60.

[70] G.Tweedale, 'Geology and Industrial Consultancy: Sir William Boyd Dawkins (1837-1929) and the Kent Coalfields', British Journal for the History of Science', 24 (1991), 435-51.

[71] Michael Sanderson, 'The University of London and Industrial Progress 1880-1914', Journal of Contemporary History, 7 (1972), 243-62, pp.244, 249-51.

goes as far as to insist that since there was very little firm-based or corporately organised research in Britain prior to the Great War, 'most scientific research for industry before 1914 was undertaken not by firms themselves, but by university departments in close contact with industry'.[72] He therefore concludes that by the 1890s 'vitally important researches' were being conducted within the walls of most of Britain's leading universities:

> [They] had long been valuable in developing the routine technologies of various industries, coal mining, engineering and so forth. Yet in this decade university departments achieved two of the most important breakthroughs in physics that were to shape the twentieth century: nuclear physics and practical wireless.[73]

The writers of the various celebratory volumes which have appeared over the years to mark the passing of significant anniversaries in the history of particular institutions have also highlighted the fact that a good deal of important research was being conducted in British universities by the end of the nineteenth century. However, books of this kind tend to be over-simplistic, narrative accounts or administrative histories, which highlight prominent examples of the discoveries made by the staff and students of the university or college in question, but invariably fail to locate these revelations in a wider interpretative context. Negley Harte and John North's illustrated history of University College London is typical of the genre. They suggest that many of the first professors appointed to chairs at UCL conducted extensive and important research in various fields, highlighting, in particular, the work of Anthony Todd Thompson, Professor of Materia Medica (1828-1849), Robert E. Grant, Professor of Comparative Anatomy (1828-1874), and Edward Turner, the first Professor of Chemistry (1828-37), and the fact that the use of anaesthetics was pioneered at UCL - Robert Liston, Professor of Clinical Surgery (1835-47), performing the first operation to be conducted under anaesthetic anywhere in Europe at University College Hospital on 21 December 1846. Later men like A.W. Williamson, Professor of Chemistry and Practical Chemistry (1849-1887), Ambrose Fleming, Professor of Electrical Engineering (1885-1926), and the Reverend T.G. Bonney, Professor of Geology (1877-1901), all conducted important research in their respective fields. In our period, Harte and North report that there was an 'enormous output of research' from the laboratory of Karl Pearson, Goldsmid

[72] Sanderson, 'Civic Universities', pp.99-100.
[73] Sanderson, Universities, pp.189-90.

Professor of Applied Mathematics (1884-1911) and Galton Professor of Eugenics (1911-1933), and note that Sir William Ramsay's Noble Prize-winning discoveries were all made in the Chemistry Department at UCL during his long tenure in the Chair of General and Inorganic Chemistry from 1887-1913. Meanwhile, John Burdon Sanderson, Jodrell Professor of Physiology (1870-1883), Ray Lankester, Professor of Zoology and Comparative Anatomy (1874-1891), and Alexander Kennedy, Professor of Mechanical Engineering (1874-1889), were encouraging their students to undertake their own experiments and investigations, and 'establishing laboratory work as a fundamental part of undergraduate education'.[74] However, beyond noting that the years after the reincorporation of the College into the University of London in 1907 'saw significant steps towards the establishment of substantial research programmes of the type increasingly familiar in the twentieth century', they make no serious attempt to explain how and why the aims and objectives of the College came to include a dual commitment to teaching and research in this period.[75] The authors of these anniversary tributes and celebratory volumes have therefore exaggerated the significance, scale and extent of the commitment to research that began to emerge in British universities in the last years of the nineteenth century and early 1900s. As a result, the most important questions regarding precisely how, when and why Britain's universities came to be reconstituted as places of teaching and research have remained unanswered.

Research Schools

More recently, however, a new generation of scholars working primarily on the history of science have begun to address some of these questions through their work on particular discoveries, disciplines, laboratories and institutions. These accounts have reinforced the claim that a good deal of important research was being conducted in British universities in the last years of the nineteenth century and early 1900s, but the authors of these more localised studies have gone much further to investigate 'the complex way in which personal, social, conceptual and technical factors interact to shape scientific research and to produce scientific change'.[76] Much of

[74] Harte and North, UCL, pp.101-5. See also Bellot, UCL, especially pp.374-416.
[75] Ibid, p.165.
[76] Gerald L.Geison, 'Scientific Change, Emerging Specialities, and Research Schools', History of Science, 19 (1981), 20-40, p.32.

the best work in this area concerns the emergence of 'research schools' and the growth of a 'professional research imperative' within Britain's universities during the last quarter of the nineteenth century.[77]

Gerald Geison defines the research school as a 'small group of mature scientists pursuing a reasonably coherent programme of research side-by-side with advanced students in the same institutional context and engaging in direct, continuous social and intellectual interaction'.[78] It is essentially an academic micro-environment in which professors carry out their own investigations and train their students in the methods of research, while working alongside them - 'cheek by jowl' - in the laboratory or seminar room, usually on a central problem, or employing distinctive techniques or technologies, which give the school a unity of purpose. Simon Schaffer explains that research schools are founded upon the belief that although geniuses make discoveries, well-trained or disciplined students 'transform . . . discoveries into disciplines' - thereby highlighting the fact that the research and pedagogical functions of the research school are inextricably linked.[79] In the most successful schools, the students become disciplined research workers, capable of teaching as well as continuing and extending the work of the school. As Michael Dennis explains:

[77] Jarausch, 'Higher Education and Social Change', p.21. According to Sheldon Rothblatt, the process of academic professionalisation accelerated from about 1870 onwards, and turned to a 'wholly new object, mission or purpose' as the functions of the University came to include a 'formal research mission' (Sheldon Rothblatt, 'The Diversification of Higher Education in Britain', in Jarausch, Transformation of Higher Learning, p.136). See also Sheldon Rothblatt, The Revolution of the Dons: Cambridge and Society in Victorian England (London: Faber and Faber, 1968); A.J.Engel, From Clergyman to Don: The Rise of the Academic Profession in Nineteenth-Century Oxford (Oxford: Clarendon, 1983); Harold Perkin, Key Profession: The History of the Association of University Teachers (London: Routledge and Kegan Paul, 1969); Philippa Levine, The Amateur and the Professional: Antiquarians, Historians and Archaeologists in Victorian England, 1836-1886 (Cambridge: Cambridge University Press, 1986); R.D.French, Antivivisection and Medical Science in Victorian Society (Princeton: Princeton University Press, 1978), and Christopher Lawrence, Medicine in the Making of Modern Britain, 1700-1920 (London: Routledge, 1994).

[78] Geison, 'Scientific Change', p.23. Also see the 1993 edition of Osiris which was devoted entirely to the subject of 'Research Schools: Historical Reappraisals'. Although the term 'school' - in the sense of 'groups, of sometimes but not always teachers and disciples, that are united by the possession of a common doctrine, method or style - has a long history, the term 'research school' dates from the early 1970s, when historians were striving to make the history of science more sensitive to social context, more comparative and more 'fully historical'. This concept revolutionised the teaching and understanding of the history of science in the 1970s and had come to be regarded as 'elemental to modern science' by many historians of science by the early 1990s. John Servos, 'Research Schools and their Histories', Osiris 8 (1993), 3-15.

[79] Simon Schafer, 'Scientific Discoveries and the End of Natural Philosophy', Social Studies of Science, 16 (1986), 387-420.

> The professors and students in the research schools . . . found their fulfilment through teaching and research, the twin motors of the disciplines. Each activity propelled the university and disciplines into the future; the very word, *'re-search'*, emphasized repetition and time.[80]

In his seminal essay on the research schools of Justus von Liebig and Thomas Thomson, Jack Morrell drew up a conjectural model summarising the characteristic features of the 'ideal' research school - a schema for investigating the complex web of intellectual, institutional, technical, psychological and financial factors which underlay the emergence of a successful school. As Morrell readily admits, there are a number of problems with this model, but it does provide a 'useful schematic catalogue of the factors to be considered when examining a research school'.[81]

Judged according to Morrell's rigorous standards, there were few genuine research schools in late nineteenth-century Britain, and unfortunately there are even fewer accounts of their work. Morrell, himself, has discussed Thomas Thomson's pioneering, but 'not by any means totally successful', attempt to establish a chemical research school at the University of Glasgow between 1817 and 1852; and more recently he has also investigated W.H. Perkin's school of organic chemistry at the University of Manchester, and his subsequent attempt to introduce 'Germanic notions and practices of research' at Oxford between 1913 and 1929.[82] Gerald Geison has examined the development of the Cambridge school of physiology under Michael Foster in the 1870s, using Morrell's model to explore the combination of individual and institutional factors which explain the extraordinary success of the school. In particular, Geison notes the significance of Foster's 'charismatic' personality, his broadly biological and evolutionary approach to the study of the mammalian heart-beat, which gave the embryonic school a unity of purpose, and the favourable institutional context of late-Victorian Cambridge.[83] Some years later, Stella Butler followed up Geison's work on Foster with a comparative study of the physiology schools established at UCL, Oxford, Cambridge, Manchester, Liverpool and Leeds. Using the Morrellian model as a loose framework, Butler attempts to explain why the physiology departments at University College London

[80] Michael Aaron Dennis, 'Accounting for Research: New Histories of Corporate Laboratories and the Social History of American Science', Social Studies of Science, 17 (1987), 479-518, p.500.
[81] Jack Morrell, 'The Chemist Breeders: The Research Schools of Liebig and Thomas Thomson', Ambix, XIX (1972), 1-46; Geison, 'Scientific Change', pp.26, 34-6. See below, pp.181-2.
[82] Morrell, 'Chemist Breeders'; Jack Morrell, 'W.H.Perkin Jr. at Manchester and Oxford: From Irwell to Isis', Osiris, 8 (1993), 104-26.
[83] Gerald L.Geison, Michael Foster and the Cambridge School of Physiology: The Scientific Enterprise in Late Victorian Society (Princeton, NJ: Princeton University Press, 1978).

and Cambridge won international acclaim and recognition in the period 1870-1914, while those established in Oxford, Manchester, Liverpool and Leeds enjoyed more limited success. She concludes that the supply of research personnel was the most important factor in this instance:

> Cambridge and University College London clearly had no problem in attracting ambitious young graduates aiming for a research career. Oxford and the provincial laboratories on the other hand, experienced severe problems in persuading talented physiologists to take advantage of their facilities.[84]

Geison also (tentatively) suggests that the Cavendish physics laboratory at Cambridge shared some of the characteristics of the model research school - 'like the Cambridge School of Physiology it descended from and crystallised around a single research problem, to the relative exclusion of others - the redetermination of electrical standards',[85] but there are no other major studies dealing specifically with the emergence of research schools in Britain's universities and colleges in this period. However, there are a number of similar local studies of the work of individual university schools, laboratories and departments which do shed further light on this question. For example, much of Robert Kargon's work on *Science in Victorian Manchester* is concerned with the development of research schools in physics and chemistry under Edward Frankland, H.E. Roscoe, Arthur Schuster and Balfour Stewart at the University of Manchester.[86] Similarly, Melba Phillips and Romualdus Sviedrys have highlighted the significance of the role of research in the appearance and proliferation of physics laboratories in academic institutions between 1865 and 1885,[87] and Graham Gooday has discussed the emergence of an academic culture of teaching and research in precision measurement in British physics laboratories in

[84] Stella V.F.Butler, 'Centers and Peripheries: The Development of British Physiology, 1870-1914', History of Biology, 21/3 (1988), 473-500. See also S.V.F.Butler, 'Science and the Education of Doctors During the Nineteenth Century: A Study of British Medical Schools with Particular Reference to the Development and Uses of Physiology' (Unpublished Ph.D. Thesis, University of Manchester Institute of Science and Technology, 1982), especially pp.214-52, and S.V.F.Butler, 'A Transformation in Training: The Formation of University Medical Faculties in Manchester, Leeds and Liverpool, 1870-1884', Medical History, 30 (1986), 115-32.

[85] Geison, Foster, pp.113-15. Similarly, Michael Sanderson has shown that from the 1890s the Cavendish developed a 'cohesive team of researchers grouped around a professor with its own society, tea parties and group photographs, in a manner more common in Germany since the days of Bunsen and Von Liebig'. Sanderson, Universities, pp.189-90.

[86] Kargon, Science, especially pp.153-237.

[87] Melba Phillips, 'Laboratories and the Rise of the Physics Profession in the Nineteenth Century', American Journal of Physics, 51/6 (1983), 497-503; R.Sviedrys, 'The Rise of Physics Laboratories in Britain', Historical Studies in the Physical Sciences, 7 (1970), 405-36. See also Simon.Schaffer, 'Late Victorian Meteorology and its Instrumentation: A Manufactory of Ohms', in R.Bud and S.E.Cozzens, Invisible Connections: Instruments, Institutions and Science (Bellingham, Washington: SPIE Optical Engineering Press, 1992).

this period, stressing that while emphasis is usually placed on research, the predominant function of these laboratories was pedagogical.[88] The best recent account of the 'intellectual micro-environments' of late-Victorian Cambridge is Andrew Warwick's comparative study of Ebenezer Cunningham's work on electromagnetic equations and Norman Campbell's theory of the electrodynamics of moving bodies, and their contradictory responses to Einstein's theory of relativity. Warwick's aim is to compare rival traditions in Cambridge physics in the Mathematics Tripos and the Cavendish Laboratory, but this account also reveals a great deal about the structure and organisation of teaching and research in late-Victorian and Edwardian Cambridge.[89]

There has only been one attempt to investigate the origins and development of a research school at University College London in this period. In the course of her doctoral research on 'Sir William Ramsay and the Chemical Community', Katherine Watson examined Ramsay's pioneering attempt to establish a school of chemical research at UCL in the context of a more general account of his life and work.[90] She argues that Ramsay's school was unusual in that it was built around a particular set of techniques for dealing experimentally with gases and vapours in minute quantities, rather than a specific research programme or theoretical concept. Her account focusses on a 'research group' made up of Ramsay and some of his junior colleagues and senior students. She insists that only those students who worked closely with Ramsay, using certain techniques of gas manipulation, can be considered to have been members of his school, and concludes that Ramsay was unable to create a widely extended research school of the type commonly associated with Liebig, and that his school at UCL was ultimately 'short lived'.[91] Eileen Magnello's work on Karl Pearson is also interesting in this context. Although she does not frame her analysis in precisely these terms, much of her work -

[88] Graeme Gooday, 'Precision Measurement and the Genesis of Physics Teaching Laboratories in Victorian Britain', British Journal for the History of Science, 23 (1990), 25-51.

[89] He demonstrates, for example, that Lord Rayleigh developed a systemized programme for training students to do experimental work, centring on a series of graded exercises which his students were required to perform in a certain order. Andrew Warwick, 'Cambridge Mathematics and Cavendish Physics: Cunningham, Campbell and Einstein's Relativity 1905-11. Part I: The Uses of Theory', Studies in the History and Philosophy of Science, 23 (1992), 625-56; 'Andrew Warwick, 'Cambridge Mathematics and Cavendish Physics: Cunningham, Campbell and Einstein's Relativity 1905-11. Part II: Comparing Traditions in Cambridge Physics', Studies in the History and Philosophy of Science, 24 (1993), 1-25. See also Schaffer, 'Late Victorian Meteorology and its Instrumentation', and Crosbie Smith and M.Norton Wise, Energy and Empire: A Biographical Study of Lord Kelvin (Cambridge: Cambridge University Press, 1989).

[90] Watson, 'Aspects', especially pp.13-134.

[91] Ibid, pp.29-31, 54-73, 103-36. See below, Chapters 5-8.

particularly her recent article on 'Rival Forms of Laboratory Work' in Pearson's career at UCL - has been concerned with the structure and organisation of the Department of Applied Mathematics and Statistics and the various other laboratories and sub-departments presided over by Pearson in this period.[92] The pattern of growth and development observed in the Department is highly reminiscent of Morrell's 'ideal' research school. Moreover, Magnello has argued that the two most important laboratories in the Department - the Drapers Biometric Laboratory and Galton Eugenics Laboratory - were entirely separate concerns, and her account therefore suggests that Pearson was the principal architect and director of two quite different and distinct, but equally successful, research schools at UCL in the period 1890-1914.[93]

Geison and Butler have discussed Michael Foster and John Burdon Sanderson's failure to establish a successful research school in the Physiology Department at UCL in the 1870s and 80s,[94] but W.J. O'Connor insists that under the direction of Edward Sharpey Schafer, Ernest Starling and William Bayliss from 1883 to 1927, the Institute of Physiology at University College became 'a great centre of physiology - perhaps the greatest in the world'.[95] During his tenure in the Jodrell Chair of Physiology from 1883-1898, Schafer became internationally famous for his pioneering work in the fields of histology and endocrinology, and postgraduate students were drawn to the school from universities and colleges all over the world. These students were trained in the methods of research, encouraged to conduct their own experiments and investigations, and given an opportunity to publish the results. As O'Connor explains, Schafer was the very epitome of the Morrellian director of a flourishing research school - he was a very active research worker, a 'capital head of department, encouraging and advising those who were working there', and someone with sufficient reputation and 'placement power' to ensure that his pupils were

[92] Magnello, 'Non-Correlation'; Magnello, 'Pearson and the Emergence of a Modern Theory of Statistics, 1884-1936'; Eileen Magnello, 'Karl Pearson's Gresham Lectures: W.F.R.Weldon, Speciation, and the Origins of Pearsonian Statistics', British Journal for the History of Science, 29 (1996), 43-63; Eileen Magnello, 'Karl Pearson's Mathematization of Inheritance: From Ancestral Heredity to Mendelian Genetics (1895-1900)', Annals of Science, 55 (1998), 35-94.

[93] Watson, 'Aspects', especially pp.13-134.

[94] Geison, Foster, pp.69-72; Butler, 'Centers and Peripheries', pp.475-6, 480-1. See also Terrie M. Romano, 'Gentlemanly Versus Scientific Ideals: John Burdon Sanderson, Medical Education and the Failure of the Oxford School of Physiology', Bulletin of the History of Medicine, 71 (1997), 224-48.

[95] W.J.O'Connor, British Physiologists: A Biographical Dictionary (Manchester: Manchester University Press, 1991), pp.121-49. See also Butler, 'Centers and Peripheries', pp.476-81, Butler, 'Science and the Education of of Doctors', pp.217-20, 278-97, and French, Antivivisection and Medical Science, p.402.

eventually appointed to important and prestigious posts elsewhere.[96] Stella Butler's account focusses more closely on Starling and Bayliss, and their development of the theory of hormonal regulation, which she insists represented a major 'paradigm shift' away from traditional 'reductionist-mechanical' approaches, towards a more holistic view of the human body.[97] Butler discusses Starling's work in this period in the context of his institutional ambitions and wider political and social beliefs, highlighting the significance of his entrepreneurial role in securing financial and institutional support for his school and his involvement in the campaign to reform the university of London.[98]

The growing body of literature on the emergence of research schools in this country therefore provides an invaluable insight into the structure, organization and scale of university research in this period, highlighting the fact that a good deal of important research was being conducted within the walls of (some of) Britain's leading universities and university colleges by the end of the nineteenth century. Moreover, it has also put some of the more over-zealous claims of the apologists and institutional historians into perspective, highlighting the fact that one research professor, however distinguished, does not make a research university, or even a research school. For example, Kargon notes that Edward Frankland, the first Professor of Chemistry at Owens' College, Manchester, was provided with 'one of the most capacious, modern, and best-designed' laboratories in the country. During his career at Owens, he carried out a series of investigations on organo-metals and the concept of 'atomicity' or valency, and ensured that his students were given the opportunity to conduct their own experiments and investigations. But, within a few years he had come to the conclusion that he could not devote sufficient time and attention to his researches in Manchester. Moreover, many of his students had been 'remiss in their exertions, especially those belonging to the laboratory class'; and Frankland therefore resigned his post in 1856, complaining in a letter to Bunsen:

> It must be in the highest degree satisfactory to you to be surrounded by such a number of students, so many of whom are engaged in original research. Unfortunately this is far from being the case here and there is rarely any further desire for knowledge than the testing of 'soda-ash' and 'bleaching powder'.[99]

[96] O'Connor, British Physiologists, pp.121-4.

[97] Butler, 'Science and the Education of of Doctors', pp.278-97. See also William Bayliss and Ernest Starling, 'The Mechanism of Pancreatic Secretion', Journal of Physiology, 28 (1902), 325-53, and Merrily Borrell, 'Origins of the Hormone Concept: Internal Secretions and Physiological Research, 1889-1905' (Unpublished Ph.D. Thesis, Yale, 1976).

[98] Ibid, pp.171-207.

[99] Frankland to Bunsen, 3 March 1856 (Bunsen Papers, Heidelberg University), quoted in Kargon, Science, p.164.

Perhaps even more importantly, the concept of the research school also has significant implications for our understanding of the meaning and use of the terms 'research' and 'research university'. According to the *Oxford English Dictionary*, research, as defined as 'a search or investigation directed to the discovery of some fact by careful consideration or study of a subject; a course of critical or scientific inquiry', was in common use during the second-half of the nineteenth century.[100] The term *researcher*, defined as 'one who researches; an investigator; inquirer', was also in common parlance. However, in this period it was increasingly coming to mean 'one who devotes himself to scientific or literary research (esp. as contrasted with one whose time is chiefly occupied in teaching or directly renumerative work)', and it is interesting to note that the word researcher was first used as a term of abuse in mid-nineteenth century Oxford to 'stigmatise' the supporters of the endowment of research movement.[101] This definition, supplemented by a reminder of the scientific and technological connotations implicit within most modern definitions of the term,[102] will suffice; but the *research university* is not simply a research institution (despite the recent claims of some of Britain's leading universities). Nor is it a place where teaching and research happen to be conducted alongside each other. Rather, the pedagogical and research functions of the modern university are inextricably linked - so closely related in fact that 'the one informs the other';[103] and the best universities are characterised by a specific culture of *teaching and research*. This is, perhaps, the defining characteristic of modern universities throughout the world. For example, Michael Dennis has argued that in the American research universities of the late nineteenth century, 'research remained part of a pedagogical practice, not a separate activity pursued for its own sake';[104] and having reviewed the *Research Foundations*

[100] Though, interestingly, the plural form, researches, was much more common, e.g. 'Such ambiguous facts . . . often baffle the researches of historians' (1830), Oxford English Dictionary (Second Edition).

[101] MacLeod, 'Resources of Science', p.134.

[102] 'Original Investigation, usually of a scientific or technical nature'. Edgerton, Industrial 'Decline', p.71.

[103] Burton R.Clark, 'Graduate Education and Research Training', in Thomas G.Whitson and Roger L. Geiger, Research and Higher Education: The United Kingdom and the United States (Buckingham: Society for Research into Higher Education and Open University Press, 1992), pp.138-9.

[104] Dennis goes on to insist that the separation of research from teaching was the 'crucial innovation' of the new corporate research laboratories that were established in America at the beginning of the Twentieth Century. Dennis, 'Accounting for Research', pp.496-7, 504-6. Also see Dennis' commentary on Henry Rowland's 1883 address to the American Association for the Advancement of Science entitled 'A Plea for Pure Science', pp.499-502.

of Graduate Education in Germany, Britain, France, the United States and Japan, Burton R. Clark insists: '[t]he coupling of research with teaching is a basic feature of modern higher education'.[105] Similarly, while admitting that 'far from being a natural match, research and teaching can only be organised within a single framework under specific conditions', Joseph Ben-David has argued that one of the most important variables in determining the degree of success in science between countries is the 'degree to which the functions of teaching and research are combined and performed by the same people and in the same organisations', noting that the most successful countries have been those 'where the combination of research with higher education was optimal'.[106]

Germany and the United States

The significance of this dual commitment to teaching and research is also discussed in the literature on the emergence of research universities in other countries, most notably in Germany and the United States. Most historians trace the origins of the modern conception of the university as a place of teaching and research directly to early nineteenth-century Prussia and the founding of the University of Berlin in 1809. In seeking to restore social, political and cultural stability and economic prosperity in the aftermath of Prussia's defeat at the hands of Napoleon in 1806, Wilhelm von Humboldt, the principal founder of the University, argued that the university system should be reformed on the basis of the pursuit of 'universal' or 'absolute knowledge' by staff and students alike, with a view to reorganising state and society on the basis of this knowledge. He therefore placed the subject, not the student, at the centre of his conception of the role and function of the new University. Its principal aim would be 'knowledge creation':

> The relationship between teacher and student is changing. The former does not exist for the sake of the latter. They are both at the University for the sake of science and scholarship.

Clark describes this as the oldest and 'purest' expression of the principle that the pedagogical and research functions of the university should be linked - that

[105] Burton R.Clark, ed., The Research Foundations of Graduate Education: Germany, Britain, France, United States, Japan, (Berkeley: University of California Press, 1993), p.xv. This ideal has had a 'strong run historically in German, British and American higher education, and in all other systems or parts thereof influenced by these major international models'. Clark, 'Graduate Education', pp.158-9.

[106] Ben-David, Scientist's Role, pp.173-6.

professors and students should 'join hands in the pursuit of new knowledge'.[107] But it is important to stress that Humboldt did not envisage the creation of universities dedicated exclusively, or even primarily, to research. In fact, his original conception of *Wissenschaft* (academic learning and research), was not unlike the British concept of a general liberal education - Humboldt insisting: 'general education is meant to strengthen, ennoble and direct man himself, the specialist education will only provide him with skills for practical application'.[108]

Historians have, therefore, perhaps rather exaggerated the significance of this episode. This period witnessed the birth of a *concept*, not the origins of the modern 'research university'. However, the foundation of the University of Berlin 'shocked the entire system', and rival German states hurriedly tried to found similar institutions, or reorganise existing universities and colleges on the basis of the Berlin model. Joseph Ben-David and R. Steven Turner have argued that the growth of the research ethos in German universities was primarily due to the decentralisation of the German system, and competition between the rival states which sought to build up their universities in order to demonstrate 'their political and cultural prowess'.[109] As the Berlin model was taken up and expanded upon in rival institutions, the Humboldtian ideal was corrupted and distorted - the definition and implicit meaning of 'research' subtly shifting all the while, and something closer to the modern conception of the research university was born. For example, most historians agree that the first research school was founded by Justus von Liebig, not in Berlin, but at the University of Giessen in 1824.[110] The Humboldtian quest for truth and knowledge

[107] Quoted in Clark, Research Foundations, pp.3, 9.

[108] Ibid, p.7. See also Pollard, Britain's Prime, p.208.

[109] Ben-David, 'Scientific Productivity and Academic Organization'. Similarly the principal dynamic in the growth of the research ethos in American universities was the decentralisation of the university system and competition between rival institutions: 'The university research system emerged incrementally through a series of initiatives on the part of universities and a plurality of funding sources, within an economic and political context that increasingly encouraged scientific research'. In the U.S. this competition was based not on political rivalry between states, but competition for funds between different universities and colleges. In other words it was the result of the 'entrepreneurial' nature of the American system of higher education. Clark, Research Foundations, pp.227-30; Ben-David, Fundamental Research, p.45.

[110] Morrell traces the origins of the pedagogical tradition of fusing teaching and research together in the same laboratory space to this point. Though it was not the first chemical laboratory in a European university, it was the first institutional laboratory in which 'students experienced systematic preparation for chemical research, and in which they were deliberately groomed for membership of a highly effective research school'. Morrell, 'Chemist Breeders', p.45.

therefore came to be applied to a broader range of subjects, and was also associated with the 'paradigm shift' from analytical / museological 'ways of knowing' towards *experimental* research, first in chemistry and then the biological sciences, especially physiology, and from the 1870s also in physics.[111] In the second-half of the nineteenth century, with the rise of science-based industry in Germany, this quest for knowledge and truth increasingly came to focus on experimental scientific research,[112] particularly in the 'propitious political environment for science' which existed in Germany:

> [Research] provided the foundation of all the sciences . . . and of the nation. It made men as well as machines. It increased the material and spiritual well-being of all Germans. It could unify a disunited and poor folk into one rich cultural whole. It was to be a key element in the new Germany.[113]

As the German principalities demonstrated their burgeoning economic, industrial and military strength in the late 1860s and early 1870s, their universities became 'the envy of the western world',[114] and the German model exerted a profound influence on the development of systems of university education throughout the world in this period, most notably perhaps in Britain, but also in the United States. Under the influence of successive generations of students who went to Germany to study, the foundations of the modern American research university were laid at Yale, with the institution of organised courses for graduate students in 1841 and the launching of the Ph.D. in 1861.[115] However, graduate education and research did not really achieve 'a stable American presence' until the last quarter of the nineteenth century, and most historians trace the origins of the research university in the United States to the founding of Johns Hopkins University, with its 'explicit organizational mission' of graduate education and research, in 1876.[116] It is important

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[111] J.Pickstone, 'Ways of Knowing: Towards a Historical Sociology of Science, Technology, and Medicine', British Journal for the History of Science, 26 (1993), 433-58. See also John V.Pickstone, Ways of Knowing: A New History of Science, Technology and Medicine (Manchester: Manchester University Press, 2000).

[112] A.M.Tuchman, 'Experimental Physiology, Medical Reform and the Politics of Education at the University of Heidelberg: A Case Study', Bulletin of the History of Medicine, 61 (1987), 203-15, p.204.

[113] D.Cahan, 'The Institutional Revolution in German Physics, 1865-1914', Historical Studies in the Physical and Biological Sciences, 15 (1985), 1-65, pp.38-44.

[114] Clark, Research Foundations, p.10.

[115] Geiger, To Advance Knowledge, p.2.

[116] Clark, Research Foundations, p.227.

to stress that the changes instituted in the organisation of teaching and research in Britain and America in the last quarter of the nineteenth century and early 1900s 'reflected the most advanced, and not the actual state of affairs', in the German universities.[117] The Humboldtian ideal was therefore further refined (and distorted) as universities throughout Britain and North America tried to emulate the achievements of their German counterparts and colleagues. But the concept of a dual commitment to *teaching and research* survived, and achieved a new significance in the United States. As Burton Clark explains, Johns Hopkins is widely regarded as being the 'prototype and propagator of research as a major university function',[118] but Michael Dennis insists that 'the University's primary role was pedagogical'.[119] Its first president, Daniel Coit Gilman, was insistent that 'teaching remained the university's first task', and Owen Hathaway and Larry Owens have observed that Gilman (merely) replaced the traditional forms of College discipline with the 'discipline' of the laboratory and seminar, while retaining the goal of making 'worthy citizens':

> The Laboratory and seminar prepared individuals to work and live as members of organized groups in the developing national society. Laboratories and seminars were pedagogical innovations emphasizing cooperation. Through their work with each other and their teachers, students experienced a model of 'social harmony'. The value of science lay in the methods of producing scientific knowledge, not the content of such knowledge . . . . Exposed to the methods of science through their laboratory experiences the college student emerged prepared for life in a dynamic and turbulent world.[120]

Michael Dennis therefore concludes: 'Research and teaching were bound together, the latter more important than the former, even at the University where historians most want to locate the origins of the research spirit'.[121]

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[117] As Joseph Ben-David explains, 'Advanced students visiting Germany in great numbers starting from the 1860s usually chose the most famous teachers and the best institutes, and were treated with special consideration. Thus they returned home with an image of research and training practice that was far superior to and far more liberal than what generally prevailed in Germany'. Joseph Ben-David, Fundamental Research and the Universities: Some Comments on International Differences (Paris: OECD,1968), p.36.

[118] Clark, Research Foundations, p.227.

[119] Dennis, 'Accounting for Research', p.494.

[120] Owen Hathaway, 'The German Model of Chemical Education in America: Ira Remsen at Johns Hopkins (1876-1913)', Ambix, 23 (1976), 145-64; Larry Owen, '"Pure and Sound Government" Laboratories, Gymnasia and Playing Fields in Nineteenth Century America', Isis, 76 (1985), 182-94; D.Hollinger, 'Inquiry and Uplift: Late Nineteenth-Century Academics and the Moral Efficacy of Scientific Practice', in T.Haskell, ed., The Authority of Experts (Bloomington: Indiana University Press, 1984).

[121] Dennis, 'Accounting for Research', p.495.

Aims and Objectives

The extensive secondary literature on Germany and the United States further highlights the inadequacy of the existing material on the emergence of the research university in this country. Historians have quite simply failed to explain the origins and development of the modern conception of the British university as *a place of teaching and research.* Generations of declinist historians have been over-critical and ahistorical in condemning Britain's universities as failures as centres of research in the late nineteenth century; but few anti-declinists have addressed this question in any sort of detail, and the authors of the various celebratory volumes that chart the illustrious histories of particular universities and colleges, have been similarly over-zealous in suggesting that a great deal of important research was being conducted within the walls of most of Britain's leading universities by the end of the nineteenth century. Most problematically, none of these accounts fully grasp the significance of the close - almost symbiotic - relationship that exists between the pedagogical and research functions of the modern British university. However, the growing body of literature on the history of university education in Germany and North America, and on the emergence of research schools in certain British universities and colleges, does suggest a possible strategy for investigating the origins and development of the research university in Britain, based on local studies of particular universities, colleges, departments and laboratories. The principal aim of this thesis is therefore to put the speculation and generalisations of other historians to one side, and attempt to explain precisely how and why one particular university institution began to reinvent itself as a centre for teaching and research in the late 1890s and early years of the twentieth century.

This historiographical review has also demonstrated that the University of London is largely absent from the existing secondary literature on Britain's universities and the rise of research, particularly from the declinist account. However, there is some evidence to suggest that the experience of the London colleges was unique in Britain in this period, and it has been argued that the University of London played a pioneering role in the introduction of the research university in this country.[122]

[122] Thompson, University of London, pp.xiv-ix. See also Sanderson, 'University of London and Industrial Progress', and Simpson, Ph.D., pp.90-2.

It is therefore hoped that the present study of the organisation, ethos and work of one of the leading London colleges will go some way towards making good this gap in the historiography.

This investigation will take the form of a detailed re-examination of the development of government policy towards Britain's universities and colleges in this period, based on the analysis of the government papers relating to the Parliamentary Grant-in-Aid to University Colleges in Great Britain; a brief review of the administrative history of UCL and the University of London, focussing in particular on the College Council and its changing conception of the role and function of the College; and a more detailed investigation of the work of three individual departments of the College, based on extensive research in the College archives and Record Office, looking not for isolated examples of particularly significant or prestigious experiments, innovations and discoveries, but for evidence of the emergence of a genuine culture of teaching and research in the libraries and laboratories of UCL in this period. It will be argued that the origins of the modern conception of University College London as a place of teaching and research are to be found in the efforts of certain (key) professors in certain (key) departments of the College - men like Karl Pearson, Sir William Ramsay and Albert Frederick Pollard - who managed to pursue successful research careers in this period, while training their students in the proper methods of research and encouraging them to conduct their own experiments and investigations. Through their efforts to secure the necessary financial and institutional support for their work, and their involvement in the politics and administration of the College and the battle to reform the University of London, they also played a central role in shaping the College Council and University authorities' changing conception of the aims and objectives of the College in this period.

However, Part One of this thesis - which is loosely focussed on the role of society and the state, and the revolution in the official conception of the role and function of the College - begins with a detailed re-examination of the existing secondary literature on Britain's universities and the rise of research, and an attempt to piece together a general account of the origins and development of the 'research university' in this country based on the best available sources, in order to establish some sort of context in which to place this analysis of developments at UCL in the period 1890-1914. As we have already seen, most of the historians who have dealt with this question in any sort of detail have done so in the context of a more

general discussion about the development of public and government attitudes towards science and the promotion of research in the period 1870-1920. Implicit within most of these accounts is the assumption that government money and initiatives played a decisive role in persuading Britain's universities and university colleges to reconstitute themselves as research institutions during the early years of the twentieth century. The origins and development of the research university in this country can only really be understood in the context of the monumental change that took place in the relationship between the universities and the state, and in the government's conception of its proper role in the promotion and organisation of original research, during the last quarter of the nineteenth century. But there has been no sustained analysis of the development of government policy towards the universities and university colleges in this period, and the existing literature on the subject is confusing and contradictory.

Chapter Three therefore examines the impact of the most significant state-sponsored initiative of the period - the Parliamentary Grant-in-Aid to University Colleges in Great Britain - through a close analysis of the government papers relating to the grant in the Treasury, Board of Education and University Grants Committee files at the Public Record Office, and also in the archives of UCL and the University of London. These papers - especially the reports of the inspectors appointed by the Treasury to investigate the progress made by the colleges participating in the scheme - are an invaluable resource for the historian of higher education in this period, providing a relatively impartial, comparative account of the work of Britain's leading universities and colleges. They have been used extensively by Christine Shinn in the course of her work on the history of the UGC,[123] but have largely been ignored by the protagonists in the debate over the causes of Britain's relative economic and industrial decline, and also by the historians of individual universities and colleges. Moreover, there has been no attempt to examine the significance of the grant in the context of the story of the origins and development of the research university in this country. There is some evidence to suggest that it acted as an 'indirect endowment of research', but there is little proof that the state's intention was to stimulate research in the Treasury and Board of Education papers relating to the grant. The individual colleges retained a great deal of autonomy in deciding how to distribute the money that they received from the

[123] Shinn, Paying the Piper, especially pp.1-57.

government, and the fact that they used it to subsidise various research projects highlights the emergence of a growing belief among British academics and university administrators that the functions of the modern university should include both teaching and research. Furthermore, a detailed review of the accounts and other financial papers of the College Council highlights the significance of private money in underpinning the growth and expansion of the College in this period and the emergence of an institutional commitment to teaching and research. It therefore seems that the origins of the modern conception of the British university as a place of teaching and research are to be found in the individual universities and university colleges themselves, and that the role of the state was merely to consolidate the effects of various developments that were taking place within the university sector.

Chapter Four therefore focusses more closely on the emergence of an institutional commitment to teaching and research at UCL in the period 1890-1914, highlighting in particular the significance of the College Council and its changing conception of the role and function of the College, and also looking for evidence of the emergence of a genuine *culture* of teaching and research in some of the individual departments of the College. This account is based on the careful analysis of the Annual Reports and other papers of the College Council (and the various other committees and sub-committees responsible for the administration of the College and University in this period), which are housed in the Manuscripts Room in the College Library and the College Record Office. It also makes extensive use of material relating to the politics and administration of the College in the University of London Library, at the Public Record Office, and among the private papers of certain individual members of the academic and administrative staff of the College. It is hoped that the detailed investigation of these various sources will make it possible to put all speculation about what the College might - or should - have been like one-hundred years ago to one side, and answer certain basic questions about the growth of the academic staff and postgraduate population of the College, and their collective output of original papers and other publications. It is also hoped that it will be possible to discover more about the structure, organisation and ethos of the College, and the institutional and financial context of teaching and research at UCL in this period.

A systematic review of the Annual Reports of the Council reveals that the period 1870-1914 was marked by a growing commitment to the promotion of original research at UCL, alongside the more traditional pedagogical aims and objectives of the College, which culminated in the formal reconstitution of University College London as a place of teaching and research in 1905. This revolution in the official conception of the role and function of the College acted as a powerful stimulus to the work already going on at UCL, but it would take several decades for a genuine culture of teaching and research to emerge on a College-wide scale. In this period the 'research revolution' was led by a handful of pioneering professors in certain individual departments of the College. Despite the unfavourable institutional circumstances of the late nineteenth century, these remarkable men managed to pursue successful research careers in the libraries and laboratories of University College, while simultaneously introducing the concept (and devising the methods) of research training for students. Moreover, through their involvement in the politics and administration of the College and the campaign to reform the University of London, they were also instrumental in persuading the College Council to adopt a much broader definition of the aims and objectives of the College in this period.

Part Two of this thesis therefore concentrates on the work of three of the most active 'research departments' at UCL in this period, using Jack Morrell's model of the 'ideal' research school as a framework for examining the complex web of intellectual, institutional, technical, psychological and financial factors which underlay the emergence of research schools in certain departments of the College, and also to investigate the impact and implications of these developments on the official conception of the role and function of the College. The Departments of Applied Mathematics and Statistics, Chemistry and History were particularly active in the area of original research, together accounting for just under one-third of the postgraduate students who passed through the College between 1890 and 1914, and approximately 30% of the original papers and other publications produced by the staff and students of the College during the first decade of the twentieth century. They are also representative of the main lines of research pursued in the arts, sciences and 'social sciences' at UCL in this period. Moreover, in each case the principal architect and director of the school - Karl Pearson, William Ramsay and A.F.

Pollard - was also involved in the politics and administration of the College and University, and played a prominent role in persuading the College Council and University authorities to accept a new conception of the aims and objectives of University College London in the period 1890-1914.

These departmental case studies therefore suggest that the origins of the modern conception of UCL as a centre for the advancement and dissemination of knowledge are to be found within the individual departments of the College - in the efforts of certain individual professors, in certain (key) departments, to conduct their own experiments and investigations, to train their pupils in the methods of research, and to secure the necessary financial and institutional support for their work.

Part 1. Science, Society and the State

2. The Universities and the Rise of Research - An Overview

Before the [First World] War, most of the research in universities was carried out by professors, lecturers and other university teachers in their spare time . . . . [However] it was coming to be understood more and more that research was as important, if not more important, to the university as was teaching.

J.D.Bernal, 1939.[1]

Although we still lack a comprehensive account of the origins and development of the modern conception of the British university as 'a place of teaching and research', it is possible to piece together a very general account based on those histories of individual universities and colleges which take a broadly analytical (rather than celebratory) approach to the subject, and the literature dealing with the history of particular disciplines and discoveries and the 'intellectual microenvironment' of individual research schools, laboratories and university departments. As we have already seen, most of the historians who have discussed the origins of the 'research university' in Britain have done so in the context of a more general discussion about the development of public attitudes and government policy towards science and the promotion of research in the period 1870-1920. The universities did not exist in a vacuum; rather, as Jack Simmons explains, they were 'delicately sensitive barometer[s]' of social and political change, and their transformation between 1890 and 1914 was 'in close harmony with the spirit of the time'.'[2] The emergence of a new conception of Britain's universities as centres of teaching and research in the last years of the nineteenth century and early 1900s can therefore only really be understood in the context of the concurrent transformation in the attitude of the British people and government towards science and research, and the monumental change that took place in the relationship between the universities and the state over approximately the same period. To quote Roy MacLeod, 'a scientific spirit was abroad in the land' in this period ,[3] and as Mark Pattison observed in 1885, it was thanks to the 'silent and permeative genius of science that . . . a large and comprehensive view of the function of a University . . . spread'.[4]

[1] J.D.Bernal, The Social Function of Science (London: Routledge, 1939), p.36.
[2] Simmons, New University, p.18.
[3] MacLeod, 'Resources of Science', p.116.
[4] Mark Pattison, Memoirs (London: Macmillan, 1885), p.24.

The Ancient Universities

Until as late as 1832, there were only two universities in England, and those eminent institutions - 'the two great public nuisances' long established at Oxford and Cambridge - were not great centres of *teaching and research* where students were introduced to the methods of academic research by distinguished professors who meanwhile undertook their own pioneering investigations.[5] Although the Oxbridge colleges have always 'housed scholars of considerable eminence . . . and well-read cultivated men; and there was ample opportunity for a serious man to study on his own',[6] Michael Sanderson explains that 'the chief function of the university was seen very much in terms of transmitting a received body of knowledge, in teaching rather than in the creation of new subjects or areas of study through research'.[7]

Taking the complaints of their contemporary critics at face value, historians have been fairly unanimous in their condemnation of the Oxbridge colleges of the early nineteenth century, dismissing them not just as failures as centres of research, but more generally as failures as centres of any sort of worthwhile academic endeavour. According to Professor Green, for example, the ancient universities were little more than 'super-public schools inhabited by large children'; establishments where, to quote Matthew Arnold, 'the youth of the upper-classes prolong[ed] to a very great age . . . their school education'. Most Oxbridge fellows had 'scant regard' for their duties, 'exercises for degrees had degenerated into meaningless formalities', and 'even when the teaching was conscientious . . . scholarship was neither original or profound'.[8] The great majority of Oxbridge students were merely destined to return to their estates and a life of privileged ease, and thus 'had little motive for serious academic exertion'. Noting the example of William Makepeace Thackeray's account of the life and times of 'a rich idler at Oxford' in *Pendennis*, Sanderson insists that such men went off to Oxford or Cambridge simply to enjoy a 'spell of extravagant idleness and fun',[9] while others saw their

[5] Jeremy Bentham quoted in Harte and North, World of UCL, p.12.

[6] Green, Universities, p.204.

[7] Sanderson, Universities, p.6.

[8] Green, Universities, pp.204-06; Matthew Arnold, Schools and Universities on the Continent (London: Macmillan, 1868), quoted in Eric Ashby, Technology and the Academics: An Essay on Universities and the Scientific Revolution (London: Macmillan, 1958), p.13.

[9] William Makepeace Thackeray, The History of Pendennis, His Fortunes and Misfortunes, His Friends and His Greatest Enemy (Leipzig: Bernhard Tauchwitz, 1849), quoted in Sanderson, Universities, pp.90-1.

university days as a 'character building' exercise, or sought the enormous social advantages to be gained from 'mixing with a large body of young men . . . who represent[ed] the best classes of . . . society'.[10] 'Hard-reading men' were therefore in a minority';[11] and those students who were diligent in their studies were only instructed in the 'liberal' arts, centring on the study of classics at Oxford and mathematics at Cambridge. While not in itself fitting the recipient for any particular occupation, a liberal education was thought to induce habits of rational thought and analysis, as well as 'schooling the memory', while 'liberality' was also associated with moral qualities, like 'openness [and] generosity of spirit - the traits of the gentleman'. According to Sanderson, the chief purpose of a liberal education was ostensibly the pursuit of knowledge for 'its own end', but it ultimately did little more than give a 'gentlemanly stamp to those . . . who had no need to earn a living or whose position was assured', and prepare 'the less well-to-do' for a career in the Church of England (or, from 1853, in the civil service).[12] Oxbridge students therefore showed 'scarcely any interest in [the] work . . . [of] enlarging and deepening the field of knowledge'.[13]

As we have already seen, much of the existing secondary literature on Oxford and Cambridge is marred by an uncritical acceptance of the complaints of certain (early) nineteenth-century critics of the ancient universities, and a remarkable tendency to assume that what may have been true of Oxford in 1820 was also true of Cambridge in 1870 (and vice versa). However, more recent scholarship, based on extensive research in the University and College archives, has demonstrated that it is harder to make generalisations about the ancient universities and their constituent colleges than the declinists would have us believe. For example, in her recent essay on the natural sciences at Oxford, Janet Howarth argues that there was a great deal of variation between the various Oxbridge colleges in terms of their commitment to science and research in the period 1880-1914:

[10] Edward Bradley, The Adventures of Mr.Verdant Green, An Oxford Freshman (London: Nathaniel Cooke, 1853), pp.10-11. See also Peter Searby, A History of the University of Cambridge. Volume III 1750-1870 (Cambridge: Cambridge University Press, 1997), pp.60-70.

[11] Sanderson, Universities, p.78.

[12] Ibid, pp.1-3.

[13] Simmons, New University, p.13. See also Searby, Cambridge, pp.111-17, and Christopher N.L. Brooke, A History of the University of Cambridge. Volume IV 1870-1990 (Cambridge: Cambridge University Press, 1997), pp.20-33.

> Some colleges took a lead in patronising science - at Cambridge preeminently Trinity but also Caius and St. John's; at Oxford, Christ Church, Magdalen, and later Balliol, Trinity and Jesus.[14]

She has also highlighted the significance of the work undertaken by individual members of staff working independently in the small College libraries and laboratories, including, for example, the pioneering physical chemist A.G. Vernon Harcourt, who presided over a small but fairly successful laboratory at Christ Church between 1859 and 1902.[15] But while research was 'possible' at Oxford, the University 'was not organised to promote it', and Howarth is forced to conclude that 'Oxford's contribution to learning in these years cannot compare with its own record in the thirteenth, seventeenth or high twentieth centuries, nor with the contemporary output of some of the universities and research institutes on the continent'.[16] Although 'some original work was done', professors and other members of staff were not required, or even encouraged, to pursue their own researches.[17] The 'merit acquired by research might weigh in the appointment to a post for teaching and administration',[18] but, as Sanderson explains, 'election to a fellowship was regarded as a reward for past achievements entailing a right to the annual share-out of dividends of college income, rather than as an appointment to a post of employment entailing a job of work and a career',[19] and Peter Searby insists:

> [U]ntil the reforms of the 1870s Cambridge Fellows did not have an obligation to perform tasks in return for their guaranteed stipend; the burdens of scholarship and tuition were voluntary, and were assumed by men like Adam Sedgwick and James Wood because they were naturally industrious . . . . Eighteenth-century fellows wrote, or at least published, very little . . . . In the nineteenth century fellows became more productive, though not so as to astound us with their industry.[20]

In fact, there existed a 'residual opposition' to the institutionalisation of science and research in the ancient universities, on both intellectual and financial grounds. According to Janet Howarth for example, there is more than a grain of truth in the old

[14] Janet Howarth, '"Oxford for Arts": The Natural Sciences, 1880-1914', in M.G.Brock and M.C.Curthoys, eds., The History of the University of Oxford. Volume VII. Nineteenth-Century Oxford, Part 2 (Oxford: Clarendon Press, 2000), pp.484-5.
[15] Ibid, pp.462-4. See also H.B.Hartley, 'The Contribution of the College Laboratories to the Oxford School of Chemistry', in Studies in the History of Chemistry (Oxford: Clarendon, 1971); K.J.Laidler, 'Chemical Kinetics and the Oxford College Laboratories', Archives for the History of Exact Sciences, 38 (1988), 197-283, and C.King, 'The Chemist in Allegory: Augustus Vernon Harcourt and the White Knight', Journal of Chemical Education, 60 (1983), 177-80.
[16] Janet Howarth, 'The Self Governing University, 1882-1914', in Brock and Curthoys, Oxford, pp.616-22.
[17] Simmons, New University, p.10.
[18] Nature, 96 (1915-16), p.453.
[19] Sanderson, Universities, p.76
[20] Searby, Cambridge, p.112 (see also Appendix IXa).

argument that '[s]cholars in the older deductive disciplines at both places sometimes regarded experimental science with suspicion or contempt, as no more than a "pleasant recreation" or "hobby" for amateurs'.[21] The traditional liberal arts subjects were valued for their relative constancy and 'timeless, unquestionable authority'. If research was to become accepted alongside teaching as a major function of the universities, then 'much of the clear-cut traditional authority of the old subjects would be eroded as students no less than teachers would be expected to question and inquire as they saw old truths replaced by new uncertainties'. The liberal arts were also relatively inexpensive. The classical texts did not change, and new research did not render the existing literature obsolete. Existing funds catered for the traditional subjects, but the introduction of new disciplines and a growing commitment to original research entailed 'expensive laboratory building, equipment and salaries for new professorships, fellows with new expertises and an open-ended commitment to library expansion in an on-going discipline'.[22] The collegiate system was therefore 'ill-adapted to the needs of disciplines requiring expensive plant and specialised teaching'.[23] Endowments were generally attached to individual colleges and heavily committed to fellowships and scholarships in classics at Oxford and mathematics at Cambridge, and since the fellows of each college divided its annual profits between them, there was a strong vested interest against increasing 'unnecessary' college expenses. Moreover, 'the low overheads of classics and mathematics teaching obviated the need for a strong, central, well-financed, interfering university', and the institutionalisation of research would also threaten the traditional character and power structure of the ancient universities. They were divided into, and dominated by, semi-independent colleges, which, though wealthy, could not afford to install the expensive facilities and equipment required for research separately. Scientific research would have to be carried out on a joint basis under the auspices of the university - and that would threaten the historic dominance of the colleges over the university.[24]

Although the Scottish universities were similarly ancient and equally committed to the concept of a general liberal education, there appears to have been a much stronger research tradition in Scotland. For example, in his account of the

[21] Howarth, 'Oxford for Arts', pp.484-5.
[22] Sanderson, Universities, pp.5-7.
[23] Howarth, 'Oxford for Arts', p.485.
[24] Sanderson, Universities, pp.5-6. On the structure and organisation of Oxbridge colleges and their relationship with the universities see also Searby, Cambridge, pp.45-60, 82-117.

Patronage of Mid-Victorian Science in the University of Edinburgh, Jack Morrell argues that 'though the science professors were paid primarily to teach . . . , without exception the[y] . . . used their chairs to do research'.[25] Morrell has also discussed Thomas Thomson's pioneering, but only partially successful, attempt to establish a research school in chemistry at the University of Glasgow between 1817 and 1852;[26] and it has also been argued that the Scottish universities led the way in the introduction of research degrees for advanced students in Great Britain. Simpson notes that the Edinburgh D.Sc., which was introduced in 1864-65, included a research component from the very beginning, and in 1895 all four Scottish universities adopted the D.Sc., D.Lit. and D.Phil. as five year research degrees.[27] However, there was 'a persistent and frustrating disparity between teaching and research in science' in Scotland, and Morrell concludes that 'perhaps the most telling feature of the research done in science at the University of Edinburgh in the mid-Victorian period was the absence of those institutionally supported research schools which had evolved in the leading German universities' (which he blames on the lack of substantial state patronage).[28] The cost of research in the form of materials, apparatus and equipment therefore had to be borne by individual professors. Some of them held prestigious secondary posts, which they tried, with varying degrees of success, to exploit for research,[29] but most were in the same position as P.G. Tate, who, as Professor of Natural Philosophy at Edinburgh, was forced to confine his attention to 'those research problems which he could finance from his own pocket' and to run his laboratory 'from the same source'. Moreover, the professors' dependence on their income from the fees paid by their students, and the fact that 'keeping themselves in business as teachers inevitably consumed much professional effort and time', meant that 'research was . . . usually squeezed into the intervals between teaching'.[30]

[25] Morrell, 'Patronage of Mid-Victorian Science', p.360.
[26] Morrell, Chemist Breeders.
[27] Simpson, Ph.D., pp.67-70.
[28] Morrell, 'Patronage of Mid-Victorian Science', pp.386-7.
[29] For example, the Professors of Botany, Geology and Practical Anatomy, were, respectively, Regius Keeper of the Royal Botanic Gardens, Director of the Scottish Geological Survey, and Astronomer Royal for Scotland, while Wyville Thomson, the Natural History Professor, mounted the famous *Challenger* expedition and had his research 'extensively patronised' by the Admiralty. One obvious and traditional sources of income came from the writing of text books and popular works, while others, such as Fleeming Jenkin and Sir William Thomson, subsidised their research through consultancy work or professional practice. Ibid, pp.382-5.
[30] Ibid, pp.381-2.

The University of London

Although a number of new universities and university colleges were established in the course of the nineteenth century, the aims and objectives of these institutions were essentially modest, at least in terms of their commitment to research. There was an attempt to provide a broader curriculum than the ancient universities (including a pioneering attempt to introduce instruction in engineering) at the University of Durham, which was founded by the Cathedral Chapter in 1832. But ultimately the new university was little more than a 'poor imitation of Oxford and Cambridge, largely devoted to trying to make clergymen out of youths lacking the academic ability or social standing to enter the ancient universities'.[31] Similarly, the aim of the University of London, as defined in the Charter of Incorporation (finally) granted on 28 November 1836, was simply 'to hold forth to all classes and denominations of Our Faithful subjects . . . an encouragement for pursuing a regular and liberal course of Education'; its 'purpose', to ascertain, 'by means of examinations, the persons who have acquired proficiency in Literature, Science and Art, by the pursuit of such courses of education', and to reward them with 'Academical Degrees'.[32] Thus it was little more than an examining board for the newly reconstituted University College London, and also for Kings College London, which was established as an Anglican riposte to the 'sty of infidelity in Gower Street' in 1831 - its principal aim: to 'imbue the minds of youth with a knowledge of the doctrines and duties of Christianity as inculcated by the United Church of England and Wales'.[33]

And what of the 'godless institution in Gower Street'?[34] As we have already seen, when UCL was founded in 1828, its aims, though revolutionary in so many respects,[35] were similarly modest in terms of its commitment to teaching - its mission: to encourage 'the advancement and promotion of literature and science by affording to young men . . . adequate opportunities for obtaining literary and scientific education at moderate expense'. The founders of University College did put a great deal of

[31] Sanderson, Universities, p.32.

[32] 'Charter Granted by His Majesty to the University of London', 28 November 1836, Historical Record, pp.26-30. On the origins of the University see Harte, University of London, pp.9-76.

[33] Hearnshaw, King's College London, pp.41-7.

[34] Ibid, p.42. On the origins of UCL see Bellot, UCL, pp.1-59.

[35] As Jack Simmons explains, 'It presented the strongest imaginable contrast to Oxford and Cambridge. Not only did it impose no religious tests on its members, whether tutors or students: it specifically declined to teach theology in any form. It offered no residential accommodation whatever, [and] the fees it charged were extremely low'. Simmons, New University, p.14.

emphasis on the natural sciences, insisting that, alongside the more traditional academic disciplines, Chemistry, Natural Philosophy, Astronomy, Logic and the Philosophy of the Human Mind were 'subjects which constitute[d] the essential parts of a liberal education, and also providing for Chairs in Geology, Mineralogy, Botany and Zoology.[36] Moreover, as Donald Cardwell has argued, 'as regards science, the subjects taught were very up-to-date, the latest knowledge being incorporated in the syllabuses; the study of the steam engine was included in the physics course and, in mathematics, analytical methods were used'.[37] But the emphasis was always on teaching and instruction:

> The Plan of the institution will comprehend public lectures, with examinations by the Professors; mutual instruction among the pupils, and the aid of tutors in those parts of knowledge which require to be minutely and repeatedly pressed on the memory'.[38]

The professorial staff were not paid to conduct their own research, and they were given little or no institutional support by the College. The University authorities merely required that each professor devote at least two hours a week to the instruction of his pupils - 'one hour to be occupied by the lecture, and another hour to be devoted to the examination of the pupils'.[39] While this does not appear to be a particularly onerous burden (particularly when compared to the extensive teaching demands made of the modern professor), Roy MacLeod notes that Thomas Hirst, an early Professor of Mathematics at UCL, resigned his Chair in 1854, complaining:

> I cannot at present do any original work, [and] it is only by devoting myself wholly to lecturing that I can keep up my number of students at the College, and thus secure my bread.[40]

Similarly, noting the fact that Karl Pearson's time was given over primarily to teaching ('a good sixteen hours a week'), Daniel J. Kevles has argued that 'research was regarded as an indulgent luxury' at University College,[41] and most historians would concur with Roy MacLeod's judgment that UCL, even 'with its strong scientific tradition, offered very limited opportunities for research'.[42]

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[36] Statement by the Council of the University of London, pp. 31-41. The Prospectus produced by the Council in 1826 is reproduced in Harte and North, World of UCL, pp.17-19.

[37] Cardwell, Organisation of Science, pp.46-7.

[38] Statement by the Council of the University of London, p.32.

[39] Ibid, pp.17-18.

[40] Hirst Diaries (Royal Institution) iv f. 28 February 1859, quoted in MacLeod, 'Resources', p.122. In fact, Hirst was Professor of Mathematics at UCL from 1865-70. This extract form his diary actually refers to his resignation as a member of staff at Queenwood College in Hampshire.

[41] Daniel J.Kevles, In the Name of Eugenics: Genetics and the Uses of Human Heredity (Berkeley and Los Angeles: University of California Press, 1985), p.26.

[42] MacLeod, 'Resources of Science', p.122.

The Civic Universities

However, in the second-half of the nineteenth century, the work of expansion was taken up again 'with all the accustomed furious energy of that age', and by 1914 there were fifteen English universities (including five university colleges), and a total of 31 university institutions in the British Isles as a whole. The university population was also growing - the number of undergraduates rising from only 2,000 in 1815, to more than 18,000 by 1914.[43] Moreover, as the number of universities multiplied, 'their scope . . . widened far beyond the conception of any earlier age',[44] and, as Harold Perkin explains, the British University was transformed from a marginal institution, an optional finishing school for young gentlemen and prospective clergymen, into the central powerhouse of modern industrial society'.[45]

Between 1850 and 1885 new 'civic' university colleges, operating under the academic patronage of the University of London,[46] (and, to a lesser extent, Oxford and Cambridge),[47] were established in Manchester (1851), Newcastle (1871), Reading (1872), Aberystwyth (1872), Leeds (1874), Dundee (1874), Birmingham (1875), Bristol (1876), Sheffield (1879), Liverpool (1881), Nottingham (1881), Cardiff (1883) and Bangor (1884) - Owen's College Manchester, the Yorkshire College of Science, and University College, Liverpool, amalgamating to form the federal Victoria University in 1880.[48] These colleges were generally founded on the initiative of local industrialists and businessmen, and therefore reflected the demands of local trade and industry for people with academic training.[49] As a result of this connection with local firms and businesses, these colleges generally put more

[43] Simmons, New University, pp.9-10.

[44] Ibid, p.49.

[45] Harold Perkin, 'The Pattern of Social Transformation in England', in Jarausch, Transformation of Higher Learning, p.207.

[46] From 1837 the University of London assumed responsibility for examining all the academic institutions in the United Kingdom which it was prepared to recognise as such, and after 1849 its jurisdiction was extended to include the whole Empire, thus providing the major impetus for the expansion of the university system in Britain (and, indeed, throughout the colonies and dominions).

[47] Under the auspices of the Oxbridge-based University Extension Movement, Oxford and Cambridge professors delivered regular courses of lectures in provincial towns throughout Britain in the 1860s and 70s, thereby stimulating a demand for university education, and 'providing a root from which some of the civic universities . . . sprang, notably Sheffield, Reading and Nottingham'. Sanderson, Universities, pp.146-47; Simmons, University, pp.26-7.

[48] See Sanderson, 'Civic Universities'; Jones, Origins of the Civic Universities; Armytage, Civic Universities; Kargon, Science, and Roderick and Stephens, 'Scientific Studies and Scientific Manpower in the English Civic Universities'.

[49] Simmons, New University, pp.9-10. See also Owen, English Philanthropy, pp.361-7.

emphasis on scientific and technological subjects than the ancient universities; but their aims were similarly modest in terms of their commitment to research. For example, the principal aim of the chief benefactor of Owens College, Manchester, was to establish a local institution where 'young men' would receive 'instruction . . . in such branches of learning and science as now and may be hereafter taught in the English universities', especially those 'departments of knowledge as are most generally subservient to the purposes of community life'.[50] Similarly, the Yorkshire College of Science (which was eventually reconstituted as the University of Leeds) was founded in 1874 as a provincial centre for instruction 'in such sciences and arts as are applicable or ancillary to the manufacturing, mining, engineering and agricultural industries' of the county.[51] Moreover, although Roy Lowe has argued that the civics 'represented a direct attack upon the concept of a university as a monastic institution offering a human education in the Liberal arts',[52] the Oxbridge colleges continued to exert a considerable influence over the development and official conceptualisation of the role and function of Britain's universities and university colleges. As Elizabeth Morse explains, 'there is in this country a most captivating idea of a university based firmly and immutably upon the ancient foundations at Cambridge and Oxford'.[53] Similarly, pointing to the fact that Owens College, Manchester, was initially 'devoted to the old liberal education', Michael Sanderson insists that the policy of the new colleges was 'to try to carry on the education of the ancient universities in a rather skeptical northern environment, and . . . [they] atrophied as a result'.[54]

However, whatever their stated aims and intended purpose, the staff and students of these new universities and colleges often carried out a great deal of research in connection with the demands of local industry, principally as a means of 'prov[ing] their value to the industrial patrons who provided their laboratories'.[55] As we have already seen, Sanderson, Tweedale, Kargon and others have highlighted the significance of the consultative work and applied research undertaken by the professorial staff of the civic universities on behalf of local firms and industrial patrons

[50] John Owen's will, quoted in B.W.Clapp, John Owens, Manchester Merchant (Manchester: Manchester University Press, 1965), p.173.
[51] Aims of the Yorkshire College of Science, quoted in Green, Universities, pp.114-15.
[52] Roy Lowe, 'The Expansion of Higher Education in Britain', in Jarausch, Transformation of Higher Learning, p.40.
[53] Morse, 'English Civic Universities', p.183.
[54] Sanderson, Universities, p.79.
[55] Ibid, p.7.

from further afield.[56] However, although individual members of staff often carried out important research in this period, it took much longer for a genuine culture of *teaching and research* to emerge on any significant scale.[57] The dearth of material on the development of research schools in Britain is perhaps no more keenly felt than in this area, but Robert Kargon's work on Manchester does shed some light on the organisation of teaching and research in science at Owens College in the last quarter of the nineteenth century and early 1900s.

According to Kargon, Edward Frankland's successor in the Chair of Chemistry, Henry Enfield Roscoe, put even more emphasis on original research than his predecessor, insisting:

> The spirit of research must be felt in the atmosphere of the laboratory . . . . The stimulus for Original Work must be given by the teacher, and it is he only whose head, hand and heart are thus occupied, who can induce others to follow the same difficult though delightful path.[58]

Under the direction of the charismatic Roscoe, 235 original publications were produced by the staff and students of the Chemistry Department at Owens College between 1856 and 1887, and his school became renowned as the 'most important center for chemical research in England'.[59] Roscoe's colleague in the Chair of Natural Philosophy, Balfour Stewart, was also a distinguished and wide-ranging scientist. He had already published work on astronomy, meteorology, chemistry and mathematics, and had been awarded the Royal Society's prestigious Rumford Medal in 1868 for his work on radiant heat. He was insistent, moreover, that the 'Physical Laboratory would not only be used in experimental [illustrations] of certain laws enunciated in the lectures but . . . some observational and also some experimental research ought always to be going on'.[60] Stewart's most distinguished pupil, J.J. Thompson, recalls approvingly:

> We set up the apparatus for ourselves and spent as much time as we pleased in investigating any point of interest that turned up in the course of our work . . . . Balfour Stewart was enthusiastic about research and succeeded in imparting the same spirit to some of his pupils.[61]

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[56] See, for example, Donnelly, 'Industrial Recruitment'; Divall, 'Measure of Agreement'; Sanderson, 'Professor as Industrial Consultant', and Tweedale, 'Geology and Industrial Consultancy'.

[57] Roderick and Stephens, 'Scientific Studies and Scientific Manpower', pp.52-3.

[58] H.E.Roscoe, Record of Work Done in the Chemical Department of the Owens College 1857-1887 (Manchester, 1887), pp.23-26, quoted in Kargon, Science, p.179.

[59] Butler, 'Centers and Peripheries', p.497. See also G.N.Burkhardt, 'Schools of Chemistry in Great Britain and Ireland, the University of Manchester', Journal of the Royal Institute of Chemistry, 78 (1954), 448-60.

[60] Stewart to Roscoe, 2 June 1870 (B.C.S. Archives), quoted in Kargon, Science, pp.215-16.

[61] J.J.Thompson, Recollections and Reflections (London,1936), pp.19-20.

In 1887 Arthur Schuster succeeded Stewart as Langworthy Professor of Physics. According to Kargon, 'sophisticated researches on the latest and most interesting problems were executed by [the] staff and students' under his direction - Schuster, himself, continuing to pursue his own pioneering researches in spectroscopy, astronomy and astrophysics.[62] He strove to create a real 'sense of a research community'. The course of practical physics was modified in order to accommodate 'an original investigation' to be completed during the third year of study. A physics colloquium 'for the encouragement of research and the acquisition of knowledge of recent advances in physics and allied subjects' was launched in 1874; and a new laboratory, complete with special facilities for advanced research in electricity and electrical engineering, spectroscopy, meteorology, radioactivity, thermal conductivity, electrochemistry and electrometallurgy, was opened in 1898.[63]

Meanwhile, in the Department of History, T.F. Tout was striving to win 'recognition for the principle that a university history school should train its students to do historical research'.[64] He was one of the leading members of a new generation of 'professional' historians who rose to prominence in the last years of the nineteenth century, insisting that the 'spirit of research [was] in the air', and that it was the 'function of the historical professor, not only to teach, but also to write books'.[65] Tout maintained that the 'true measure of academic progress [was] the share which the university [took] in the advancement of knowledge and the part which it play[ed] in training its alumni in original investigation.[66] He therefore introduced a compulsory thesis or dissertation based on original archival research as the centrepiece of the undergraduate history course at Owens College, and established a rigorous postgraduate training course for professional historians. As John Kenyon explains, a

[62] Kargon, Science, pp.222-5.

[63] Arthur Schuster, 'The New Physical Laboratory of the Owens College, Manchester', Nature, 58 (1898), 621-2.; Kargon, Science, pp.228-30. On developments in physiology at Manchester, Liverpool and Leeds see Butler, 'Transformation in Training'; Butler, 'Science and the Education of of Doctors', pp. 222-32, and Butler, 'Centers and Peripheries', especially pp.482-7.

[64] Slee, Learning and a Liberal Education, p.153.

[65] T.F.Tout, 'Schools of History' (Lecture delivered at Newnham College, Cambridge, 26 January 1906), reproduced in The Collected Papers of Thomas Frederick Tout with a Memoir and Bibliography. Volume I. Miscellaneous Papers Chiefly on the Study of History and the University of Manchester (Manchester: Manchester University Press, 1932), p.96.

[66] T.F.Tout, 'Four Years of Development', Manchester Guardian, 14 January 1908, reproduced in Ibid, p.54.

'remarkable succession of students and apprentice historians' passed through the Department - principal among them James Tait, Ramsay Muir, George Unwin, W.A. Shaw and Maurice Powicke - and by 1900 Tout was the director of the leading research-based history school in the country.[67]

The Ancient Universities and the Rise of Research

Recent work on the ancient universities has demonstrated that there were similar developments at Oxford and Cambridge over approximately the same period. A new tripos in the Moral Sciences was introduced at Cambridge in 1848, and a Natural Science Tripos was established three years later; while Honours Schools in Modern History, Mathematics, Physics, Law and the Natural Sciences were introduced at Oxford in 1850.[68] Meanwhile, a small, but not insignificant, number of Oxbridge professors - principal among them H.H. Vaughan, Thomas Appleton and Mark Pattison (Renate Simpson's great 'champion of research')[69] - campaigned for the 'endowment of research' within the ancient universities. For example, in his *Suggestions on Academical Organisation*, Mark Pattison insisted:

> We shall never place our university on a sure footing as long as we regard the undergraduate alone as the end and purpose of the institution . . . . The professor of a modern university ought to regard himself as primarily a learner, and a teacher only secondarily . . . . It is requisite . . . that the university teacher should be first himself a man of science; that science should be his own pursuit, and the object of his life, with its own ends and rewards, and that it should not be merely taken up that he may teach it again to others.[70]

The advocates of reform came together in 1872 to form the Association for the Study of Academical Organisation, which was established to consider 'the low state of learning and science in the older universities', its members insisting that 'the chief end to be kept in view' was 'the adequate maintenance of mature study and scientific research'.[71]

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[67] Kenyon, History Men, p.190; Slee, Learning and a Liberal Education, pp.153-65.

[68] See Searby, Cambridge, pp.203-59; Brooke, Cambridge, pp.82-98; and M.G.Brock, 'A "Plastic Structure"', Christopher Harvie, 'From the Cleveland Commission to the Statutes of 1882', and Howarth, 'Self Governing University', in Brock and Curthoys, Oxford.

[69] Simpson, Ph.D., pp.26, 38-40. On Vaughan see E.G.W.Bill, University Reform in Nineteenth-Century Oxford: A Study of Henry Halford Vaughan, 1811-1885 (Oxford: Clarendon Press, 1973).

[70] Mark Pattison, Suggestions on Academical Organisation with Especial Reference to Oxford (Edinburgh: Edmonston and Douglass, 1868), pp.163-8.

[71] The Academy (1 December 1872), p.459, quoted in MacLeod, 'Resources', p.132. See also Sanderson, Universities, pp.119-20.

The pace of reform quickened in the late 1860s and early 1870s as the German principalities demonstrated their burgeoning economic, industrial and military strength. The result was a growing appreciation of the strengths of the German university system and the ideal of *Wissenschaft*,[72] which MacLeod insists prompted the 'growth of a large and comprehensive view of the function' of the British university'.[73] As Gerald Geison explains, under the influence of the German universities, a significant number of Oxbridge Dons began to 'doubt that their traditional mode of education fully met the needs of the rapidly changing world around them'. At Cambridge, in particular, this doubt gave rise to an 'expanded conception of university purpose and a new sympathy towards the claims of science and other modern studies'.[74] This transformation in many Cambridge men's conception of their role and function was dubbed *The Revolution of the Dons* by Sheldon Rothblatt,[75] and Arthur Engel has examined the concurrent, but 'more leisurely', transformation of the Oxford professor *From Clergyman to Don*.[76] College tutors increasingly looked to a full-time career in teaching, the holders of college fellowships increasingly taught in College, University Professors took an increasingly central role in College life and more responsibility for the production and transmission of knowledge, and the Senate gave an increasingly sympathetic hearing to the plea for an expanded curriculum and emphasis on the natural sciences and other 'modern' studies, thereby 'challenging institutional aims taken for granted a generation before'.[77] Departments of Physiology, Chemistry, Zoology, Human Anatomy, Archaeology, Ethnology, Forestry and Engineering were introduced at both universities, and large physical and chemical research laboratories were established in the 1870s - the Clarendon Laboratory in Oxford (in 1872) and the Cavendish at Cambridge (in 1874).

[72] Geison, Foster, pp.86-7. See also George Haines, 'The German Influence upon Scientific Instruction in England, 1867-1887', Victorian Studies, 1 (1958), 215-44.

[73] MacLeod, 'Resources of Science', pp.116.

[74] Geison, Foster, pp.89-100, 111-15. On the differences between Oxford and Cambridge see Sanderson, Education and Economic Decline, pp.48-54, and Howarth, 'Oxford for Arts', pp.485-92.

[75] Rothblatt, Revolution of the Dons. Geison has stressed that this was not a violent revolution nor a wholesale rejection of the past, they merely sought 'to expand their conception of the universities purpose, not overthrow it . . . . The revolution of the Dons, that is to say, had less to do with the legal or social structure of the university than with a major shift in the attitudes of those who worked there'. Geison, Foster, p.85.

[76] Engel, From Clergyman to Don.

[77] Geison, Foster, pp.81-2.

More work needs to be done in this area, particularly on Oxford (and especially the Clarendon Laboratory), but there have been some interesting and important studies of the emergence of continental-style research schools in physiology and physics at Cambridge. For example, in his work on the emergence of the Cambridge school of physiology under Michael Foster in the 1870s, Geison reveals that Foster not only revolutionised the teaching of physiology, emphasising experimental and practical approaches to the subject and thereby launching a 'new epoch in the teaching of biology in the English universities', he (or rather his students) also conducted ground-breaking work on the mammalian heartbeat. Foster 'like Liebig before him . . . spent several years working cheek by jowl with a small band of students in an undersized and under-equipped laboratory',[78] instructing his students in the methods of scientific research, and encouraging them to pursue their own experiments and investigations,[79] and, moreover, to publish the results.[80] The Cambridge school played a crucial role in the development of a (histological and broadly biological) 'national style' for late Victorian physiology, and, moreover, led the way in the resurgence of English physiology in this period. The work on the myogenic theory of the heartbeat which was carried out in Cambridge, culminating in the publication of W.H. Gaskell's ground-breaking paper of 1883, marked a watershed in the history of cardiovascular physiology:

> Before long his myogenic theory of the heartbeat and concept of heart block were incorporated into the pathology, pharmacology, and therapeutics of the heart, and his conclusions have remained at the base of cardiology ever since.[81]

The most celebrated Oxbridge research school was the Cavendish physics laboratory, which was established at Cambridge in 1874 thanks to the munificence of William Cavendish, the seventh Duke of Devonshire. The opening of the Laboratory, prompted *Nature* to enthuse:

> The genius possessed by Professor Clerk Maxwell [its first Director] and the fact that it is open to all students of the University of Cambridge for researches will, if we mistake not, make this before long a building very noteworthy in English science.[82]

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[78] Geison, Foster, pp.82-8, 116-19.

[79] One of his students recalling that '[t]he desire to undertake research was imbibed in him . . . . It was in the air we breathed'. Quoted in Geison, Foster, p.184.

[80] For this purpose he founded the journal Studies *From the Physiological Laboratory in the University of Cambridge*, insisting that although the papers published did not make significant contributions to the study of physiology, 'their publication [might] help towards the establishment of a habit of research among our students of physiology at Cambridge'. Ibid, pp.186-7.

[81] Ibid, pp.290-1, 331-7.

[82] 'The New Physical Laboratory of the University of Cambridge', Nature, 10 (1874), 139-42.

Over the next decade the Cavendish became renowned as a world centre for pioneering research in the field of electromagnetism. Clerk Maxwell was succeeded by Lord Rayleigh in 1882. During his brief spell as Director of the Laboratory, Rayleigh and his colleagues were principally occupied with his ground-breaking work on electrical resistance.[83] But it was Balfour Stewart's most illustrious pupil, J.J. Thompson, who, as Director of the Laboratory from 1884-1919, was chiefly responsible for the development of a Morrellian-style research school at the Cavendish. Thompson was not only responsible for a series of pioneering researches in the field of nuclear physics, which culminated in the discovery of the electron in 1897, but, as Christopher Brooke explains, 'his brilliance and width of knowledge, his enthusiasm and readiness to listen and to help, made him a notable leader . . . [and] he fostered a group of young scientists of an extraordinary range of talent', including Ernest Rutherford, C.T.R. ('Cloud') Wilson, R.J. Strutt, John Townsend and many others.[84]

In her recent article on 'William Bateson and the Newnham College Mendelians', Marsha L. Richmond has demonstrated that between 1900 and 1910 Bateson coordinated the work of an active group of researchers at Cambridge, 'whose goal it was to investigate the validity and complexities of Mendelian heredity through breeding experiments using a wide variety of plants and animals', noting the fact that 'Bateson's early group consisted primarily of women'.[85] Christopher Brooke has also discussed the emergence of a new commitment to *teaching and research* in the Departments of Botany, Palaeobotany, Biochemistry, Chemistry, Archaeology and Anthropology at Cambridge in this period.[86] He pays particular attention to the Department of Geology, where T.G. Bonney 'played the role that Michael Foster played in Physiology . . . the creation of an enhanced and lasting cadre of teachers

[83] Richard T.Glazebrook, 'Lord Rayleigh's Professorship', in A History of the Cavendish Laboratory, 1871-1910 (London: Longmans and Co., 1910).
[84] Brooke, Cambridge, pp.184-5. See also G.P.Thomson, J.J.Thomson and the Cavendish Laboratory in His Day (Edinburgh: Nelson, 1984), and J.G.Crowther, The Cavendish Laboratory, 1874-1974 (London: Macmillan, 1974), pp.133-51.
[85] Marsha L.Richmond, 'Women in the Early History of Genetics: William Bateson and the Newnham College Mendelians, 1900-1910', Isis, 92 (2001), 55-90, p.56. On the Mendelian research programme see pp.66-83, and L.C.Dunn, A Short History of Genetics: The Development of Some of the Main Lines of Thought, 1864-1939 (Ames: Iowa State University Press, 1991), pp.65-6.
[86] Brooke, Cambridge, pp.151-209.

and . . . a framework within which others could do research'. According to Brooke, the period 1870-1914 was 'a golden age in Cambridge geology', during which the school produced 'a notable outcrop of good geologists . . . [and] became the centre of a significant research effort, [which] culminat[ed] in the establishment of the Cambrian Revolution - the definition, that is, of a key moment in the earth's history'.[87]

Considerably less has been written about developments at Oxford in this period, and it is generally accepted that Oxford failed to develop as a great centre for teaching and research in the years leading up to the outbreak of the First World War. Janet Howarth's work on Oxford science has demonstrated that the 'reputation of Oxford science actually deteriorated sharply' in the period 1890-1920. She argues that 'the modern ideal type of the professional scientist and department builder [was] . . . less easily reconciled with the traditions of the University . . . and there was a shortage . . . of the entrepreneurial flair needed to establish the sciences as successful university disciplines'.[88] Her account focusses in particular on the 'lamentable state' of the University chemistry laboratories and the 'decay' of the Clarendon Laboratory, which was 'the most striking feature of the malaise of Oxford science' in this period. The Waynflete Professor of Chemistry, William Odling, who occupied the Chair for nearly forty years and was in his late seventies when he finally retired, 'took the novel view that it was "not etiquette" for the Professor to enter the Laboratory',[89] and the research output of the Clarendon was 'negligible' under R.B. Clifton who presided over the Laboratory from 1882-1915. In 1897 the professor's private laboratory was converted into an elementary teaching laboratory for undergraduates. There was therefore 'no place' in which the professor and his assistants could carry out research, and Clifton was forced to conclude that 'all attempts at such work must in future be abandoned'.[90]

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[87] Brooke, Cambridge, pp.157-60. Bonney was simultaneously Professor of Geology at Cambridge and UCL from 1877-1901. See also Roy Porter, 'The Natural Science Tripos and the "Cambridge School of Geology", 1850-1914', History of Universities, 2 (1982), 193-216.

[88] Howarth, 'Oxford for Arts', pp.457, 495-6. See also J.Howarth, 'Science Education in Late-Victorian Oxford: A Curious Case of Failure', English Historical Review, CII (1987), 334-71.

[89] Ibid, p.464.

[90] Howarth also reports that an application for £4000 to purchase an in-house generator for electric lighting in the Clarendon was turned down in 1892, despite the fact that the Laboratory was supplied with electricity by a voltaic battery which emitted noxious fumes. Remarkably, the Clarendon was not connected to mains electricity until as late as 1919. Ibid, pp.459-62.

However, while conceding that 'Oxford science failed to keep pace with developments at Cambridge', Howarth also argues that there were 'areas of notable strength'.[91] It is interesting to note, for example, that Oxford played a pioneering role in the introduction of research degrees in this country. Renate Simpson has shown that doctoral degrees were awarded only on the basis of the submission of 'copies of papers or books containing an original contribution to the advancement of science and learning' at Oxford from as early as 1900, and that Oxford actually became the first British university to award the Ph.D. ('or - as in its traditionally individualistic fashion it designates it - the D.Phil.') in 1917.[92] Moreover, the Oxford University Press has been described as the 'single most important source of patronage for research' in this period, and also demands further attention.[93] There were a number of distinguished research scientists working at Oxford in this period, including, for example, the anthropologist, E.B. Tylor, entomologist, E.B. Poulton, and geologists, Joseph Prestwich, A.H. Green and W.J. Sollas. H.A. Miers established a 'small but productive centre for crystallography' in the Oxford Museum, as Professor of Mineralogy from 1895-1908, and Charles Pritchard presided over 'the most active university observatory' in the country, where he made innovative use of photography in determining the distances of fixed stars [94] J.S.E. Townsend was appointed to the Wykeham Chair of Physics in 1900, and he 'contrived in time to build up a research team and carry out important work on gaseous ions'.[95] A strong 'indigenous research tradition' also developed in the Department of Zoology under E. Ray Lankester, Linacre Professor of Zoology from 1891 to 1899. Lankester established an informal research seminar for zoologists in 1891, and the staff and students of the department were encouraged to publish their own research papers in

[91] Howarth, 'Oxford for Arts', pp.457-62.
[92] Simpson, Ph.D., pp.135-40.
[93] Howarth, 'Self Governing University', p.615. See also Peter Sutcliffe, 'The Oxford University Press', in Brock and Curthoys, Oxford, pp.643-58.
[94] Howarth, 'Oxford for Arts', pp.466-9. See also E.A.Vincent, Geology and Mineralogy at Oxford 1860-1986: History and Reminiscence, (Oxford, 1994), and R.Hutchins, 'John Phillips, "Geologist-Astronomer", and the Origins of the Oxford University Observatory', History of Science, XII (1994), 236-7.
[95] Ibid, p.461. See also Jack Morrell, 'Research in Physics at the Clarendon Laboratory, Oxford, 1919-39', Historical Studies in the Physical and Biological Sciences, 22 (1992), 263-307.

a series of *Reports*.[96] Moreover, despite the shortcomings of the university chemistry laboratories, Howarth insists that the subject was well catered for in some of the College laboratories. As we have already seen, Vernon Harcourt presided over a well-equipped laboratory at Christ Church, which was provided with a generous research grant of £250 - £375 a year. As Howarth explains, '[h]is influence as a teacher and founder of a research tradition was to extend across the generations', and a number of distinguished chemists, including H.B. Dixon, N.V. Sidgwick, F.D. Chattaway, Sir John Conroy and D.L. Chapman, were trained in his laboratory.[97] Moreover, when W.H. Perkin was appointed to the Waynflete Chair of Chemistry in 1912, 'Oxford at last acquired the entrepreneurial professor in the German style':

> [B]y the end of the War results were apparent in the new organic chemistry laboratory, built and endowed with funding from the Worcester sauce manufacturer Charles William Dyson Perrins, and an increase in the rate of Oxford chemistry publications to a level that equalled Cambridge and Imperial College, London.[98]

But it was not only the scientific departments that witnessed the emergence of a dual commitment to teaching and research in the last quarter of the nineteenth century and early years of the twentieth century. The study of history at Oxford and Cambridge was revolutionised by the appointment of William Stubbs as Regius Professor of History at Oxford in 1866. John Kenyon has argued that '[i]t was Stubbs who initiated the serious study of history at Oxford, [and] indeed, in the English universities. He was also the first English historian of any weight to make a significant contribution to knowledge while he was a university teacher'. In other words, he was the first 'professional historian in England as the term is now understood'.[99] Over the next 30 years a number of eminent historians - including, for example, John Seeley, E.A. Freeman, R.L. Poole and Frederick Yorke Powell - presided over the Oxford and Cambridge schools of modern history, and almost without exception they 'defined their professional function in terms of advancing the

[96] Howarth, 'Oxford for Arts', p.467.
[97] Ibid, pp.462-4. See also Jack Morrell, Science at Oxford 1914-39: Transforming An Arts University (Oxford: Clarendon, 1997), pp.318-38.
[98] Howarth, 'Oxford for Arts', p.465. See also Morrell, 'Perkin at Manchester and Oxford', especially pp.124-6, and Morrell, Science at Oxford, pp.338-52.
[99] Kenyon, History Men, p.154. See also Reba N.Soffer, 'Modern History' in Brock and Curthoys, Oxford, pp.361-84.

study of history through the prosecution of detailed research'.[100] Some of them also encouraged their students to venture into the archives and to write their own source-based essays and dissertations. For example, John Seeley, Professor of Modern History at Cambridge from 1869-1895,encouraged the 'best students of each year to write dissertations involving original research',[101] and R.L. Poole gave the undergraduate A.F. Pollard the 'opportunity of undertaking some historical investigation', insisting that a training in the methods of 'research in the materials of historical knowledge' constituted 'the most valuable, if not [an] indispensable, preliminary qualification' for an academic post.[102] But the origins of the modern conception of the Oxbridge history school as a centre for teaching and research are to be found in the efforts of John Bagnell Bury and Charles Harding Firth to 'reduce the distinction between the dual functions of teaching and research by teaching research techniques'.[103] As Firth explained in his inaugural *Plea for the Historical Teaching of History*:

> Surely the teaching of history means an endeavour to train men capable of adding to knowledge? This, at all events, is the principle upon which I base my conception of my duty here.[104]

He therefore instituted a 'programme of Advanced Historical Training' in the Oxford History School, and during his long tenure in the Regius Chair from 1904 - 1925, he succeeded in winning recognition for the principle that 'training in the techniques of research was . . . an integral part of the school's programme'.[105]

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[100] Slee, Learning and a Liberal Education, p.129.
[101] Kenyon, History Men, p.180.
[102] Testimonial by R.L.Poole included in 'Application of A.F.Pollard, B.A., Jesus College Oxford; a Candidate for Election to the Post of Lecturer in History and Political Economy at the University College of South Wales and Monmouthshire', 12 September 1892, which is included among various personal papers in Box 12 of the Pollard Papers (MS 860) in the Palaeography Room at London University Library [hereafter LU/AFP/12, etc].
[103] Slee, Learning and a Liberal Education, p.129.
[104] C.H.Firth, A Plea for the Historical Teaching of History: An Inaugural Lecture delivered on November 9th 1904 (Oxford: Oxford University Press, 1904), p.11. See also J.B.Bury, The Science of History: An Inaugural Lecture delivered in the Divinity School, Cambridge on January 26, 1903 (Cambridge: Cambridge University Press, 1903). On Firth see Soffer, 'Modern History', pp.370-2.
[105] Slee, Learning and a Liberal Education, p.148. Reba Soffer has also highlighted the significance of the inter-collegiate student history societies, such as the Stubbs Society, that were established in this period: 'In these bodies, students and the Dons who joined and encouraged them attempted original scholarship and the criticism of historical materials, then weighed evidence, judged conduct, agreed on canons of interpretation and debated conclusions'. Soffer, 'Modern History', p.380.

The Turning Point c.1890-1914

Slowly, in the course of the second-half of the nineteenth century a new conception of the British university as a place of teaching and research therefore began to emerge. By the turn of the century 'vitally important researches' *were* being conducted within the walls of many, if not most, of the major British universities,[106] and there were also growing opportunities for students to learn the methods of research and undertake their own investigations. Robert Kargon insists that under the influence of Frankland, Roscoe, Stewart and Schuster, Owens College, Manchester, became renowned as 'a world centre for scientific research', at least in physics and chemistry',[107] and it was quickly accepted that the 'extension of knowledge was as necessary for a university teacher as its transmission'. Armytage has argued, moreover, that what he calls the 'Manchester tradition' was to 'predominate in the second-half of the nineteenth century as the civic pattern took shape';[108] and during the early years of the twentieth century this growing commitment to research found expression in the aims and objectives of the new colleges as they were reconstituted as independent universities.[109]

Speaking in Birmingham in 1905, Joseph Chamberlain, a former mayor of the city and the principal founder of its University, explained that the *raison d'être* of the new university was 'to teach as it had never been taught before, science, and also to proceed in the work of scientific research'.[110] And as early as 1875, as pressure for the reconstitution of Owens College as an independent university grew, the promotion and organisation of (scientific) research assumed a new significance among the aims of the institution. For example, in the spring of that year, H.E. Roscoe circulated a pamphlet in which he argued that the 'foundation of a university in Manchester would greatly contribute towards the important object of stimulating original powers and original work'.[111] Owens College was not formally reconstituted

[106] Sanderson, Universities, pp.189-90.
[107] Kargon, Science, p.234.
[108] Armytage, 'Rise of Civic Universities', p.71.
[109] Birmingham in 1900, Manchester in 1903, Liverpool in 1903, Leeds in 1904, Sheffield in 1905 and Bristol in 1907.
[110] Reported in The Times, 15 May 1905.
[111] This document was reprinted in the Manchester Guardian, 29 June 1876, and is quoted in Kargon, Science, pp.218-19.

as an independent university until 1903. In the meantime, the London School of Economics and Political Science had been founded in 1895, its primary aim: to stimulate 'objective and impartial investigation and research, with "educational lecturing" as a secondary intention'.[112] The Imperial College of Science and Technology was established in 1907 as a 'London Charlottenburg',[113] an 'institute of scientific technology adapted to postgraduate work and the experimental application of science to industrial processes',[114] its 'function':

> To give the highest specialised instruction and to promote the fullest equipment for the most advanced training and research in various branches of science, especially in its application to industry.[115]

And in 1898 the whole University of London was reconstituted, its revised aim:

> [T]o hold forth to all classes and denominations in the United Kingdom and elsewhere without any distinction whatsoever an encouragement for pursuing a regular and liberal course of education . . . [and] *to promote research and the advancement of science and learning* (my italics).[116]

However, one should not overestimate the speed, scale and significance of these developments. It would take several decades for a genuine *culture* of teaching and research to develop on a university-wide, and then national, scale. For example, in 1905/06 approximately one in ten students at Liverpool University were registered as 'postgraduate and research students'.[117] A research chair in biochemistry had been endowed by William Johnston, a sophisticated new

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[112] Aims of the London School of Economics and Political Science, quoted in Harte, University of London, p.171. Beatrice Webb outlined her husband's 'vision' for the new institution in her diary on 21 September 1894, explaining that the LSE was to be a centre 'not only of lectures on special subjects but an association of students who [would] be directed and supported in doing original work'. Norman and Jane Mackenzie,eds, The Diary of Beatrice Webb. Volume II. All the Good Things in Life. 1892-1905 (London: Virago/LSE, 1984), p.561. The aims and origins of the London School of Economics are discussed in Ralf Dahrendorf, LSE: A History of the London School of Economics and Political Science. 1895-1995 (Oxford: Oxford University Press, 1995), pp.3-63.

[113] The Königlich Technische Hochschule zu Berlin in Charlottenburg, which was founded in 1879, 'had almost come to symbolise the scientific supremacy of Germany, Britain's political rival in Europe, and inspired the planning for a similar institution in London'. Alter, Reluctant Patron, p.153.

[114] S.Webb, 'London University: A Policy and a Forecast', The Nineteenth Century and After, 51, (1902), 927.

[115] Aims of the Imperial College of Science and Technology, quoted in Alter, Reluctant Patron, p.168. On the origins and development of Imperial College see Rupert A. Hall, Science for Industry: A Short History of the Imperial College of Science and Technology and its Antecedents (London: Imperial College of Science and Technology, 1982).

[116] 'Statutes made for the University of London by the Commissioners appointed under the University of London Act, 1898', Historical Record, pp.70-99.

[117] Simpson, Ph.D., p.96.

laboratory was built, and 'there were always at least ten workers engaged in research'. During the 1906-07 session, 'no fewer than 60 papers were published', but the endowment was not sufficient to pay for the equipment and day-to-day running costs of the laboratory. Moreover, this chair was 'the only one of its kind in the University. In all other cases professors and lecturers were appointed to teach, research being fitted in wherever possible'; and since the staff of the college was small in number, teaching duties tended to be heavy, or even 'excessive', and research work was 'retarded' as a result.[118] Writing in 1939, J.D. Bernal could still insist:

> The position of the research [fellow] in the universities is still anomalous. He has no recognized place but is treated as part-student and part-teacher. As a result, permanent or professional research workers are still rare . . . . [Though] fundamental scientific research is carried out in a large number (approximately 400) of independent laboratories. Only a few of them are equivalent to the scientific institutes on the Continent, employing some twenty to forty research workers. The majority are one or two-man departments.[119]

Four years later, when Bruce Truscot reviewed the work of Britain's 'Red Brick' universities, he reported:

> It will be generally agreed that the university has two chief aims, research and teaching - or, as the Leeds Charter calls them, 'the advancement and dissemination of knowledge' . . . . [But to] anyone acquainted with the universities, it is a truism to say that neither at Oxbridge nor at Redbrick is the amount of research done either by teachers or by graduate students anything approaching what it should be.[120]

Science, Society and the State

It is nevertheless clear that the period 1890-1914 was a crucial one in the history of Britain's universities and university colleges, witnessing a series of pioneering attempts to establish continental-style research schools and the emergence of an institutional commitment to the promotion of original research. What is much less clear is precisely how and why Britain's universities and colleges began to reinvent themselves as places of teaching and research in this period. As we have already seen, most of the historians who have made any serious attempt to investigate the origins of the research university in this country have done so in the context of a more general discussion about the 'movement for the endowment of research' and the development of public and government attitudes towards science

[118] Roderick and Stephens, 'Scientific Studies and Scientific Manpower', pp.52-3. See also Butler, 'Centers and Peripheries', pp.489-94.
[119] Bernal, Social Function of Science, pp.37-8. Also see Appendix 1, pp.417-19, which highlights the problem of scale in much of the literature on research in British universities in this period.
[120] Bruce Truscot, Red Brick University (Harmondsworth: Penguin, 1943), pp.141-57.

and research in the period 1870-1920.[121] According to this interpretation, the British universities' 'failure' to develop as great centres of research in the nineteenth century reflects a more general disregard for the scientist and researcher in this period. The origins of the research university are therefore to be found in the late nineteenth-century revolution in public and government attitudes towards science and research, and the concurrent transformation in the relationship between the universities and the state.

This interpretation has its origins in the complaints of the nineteenth-century 'spokesmen of science' who argued that 'Britain . . . lacked a sound foundation of scientific education and research', and maintained that 'state or private action to meet these objects was of the utmost importance'.[122] These 'public scientists' included amongst their number Sir Humphrey Davy, Michael Faraday, Sir John Herschel, Sir John Lubbock and William Robert Grove, who led the campaign for the professionalisation of science in the early nineteenth century; the 'Declinist' faction of the 1830s, which was led by the mathematicians, Charles Babbage and Sir David Brewster; T.H. Huxley, John Tyndall, Edward Frankland and Thomas Archer Hirst, who formed the nucleus of the so-called 'X-Club'; the astronomer, Sir J.Norman Lockyer; the Oxford-based reformers, Mark Pattison and Charles Appleton; the former Indian army officer and amateur astronomer, Lieutenant-Colonel Alexander Strange; the industrial chemist, George Gore; the chemist and politician, Sir Lyon Playfair; the Prince Consort, and Britain's premier 'statesman of science', Richard Burdon Haldane.[123] According to these champions of the endowment of research, the British public generally had little or no interest in science in this period, particularly in 'the steady, plodding work which culminates in great discoveries',[124] and few government ministers - and all but an 'insignificant and largely unregarded minority' of

[121] See, for example, Cardwell, Organisation of Science; MacLeod, 'Resources of Science', and Alter, Reluctant Patron, especially pp.22-35. Peter Alter uses the term 'Endowment of Research Movement' to describe the Oxbridge-based reformers of the 1870s who made up the Association for the Study of Academical Organisation (Alter, Reluctant Patron, p.84), while MacLeod insists that the 'endowment of science movement proper' grew out of the development of a working alliance between the university and London-based reformers in the period 1876-80, but uses the term more generally to describe the efforts of the 'researchers' between 1868 (or rather 1850) and 1900 (pp.164-5).

[122] MacLeod, 'Resources of Science', p.121.

[123] Alter, Reluctant Patron, pp.177-90.

[124] Meldola, 'Position and Prospects of Chemical Research', p.231.

M.P.s - took an active interest in the subject.[125] Central government therefore adopted a *laissez-faire* attitude towards science and research, and there was virtually no formal organisation of science in Britain in this period. As a result, the British scientists of the early nineteenth century were predominantly amateur devotees - 'gentleman amateurs' or 'intellectual men of leisure';[126] and, despite their best efforts, by 1873 it was 'known to all the world that science was all but dead' in this country'.[127]

Recalling Jeremy Bentham and Adam Smith, the supporters of the endowment of research argued that scientific research produced results which were practical and useful to the community and nation. In fact, the nation derived 'as great [a] benefit as anything material can possibly produce' from scientific research.[128] Scientific discovery and research was therefore 'national work', and it was 'the duty of the state to provide and pay for it, because, as George Gore told a meeting of the Social Science Association in Plymouth in 1872, such work was of 'immense value and indispensable to the nation; also because nearly the whole benefit of it [went] to the nation and scarcely any to the discoverer, and because there [was] no other means by which scientific investigators [could] be paid for their labour'.[129] Moreover, science also had a vital role to play in the 'struggle for existence among nations'.[130] In the face of mounting evidence of relative economic and industrial decline, particularly in comparison to Germany and the United States,[131] it was noted that Britain's future prosperity was contingent upon the survival and strength of her industry, which was, in turn, dependent on the endowment of scientific research:

> In the present stage of human progress science is indispensable to national greatness. In a nation that neglects science the arts can not flourish, trade can not prosper, knowledge cannot advance, and war cannot succeed . . . . A nation that is not foremast in science can not be foremost in civilisation.[132]

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[125] Alter, Reluctant Patron, p.184. See also MacLeod, 'Resources of Science', pp.149-51.
[126] Crowther, Statesmen, pp.77.
[127] 'A Voice From Cambridge', Nature, 8 (1873), 21-2.
[128] Lord Kelvin (Sir William Thomson), quoted in Crowther, Statesmen, p.264.
[129] George Gore, 'On the Present Position of Science in Relation to the British Government', Transactions of the Social Science Association (Plymouth,1872), p.280, quoted in MacLeod, 'Resources', p.129.
[130] Norman Lockyer , 'The Influence of Brain Power on History', Nature, 68 (1903), 439-47.
[131] In particular, it was noted, and with some trepidation, that 'the increase in Germany's political, and ultimately military, strength was based on her economic power, and that in its turn was based on the quality of her science'. Alter, Reluctant Patron, pp.116-37.
[132] Alexander Strange quoted in Crowther, Statesmen, p.244.

Successive generations of declinist historians have accepted the complaints of the nineteenth-century science lobby uncritically, concluding that the British government has neglected science for centuries, and that this has been the principal cause of Britain's economic and industrial 'decline' since 1870. As we saw in the previous chapter, more recently a number of revisionist historians have successfully challenged these arguments. But the declinist thesis demands further attention here because of its enduring influence in the literature dealing with the history of university education in this country and the rise of research, and also because the declinists and spokesmen of science played an important role in shaping the intellectual climate of opinion in which Britain's universities and university colleges began to reinvent themselves as places of teaching and research between 1890 and 1914. Moreover, regardless of whether or not the picture painted by the nineteenth-century science lobby is accurate in its depiction of the state's contribution to the promotion and organisation of scientific research, the public and government were nevertheless convinced by their arguments as alarming reports of Britain's growing economic and industrial 'backwardness', and the mounting imperial rivalry and international economic competition of the period, highlighted the importance of science and research in the expanding industrial economy of the late-Victorian period.[133]

For example, Britain's poor showing at the Paris Exhibition of 1867 caused great 'alarm' and 'near panic' at home,[134] bringing the demands of the science lobby to the attention of the public and government to a new, and hitherto unprecedented, extent. Over the next 30 years a series of Royal Commissions and public boards of inquiry investigated various aspects of the organisation of science and research in Britain. In March 1868 a Parliamentary Select Committee under Bernard Samuelson was appointed to examine the question of technical education and scientific instruction,[135] and from 1881 to 1884 a Royal Commission on Technical Instruction (also chaired by Samuelson) conducted an extensive survey of the provision for technical education in Britain and around the world. Samuelson and his colleagues paid particular attention to the German organic chemical and electrical industries, concluding that the strength of these industries was based upon 'first-class technical

[133] Alter, Reluctant Patron, pp.98-99.
[134] Cardwell, Organisation of Science, p.111.
[135] Report of the Select Committee on Scientific Instruction (London: HMSO, 1868).

instruction, original research and a widespread appreciation of the value of learning and research'. Hitherto the Englishman had been 'accustomed to seek for an immediate return and ha[d] yet to learn that an extended and systematic education up to and including the methods of original research [was] now a necessary preliminary to the fullest development of industry'.[136] The most important and far-reaching inquiry of the period was the Royal Commission on Scientific Instruction and the Advancement of Science, which was launched in February 1870 and chaired by William Cavendish.[137] In its final report, published in June 1875, the Committee concluded that the 'progress of scientific research must in a great degree depend upon the aid of government', insisting:

> Whatever may be the disposition of individuals to conduct their own research at their own cost, the advancement of modern science requires investigation and observation extending over areas so large and periods so long that the means and lives of nations are alone consumerate with them . . . . [The Government] is bound to assume the large proportion of the National Duty which individuals do not attempt to perform, or cannot satisfactorily accomplish.[138]

By the turn of the century, Britain's relative economic and industrial 'decline' was increasingly being documented and discussed by contemporary critics, and the newspapers were full of warnings about Britain's imminent defeat in the 'battle for commerce in almost every land on earth'.[139] It was becoming increasingly apparent to the British people and government that Britain's (perceived) weakness in the fields of scientific education and research, and in applying the results of scientific research to industrial production, was the principal cause of her economic and industrial malaise. Moreover, this debate coincided with (and inevitably contributed to) the 'profound crisis in the national consciousness' which afflicted all areas of British social, political, cultural and intellectual life in the early years of the twentieth century, precipitating a series of reforms in the fields of health care, social welfare, the machinery of government and education.

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[136] Second Report of the Royal Commission on Technical Instruction (London: HMSO, 1872), Volume I, p.525.

[137] The other Commissioners were Samuelson, Huxley, Lockyer, Lubbock, James Kay-Shuttleworth, the Marquis of Lansdowne, W.A.Miller, H.J.S.Smith, William Sharpey and George Stokes.

[138] Eighth Report of the Royal Commission on Scientific Instruction and the Advancement of Science, Cd.1298 (London: HMSO, 1875), p.2. See also MacLeod, 'Resources of Science', pp.127-8; Cardwell, Organisation, pp.92-8; Crowther, Statesmen, pp.222-33, 248-65.

[139] Alter, Reluctant Patron, pp.107-8.

The humiliations of the Boer War had, in the words of Rudyard Kipling, taught the British 'no end of a lesson'.[140] Like the Crimean War and the Wars of German Unification, the South African conflict delivered alarming proof of the enhanced pace of industrialisation in Continental Europe, and exposed organisational and logistical weaknesses in the British Army and technical faults in her armaments.[141] Moreover, the reports compiled by the Inspector-General of Recruiting revealed the 'gradual deterioration of the physique of the working-classes, from which the bulk of recruits [were] drawn'. According to Geoffrey Searle, this was the most important piece of statistical evidence used to bolster the theory of 'national degeneration', which prevailed among journalists and social commentators in Britain around the turn of the century. It was widely agreed that the nation's health was deteriorating, and that 'degeneracy' in its various forms was on the increase. Such was the impression conveyed by the social surveys conducted by Charles Booth and Joseph Rowntree, and there was also evidence to suggest that insanity, feeblemindedness and 'constitutional disease' were on the increase.[142] Meanwhile, the eugenists warned that the birth-rate was falling dramatically among the 'fit' sections of society, while the 'unfit' were reproducing rapidly and thereby threatening to 'drag the nation down into inevitable biological decline and final extinction'.[143] Social Imperialists, such as Lord Brabazon and General Maurice, considered these developments in the context of Britain's future as an imperial power, precipitating an 'agonised debate about the sources of imperial greatness' - 'For how could the British Empire survive if there were not an "imperial race" to sustain it?'.[144]

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[140] Quoted in Geoffrey Searle, The Quest for National Efficiency (Berkeley and Los Angeles: University of California Press, 1971), p.38.

[141] Alter, Reluctant Patron, pp.99-103.

[142] Geoffrey Searle, Eugenics and Politics in Britain, 1900-14 (Leyden: Noordhoff International Publishing, 1976), pp.20-4.

[143] Karl Pearson, The Scope and Importance to the State of the Science of National Eugenics (London: Dulau, 1911), pp.24-37; Gareth Stedman Jones, Outcast London (Oxford: Clarendon, 1971); Dorothy Porter, '"Enemies of the Race": Biologism, Environmentalism and Public Health in Edwardian England', Victorian Studies, 34/2 (1991), 159-78; Searle, Quest for National Efficiency, pp.54-106.

[144] Quoted in Searle, Eugenics and Politics, pp.22-3. See also Bernard Semmel, Imperialism and Social Reform: English Social-Imperial Thought 1895-1914 (London: Allen Unwin, 1960).

These matters were discussed with growing alarm, and the result was a decisive shift in the attitude of the British people and government. The question of the endowment of research was widely discussed and debated in the press, the *Daily Mail* insisting in June 1902 that 'if the position which this country is slowly losing is to be regained, there can be no doubt that England must improve her education and more richly endow research'.[145] The attitude of the state was similarly transformed. In January 1902, the Prime Minister, Arthur Balfour, candidly admitted in the House of Commons that 'the amount of government money given to research in this country [was] not very large',[146] and in 1913 Joseph Pease, President of the Board of Education, told the House:

> We have realised that it is essential, if we are going to maintain our position in the world, that we must make better use of our scientifically trained workers, that we must increase the number of those workers, we must endeavour to see that industry is closely associated with our scientific workers, and *we must promote a proper system of encouragement of research workers, especially in our universities* (my italics).[147]

In 1904 the Royal Society had remarked upon 'the fuller recognition by the government and the public of the need for scientific advice and direction in matters of national concern',[148] and in 1910 the British Science Guild gave its cautious approval to the slowly emerging transformation in the state's attitude towards science and scientific research, applauding the fact that 'the present government ha[d] shown itself more anxious to promote scientific inquiry than any of its predecessors'.[149]

This was the context in which Britain's universities and university colleges began to reconstitute themselves as places of teaching and research, and the government began to adopt a more proactive and interventionist approach to the promotion and organisation of research. However, despite the criticisms of contemporary scientists and modern historians, the state had been willing to offer financial support to a very specific, but diverse, range of scientific enterprizes from the middle of the nineteenth century onwards, primarily for utilitarian purposes. Such support was generally given in an unsystematic and uncoordinated manner, but

[145] The Daily Mail, 8 June 1901. Similarly, according to *The Times*, science had 'become, or [was] fast becoming, the dominant factor in human affairs; it will determine who shall hold the supremacy among nations'. 'The Royal Society: A Retrospect of 250 Years', The Times, 16 July 1912.
[146] Hansard, Parliamentary Debates (House of Commons), Fourth Series, Vol.101, col.800 (24 January 1902).
[147] Ibid, Fifth Series, Vol.71, col.1903 (13 May 1913).
[148] 'Anniversary Meeting of the Royal Society', Nature, 71 (1904), 105-11, p.107.
[149] 'Annual Meeting of the British Science Guild', Nature, 85 (1910), 100.

could nevertheless be fairly generous; and certain projects, the Geological Survey and Royal Observatory, for example, benefited from long term support from the state. The government also provided subsidies to certain scientific and learned societies. For example, a Parliamentary Grant-in-Aid for Scientific Investigations - initially totalling £1,000 per annum, but rising to £5,000 in 1876 - was launched in 1849 and administered by the Royal Society on behalf of the government;[150] and more substantial grants were awarded to help subsidise specific research projects, conferences and expeditions. This support could sometimes be very generous indeed, especially when particular enterprises were connected with national prestige or promised to be of economic or strategic value. For example, the Royal Astronomical Society was awarded a government grant of £15,000 to help subsidise an expedition to observe the transit of Venus in 1872, and the *Challenger* expedition of the 1870s received government assistance amounting to more than £30,000.[151]

Prompted by the great resurgence of public interest in science in the wake of the Great Exhibition, and the efforts of the Prince Consort and the Commission of 1851 to ensure that the profits of the Exhibition were devoted to 'the advancement of science . . . and the extension of the influence of science and art upon the productive processes', Parliament was also persuaded to grant the Commission £150,000 to assist in the purchase of a large area of land in South Kensington. The Commissioners planned to build a great 'Metropolitan Institution' - a 'government establishment for the diffusion of science generally as applied to industry', comprising a technical university, a complex of museums and art galleries, and a central headquarters for the various scientific and learned societies - on the site.[152] In the same year a Government School of Mines and Science Applied to the Arts was established in Jermyn Street, London; and in 1853 a Government Department of Science and Art, responsible for the Royal College of Chemistry, the School of Mines, the Museum of Practical Geology, and various other scientific institutions, was established under the control of the Education Department of the Privy Council.

[150] Roy MacLeod, 'The Royal Society and the Government Grant: Notes on the Administration of Scientific Research, 1849-1914', Historical Journal, 14 (1971), 323-58.
[151] Alter, Reluctant Patron, pp.65-7.
[152] Quoted in Crowther, Statesmen, pp.197-208.

Prompted by the demands of a rapidly urbanising and industrialising society, 'the state took on more and more scientific functions which were able to assist it in its growing and increasingly differentiated administrative tasks' as the nineteenth century progressed. Its involvement in promoting (scientific) research increased 'automatically, as it were, as a consequence of its expanding functions', and by 1900 'scientific and specialist expertise, within limits, was becoming part of the accepted orthodoxy'.[153] Individual scientists were invited to advise the government on particular questions, and scientific experts became increasingly prominent within the civil service. Various institutions were founded specifically to provide the government with scientific information, and special departments were established in the Treasury, Board of Trade, Home Office, Colonial Office, Royal Mint, Privy Council, Local Government Board, Admiralty and War Office to carry out and monitor routine scientific tasks.[154] Similarly, Philippa Levine has demonstrated that in the 1850s central government began to undertake a 'whole host of historical projects from the long-awaited erection of a central record office to the publication of items too specialised or costly either for the more usual commercial consideration or for the printing clubs with their limited funds'.[155] The government also assumed responsibility for various museums, including the British Museum and the South Kensington complex, and the botanical gardens established in London, Edinburgh and various other parts of the country.[156]

However, according to Peter Alter it was not really until the turn of the century that the state began to abandon its traditional *laissez-faire*, utilitarian stance, and to adopt a more proactive and systematic approach to the organisation and support of science and research in Britain - as the Boer War, the growing pressure of international economic competition, and mounting evidence of the 'backwardness' of British industry, precipitated a major 'crisis of confidence', finally persuading the

[153] Alter, Reluctant Patron, pp.62-7, 70-1, 119-20; Roy MacLeod, 'Statesmen Undisguised', American Historical Review, 78 (1973), 1386-1405.

[154] See, for example, Roy MacLeod, 'The Alkali Acts Administration, 1863-84: The Emergence of the Civil Scientist', Victorian Studies, 9 (1965), 85-112; Roy MacLeod, 'Government and Resource Conservation: The Salmon Acts Administration, 1860-86', The Journal Of British Studies, 7 (1968), 114-150, and Roy MacLeod, 'Science and Government in Victorian England: Lighthouse Illumination and the Board of Trade, 1866-86', Isis, 60 (1969), 5-38.

[155] Levine, Amateur and Professional, p.2.

[156] MacLeod, 'Support of Victorian Science', p.204.

government that urgent action was necessary, and encouraging the late-Victorian / Edwardian public to tolerate greater state intervention in science (as well as in other areas of social and economic life). Initially the state's policy was essentially reactive, central government responding to suggestions for the organisation and support of science which were brought to it 'from outside'. For example, the National Physics Laboratory and the Imperial College of Science and Technology both owe their origin to private initiative, but their subsequent development shows that the state was increasingly willing to join in private initiatives and offer financial support.[157] In this way the state gradually ventured into areas which had previously been left to private initiative, organisation and finance.

There has been some debate about the precise timing of this revolution in government policy towards science and the promotion of research, and the significance of particular policy initiatives and developments. According to Russell Moseley, for example, the establishment of the National Physics Laboratory in 1900 signalled the beginning of 'a new relationship between the British government and scientific activity',[158] while Keith Vernon has argued that the most significant state sponsored initiative of the period was the Road Improvement Act of 1909, and the establishment of the Development Commission to oversee various new agricultural research schemes.[159] What is abundantly clear, however, is the fact that central government was increasingly seen to be adopting a more proactive, initiatory and regulative role in the promotion and organisation of scientific research during the first decade of the twentieth century, and that the process continued in the years leading up to the outbreak of the First World War, culminating in the launching of the Medical Research Committee in 1913,[160] and the establishment of the Department of Scientific and Industrial Research in 1915.[161]

[157] Alter, Reluctant Patron, pp.138-72, 249-50.

[158] Russell Moseley, 'The Origins and Early Years of the National Physics Laboratory: A Chapter in the Prehistory of British Science Policy', Minerva, 16 (1978), 222-50, p.222.

[159] Keith Vernon, 'Science for the Farmer? Agricultural Research in England 1909-36', Twentieth Century British History, 8/3 (1997), 310-33, p.310; R.Olby, 'Social Imperialism and State Support for Agricultural Research in Edwardian Britain', Annals of Science, 48 (1991), 509-26.

[160] A.Lansborough Thomson, Half A Century of Medical Research, Volume. 1, Origins and Policy of the Medical Research Council (UK) (London: HMSO, 1973).

[161] See Harry Melville, The Department of Scientific and Industrial Research (London: Allen and Unwin, 1962), and Ian Varcoe, 'Scientists, Government and Organised Research in Great Britain 1914-16: The Early History of the DSIR', Minerva, 8 (1970), 192-216.

Conclusion

The existing literature on university education in Britain and the rise of research therefore suggests that the origins of the modern conception of the British university as 'a place of teaching and research' are to be found in the period 1890-1914, and that this revolution in the official conception of the role and function of Britain's universities and university colleges can only really be understood in the context of the monumental change which took place in the attitude of the British public and government towards science and the promotion of research over approximately the same period. According to this interpretation, the origins of the 'research university' are to be found in this revolution in the attitudes and opinions of the British people and government, which both transformed the context in which the universities existed, and also had a more immediate and direct impact, as the state began to concern itself with the role and function of the university in British life. As Sanderson explains, 'at no time before or since were the universities subjected to such lengthy and intensive investigation . . . . Far from being institutions operating in some non-accountable independence of the state they were subject to an almost perpetual detailed public investigation and cross-examination from the 1850s onwards'.[162] Moreover, the various commissions and boards of inquiry appointed to investigate the work of Britain's universities and colleges in this period eventually came to the conclusion that their work should include both teaching and the promotion of research. As Sheldon Rothblatt explains, the commissioners who investigated Oxford and Cambridge in the 1850s thought in terms of a teaching institution, 'keeping before them the traditional "idea" of a university as a place for the dissemination of knowledge, not its advancement, and for the moral superintendence of young and immature students rather than for the imparting of skills and competencies'. By contrast, later inquires concentrated on improving the 'university or professional part of instruction, and this began to include a formal research mission'. They therefore talked about 'encouraging research, improving technical and professional competencies and building up new specialities and disciplines'.[163]

[162] Sanderson, Universities, p.12.
[163] Rothblatt, 'Diversification of Higher Education in Britain', p.136.

This revolution in the state's conception of the role and function of Britain's universities and colleges is particularly significant because government influence over the universities inevitably increased over time with the steady growth of Treasury expenditure on higher education. The following chapter therefore examines the impact of the launching of the most significant state-sponsored initiative of the period - the Parliamentary Grant-in-Aid to University Colleges in Great Britain - in 1889, and the claim that it 'inevitably acted as an indirect endowment of research'.[164]

[164] MacLeod, 'Resources', p.161.

3. 'An Indirect Endowment of Research'? The Parliamentary Grant-in-Aid to University Colleges in Great Britain

I quite appreciate the importance attached . . . to the work of research which these University Colleges ought to develop very largely. If I have said nothing about it, it is not because I underrate it, but because I think it is not by giving grants for the work itself that it can be best assisted, but by helping the Universities who will provide both the staff and the opportunities for the research which we hope to see made.

Austen Chamberlain, Chancellor of the Exchequer, 17 February 1904.[1]

It is a common assumption in the literature dealing with the history of Britain's universities and colleges and the rise of research, that the origins of the 'research university' in this country are to be found in the late-nineteenth century revolution in public and government attitudes towards science and research, and the concurrent transformation in the relationship between the universities and the state. The launching of the annual Parliamentary Grant-in-Aid to University Colleges in Great Britain in 1889, and the universities' growing financial dependence on the state, is central to this interpretation. Peter Alter has argued that the universities quickly became 'dependent on state subsidies' and this gave central government more and more influence over their development;[2] and in his more authoritative account of 'The Expansion of Higher Education in Britain', Roy Lowe insists that although this governmental involvement was 'frequently cloaked in "laissez-faire" philosophy which disguised the degree to which central management went on . . . . [b]y the early twentieth century the pattern of growth in all areas was effectively controlled and directed by government agencies' through the mechanism of the grant.[3] It is widely assumed that the purpose of the Parliamentary Grant was to stimulate research in Britain's universities and university colleges. For example, in her guide to the government papers relating to education, Anne Morton insists that only those colleges which made provision for postgraduate research were entitled to receive a share,[4] and Renate Simpson has therefore argued that state aid for the universities was 'essential for the development of their research function',[5] while Roy MacLeod insists that the grant 'inevitably acted as an indirect endowment of research'.[6]

[1] 'Reply of the Chancellor of the Exchequer to a Deputation from University Colleges, asking for increased Government grants, at the Treasury, 17 February 1904', contained in File marked 'Extracts from Treasury Papers relating to Grants to University Colleges' (UGC5/18) at the Public Record Office [hereafter PRO/UGC5/18, etc].
[2] Alter, Reluctant Patron, pp.34-5.
[3] Lowe, 'Expansion of Higher Education', p.55.
[4] Ann Morton, Education and the State from 1833 (Kew: PRO Publications, 1997), p.98.
[5] Simpson, Ph.D., p.85.
[6] MacLeod, 'Resources', p.161.

This would seem to suggest that the modern conception of the role and function of the British university as a centre for teaching and research was imposed from 'above', principally through the mechanism of the government grant. However, there has been no systematic attempt to examine the development of government policy towards Britain's universities in the period 1890-1914, and to investigate the impact and implications of the launching of the Parliamentary Grant. The aim of this chapter is therefore to investigate the origins, development and impact of the grant through a close analysis of the government papers relating to it in the Treasury, Board of Education and UGC files at the Public Record Office, and also in the archives of the College and University of London, in order to test the hypothesis that government initiatives and finance were crucial to the development of the research university in this country. It will be argued that the original purpose of the grant was not to stimulate research, that private money underpinned the growth and expansion of Britain's universities in this period and the emergence of an institutional commitment to teaching and research, and that the origins of the research university are to be found within Britain's individual universities and colleges.

The Origins and Development of the Grant

The earliest national grant for university education in Britain dates from the union of England and Scotland in 1706, when the pre-existing Scottish commitments to higher education were taken over by the Exchequer in London. From 1836 the University of London was awarded a small annual grant to defray the cost of the various administrative expenses it incurred in fulfilment of its role as the principal examining board for universities and colleges throughout England and Wales and the Empire.[7] But, according to the principal historian of the British government's relationship with the universities in this period, these grants were mere 'gestures and not indications of policy or commitment',[8] and prior to the late 1880s the government was insistent that it was not and 'had never been [its] policy to give financial

[7] See undated memorandum on the history and details of the Grant, entitled 'Universities and University Colleges, Great Britain; and Intermediate Education, Wales', c.1908-09, PRO/ED24/517. The assistance given by the state to the University of London was at times remarkably generous. For example, from 1870-1900 the University occupied 'a stately building erected for it in Burlington Garden at a cost to the Exchequer of over 75,000 *l.*, and maintained and furnished at public expense'.
[8] Shinn, Paying the Piper, p.22.

assistance for the provision of higher education in England'.[9] Moreover, before the second-half of the nineteenth century, there was no significant pressure for a programme of government investment in higher education because the ancient universities, and the College established at Durham in 1832, could all rely on large private endowments. The major impetus for the launching of the grant came from the new university colleges which were established in provincial towns throughout England and Wales in the second-half of the nineteenth century. In fact, Owens College, Manchester, presented a request for government assistance as early as 1852 - the very year of its foundation. These colleges lacked the financial security which the ancient universities enjoyed, and by the early 1880s they were all facing severe financial problems which threatened their very existence. According to Christine Shinn, 'the financial distress of Manchester, Birmingham and Reading was acute and . . . Sheffield was in dire straits',[10] and by 1887 University College London was facing a total debt of £11,500.[11]

The result was growing pressure on the government to offer Britain's universities and university colleges some sort of financial assistance. The academic and administrative staff of University College played an important role in the campaign to secure government funding. Prompted by the Devonshire Commission's insistence that UCL and Kings had 'established a claim to the aid of government which ought to be admitted',[12] a special committee was set up in 1875, charged with the task of bringing the claims of the College for state funding before the government.[13] A deputation led by Lord Belper, the President of the College Council, and made up of various members of the Council and Senate and 'several distinguished men of science', was received by the Duke of Richmond, the Lord President of the Council, on 9 March 1875. Belper presented a statement of the claims of the College upon public support, and gave numerous examples of the

[9] Charles Grant Robertson, The British Universities (London: Methuen, 1944), p.56.
[10] Shinn, Paying the Piper, p.23.
[11] 'Memorandum by the Chairman of the Committee of Management on the Financial Condition of the College', contained in box marked 'Financial 1890s Misc. Printed Papers', which forms part of the College Collection in the Manuscripts Room at University College London Library [hereafter UCL/CC].
[12] Fifth Report of the Royal Commission on Scientific Instruction and the Advancement of Science, Cd.1087 (London: HMSO, 1874), quoted in Reports 1875, pp.13-14.
[13] Ibid, p.14.

ways in which assistance from public funds 'would conduce to the advantage of the community at large'. According to the Annual Reports of the College Council, the Duke 'listened attentively and courteously to the representations made to him, and undertook to bring the subject under the consideration of his colleagues in the government'. In February 1876 the Council reported that 'communications on this matter ha[d] recently passed between the Duke of Richmond and Lord Belper', from which it appeared that something might be done 'in the course of the present session of Parliament, to carry into effect the recommendations made by the Royal Commissioners'.[14] In fact, it was not until 1890 that the Council had the 'great pleasure' of announcing that 'Her Majesty's Government [had] procured the vote by Parliament of a sum of money to University Colleges in Great Britain;[15] and, despite the significance of the role played by representatives from UCL, the principal impetus for the launching of the grant actually came from Wales.

In the face of mounting pressure from University College, Aberystwyth, the Aberdare Committee, which was appointed to investigate the Welsh education system in 1880, concluded that government grants were necessary as a means of establishing a proper network of secondary and university education in Wales.[16] In 1882 the government finally yielded, offering a small grant of £4,000 to Aberystwyth, and later to the colleges founded in Cardiff and Bangor (in 1883 and 1884 respectively). The success of the Welsh colleges in securing a small measure of government assistance prompted the English colleges and their supporters to redouble their efforts. William Ramsay, who was at this time Professor of Chemistry and Principal of University College, Bristol, and W.M. Hicks of Firth College, Sheffield, discussed the matter with Viriamu Jones, the Principal of University College, Cardiff, as they made their way back from a meeting of the British Association in Montreal in 1884. On their return they launched a campaign to secure a similar grant for the English colleges at the Annual Meeting of the Principals of English University Colleges, and within a few years they had secured the support of all of the new university colleges that had been established in England and Scotland over the previous half-century. The ancient universities stood aloof, and Owens

[14] Reports 1876, p.16.
[15] Reports 1890, p.14.
[16] See 'Report of the Aberdare Committee', 1880, PRO/ED91/8.

College, Manchester, the Yorkshire College of Science and University College, Liverpool, chose to pursue their claims independently. But Ramsay and Hicks also managed to enlist the support of a number of prominent public figures - principal among them Joseph Chamberlain, Sir Lyon Playfair, Sir Bernard Samuelson and Benjamin Jowett - and by the late 1880s the campaign to secure a government grant for Britain's university colleges carried considerable weight.

On 3 March 1887 Jowett wrote to *The Times* pointing out that only three of the new colleges possessed any considerable endowment beyond their sites and buildings, the others being 'either in debt or insufficiently provided with professors and lecturers'. His comments were subsequently taken up in a *Times* editorial which insisted that there could be no doubt that the new university colleges had 'proved their value' over the previous fifteen years, agreed that they could not survive without 'external help', and endorsed Jowett's estimate that a government grant of £100,000 a year would 'suffice to maintain colleges in all the larger towns'.[17] Meanwhile Sir John Lubbock, Henry Roscoe and A.J. Mundella repeatedly raised the matter in Parliament, and on 30 April 1887 Lubbock led a deputation which presented a formal claim for the introduction of an annual grant of £50,000 to the Chancellor of the Exchequer. He pointed out that 'even the oldest and richest [colleges] were crippled through lack of funds', and stressed:

> The claims of these colleges were not only based on the grounds of their service to learning and study; they were calculated to contribute largely to the material prospect of the country . . . . Our ignorance costs us very much more than our education.[18]

It was on these grounds that, after two more years of 'ceaseless and devoted activity',[19] the government finally yielded and awarded the colleges an annual grant, initially totalling £15,000, which was to be shared between Owen's College, Manchester; University College, London; King's College, London; University College, Liverpool; Mason's College, Birmingham; the Yorkshire College, Leeds; University College, Nottingham; University College, Bristol; the Durham College of Science; Firth College, Sheffield, and University College, Dundee. This was

[17] The Times, 3 March 1887.
[18] Reported in The Times on 1 July 1887.
[19] W.H.G.Armytage, 'The Rise of the Civic Universities in England', in G.Z.F.Bereday and J.A.Lauwreys, eds., The Year Book of Education, 1959: Higher Education (London: University of London Institute of Education, 1959), p.77.

considerably less than the £100,000 originally asked for, and represented 'the thin end of the wedge' according to Ramsay. But he was nevertheless determined to 'keep on trying to increase it';[20] and in the wake of further pressure from the universities the grant rose steadily over the next decade. It was increased to £15,500 per annum in 1894 (when Bedford College, London, was admitted to the scheme), and to £25,000 a year, subsequent to the inspection of the participating colleges by a team appointed by the Treasury, two years later. The colleges were inspected again in 1902, and the total grant rose to £27,000 per annum when Southampton and Reading were admitted to the scheme, doubling to reach £54,000 in 1904/05, and again in 1905/06 to reach £100,000 by the end of our period (see Table 3.1).

Table 3.1 Parliamentary Grant and Portion Allocated to UCL (1889-1910)

	Total Grant	Portion allocated to UCL
1890-91	£15,000	£1,700
1891-92	£15,000	£1,700
1892-93	£15,000	£1,700
1893-94	£15,000	£1,700
1894-95	£15,500	£1,737 10s 0d
1895-96	£15,500	£1,812 10s 0d
1896-97	£25,000	£2,025
1897-98	£25,000	£3,000
1898-99	£25,000	£3,000
1899-00	£25,000	£3,000
1900-01	£25,000	£3,000
1901-02	£25,000	£3,000
1902-03	£27,000	£3,000
1903-04	£27,000	£3,000
1904-05	£54,000	£6,750
1905-06	£100,000	£10,000
1906-07	£100,000	£10,000
1907-08	£100,000	£10,000
1908-09	£100,000	£10,000
1909-10	£100,000	£10,250

(*Source*: University College London Annual Reports 1891-1911 (London: UCL, 1891-1911)).

[20] William Ramsay [hereafter WR] to W.M.Hicks, 27 February 1889, UCL/WR/06/1.

The Impact of Grant

The initial grant was, nevertheless, extremely disappointing, and most historians have dismissed it as a paltry sum - it was 'minute' says Harold Perkin, 'a tiny sum' insists Jack Simmons.[21] Moreover, only twelve colleges were admitted to the scheme. Participation was restricted to 'university colleges' until the turn of the century, and the ancient universities were excluded until 1919. However, Christine Shinn has argued that 'the size of the grant was out of all significance to the importance of the act' of launching it:

> It marked a watershed . . . . By the 1889 grant the government acknowledged that the . . . central contribution that the universities and university colleges were making to the prosperity and well-being of the nation . . . was so vital to the individual citizen and to the nation that state support would be provided to allow it to increase . . . . It also established a commitment by the state to the provision of higher education of a university type . . . . The state had accepted a responsibility to participate in the universities' development by providing money for it.[22]

This was the real significance of the grant, as a disappointed Ramsay readily admitted: 'it [would] certainly not be withdrawn'.[23] But it also had a more immediate and direct impact on the colleges participating in the scheme - indeed, Dr. Chapman insists that it would be 'difficult to exaggerate' its importance, even in the very short term.[24]

In 1892 the Committee appointed to advise the Treasury on the allocation of the grant was asked to consider whether or not the country was receiving an 'adequate return' from the universities for 'the amount contributed out of general taxation'. The secretary of the Committee wrote to each of the colleges participating in the scheme, asking them to report on the impact of the grant in their locality.[25] The

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[21] Perkin, 'Pattern of Social Transformation', p.212; Simmons, New University, p.40. To put this figure into perspective one should note that this was considerably less than the amount spent on universities in Germany. For example, Donald Cardwell estimates that while the total amount expended by the state on English universities in 1897/8 was approximately £26,000, expenditure in Prussia amounted to some £476,000. Moreover, the £15,000 subsidy granted by state in 1889 to be distributed between the ten English universities and university colleges was exactly equal to the annual state subsidy of the Zurich Polytechnic. Cardwell, Organisation of Science, pp.161, 202-4.

[22] Shinn, Paying the Piper, p.26.

[23] WR to Hicks, 27 February 1889, UCL/WR/06/1.

[24] A.W.Chapman, The Story of a Modern University (Oxford: Oxford University Press, 1955), p.65.

[25] Each college was asked to answer the following questions: 1. Has the grant tended to increase local interest and support and, if so, in what way? 2. Is the nation and local community receiving an adequate return for its investment? 3. Has the number of students taking courses of study of 'university rank' increased? 'Report of the Committee on Grants', pp.1-2, PRO/ED24/78.

answers received revealed that the grants had been 'most stimulating and beneficial'. Even at this early stage, the members of the Committee could conclude that they were 'unanimously of the opinion that evident and in some cases very good progress ha[d] been made, and that it [was] largely due to the grant'. The Committee drew particular attention to the experience of one (anonymous) College, which had reported:

> [T]he accelerated rate of progress during the last two or three years, has been directly due in large measure to the Government grant. With it we make steady and even rapid advance, without it we should struggle on penuriously and probably unprogressively, or flounder into debt.[26]

Not only did recognition by the government 'greatly stimulate the efforts of the staff',[27] the grant - small as it was- significantly improved the financial position of most of the colleges participating in the scheme at a crucial point in their history, almost certainly saving some of them (notably Firth College, Sheffield) from early collapse.[28] It also lead to an increase in endowments, donations and benefactions from private sources. To quote the inspectors appointed to investigate the work of the colleges in 1901, 'an understanding of the principle upon which the Government helps those who help themselves has increased the willingness of wealthy residents in the district to render the College still more deserving of Treasury Grant',[29] and this further improved the financial circumstances of the colleges. Moreover, once their financial position had been secured, they were able to 'launch out in new directions' as the grant was steadily increased and their income from other sources rose exponentially.[30]

As we have seen, it has therefore been argued that state aid for the universities was 'essential for the development of their research function'.[31] To some extent this conclusion is borne out by a brief review of the impact of the grant at University College London. The grant did much to improve the financial position of

[26] 'Report of the Committee on Grants', pp.1-3. In its return to the Committee the College Council reported that it had 'no hesitation' in saying that the work that the UCL was doing which was 'useful to the country . . . ha[d] largely increased'. J.M.Horsburgh to H.E.Oakley, Secretary to the Committee on Grants to University Colleges, 12 June 1891. Contained in a box marked 'Financial 1890s Misc. Printed Papers', UCL/CC.
[27] 'University Colleges, Great Britain. Report by Dr.H.G.Woods and Dr.Alex Hill', 31 December 1901, p.8, PRO/ED24/82A.
[28] Chapman, Modern University, p.65.
[29] 'Report by Woods and Hill', p.8, PRO/ED24/82A.
[30] 'Report of the Committee on Grants', pp.1-3, PRO/ED24/78.
[31] Simpson, Ph.D., p.85.

the College, thereby releasing funds for investment in other areas, like the building of elaborate new laboratories for teaching and research in Chemistry, Physiology and Applied Mathematics, and the installation of increasingly sophisticated apparatus and equipment. Moreover, with the doubling of the grant in 1905, the College Council decided to raise the salaries of the professorial staff, with the specific intention of rewarding their 'higher and, from the academic point of view, more valuable work' (i.e. original research).[32] At times this relationship was even more direct. For example, from 1890 to 1894 the College Council directed a large proportion of the grant to the 'Professors for Assistance and Apparatus, &c.' (see Table 3.2).[33] This was an area in

Table 3.2 Parliamentary Grant to UCL and Proportion Allocated Directly to Professors (1889-94)

	Total Grant	Allocation to Professors
1889-90	£2,125	£904 18s 6d
1890-91	£1,700	£1,494 3s 7d
1891-92	£1,700	£1,046 0s 0d
1892-93	£1,700	£1,174 13s 6d
1893-94	£1,700	£1,203 0s 0d

(*Source*: University College London Annual Reports 1891-1895 (London: UCL, 1891-1895)).

which there had been a 'most striking increase' in expenditure, according to J.F. Rotton, the Chairman of the Committee of Management. The average level of expenditure on 'Assistance and Apparatus, &c.' rose from £176 per year in the period 1867-72, to £2,378 per annum between 1892 and 1897, with the installation of new laboratories for biology, physics and physiology, the redevelopment of the chemistry laboratories, and the employment of a growing number of assistants and other junior members of staff. The 'greater part' of the cost of these developments was met out of income from the Parliamentary Grant and the London County Council Grant for Technical Education. Moreover, these grants 'not only enabled these

[32] Reports 1913, p.13.

[33] Hitherto the professors had been required to meet the cost of 'the expenses they were compelled to incur for assistance in teaching and in services, and for apparatus and materials'. They also had to pay their own research expenses and 'those of assistants who [were] working under [their] direction, and . . . [could] not, by reason of their circumstances, be expected to defray their own expenses'. 'Memorandum by Professor Schafer regarding the Expenses of Practical Departments', January 1896, pp.2-3. Contained in box marked 'Financial 1890s Misc. Printed Papers', UCL/CC.

payments to be increased, but . . . also enabled the Council to relieve the other funds of the College of this branch of expenditure to some extent'.[34]

It is unclear whether or not the Council continued to pass the bulk of the grant on to the professorial staff of the College after 1894, but the figures do suggest that there was an enduring link between the amount of money that the College received from the state and the professors' budget for 'Assistants and Apparatus, &c'. (see Table 3.3). From 1904-1910 the academic staff of the College were also in receipt

Table 3.3 Parliamentary Grant to UCL
and Grants to 'Professors for Assistance and Apparatus' (1894-1905)

	Total Grant	Expenditure on 'Apparatus and Assistance'
1894-95	£1,737 10s 0d	£1,045 0s 0d
1895-96	£1,812 10s 0d	£1,094 6s 0d
1896-97	£2,025	£1,172 16s 0d
1897-98	£3,000	£1,414 5s 0d
1898-99	£3,000	£2,604 8s 5d
1899-00	£3,000	£2,590 10s 10d
1900-01	£3,000	£2,641 19s 8d
1901-02	£3,000	£2,511 7s 5d
1902-03	£3,000	£1,984 5s 0d
1903-04	£3,000	£3,024 17s 11d
1904-05	£6,750	£3,093 3s 0d

(*Source*: University College London Annual Reports 1894-1906 (London: UCL, 1894-1906)).

of a 'special' Treasury Grant specifically for the purpose of assisting them in obtaining research apparatus, although a remarkably small proportion of the funds available was actually expended (see Table 3.4). Moreover, it was directly in response to the report of the commissioners appointed to inspect the College in connection with the grant, that the College Council concluded that its 'public usefulness' would be 'increased by its concentrating its efforts more and more in [the] direction . . . of independent work and research'.[35]

[34] 'Memorandum by the Chairman of the Committee of Management', pp.14-15, UCL/CC.
[35] Reports 1903, pp.19-22.

Table 3.4 'Special' Treasury Grant for Apparatus / Research (1904-1910)

	'Special' Grant	Amount Expended
1904-05	£700 0s 0d	£464 18s 11d
1905-06	£850 0s 0d	£321 3s 0d
1906-07	£350 0s 0d	£70 0s 4d
1907-08	-	£212 7s 11d
1908-09	£450 0s 0d	£94 6s 4d
1909-10	£450 0s 0d	£27 14s 11d

(*Source*: University College London Annual Reports 1906-1911 (London: UCL, 1906-1911)).

Calling the Tune?

As the grant was steadily increased in the period 1889-1899, and more rapidly between 1900 and 1905, it became an increasingly important source of funding for Britain's universities and university colleges, accounting for more than a quarter of their total income by 1910. For example, during the academic year 1908-09, 26.6% of their funds came directly from the Treasury, 6.3% from local authorities, 32.2% from student fees, 19.9% from donations and endowments, and 14.9% from various other sources.[36] It has therefore been argued that, as a result of their growing financial dependence on the state, the pattern of growth and development observed in Britain's universities was 'effectively controlled and directed' by central government and its agencies in this period.[37] This would seem to suggest that the impetus for the universities' decision to reinvent themselves as research institutions came from the state. After all, as we have already noted, at UCL the College Council's decision to concentrate on 'independent work and research' was directly prompted by the Treasury inspectors.

[36] Reports from those Universities and University Colleges in Great Britain which participated in the Parliamentary Grant for University Colleges in the Year 1908-9, Cd.5246 (London: HMSO, 1910), p.xi. Further evidence for the growing significance attached to the grant is to be found in the colleges' desire for stability and continuity. For example, in 1905 a representative from Kings College London insisted: The fixed grant to each College . . . should be as large a possible, and . . . should be sufficiently permanent for the College to count on its Estimates for the future'. Treasury Minute 13461, 19 July 1905, 'Observations of the University Colleges on the Third Report of the Haldane Committee', pp.1-2, PRO UGC5/18.

[37] Lowe, 'Expansion of Higher Education', p.55.

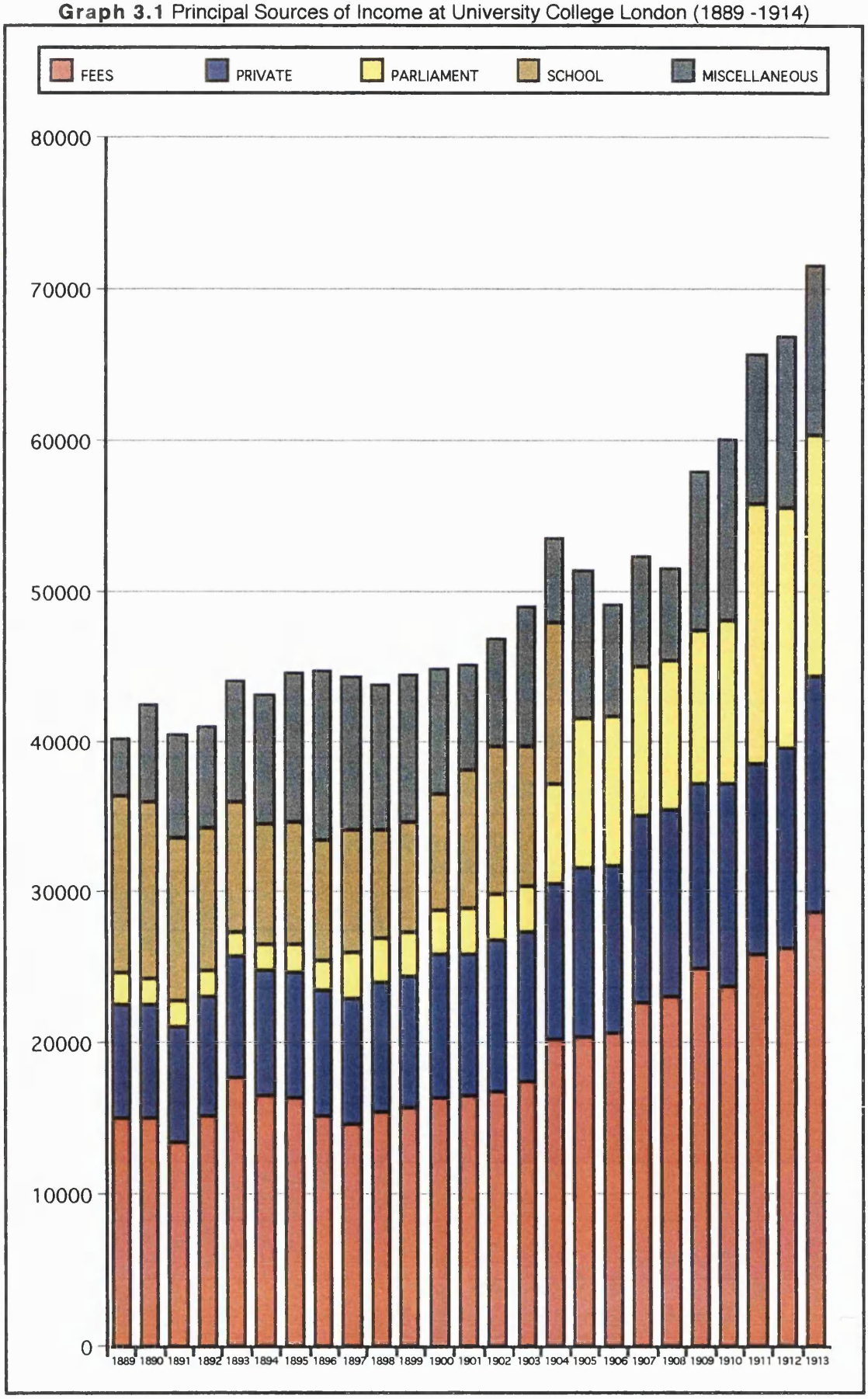
However, while the Parliamentary Grant accounted for a substantial and growing proportion of the funds available to the staff and students of University College, the £152,700 allocated to UCL between 1890 and 1914 only represents 12% of the total income of the College in this period. Graph 3.1 clearly demonstrates that the majority of the funds available to the College Council in the last years of the nineteenth century and early 1900s came from students fees. The £474,500 received in lieu of student fees between 1890 and 1914 accounts for approximately 38% of the total income of the College in this period, while private donations, subscriptions and benefactions of various kinds account for a further 20%.[38] Moreover, these figures do not include the considerable sums that individual members of staff invested in their own laboratories and departments, or the funds contributed in response to the various public appeals that were launched during the first decade of the twentieth century to subside the extensive programme of building and redevelopment that was contemplated in this period - including, for example, the £30,000 donated to the appeal to raise money for the erection of new chemistry laboratories by Sir Ralph C. Forster in 1911, and Sir Herbert Bartlett's donation of £30,000 to pay for a new building to house the Department of Applied Statistics and the biometric and eugenics laboratories. As we will see in Chapter Eight, most of the funds that underpinned the growth and expansion of the College in this period - and the emergence of an institutional commitment to *teaching and research* - came from private sources.

One should also note that, while the Treasury was insistent that 'the State ought to have some means of ensuring that it [got] a return for the assistance it [gave]', and though conditions were attached to the grant,[39] the colleges retained a good deal of autonomy in deciding how they spent the money they received from the government. To quote from the Report of the Committee appointed to advise the Treasury on the distribution of the grant for 1908-9:

[38] The College Council's other principal sources of income in this period include the student fees and other monies received from University College School prior to the formal separation of the School and College in 1907, and various miscellaneous sources, including, for example, ground rents, the dividends and interest paid on various investments, and the money the College received from the Technical Education Board of the London County Council.

[39] 'Report of the Committee on Grants', p.3, PRO/ED24/78. On occasion the Treasury was prepared to dictate to the universities. For example, in 1894 the Liberal government insisted that it would not continue the Treasury grant to Kings College London unless it removed the requirement that its teachers should all be members of the Church of England. See PRO/ED24/81.

Graph 3.1 Principal Sources of Income at University College London (1889 -1914)



Source: University College London Annual Reports 1901-1915 (London: UCL, 1901-1915).

> If State aid to Universities and University Colleges is to be fully effective, a degree of freedom must be allowed in the working of these institutions.

They conceded that it was 'necessary that there should be sufficient guarantee of educational results to justify the expenditure of public money', but insisted that the state should 'leave each College ample freedom for any special development that proved desirable.[40] The fact that the grant took the form of what was technically known as a 'Parliamentary grant-in-aid' is therefore highly significant. Christine Shinn explains that 'the nomenclature was specific, and within Parliamentary terminology, had a very precise definition'. In 1896 the Public Accounts Committee described the grant-in-aid as 'an exception to the rule that monies voted by Parliament that are unspent at the end of the financial year must be surrendered to the Exchequer'. This enabled the UGC to build up its own reserves of money, and therefore to increase its independence from Parliament and the Treasury. University autonomy was, moreover, built into the system from the very beginning. By establishing an independent advisory committee to advise the government on the allocation of the grant, the Treasury accepted the principle of university autonomy and academic authority within the university. Accountability was expected, but the role of the Committee, and the system of block allocation, ensured that it was complemented by autonomy - 'The existence of the grants-in-aid device was a manifestation of the concern of both provider and provided that the state should support but not shackle, should contribute yet not control'.[41]

The government was also mindful of the 'kind of pressure that a University is able to exert when it fears its interests are affected',[42] and was therefore anxious to avoid any impression that they were seeking to dictate to the universities and interfere in their day to day running and organisation. To note one prominent example of what Robert Berdahl has called 'Whitehall's sensitive regard for

[40] 'University Colleges (Great Britain) Grant in Aid. Report of the Committee', 24 July 1908, p.1, contained in file marked 'Advisory Committee on the Distribution of the Exchequer Grants to Universities (1891-1911)', PRO/ED54/1.

[41] 'Grants-in-aid allowed state support to be given to accredited bodies, while permitting these bodies the freedom of action that their responsibilities required. They assisted in the promotion of functions of national importance . . . . which could not attain financial viability as voluntary bodies, but which for the most sensitive of reasons, could not be properly undertaken by government departments'. Shinn, Paying the Piper, pp.25, 50-1.

[42] Robert Morant to the Lords Commissioners of His Majesty's Treasury, 17 December 1908, PRO/ED54/1.

university feeling',[43] when the Haldane Committee suggested the setting up of a permanent advisory committee to oversee the administration and distribution of the grant in 1905, the Treasury made sure to canvass the opinion of all the colleges participating in the scheme. Although they decided to go ahead with the establishment of a permanent committee, they acknowledged that several of the colleges were 'afraid that this Committee [would] interfere too much with their internal affairs and [would] be too powerful',[44] and stressed that 'They ha[d] no intention of contributing to any such result; and, in framing the instructions to be given to the Committee, They [would] bear this consideration in mind'.[45]

Moreover, although the origins of the grant are to be found in the campaign for the endowment of research, it is far from clear that its purpose was to endow research through the universities.

The Purpose of the Grant c.1889-1899

The idea of a Parliamentary grant to the universities was first mooted by an official representative of the government in 1874, in the Fifth Report of the Royal Commission on Scientific Instruction and the Advancement of Science. It was suggested specifically in the context of encouraging the universities to develop their research function. For example, in the sections of their report focusing on UCL and Kings College London, the Commissioners insisted:

> The evidence which has been laid before us clearly shows that the usefulness of University College is greatly restricted by the insufficiency of its funds. The difficulty is felt in two respects, principally; first in providing adequate payment for the Professors and their assistants; and secondly, in providing laboratory accommodation upon a sufficient scale, together with the proper appliances for instruction and research . . . . After carefully reviewing the evidence laid before us with regard to University and Kings Colleges . . . we are of the opinion that . . . they have established a claim to the aid of government.[46]

[43] R.O.Berdahl, British Universities and the State (Los Angeles: California University Press, 1959), p.53.

[44] For example, a representative from Kings College London noted that the appointment of such a Committee 'armed with the power of the purse . . . might be attended with results very prejudicial to the autonomy and the freedom of development which the Colleges now enjoy'. 'Observations of the University Colleges on the Third Report of the Haldane Committee', p.1, PRO/UGC5/18.

[45] Similarly the Treasury also rejected Haldane's suggestion that the Committee should be allowed to make grants earmarked specifically for salaries, because it was felt that this was too central a part of the universities' budget to be controlled by Parliament. Ibid, p.1, PRO/UGC5/18.

[46] Fifth Report of the Royal Commission on Scientific Instruction, quoted in Reports 1875, pp.13-14.

However, it is important to stress that these sentiments were more representative of the views of the universities, or more accurately of the science lobby, than of the government at this point.[47] There was actually a great deal of hostility towards the idea of state funding for Britain's universities and university colleges. For example, in 1887, noting the fact that the University of London had been partly maintained out of public funds ever since the grant of the Charter of November 1836, one anonymous Treasury official observed:

> It certainly does not say much for the liberality of those who approve of the London University if it cannot be provided with its apparently very moderate expenditure without coming to Parliament . . . . The Universities, as representing the highest intellect of the nation, should not be dependent on its politics . . . I should on this account like to see the existing pecuniary connexion between the government and the University of London severed.[48]

And as late as 1901, the Chancellor of the Exchequer, Michael Hicks Beech, could insist that the Parliamentary grant had the effect of 'demoralising' its recipients, in the same way as poor law relief was thought to demoralise the improvident pauper.[49] But, on the whole, the British politicians and civil servants of the era were merely indifferent to the plight of the universities and the wider question of the endowment of research - in the words of Joseph Chamberlain, 'few politicians care[d] about the subject'.[50] The state was, after all, beset with other, apparently more pressing, political priorities, particularly in the fields of social, public health and imperial policy, and the question of university finance was of only very limited electoral significance. Indeed, although the various reports of the Advisory Committee and Treasury Minutes on the question were brought to the House of Commons 'to lie upon the table', the matter was barely raised in Parliament right throughout the period 1889-1914. There were occasional questions from a handful of M.P.s - including Sir William Houldsworth, A.J. Mundella, Augustus Birrell, W.J. Collins and Richard Haldane - regarding the precise terms of reference of the various advisory

[47] The members of the Devonshire Commission were, after all, all prominent members of the endowment of research movement.
[48] 'Extract from Treasury Blue Note dated 1888-89 London University', pp.2-3, PRO/UGC5/18.
[49] Quoted in Searle, Quest for National Efficiency, p.120.
[50] Joseph Chamberlain to Haldane, 12 March 1905, Joseph Chamberlain Papers, Birmingham University Library, quoted in Ibid, p.155.

committees and the publication of their reports,[51] and the odd request for an increase in the grant,[52] but there was no major debate on the question in this period.[53]

Moreover, although it has been suggested that the grant was conditional on the recipient colleges making provision for postgraduate research,[54] there is no substantive evidence in the Treasury and Board of Education papers relating to the launching of the grant to suggest that the state's principal motive was to stimulate research. Rather the (original) purpose of the grant was to assist the new class of College which had 'sprung up' in recent years 'to meet the demand for higher education in great centres of population among persons who cannot afford to spend two or three years in study at the old universities', and were now doing educational work 'of some value' and providing 'teaching of a university standard in arts and science', but found themselves in dire 'pecuniary straits', facing the real possibility of financial collapse. According to the Treasury Minute appointing a small committee to advise the Board on the allocation of the grant, its purpose was as follows:

> (1) to appreciably strengthen the financial position, especially of the newer and poorer colleges, in the beginning of their struggle for existence, (2) to stimulate local munificence to renewed and greater efforts in view of the national recognition of the importance of the institutions which it is called upon to support.

Moreover, there was no mention of research among the factors to be taken into account by the Committee in deciding how much money should be allocated to each institution. Instead they were to consider:

> 1. The quality of the teaching. 2. The amount of work done there, as tested by the number of students, and the average number of lectures attended by each student, and also, perhaps, the amount of additional work that might be fairly demanded in return for the assistance given by the State . . . . 3. The income of the institution, from whatever source derived, and the amount by which it falls short of necessary expenditure . . . . 4. The proportion of income to the average no. of students. 5. The amount of pecuniary support given to the institution locally . . . . The last-named consideration is of the greatest importance.[55]

[51] See, for example, Parliamentary Debates (Hansard) House of Commons, Fourth Series, Vol. XLVII, Col. 928 (18 March 1897); Vol.101, Col. 708 (5 May 1902); Vol.159, Col. 496 (22 June 1906); Vol. 179, Col. 953 (31 July 1907), and Fifth Series, Vol.5, Col. 839, (24 May 1909).

[52] For example, on 22 February 1897 Houldsworth asked the Chancellor of the Exchequer if there was any prospect of the Colleges receiving 'an augmented grant in the next financial year'. Parliamentary Debates (Hansard) House of Commons, Fourth Series, Vol.XLVI, Col.871 (22 February 1897).

[53] Christine Shinn suggests that this was probably because the grant for university colleges was obtained through Parliamentary vote. Estimates were submitted to Parliament by the department under whose auspices the money was provided, but they outlined only the 'broad brush picture'. Moreover, the volume of Parliamentary fiscal business ensured that close scrutiny was not paid by the full House to all the departmental estimates for which it was responsible'. Shinn, Paying the Piper, pp.51-2.

[54] Morton, Education and the State, p.98.

[55] 'Memorandum by the Lord President of the Council and the Chancellor of the Exchequer', 1 March 1889, PRO/ED24/77 (See also PRO/UGC5/18).

However, although there was no specific mention of research, the Treasury's definition of the sort of institution and type of work that the grant was supposed to assist was extremely vague and imprecise, sufficiently vague, in fact, to allow those charged with the task of administering it - the ad hoc advisory committee, the inspectors appointed to consider the progress made by the colleges participating in the scheme, and ultimately the universities and university colleges themselves - a great deal of autonomy in deciding how the money was spent.[56] It is therefore highly significant that two of the five men initially appointed to advise the Treasury on the allocation of the grant - Sir John Lubbock (the Committee's Chairman) and Sir Henry Roscoe - had been active members of the campaign for the endowment of research.[57] Moreover, as we have already seen, Britain's universities and university colleges were, in this period, just beginning to formally reconstitute themselves as centres for teaching and research, and it seems that it was already widely assumed within the academic community that the 'making of knowledge', and the training of (postgraduate) students in the methods of original research, was by its very definition 'work of a university character and stamp' - that it was, in fact, *the* defining characteristic of the modern British university.

The Inspection of the Participating Colleges

While the colleges retained a large degree of independence and autonomy, the Treasury was nevertheless insistent that the 'continued participation of any particular institution in the grant for "University Colleges in Great Britain", must, of course, depend upon the evidence forthcoming . . . of its continuing adequately to discharge the duties which the title "University College" implies'.[58] Under the terms of the grant, the participating colleges were required to provide the Department of Education with an annual statement summarising their academic achievements and financial position; and, from 1896 onwards, they were periodically inspected by

[56] This imprecision is characteristic of the terminology used throughout the Treasury and Board of Education papers relating to the grant. Over the next few years the institutions that the grant was supposed to be assisting were variously described as colleges providing 'teaching of a university standard in arts and science' (PRO/ED24/77), institutions performing 'university work' and providing 'courses of study of university rank' (PRO/ED24/78), institutions in which work was done, 'which from its advanced nature can properly be called "university work"', and 'colleges doing an appreciable amount of advanced university work' (PRO/ED24/82A).

[57] The other members of the Committee were the Revd.J.Percival (Head Master of Rugby School), the Revd. G.F.Browne (Honorary Fellow of St. Catherine's College, Cambridge), and R.G.C.Mowbray M.P., with H.E.Oakley (of the Education Department) as Secretary (PRO/ED24/77).

[58] Treasury Minute, 1 July 1889, PRO/ED24/77.

senior academics and civil servants appointed by the Treasury to investigate the 'character and quality of the university work done'.[59] These inspectors were insistent that 'the duties which the title "University College" implies' should include the promotion of original research, and that the work of the modern university should include both teaching and research:

> [W]e assume that it is generally recognised that the making of knowledge is at least as important a function of a College which aspires to University rank as is the training of students.[60]

In fact, the first mention of the word 'research' in the Treasury and Board of Education papers relating to the grant is to be found in the inspectors' report for 1897. These men played a crucially important role in persuading both the government and colleges to accept this expanded definition of their role and function in this period.

The idea of an inspection was first mooted by the Committee appointed to advise the Treasury on the allocation of the grant in 1889,[61] but the colleges were not actually inspected until 1896. The first inspection was directly prompted by the efforts of the colleges participating in the scheme to secure an increase in the grant. On 28 December 1895 the Chancellor of the Exchequer received an 'influential deputation', made up of representatives from the universities and university colleges, which urged him to raise the grant. The Chancellor therefore decided to revive the idea of the inspection, explaining that 'when the results of the inquiry were before him, he would be in a position to consider the application for an increase of the grant in aid'. In view of their recommendations, it is important to stress that the inspectors were not politicians or career civil servants, but university professors. The Chancellor and Lord President of the Council believed that the inspection 'would be conducted more to the satisfaction of the Government, and of the Colleges themselves, if it were entrusted to two gentlemen who would be generally accepted as representing the University systems of Oxford and Cambridge'. They therefore commissioned Mr. T.H. Warren, President of Magdalen College, Oxford, and Professor G.D. Liveing, a Fellow of St. John's College, Cambridge,[62] to inquire into

[59] Treasury Minute, 3 March 1896, PRO/ED24/81.
[60] 'Report by Woods and Hill', p.12, PRO/ED24/82A.
[61] 'Aid to University Colleges. Report of the Committee', 1 March 1889, pp.5-6, PRO/ED24/77.
[62] Crucially, Liveing had been one of the most active Oxbridge scientists in the movement to reform scientific and scholarly studies in the ancient universities. Having studied under Karl Rammelsburg in Berlin, he established the first chemistry laboratory in Cambridge in 1853, and, according to Rainald von Gizycki, went on to champion 'reforms which foreshadowed those actually brought into force many years later'. Ronald von Gizycki, 'Centre and Periphery in the International Scientific Community: Germany, France and Great Britain in the Nineteenth Century', Minerva, 11 (1973), 474-94, p.487.

the 'character and quality of university work done by the Colleges', and instructed the Treasury clerk, Robert Chalmers, to investigate their financial position and affairs. Specifically, they were required to investigate:

> 1. The quality, character, and results of the work done at each College, which from its advanced nature can properly be called 'University work'. 2. The adequacy of educational equipment of the Colleges for such work, including the number and emoluments of the professorial and teaching staff . . . and the extent and suitability of the buildings and laboratories. 3. The rates and incidence of student fees, and whether they should be increased, varied or reduced. 4. How far the different Colleges agree in their definition of 'subjects of University rank', the duration and standard of the courses of instruction, the distinction between matriculated, occasional and other students, and an assessment of whether or not the number of students in regular attendance is such as to show that the teaching offered is really desired and appreciated in the district served by the College.[63]

In other words, there was no mention of research among the list of criteria to be investigated by the inspectors.

However, the phrase 'work of a university character' was sufficiently vague to allow them to impose their own working definition of the proper role and function of the modern university / university college on their Report. They clearly saw the training of students and the prosecution of original research as 'work of a university character and stamp', even if this assumption was not stated explicitly at this stage. For example, in the introductory remarks to their Report the inspectors enthused:

> The University Colleges of Great Britain are . . . . becoming, more and more, so many homes and rallying points of science and learning, offering, moreover, opportunities of advanced work and research, and in their libraries, museums, laboratories and other equipments, providing appliances for, and instruction in, the proper methods of investigation, and altogether in some measure doing in England, for higher studies, what has been done with so much success in Germany and her many Universities.[64]

Similarly, in the section of their Report dealing with 'Educational Equipment and Staff' they conclude:

> The Lectureships and Demonstratorships at these Colleges, it need hardly be said, offer most valuable opportunities for young men of good aptitude to pursue the study of their subjects, to execute researches and investigations which they could not carry out without the means provided by the College . . . . It might be remarked parenthetically that not the least of the services which the Colleges have rendered to the country is to be found in the opportunity which they have given to some of the very best among living investigators and teachers to discover and develop their own powers.[65]

The inspectors placed similar emphasis on research in the sections of their Report dealing in detail with each of the individual colleges that received a share of the grant. Witness, for example, their glowing report on the work of Owens College,

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[63] Treasury Minute, 3 March 1896, PRO/ED24/81.
[64] 'University Colleges, Great Britain. Report by Mssrs. Warren and Liveing', pp.3-5, PRO/ED25/81.
[65] Ibid, p.5.

Manchester:

> Its excellence is already attested by the distinction and achievements of its alumni, as well as by the published works and recognized position of its Professors both in the past and in the present . . . . It appears to be pervaded by an energetic and active spirit of interest in the concerns alike of learning and education . . . . Not less satisfactory evidence of the good work done in the College is afforded by the investigations which are carried on in its Laboratories and published from time to time in volumes of no mean bulk.[66]

Similarly, they also reported that 'the combination of the ideals of learning and research with those of education and public utility' at University College, Liverpool, was 'most remarkable'; while at Mason's College, Birmingham, they found that in 'all departments of science the courses of instruction include[d] practical work in the laboratory . . . . In most of them [they] found some research going on, and the scientific life of the College [was] generally vigorous'.[67] The inspectors' Report on University College London, which was, in the words of the Council, 'eminently favourable' to the College,[68] also put a good deal of emphasis on research:

> [I]n most or all of the departments, there are advanced students who continue their work under the guidance of professors, or engage in research under their direction. In this respect again the College is rendering service of the highest value both to education and to the advancement of knowledge.[69]

Five years later the Colleges were inspected again. On this occasion the former President of Trinity College, Oxford, Dr. H.G. Woods, and Dr. A. Hill, Master of Downing College, Cambridge, were entrusted with the task of 'testing the character and quality of the University work done', and Mr. H. Higgs of the Treasury was instructed to investigate the financial position of the colleges. Once again their Report was extremely positive:

> [V]ery remarkable . . . . we might almost say immense . . . . progress has been made by the University Colleges during the last five years . . . . There are many indications that the influence of the Colleges upon the intellectual life of the community is rapidly increasing. They are becoming the recognised centres of enlightenment and mental culture.[70]

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[66] 'Report by Warren and Liveing', pp.21-5, PRO/ED25/81.

[67] Ibid, pp.26-33.

[68] Reports 1898, pp.13-14. The inspectors concluding: UCL 'is a place of learning of some considerable prestige and tradition, and can make good the claim, which it puts forward, to have been in a sense the pioneer and model of the University Colleges throughout the country. It has produced during the years of its existence many *alumni* of much distinction, and some of great eminence . . . and has contributed not a little to the education and to the intellectual life of the country. At the present moment it possesses, as it has done in the past, an intellectual staff of Professors and Teachers of recognised and in many cases very special merit, and it has always endeavoured and still endeavours, whatever its means, to maintain a high standard of learning and teaching, and to encourage with comprehensive liberality the general advancement of knowledge and culture'. 'Report by Warren and Liveing', p.12.

[69] Ibid, pp.11-12.

[70] 'Report by Woods and Hill', pp.7-8, 12, PRO/ED24/82A.

Hill and Woods placed even more emphasis on research, making explicit the assumption that the work of a modern university should include both instruction, and the promotion of original research. They therefore devoted separate sections of their Report to 'Research' and 'Students and Original Research'. They were mindful of the fact that their Report was 'incomplete' in this respect, because they found it extremely difficult to ascertain and estimate the quality and quantity of original work produced in the time available, but felt that they were 'obliged to attempt some analysis of the output of research, since *research is such an important part of the role and function of the University Colleges*', and because they were 'persuaded that in most instances . . . the vigour and efficiency of a teacher and the vitality of the department under his charge [could] be gauged by the output of original work' (my italics).[71]

The inspectors found that there was a great deal of variation between the colleges in terms of their commitment to research - principally because 'the leisure and, therefore, the opportunities for research, which the professors enjoy[ed] var[ied] immensely'. They were forced to conclude that in most cases the professor's duties were 'far too arduous and incessant to allow him to do too much work of this kind', and that in general the 'opportunities for continued study and research were, except in London, inferior to those which Oxford and Cambridge afford[ed]'.[72] But Hill and Woods were nevertheless full of praise for the staff and students of Owens College, Manchester, and UCL, insisting that the 'College appear[ed] to be fulfilling its destiny, and discharging the duty to which any College which claims to be of university rank [was] bound - the making of knowledge'.[73] Their Report gives an interesting insight into the priorities of the College around the turn of the century, the inspectors noting:

> Although little has been done since the date of the last Commission to improve its apparatus of teaching, the College has, during this period, made notable progress in the extension and elaboration of its more advanced work . . . . As these various higher branches of study have developed, an increasing number of graduates, as well as persons unconnected with any University, have taken advantage of the opportunities which the College affords for advanced work, and especially for original research.

[71] 'Report by Woods and Hill', pp.11-12, PRO/ED24/82A.

[72] Similarly, 'With regard to the question of the desirability of encouraging students to undertake original investigations, we find that teachers hold diametrically opposed views. Some consider that to set a student to such work is to rob him of the opportunity which his student days afford of acquiring information. Others look upon experience in research as the best training which any student can receive. The amount of research work done by students depends, therefore . . . upon the position which Professors take with regard to this question'. Ibid, p.12.

[73] Ibid, p.27. On Manchester see pp.43-9.

Elaborating on this point in their General Reports on Arts and Science, they observed that the most noteworthy feature of the scientific departments of the College was the large number of 'advanced or special courses' on offer, and the 'opportunities which [were] afforded of pursuing original investigations', and applauded the fact that efforts were also being made to give a 'research character' to studies in the arts.[74] The most active departments of the College in the area of original research were Classical and Egyptian Archaeology, Philosophy, Applied Mathematics, Engineering, Botany, Zoology and Comparative Anatomy, Geology, Physiology, Pathology and Hygiene, and, above all others, the Department of Chemistry:

> Research is actively prosecuted by the Professor and Assistant Professor, their assistants and the senior students. Four 1851 Exhibition scholars have worked here since the date of the last Report, each for an average period of two years. Twelve students, in addition to the staff, were, at the time of our visit, engaged in research. We were informed that 30 original publications have issued from the Department during the past five years.[75]

The emphasis on research in the inspectors' reports did, slowly but surely, begin to have an impact on the government. For example, in deciding on the allocation of the grant for 1897-98, the Advisory Committee made 'a distinction in their apportionment in favour of Colleges doing an *appreciable amount of advanced university work,* to which alone they recommend[ed] a maximum grant' - explaining that '[s]uch advanced work [was] necessarily a source of relatively greater expense to a College, and appear[ed] to the Committee to merit favourable recognition in any apportionment of public moneys between the Colleges' (my italics). They even managed to persuade the Treasury to grant Owens College, Manchester, an extra £500, in addition to the maximum grant of £3,000 already allocated, in recognition of its 'pre-eminence' in this respect.[76] However, though the Treasury accepted this allocation of the grant, they made no mention of research in doing so, and, as we have already noted, few government ministers, M.P.s or civil servants were in favour of endowing research through the universities in this way. It therefore seems that this emphasis on research came from the inspectors - i.e. from within the university system - and not from the government.[77]

[74] 'Report by Woods and Hill', pp.19-22, PRO/ED24/82A.
[75] Ibid, pp.25-6.
[76] 'University Colleges. Great Britain. Grant in Aid. Report of the Committee', 20 May 1897, pp.74-5, PRO/ED24/81.
[77] See 'Treasury Minute of 16th June 1902, relating to the Grant in Aid of University Colleges, Great Britain', PRO/ED24/82A.

The inspectors' reports had a more immediate and direct impact on the colleges themselves, particularly on UCL. In 1902, for example, though they were full of praise for the College, the inspectors were insistent that in 'some departments the laboratory accommodation, in others the assistance given to the professor . . . , and in almost all the stipends of the professors are below the standard of the times'. They were also mindful of the fact that in certain departments, especially the Departments of Botany, Chemistry, Geology, Physiology, Pharmacology, Egyptology and Archaeology, there was a 'striking discrepancy between the work which [was] being done in them, and the narrowness and inconvenience of the quarters in which it [was] carried on', and actually concluded that 'in no other of the Colleges which we visited [was] there so great a contrast between the intellectual vitality of the College and what may be termed its bodily form'. But they were nevertheless insistent:

> We wish it to be understood that our criticisms do not imply that we found any evidence of diminution in the effectiveness of the College as a whole. We cannot but recognise, however, that the future of the College is precarious, and that it must, unless it obtain additional funds, suffer in competition with institutions which are more modern in laboratory accommodation and equipment and more highly endowed.[78]

This proved to be a major turning point for UCL. Noting that the 'inspectors refer[ed] more than once to the amount of *independent work and research* carried on in the College', the Council reached a momentous decision:

> *There can be no doubt that the output of this higher work must in the long run determine the academic rank and intellectual status of the College, and it is probable*, now that such ample provision is made by Polytechnics and similar institutions for the teaching of many subjects up to the lower stages of university work, *that the public usefulness of the College will be increased by its concentrating its efforts more and more in this direction.* No other institution in London is equally qualified by the wide range of its work and the distinction of its professorial staff to take the lead in providing advanced instruction (my italics).[79]

The origins of the official conception of UCL as 'a place of teaching and research' can be traced directly to this point - the Council, prompted by the state, thus consolidating the effects of various developments which had taken place *within* the College over the previous half-century.

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[78] 'Report by Woods and Hill', pp.18-19, PRO/ED24/82A, quoted in Reports 1903, pp.19-22.
[79] Ibid, p.22.

The College was inspected again in 1907, and though the inspection team noted the 'pressing need' for further investment and building in the Chemistry, Anatomy, Physiology and Pharmacology Departments, they could nevertheless conclude that the 'work of the College, especially advanced work and research, ha[d] been greatly strengthened during the past five years', highlighting, in particular, the 'rapid strides in research work in each of the scientific departments, and . . . the number of original publications that ha[d] issued from the departments during the past quinquennium'.[80]

The Purpose of the Grant c.1900-1910

As we saw in Chapter Two, the turn of the century marked an important turning point in the state's role in the promotion and organisation of research, particularly in the sciences. From this point onwards there was growing support in Parliament, not only for the endowment of the universities, but also for the *endowment of research through the universities*, particularly among the supporters of the so-called 'efficiency movement'.[81] The principal political champion of state funding for Britain's universities in this period was Richard Haldane, Britain's premier 'statesman of science' and a passionate supporter of the campaign for the endowment of research.[82] Other prominent supporters of the endowment of the universities included Joseph Chamberlain, who wrote to *The Times* in November 1902, insisting:

> University competition between states is as potent as competition in building battleships, and it is on that ground that our university conditions become of the highest possible national concern,[83]

and Sidney Webb, who urged that on these grounds the grant should be increased to £500,000 a year in order 'to promote national efficiency'.[84] Even the Chancellor of the Exchequer, Austen Chamberlain, was convinced that there was 'nothing more

[80] 'University Colleges (Great Britain), Grant in Aid. Report of the Committee', 6 June 1907, Appendix ('Report by Sir Thomas Raleigh and Dr.Alex Hill'), pp.63-71, in Parliamentary Accounts and Papers. 18. Education United Kingdom 1907. 64. University Colleges (Great Britain) (Grant in Aid).

[81] See Searle, National Efficiency, and Semmel, Imperialism and Social Reform.

[82] On Haldane's work on education policy see Eric Ashby and Mary Anderson, Portrait of Haldane at Work on Education (London: Macmillan, 1974), and Crowther, Statesmen of Science, pp.273-300, on his involvement with the endowment of research movement.

[83] The Times, 6 November 1902.

[84] Sidney Webb, Twentieth Century Politics: A Policy of National Efficiency (Fabian Tract No.108) (London: Fabian Society, 1901).

important than to supply the deficiencies which separate us from those with whom we are in closest competition', and that the government would therefore have to 'find a little more money' to eliminate our deficiencies with regard to 'the higher education of the people'.[85] As Prime Minister, Arthur Balfour also did all he could to promote technical education and the civic universities, and it is highly significant that the grant was doubled twice during his brief premiership at the beginning of the century.[86] Balfour was almost unique among the senior politicians of the period in that he was also a practising (amateur) scientist. He had been a Fellow of the Royal Society since 1888, and in 1904 he was elected President of the British Association for the Advancement of Science - an organisation founded specifically for the purpose of obtaining 'a greater degree of national attention to the objects of science, and a removal of those disadvantages which impede its progress'.[87] In a speech delivered at a dinner for medical graduates on 22 May 1901, Balfour admitted:

> [No] man who looks around the equipment of our Universities or medical schools, or other places of education can honestly say in his heart that we have done enough to equip research with all the costly armoury which research must have in these modern days. We, the richest country in the world, lag behind Germany, France, Switzerland, and Italy. Is it not disgraceful? Are we too poor or are we too stupid?[88]

This was the context in which the grant was increased in 1905 and the government began to adopt a more systematic approach to its organisation and administration with the establishment of a permanent advisory committee. The reforms of the period were prompted more directly by Norman Lockyer's Presidential Address to the British Association in 1903, entitled 'The Influence of Brain-Power on History', in which he argued that the remedy for Britain's present malaise was state funding for her universities:

> [I]t is the duty of a State to organise its forces as carefully for peace as for war . . . universities and other teaching centres are as important as battleships or big battalions, are, in fact, essential parts of a modern States' machinery, and as such to be equally aided and as efficiently organised to secure its future well being . . . . We are in the midst of a struggle in which science and brains take the place of swords and sinews; the school, the university, the laboratory and the workshop are the battlefields of this new struggle.

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[85] The Times, 6 November 1902. As Chancellor, Chamberlain presided over a fourfold increase in the grant; and in 1906, following the ousting of the Tories in the previous year, he tabled a Parliamentary question, asking the new Chancellor, Asquith, to consider a further increase. Parliamentary Debates (Hansard) House of Commons, Fourth Series, Vol.152, Col.776 (26 February 1906).

[86] Searle, National Efficiency, p.214.

[87] Howarth, British Association, p.21.

[88] Reported in Nature, 64 (1901), 109-10.

He was insistent, moreover, that it was 'not instruction' that was wanted, but research - 'for research is the most powerful instrument of education we possess'. Lockyer suggested that a grand total of £24,000,000 was needed for organising, building and endowing new universities and making existing ones more efficient, and maintained that this sum could only be raised by 'the powerful arm of the State or the long purse of the nation'.[89] On 17 February 1904 the Prime Minister and Chancellor of the Exchequer received a deputation, led by Lockyer and made up of representatives from each university locality, which demanded that the grant be increased in order that 'a man who has exceptional gifts of originality in science' might 'devote his life to the subject of his predilection' and 'render the full services of which he is capable to his country'.[90] In reply Balfour confessed that Lockyer's speech before the British Association had had a most profound effect upon him, and Austen Chamberlain announced a dramatic increase in the grant, insisting:

> I myself attach very great importance to the work of these University Colleges and should be glad to see it strengthened and extended as far as possible . . . . *I am certain that what is of most importance of all to the country is, that, for those who wish to take up higher work, facilities should exist in these University Colleges* . . . . What I am prepared to do, or at least to propose to the House of Commons to do, is that they should vote in the present year a total sum twice the amount of that which was voted last year, and I should hope, when next year comes, we might raise the sum to £100,000 (my italics).[91]

Renate Simpson insists that 'grandiose as this may have sounded, the figures involved were extraordinarily small . . . . Clearly the government's thinking was on an entirely different scale from that envisaged by Lockyer'. But the 1905 increase in the grant and the appointment of a new advisory committee, chaired by Haldane, to consider its allocation, marked an important turning point in the history of Parliament's relationship with the universities, and in the state's conception of their role and function:

> The list of men inside and outside the universities who made public utterances, comparing the paltry contributions of the British government with those of the continent and the States was daily growing . . . . [T]he small annual grant to universities and university colleges was gradually being increased and reports on these grant-aided institutions, as well as various Treasury Minutes, showed that the government was no longer entirely unaware of the deficiencies in postgraduate education.[92]

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[89] Norman Lockyer , 'The Influence of Brain Power on History', Nature, 68 (1903), 439-47.
[90] Quoted in O.J.R.Howarth, The British Association for the Advancement of Science: A Retrospect, 1831-1931 (London: British Association for the Advancement of Science, 1931), p.237.
[91] 'Reply of Chancellor of the Exchequer to a Deputation from University Colleges', pp.6-7, PRO/UGC5/18.
[92] Simpson, Ph.D., pp.88-9.

The Haldane Committee was told that it 'need not be bound by the principles laid down for the guidance of former Committees', and invited to report:

> How, in their opinion, State-aid to University teaching could be most effectively organised, paying special attention to the quality, character, and results of that portion of the work done at each College which, from its advanced nature, can properly be called University work, distinguishing it as far as possible from technological or trade instruction or training processes of any industry.[93]

Perhaps inevitably, given Haldane's background and beliefs and this expansive brief, the Committee's three reports - especially its revolutionary Third Report -all reflect the assumption that original research was work which 'from its advanced nature' could 'properly be called University work'. For example, in considering the possibility of new institutions being admitted to the scheme, the Committee paid particular attention to the work of the London School of Economics - 'a striking foundation which in their opinion deserve[d] special encouragement'. Although its work was admittedly of a 'somewhat special and novel nature', they were insistent that it was deserving of encouragement by the state, in view of the fact that its 'special feature [was] the very large amount of original research work done by the students under the guidance of the teachers'. Haldane and his colleagues also paid a great deal of attention to research in their analysis of the principal defects of the colleges which might be remedied by an increase in the grant. They dealt first with the absence of provision for postgraduate scholarships and fellowships in the new Colleges, insisting:

> [T]here is a lamentable absence of provision in places of higher learning for the encouragement of students of marked ability to continue their student life, after a degree has been taken, by engaging in special inquiry or research . . . . The extent to which diffusion of expert knowledge in applied science in Germany and the United States exceeds its diffusion with us is in considerable measure traceable to the greater opportunities of post-graduate work which are open to the student in those countries.[94]

This was the first official acknowledgement that the grant could - and should - be used to fund postgraduate work. Haldane even envisaged the establishment of research scholarships, insisting that a 'moderate sum should be set aside for distribution by way of payment to post-graduate students from the University Colleges who devote[d] themselves for one, two or three years to special problems'. Moreover, this was to be a grant direct to the student:

[93] 'Treasury Minute of 30th March 1904', PRO/UGC5/21. The other members of the Committee were Mr.C.A.Cripps M.P., the Revd. Dr.Woods and Francis Mowatt of the Treasury.
[94] 'University Colleges Committee. Third Report, 23rd February, 1905', pp.8-10, PRO/UGC5/21.

> The authorities, and especially the teachers of the College where the student works should be consulted; but the Committee think that to ensure the money being applied most efficiently to the stimulation of individual study, as distinguished from the general purposes of the College to the development of which other sums out of the grant are directed, the distribution should assume the form of a grant made directly to the student on the advice of some impartial authority.

The members of the Committee were also concerned about the inadequacy of the renumeration of the staff of some of the colleges participating in the scheme, the results of which were detrimental to the 'full efficiency' of the teaching staff. A professor or junior member of staff whose salary was not sufficient to keep him in 'moderate comfort', was inevitably 'driven to extend his work either inside or outside the College until there [was] left to him neither time nor energy to do full justice to his students or to keep himself abreast of the latest developments of the branch of learning which he represent[ed]'. Moreover, there was also a general shortage of books and a dearth of proper scientific apparatus and equipment, specifically the reference books and periodicals which were 'essential in almost every form of specialised work' and 'indispensable . . . for what [was] becoming increasingly known in this country as "seminar" work, or for individual research'. The Committee therefore recommended that 10% of the grant should be held back each year and allocated in the form of 'special grants towards the provision of books and apparatus, and . . . the encouragement of post-graduate work'.[95] They also envisaged a revolution in the organisation and administration of the grant - recommending the establishment of a permanent committee to advise the Treasury on the allocation and distribution of the grant and oversee the quinquennial inspection of the colleges in receipt of government assistance, insisting:

> Such a body, acting independently, but in sympathetic co-operation with the Governing bodies of the Colleges, might effect great things.[96]

[95] 'University Colleges Committee. Third Report', pp.8-10, PRO/UGC5/21.

[96] Ibid, pp.6-7. According to the Treasury Minute appointing the Permanent Advisory Committee, its main function would be 'to advise the Board of the Treasury generally as to the kind of education which should be assisted out of the grant and to satisfy themselves by inspection from time to time that the money is being applied in accordance with the intentions of the Board' (Treasury Minute 1880/06, 31 January 1906, PRO/ED24/517), and Berdahl argues that it therefore anticipated the function of the UGC - 'advice by experts essentially friendly to the universities, yet cognizant of the practical necessities of the grant'. The Third Report of the Haldane Committee was therefore a highly 'prophetic document in the development of university-state relations' in this country. Berdahl, Universities, pp.49-52.

The Treasury accepted all the recommendations of the Committee;[97] and in January 1906 a Permanent Advisory Committee on Grants-in-Aid to Universities and University Colleges - chaired by H.G. Woods, and consisting of Francis Mowatt, Sir William J. Collins, Henry Jackson and W.S. McCormick - was duly appointed.[98] It was on the initiative of this Committee that the government authorised a grant specifically for research for the first time - UCL, Kings College London, and the Universities of Manchester, Liverpool, Leeds, Nottingham, Bristol, Reading and Southampton all receiving grants of between £150 and £500 for 'Research'. The following conditions were attached to the grants:

> (a) That the money be devoted exclusively to the expenses incurred in connection with research, and in no case be utilised for the maintenance of the person engaged upon the research. Such expenses might reasonably be held to include not only the cost of books and apparatus required for the purposes of research, but also in some cases the cost of travelling (including, where necessary, some allowance for the extra cost of subsistence), or the cost of publishing results. (b) That after the grant has been expended, a detailed account of the expenditure be submitted to the Advisory Committee, with an explanation of the nature of the researches which have been assisted.[99]

Thereafter there appears to have been a general consensus among those responsible for the allocation and administration of the grant that it should be used, at least in part, to encourage the universities to develop their research function. 'Special Grants' for research expenses were awarded again in 1907-08,[100] and the inspectors appointed to investigate the progress of the colleges were instructed to 'advise as to the place which is and ought to be taken by post-graduate study and research in the activities of each College'.[101] Moreover, when responsibility for the grant was transferred to the Board of Education in 1911, it was resolved that in allocating the grant particular attention should be paid to:

[97] Although 'They doubt[ed] if it would be prudent to place the students in direct relation with the Advisory Committee. They would prefer to leave the matter in the hands of the authorities of the Colleges, with whom it would rest to make proposals to the Committee, showing the nature of the work which it is desired to undertake and the assistance which the College intended to contribute from its own resources'. 'Treasury Minute on the Recommendations of the Committee', PRO/UGC5/21.

[98] 'From this point until his death in 1930 McCormick was intimately connected with the development of the British Universities. It was he who guided the transition from ad hoc aid to a system of state support complementing university autonomy, which ultimately became the example of management of the sector for the western world'. Shinn, Paying the Piper, p.29.

[99] 'University Colleges, Grant in Aid, Report of the Committee', 2 March 1907, pp.1-2, PRO/UGC5/21. See also PRO/ED24/517.

[100] 'University Colleges (Great Britain) Committee. Report on Special Grants, 1907-8', 4 March 1908, PRO/UGC5/24.

[101] 'University Colleges (Great Britain) Grant in Aid. Report of the Committee', 24 July 1908, pp.4-5. Contained in File labelled 'University Colleges (Great Britain) Committee. Report for 1908. Minutes and Treasury Correspondence', in Box marked 'Advisory Committee of Exchequer Grants to Universities (1889 -1911)', PRO/ED54/1.

> 1. Output - Extent and character of the work being done, including the number of students, nature of instruction given, research and other work undertaken. 2. Needs - Needs in order to carry on the work efficiently; (a) staff and the renumeration of its members; (b) accommodation and equipment.[102]

By 1912 the government was even considering making 'the maintenance of Universities and of an adequate number of institutions for specialised instruction of the most advanced character as well as *the provision of funds for the conduct of researches of national importance a first charge upon the national expenditure for education'* (my italics).[103] Speaking on the occasion of the opening of the new physiological institute at University College London in 1909, Richard Haldane could therefore report:

> There has been an interest, a distinct awakening, not only to the value, but to the absolute necessity for the progress of the nation in higher knowledge, that is, knowledge of the university type, which can only be given in the institutions in which higher knowledge is taught. There is a interest on the part of Parliament, and . . . the Treasury, in this subject, which shows that the nation is in earnest, and is gradually, and even quickly, working out its own salvation.[104]

Conclusion

By the end of the first decade of the twentieth century the government had therefore accepted the principle that the state should assume partial responsibility for the endowment of research through Britain's universities and university colleges. However, this was significantly later than the point at which the universities and colleges had begun to reinvent themselves as 'places of teaching and research'. In fact, the promotion of research had been listed among the aims of University College London from as early as 1898,[105] and, as we have already seen, by the turn of the century men like William Ramsay, Norman Collie, Ernest Starling, Ambrose Fleming and Karl Pearson were conducting important research in various fields at UCL, and encouraging their students to carry out their own experiments and investigations. It therefore seems that the origins of the modern conception of the British university as a centre for teaching and research are to be found in the

[102] 'Board of Education. Copy of resolutions passed at Meeting on April 29th, 1911, of Principals of Universities and University Colleges participating in the Treasury Grant', PRO/ED54/1.
[103] 'A Policy of National Education' (Typewritten memorandum, 1912, no exact date, H.H.Asquith, Private Papers, vol.93, fol. 1, Bodleian Library), quoted in Alter, Reluctant Patron, p.249.
[104] Reports 1910, pp.27-32.
[105] When the Council sent a deputation to inform the Commission appointed to consider the terms of a new University of London Act, that the 'intention of the Founders and Benefactors of [UCL] will only be carried out by the incorporation of the College in the University, so that its resources shall still be utilised for the furtherance of the highest educational work and for research'. Reports 1899, pp.17-18.

universities and university colleges themselves, and that the role of the state was merely to consolidate the effects of various developments that were taking place within the various colleges participating in the scheme, through the grant and quinquennial inspection of their work and progress. It might even be argued that the universities persuaded the state to accept a new definition of their role and function through the mechanism of the grant, and more especially through the efforts of Haldane, the Treasury inspectors, and the colleges themselves, to secure an increase in the grant. For example, when the College Council made the decision to concentrate on 'independent work and research' at UCL in 1905, they were mindful of the fact that 'as the College develop[ed] the higher side of its work, its need for external support [would] become greater and greater', as the 'requirements of advanced study are costly and the possible returns from student fees are very small', and they therefore resolved to petition Parliament in an attempt to secure an increase in the grant.[106]

The grant does nevertheless appear to have acted as an indirect endowment of research within Britain's universities and colleges in this period (rather in the way that some of the supporters of the endowment of research had hoped), and the significance of its role in consolidating the effects of developments that were taking place within the universities should not be underestimated. The story of the Parliamentary Grant-in-Aid to Universities and University Colleges in Great Britain therefore has a number of important historiographical implications. Directly or indirectly, the state made a crucially important contribution to the development of Britain's universities and colleges in the period 1889-1914, particularly after the turn of the century. This suggests that although 'the creation of the University Grants Committee in 1919 was the most important step in the development of an internally consistent national policy for the universities',[107] the relationship between the universities and the state had already been transformed before the end of the first decade of the twentieth century.

[106] Reports 1903, pp.17-19. Noting the great pecuniary difficulties facing the would-be research student, the Senate of the University of London explained: 'The amount of accommodation and equipment required for each of the Postgraduate and Research Students is necessarily great'. Moreover, they 'have already had, either at the College or elsewhere, a long course of training: they cannot pay higher fees. It is clear that a Postgraduate or Research Student makes little or no contribution towards general Establishment Expenses, and cannot pay the cost of the direction and supervision of his work'. 'Memorandum re. Treasury Grant', p.19, PRO/ED119/47.
[107] Berdahl, British Universities, p.48.

However, despite the significance attached to the role played by the state in most accounts dealing with the origins of the research university in this country, there is little or no evidence in the government and university papers relating to the most important state-sponsored initiative of the period to suggest that public money and government initiatives played a decisively important role in the revolution that saw Britain's universities and university colleges reconstituted as places of teaching and research. Ultimately, this account of the origins, development and impact of the Parliamentary Grant to University Colleges in Great Britain therefore refocusses our attention on the universities and colleges, themselves, in our quest to discover the origins of the modern conception of the British university as a centre for teaching and research. The following chapter therefore reexamines the emergence of an institutional commitment to teaching and research at UCL between 1890 and 1914, focussing in particular on the College Council and its changing conception of the role and function of the College in this period.

4. The College Council and Its Changing Conception of the Role and Function of the College

[I]n no College has the advancement of knowledge for its own sake, as the ideal of University work, been more distinctly kept in view.

T.H.Warren and G.D.Liveing, Report on University College London, December 1896.[1]

The late nineteenth-century transformation in public and government attitudes towards science and the promotion of research was a crucial precondition for the emergence of a new conception of Britain's universities as centres of teaching and research. But, ultimately, the role of the state was merely to consolidate the effects of various developments that were taking place within the universities and colleges themselves. Long before central government and its agencies came to accept that the functions of the modern British university should include both the advancement and diffusion of knowledge, University College London had already begun to reconstitute itself as a place of teaching and research. Initially this revolution was led by a handful of pioneering professors in certain (key) departments, but the Annual Reports compiled by the College Council reveal that UCL's ruling body took a growing pride in the research interests and achievements of the academic staff and students of the College as the nineteenth century progressed, and by 1903 its members were insistent that they attached the 'greatest importance to the original work done by the teaching staff and students'.[2]

This chapter examines the College Council's changing definition of the aims and objectives of the College in the period 1890-1914. Negley Harte describes the Council as the 'all-powerful body which was to control the [College's] property, appoint the professors and regulate the education of the students'.[3] This body was originally known as the Council of the University of London. After the reconstitution of the College and University in 1836 it became the College Council, and from 1 January 1907 it was known as the University College London Committee. It was originally made up of 24 persons elected from among the 'proprietors' or shareholders of the College. The original members of the Council included George

[1] 'Report by Warren and Liveing', p.12, PRO/ED25/81.
[2] Reports 1903, p.24.
[3] Harte, UCL, p.14.

Birkbeck, Henry Brougham, Thomas Campbell, Sir Isaac Lyon Goldsmid, George Grote, Zachary Macaulay and James Mill. Three members of the Senate (later the Professorial Board) - the administrative body made up of members of the academic staff of the College - also sat on the Council in rotation. During our period the leading figures in the administration of the College were Lord Reay (Chairman of the College Council and Committee 1897-1921), Richard Burdon Haldane (Vice-President of the Senate 1896-99 and Vice -Chairman of the Council 1897-99), Lord Monkswell (Vice-President of the Senate 1895-99 and Vice-Chairman of the Council 1901-06), Sir Edward Busk (Vice-Chairman of the Council 1907-19), George Carey Foster (Vice-President of the Senate 1899-1901 and Principal of the College 1900-04), and Gregory Foster (College Principal 1904-06 and Provost 1906-29).

Academic Staff

In its initial statement 'explanatory of the nature and objects of the institution', which dates from May 1826, the newly formed Council announced its intention to appoint professors of 'eminent ability' and 'established reputation'. But this was merely in the hope that their ability and reputation would lend 'authority and lustre to their instructions, so that the University [would] not be found wanting in the means of exciting and guiding superior faculties in their pursuit of excellence, as well as of speedily and easily imparting the needful measure of knowledge to all diligent students'.[4] Many of the first professors appointed to chairs at UCL had conducted extensive and important research in various fields, and others undertook pioneering researches while ensconced at University College. However, they were not paid to conduct their own research, and they were given little or no institutional support by the College authorities. The Council merely required that each professor 'devote at least two hours to the business of instruction on each day that his class [was] appointed to meet; one hour to be occupied by the lecture, and another hour to be devoted to the examination of the pupils'.[5]

[4] 'Statement by the Council of the University of London', Reports 1827-34, p.32.
[5] Ibid, pp.17-19.

A new conception of the role of the College professor did slowly begin to emerge in the second-half of the nineteenth century. The first 'research professorship' was instituted as early as 1874, when T.J. Philips Jodrell presented the College with the sum of £7,500 for the permanent endowment of a Chair of Physiology, with the specific intention of 'encouraging original research in combination with professional teaching'. His aim was:

> to ensure such provision for the said professorship as shall induce men of eminent ability who may be willing to cultivate science for its own sake, to forego more lucrative sources of emolument, and to undertake this office on the condition of devoting to original research . . . all the time that can be spared from the work of the lecture room.[6]

The establishment of the Jodrell Chair was a vitally important development - both in the history of English physiology, and also in the context of the story of the emergence of an institutional commitment to teaching and research at UCL - but it is highly significant that the initial impetus for this innovation came from outside the College.

The earliest sign that the College Council's attitude towards research was beginning to change was the attention paid to the research interests and achievements of new and prospective members of the academic staff of the College in their Annual Reports. For example, in 1863 it was reported that Dr. Walter Hayle Walshe had retired as Professor of the Principles and Practice of Medicine, Physician to the Hospital and Professor of Clinical Medicine, and that he had been succeeded by William Jenner, who therefore surrendered the Chair of Pathological Anatomy and Clinical Medicine. Subsequently, Mr. Sydney Ringer was appointed to the Chair of Materia Medica, the Council justifying his appointment on the grounds that he had published important papers on ague, *diabetes mellitus* and scarlet fever, and 'a curious and practically useful paper of great medical and scientific value . . . "On the Alteration in the Pitch of Sounds Passing Through Solid Media"'. Dr. John Russell Reynolds, 'who was known to have assiduously devoted himself to clinical pursuits, and to have distinguished himself by many valuable scientific contributions', notably his work on *The Diagnosis of Diseases of the Brain* and *Treatise on Epilepsy*, succeeded Jenner as Professor of Clinical Medicine;

[6] Reports 1874, pp.15-16.

and Dr. Wilson Fox, a former student of the College, who had made pathological anatomy the subject of his 'especial study under the most eminent teachers in Germany', and published a memoir on the pathology of the glandular structures of the stomach which 'gave evidence of his power of original investigation, of his being an accurate observer, and of his habi[t]s of skilful research in minute anatomy', was appointed Professor of Practical Anatomy.[7] This suggests that although members of staff were not officially required or encouraged to conduct their own research, the Council were nevertheless keen to appoint men (and later women) with proven research capabilities.

The Council also seems to have taken a growing pride in the research activities of the existing staff of the College as the nineteenth century progressed. This first became apparent in the eulogies that were dedicated to distinguished members of staff when they left the College. For example, when A.W. Williamson retired as Professor of Chemistry in 1887, after nearly 40 years at UCL, the Council described him as 'an original investigator of the highest order', who had given 'invaluable services to the College and . . . not only obtained the highest distinction for himself throughout Europe, but necessarily conferred honour and distinction on the Chemical Department of University College'.[8] It therefore seems that the Council was increasingly willing to offer its tacit support to those members of staff who were engaged in producing original work, and that it was more than happy to bask in their reflected glory. From about 1870 onwards the research interests and achievements of the staff of the College were discussed in some detail in the Annual Reports. Complete lists of the 'Original Papers and Other Publications' emanating from within each individual department were reproduced in both the Reports and College Calendars from 1899-1900 onwards,[9] highlighting the fact that the professorial staff of the College were producing and publishing a good deal of original work, and,

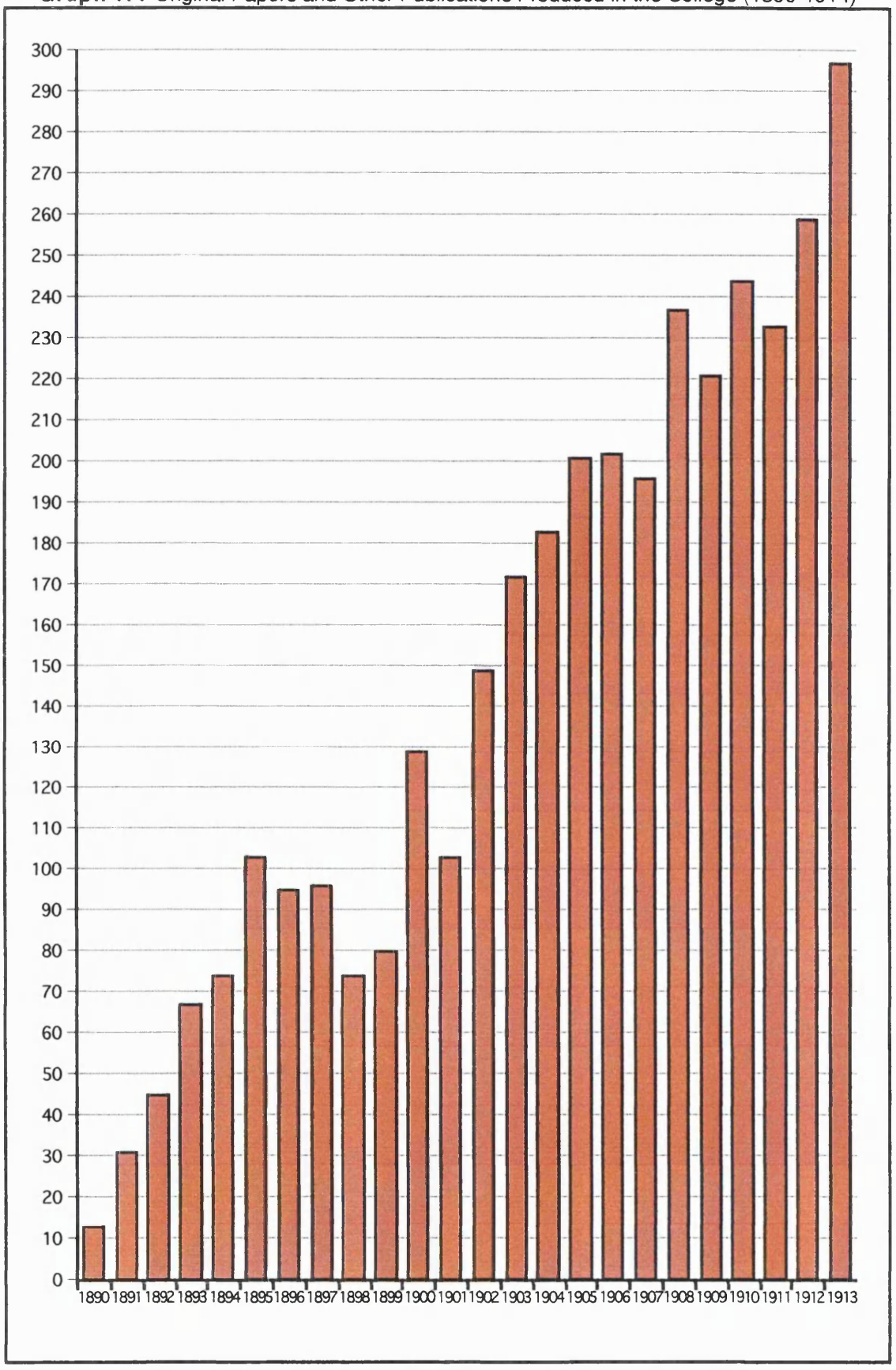
[7] Reports 1863, pp.11-14.
[8] Reports 1887, p.14.
[9] Every single 'Original Paper and Other Publication' to emerge from the College during the preceding academic session was listed in the Deans' annual report to the College Council from 1891 onwards, and after 1901 these lists were reproduced in the Annual Reports. These lists include full details of the various journal articles and books published each year. Book reviews and other similar pieces were usually listed separately, and they are not included in these totals.

moreover, that, at least from this point onwards, the Council attached the 'greatest importance to the original work done by the teaching staff'.[10]

The rising output of 'Original Papers and Other Publications' between 1890 and 1914 was the most basic feature of the growing commitment to the promotion of original research at UCL in this period (see Graph 4.1 and Appendix 5). Though only 13 books and articles were published in 1890, more than 100 were produced during the academic session 1900-01. The annual rate of publication had doubled to reach more than 200 per year by 1905-06, and almost 300 books and articles were produced by the staff and students of the College during the academic year 1913-14. These lists also highlight the extraordinary diversity of the original work that was going on at UCL at the beginning of the twentieth century. For example, during the 1908-09 session original papers were produced in the following departments: Latin (3), Greek (1), Comparative Philology (9), Sanskrit (2), Hebrew (3), North Semitic Epigraphy (2), English (7), French (2), German (6), Phonetics (5), History (5), Archaeology (5), Egyptology (4), Assyriology (4), Philosophy (10), Political Economy (5), Geography (2), Pali and Buddhist Literature (1), Tamil and Telugu (1), Architecture (2), Roman Dutch Law (1), Pure Mathematics (4), Applied Mathematics (37), Physics (9), Chemistry (41), Botany (11), Geology (2), Zoology (6), Physiology (27), Pharmacology (4), Pathological Chemistry (4), Public Health (5), Mechanical Engineering (1), and Electrical Engineering (6).[11] It is also interesting to note that original work was produced and published in a growing number of departments in this period, and, moreover, that a growing number of individual authors were responsible for the work (see Graph 4.2). In 1913-14 more than 150 independent authors, working in 33 separate departments, produced a grand total of 297 original papers and other publications.[12] This suggests that original work was being produced and published by junior members of staff and senior students, and not just by individual professors, thereby highlighting the significance of the emergence of a genuine culture of teaching and research at UCL in this period.

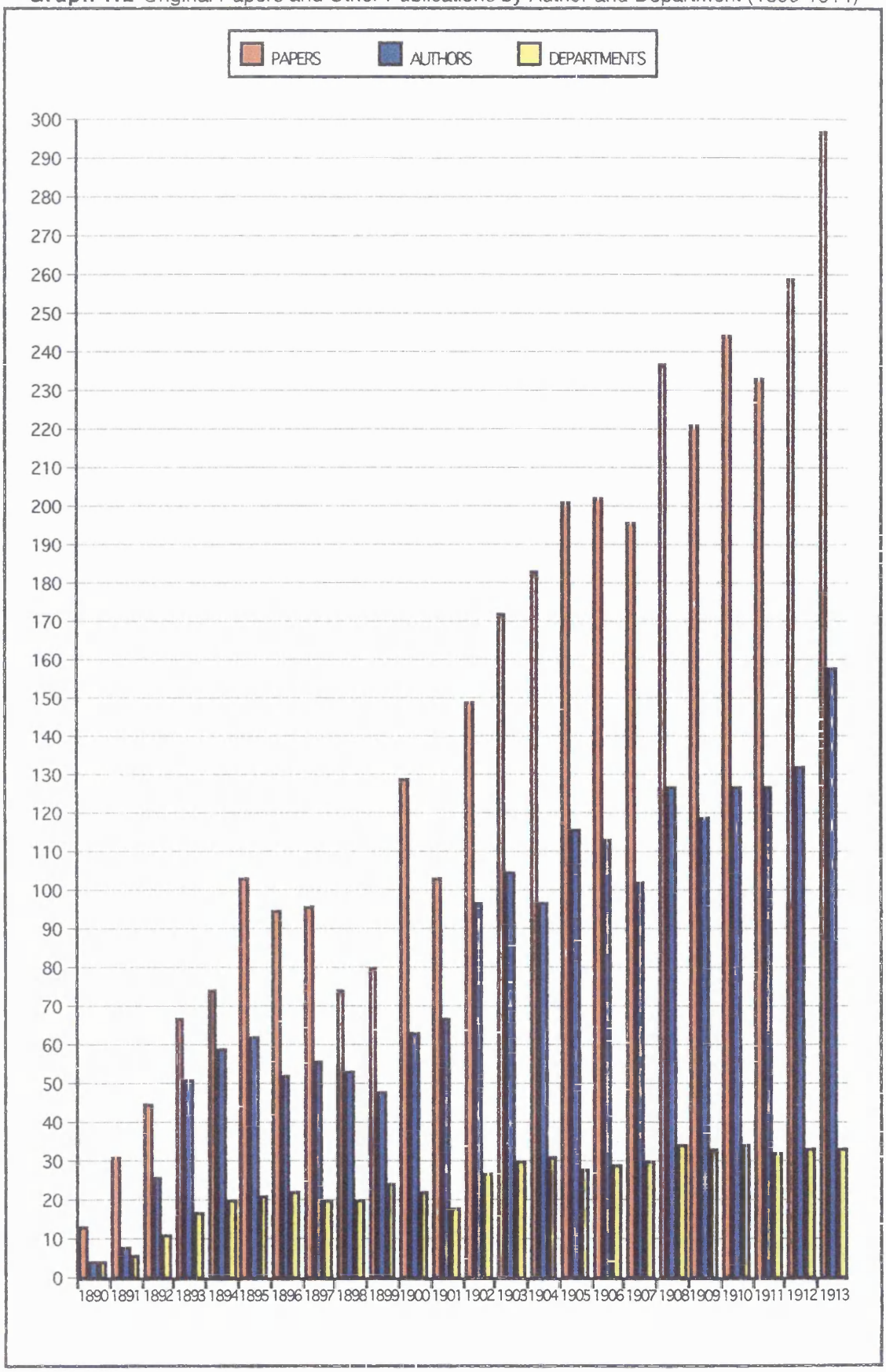
[10] Reports 1903, p.24.
[11] 'List of Original Papers and Other Publications from the Various Departments of the College, 1908-9', Reports 1910, pp.59-74.
[12] Reports 1913, pp.54-74.

Graph 4.1 Original Papers and Other Publications Produced in the College (1890-1914)



Source: The Needs of University College London (London: UCL, 1902); University College London Annual Reports 1901-1915 (London: UCL, 1901-1915).

Graph 4.2 Original Papers and Other Publications by Author and Department (1890-1914)



Source: The Needs of University College London (London: UCL, 1902); University College London Annual Reports 1901-1915 (London: UCL, 1901-1915).

However, prior to the turn of the century members of staff were not required - or materially encouraged - to conduct their own research. They were paid to teach, and received little or no institutional support and financial assistance from the College Council in obtaining the materials and equipment used in the course of their private experiments and investigations. Moreover, until the late 1880s there was generally only one member of staff - usually a single professor - working in each department, and the system whereby professors were paid directly from the fees paid by their students further tended to limit their contribution to the advancement of knowledge. Not only was the income derived from student fees relatively small (especially compared to the cost of equipment), but if a professor was to maximise his personal income he had to take on more students and devote more time to their instruction, leaving him with little or no time to devote to his own research. It was therefore a common cause for complaint among the staff of the College that their 'extensive' teaching commitments left them with insufficient time to devote to their own experiments and investigations. In 1870 Dr. Thomas Hirst actually resigned as Professor of Mathematics (to take up the position of Assistant Registrar of the University of London) because 'he found his work too heavy and incessant either to leave him time for original investigation or to be compatible with the maintenance of his health'. In the same year Michael Foster surrendered the Chair of Practical Physiology and Histology in order to take up the post of Praelector in Physiology at Trinity College, Cambridge, and the Council regrettably concluded that his was 'another resignation attributable to causes similar to those which [had] deprived the College of Dr. Hirst's services'.[13]

In 1873 the Council finally began to address some of the professors' concerns, announcing the appointment of a number of new assistant professors, whose role was to 'improve and enlarge the means of instruction at the disposal of those Professors who, owing to the special circumstances of their classes, [found] it necessary or desirable to make use of such assistance in the performance of their duties'.[14] Initially, then, the emphasis in the appointment of assistants was on 'instruction'. Moreover, junior members of staff were regarded as the professors' personal servants, and paid directly by them out of their income from the fees paid

[13] Reports 1871, p.16.
[14] Reports 1873, pp.14-15. On Foster's career at UCL see Geison, Foster, pp.48-78.

by their students.[15] The academic staff of the College nevertheless grew steadily through the 1890s, and more rapidly after the turn of the century, with the appointment of various assistant professors, lecturers, readers, demonstrators and assistants (see Graph 4.3 and Appendix 1); and the role of junior members of staff was widened to include a requirement that they assist the professors in their teaching *and* research, and where possible carry out their own inquiries and investigations at UCL. For example, in 1904, prompted by the Senate's recommendation that 'it would be advantageous to the College to attach to itself men of eminence in special departments of the subjects taught in the College . . . and thus add to its strength as a corporation for the promotion of Higher Education and as a centre for Research', the Council instituted a new grade of teachers, styled 'Lecturers'. They were required to 'deliver at the College lectures in their special subject, and *as far as possible carry out their researches in College*'. It was noted, moreover, that in appointing new lecturers particular attention would be paid to each candidate's research ability and reputation:

> The appointment to the office of Lecturer shall be made by the Council after receiving a report from the Senate on the merits of the candidate. Candidates may submit their original work. *In making their recommendation the Senate shall have special regard to the value of the original work submitted and shall specifically report on this to the Council.* Length of service as a teacher or assistant or power in elementary teaching, shall not be considered [a qualification] for the post of Lecturer (my italics).[16]

The Council's conception of the role and function of the professorial staff of the College also began to change. For example, in 1902 the Council launched an appeal to raise funds for the expansion and redevelopment of the Gower Street site in order for 'the proper carrying out of higher teaching and research at University College', insisting:

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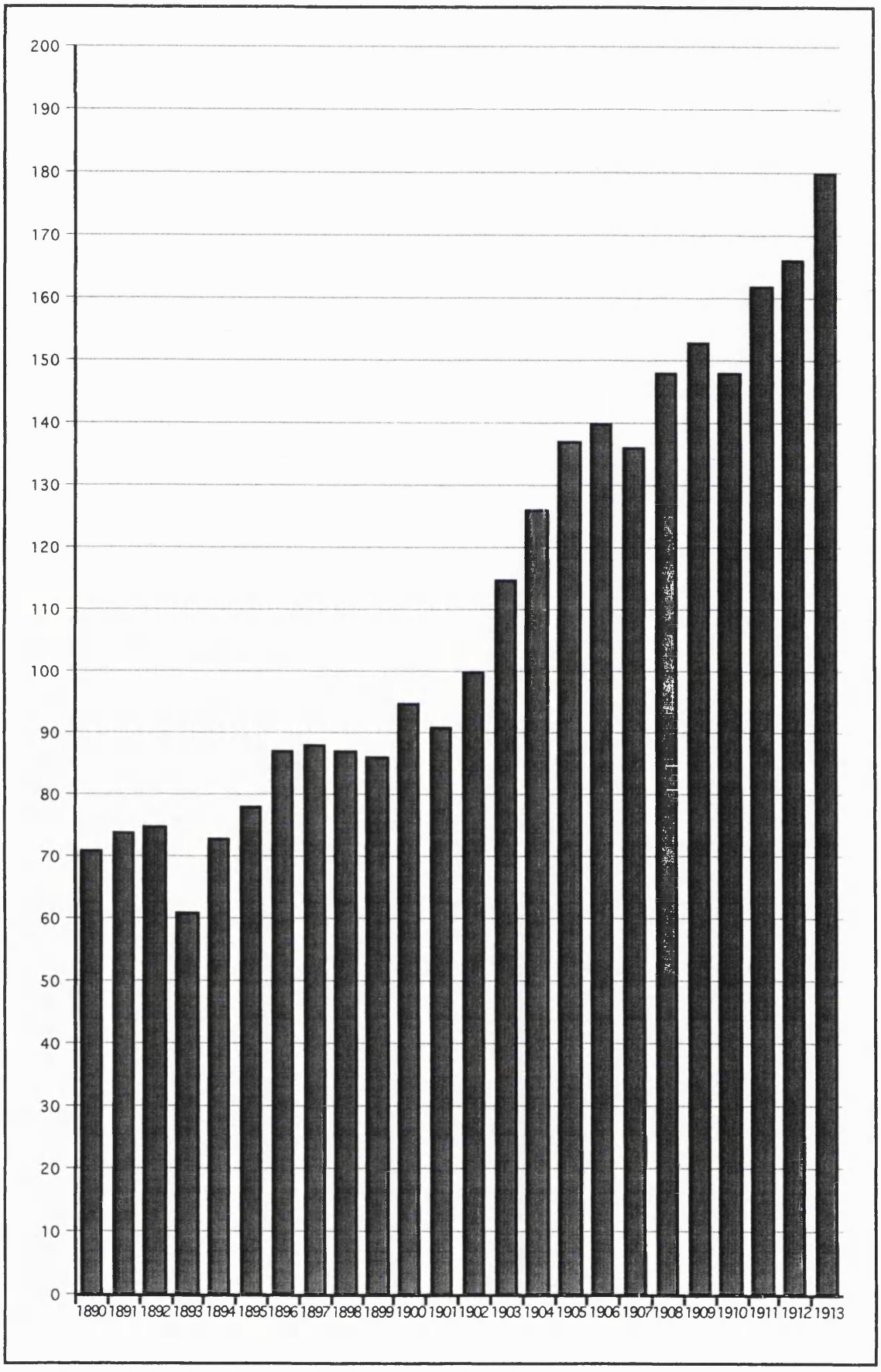
[15] As William Ramsay's assistant, Morris Travers, recalls, 'not only were the professors responsible for the conduct of their departments, but they alone were recognised by the Council, and the juniors were regarded as the professors' private assistants. No provision was made for payment of salaries to them, and these, as well as the cost of laboratory and lecture room apparatus, were supposed to be met out of the share of fees allocated to the professor . . . . Certainly, when the writer was on the staff of the College, from 1894 to 1903, he was paid by cheques on the professor's private account'. Introduction to Volume 6 of the Ramsay papers held in the Manuscripts Room at University College London Library, p.xvi [hereafter UCL/WR/6, etc]. Ramsay's papers were catalogued and bound together in 24 heavily annotated volumes by Travers, and presented to the College in 1957.

[16] Reports 1904, pp.19-21.

Graph 4.3 Growth in the Academic Staff of the College (1890-1914)



Source: University College London Calendars 1890-1914 (London: James Walton, 1890-1914).

> Still more important is the provision of men who shall direct and use this machinery of teaching and research; men who will attract students and workers, not only from London but from all parts of the Empire, and may act as leaders of great schools of research.

However, it was 'impossible to obtain or retain men of this stamp unless [they could] place at their disposal an adequate renumeration'. The members of the Council were conscious that most professors were badly paid, and, that 'owing to a lack of funds for the payment of Assistants, they [had] to devote far too large a proportion of their time to the work of elementary teaching, to the exclusion of the far more important, but unrenumerative, work of research and training of men for research'.[17] From 1894 to 1906 the professors were therefore in receipt of a fairly substantial grant specifically for 'Assistants, Apparatus, &c.' (see Table 4.1), and in 1905 the arrangements for paying the professorial staff of the College were revised in order to reward the 'higher and it may be, from the academic point of view the more valuable . . . work done by the Professor'. Conceding that the more time the professor devoted to research, the less time he would be able to spend teaching, the Council admitted that 'payment by share of fees may therefore be payment in inverse ratio to the academic value of the work done'. Thereafter the professors received a fixed

Table 4.1 Grants to Professors for 'Assistance and Apparatus, &c.' (1894-1906)

1894-95	£1045 0s 0d	1900-01	£2641 19s 8d
1895-96	£1094 6s 0d	1901-02	£2511 7s 5d
1896-97	£1172 16s 0d	1902-03	£1984 5s 0d
1897-98	£1414 5s 0d	1903-04	£3024 17s 11d
1898-99	£2604 8s 5d	1904-05	£3093 3s 0d
1899-1900	£2590 10s 10d		

(*Source*: University College London Annual Reports 1894-1906 (London: UCL, 1894-1906)).

stipend in addition to their income from students fees, and in 1913 the system whereby professors were paid directly from the fees paid by their students was abolished entirely.[18]

[17] Needs, p.6.

[18] 'University College London. Grants Committee. Report on the Renumeration of Teaching Staff in Connection with the Parliamentary Grant (Adopted by the Council in its present form on July 3rd, 1905)'; Reports 1913, p.13.

Postgraduate Students, Courses and Degrees

Although the Council was insistent that 'various and very considerable attainments [were] required of those on whom the distinction of a degree [was] to be conferred',[19] the Regulations for Examinations for Degrees (first published in 1839) make no provision for encouraging or rewarding original research by students.[20] Even the institution of Science Degrees in 1859 did little to change the situation. There was no incentive for students to conduct their own research. Candidates were merely required to pass the Matriculation Examination and 'two special examinations in scientific subjects'.[21] Certain individual professors did try to introduce their students to the methods of research, and encourage them to conduct their own experiments and investigations. Occasionally some of them even gave out prizes to reward their efforts in this direction. Alexander Williamson awarded an annual prize of £50 to the student of the Birkbeck Chemistry Laboratory who was responsible for 'the most successful experimental research' conducted during each academic session,[22] and a similar prize was established for physiology students in 1901.[23]

However, the College Council did not begin to concern itself with the opportunities for students to learn the methods of research and conduct their own investigations until the turn of the century. A special postgraduate prospectus listing details of the 'Post-Graduate Courses of Lectures and Laboratory Work Carried on at University College London' was produced for the first time in 1901, and each course was discussed in some detail in the Council's Annual Report for that year.[24] Although there were only 12 departments offering postgraduate courses in 1900, within a year there were 22 courses on offer; and by the beginning of the 1904-05

[19] Reports 1839, p.5.
[20] 'Regulations for Examinations for Degrees', Ibid, pp.20-39.
[21] Reports 1860, p.10.
[22] Reports 1853, p.7.
[23] Reports 1901, pp.23-4. A special fund was also set up by former students of University College School to promote the study of science among their fellow alumni by offering a bronze medal to former pupils for 'original work in experimental science'. Reports 1882, p.14.
[24] 'Post-Graduate Courses of Lectures and Laboratory Work Carried on at University College, London', Reports 1901, pp.13-16. These courses were listed in the Annual Reports from 1901 to 1905, and in the College Calendar from 1906 to 1914 (and beyond).

session there were no fewer than 32 separate courses for postgraduate and research students at UCL (see Table 4.2). By 1902 the Council was insistent that 'every properly organised University Laboratory' should provide 'practical instruction in scientific research', going on - in a passage which anticipates the modern conception of the role and function of the College - to explain:

> No other part of systemised educational methods affords the same training as scientific research in meeting unforeseen difficulties, ascertaining their nature, and devising rational and carefully thought-out means of overcoming them. Hence it becomes of the highest importance in our national economy that we should possess, in as high a degree as possible, the mechanism for making knowledge, for training men to make knowledge, and for equipping a large number with the habit of scientific thought. This mechanism consists in the first place of laboratories, in the widest sense of the term, and, in the second place, of picked men who are free to devote themselves to the advancement of knowledge for its own sake and to the training of men who are enabled to devote three or five years to a thorough study of a subject, and will apply the methods of their teachers to the treatment of so-called practical questions, or in turn devote themselves to the advancement of knowledge.[25]

Table 4.2 Number of Postgraduate Courses (1900-13)

1900-01	12	1907-08	32
1901-02	22	1908-09	34
1902-03	23	1909-10	35
1903-04	29	1910-11	35
1904-05	32	1911-12	38
1905-06	33	1912-13	39
1906-07	34		

(*Source*: University College London Annual Reports 1902-1905 (London: UCL, 1902-1905; University College London Calendars 1906-1913 (London: James Walton, 1906-1913)).

In 1906 new 'General Regulations as to Research Work' were therefore drawn up, stipulating that on 'the recommendation of the Professor of any Department, any student may be admitted to the College for the purpose of undertaking such work'. The fee for research students was a very reasonable £1 1s per academic session, but they were also required to 'bear the cost (if any) of [their] work'.[26]

Original research was an important component of most of these courses. Of the twelve departments originally listed as offering postgraduate courses, no fewer than nine offered their students some opportunity to conduct their own experiments

[25] Needs, pp.1-2.
[26] Calendar 1905-6, p.20.

and investigations. For example, it was noted that the Physiology Laboratory was 'open at all times for research work, and [was] well equipped in all branches, physical, chemical and histological'; while prospective zoology postgraduates were informed that the Zoological Laboratory was provided with 'aquaria, salt and fresh water, incubators, etc.', and the 'Professor [was] at all times ready to give advice and assistance to those engaged in original work'.[27] But it was not only in the scientific departments that students were encouraged to conduct their own research, and in 1905 the Council highlighted the fact that the staff of the Faculty of Arts were also prepared to make 'special arrangements for research students'.[28] 'Facilities for research' were provided in the Department of Egyptology, and Professor Petrie and his 'special students' spent each winter 'digging' in Egypt.[29] Meanwhile, 'classes of a "seminar" type', which were attended by 'a select number of students . . . [who] usually read papers in turn, involving original research, or study of a difficult problem' were organised in the Department of Archaeology.[30] However, the opportunities for students to conduct their own research were probably greater in the Faculty of Science, and perhaps greatest of all in the Department of Applied Mathematics. For example, in 1901 the Council reported that Professor Pearson was 'always willing to find research-work for those desirous of making original investigations';[31] and in 1904 postgraduate students of Applied Mathematics were 'reminded that degrees of the University of London [could] now be obtained by research work', Pearson insisting that the 'training thus gained is far more profitable than any mere examination curriculum'.[32]

[27] Reports 1901, pp.13-16.
[28] 'Post-Graduate Courses of Lectures and Laboratory Work Carried on at University College, London, Session 1904-05', Reports 1905, pp.42-50.
[29] Reports 1901, pp.13-16. The work of the Department of Egyptology is discussed in more detail in Margaret S.Dower, Flinders Petrie: A Life in Archaeology (London: Gollancz, 1985), and Rosalind Jansion, The First Hundred Years: Egyptology at UCL, 1892-1992 (London: Petrie Museum, 1992).
[30] 'Post-Graduate Courses of Lectures and Laboratory Work Carried on at University College, London, Session 1901-02', Reports 1902, pp.27-33.
[31] Reports 1901, pp.13-16.
[32] 'Post-Graduate Courses of Lectures and Laboratory Work Carried on at University College, London, Session 1903-04', Reports 1904, pp.39-46.

The total number of students taking advantage of these various opportunities to learn the methods of research and conduct their own experiments and investigations was not recorded before 1900. But in 1901 the College Council reported that there were 71 'research students' based at UCL, and from 1905 onwards the 'Post-Graduate and Research Students' were listed separately in the College Calendar. Unfortunately the Council did not make any distinction between postgraduate and research students before 1915, but by 1903-04 there were already more than 100 'Post-Graduate and Research Students' at University College, and by the eve of the First World War there were nearly 450 (see Appendix 2). Postgraduate students also made up a substantial - and growing - proportion of the total student population of the College in this period, accounting for more than 10% of the student body in 1905, and a remarkable 25% by 1910 (see Graph 4.4).[33] Crucially, a significant number of the postgraduates studying at UCL in this period were overseas students.[34] In 1904 the statutes of the University of London were revised in order to allow students who had obtained degrees (or passed equivalent examinations) in other universities to be admitted to UCL and Kings and 'proceed directly to the higher degrees of the University'. Subsequently, as the staff and students of University College began to forge an international reputation, UCL began to attract a growing number of postgraduate and research students from abroad, and not just from universities in the Colonies, 'but also in the United States and on the continent of Europe'.[35] By 1915 16% of the postgraduates registered at UCL were overseas students (see Graph 4.5 and Appendix 3).

It is also interesting to note that a significant number of the postgraduate students who passed through the College between 1890 and 1914 were women. In 1878 UCL became the first British University to admit male and female students on equal terms,[36] and by 1914 almost one-third of the postgraduate and research

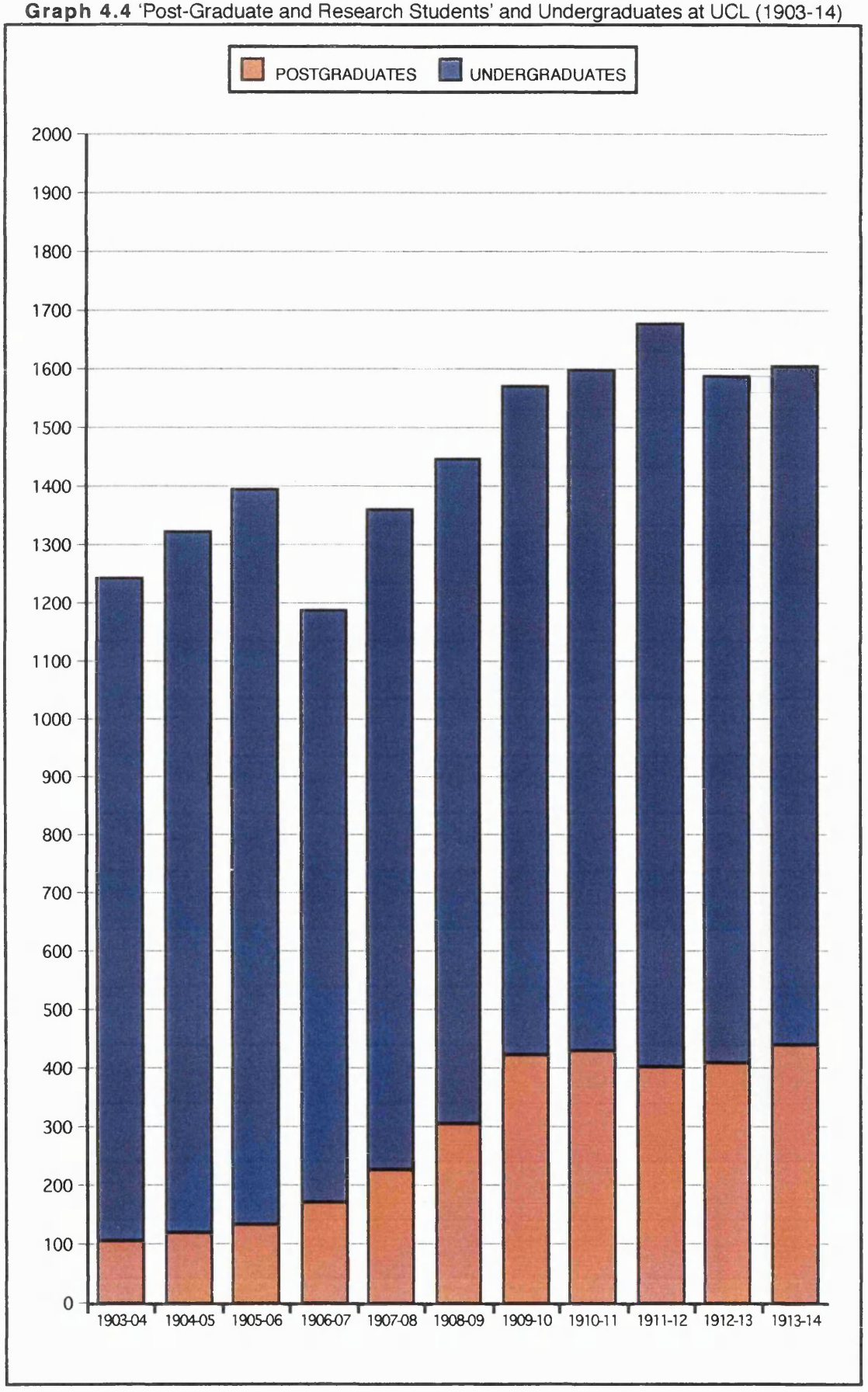
[33] Today approximately one-third of the students enrolled at the College are postgraduates - some 5,000 out of a total student population of 15,000. University College London Graduate School Prospectus 2001 (Online Version).

[34] Here the term 'Overseas Student' is used to describe all students who were not British citizens, including visiting scholars from the Colonies and Dominions, mainland Europe, the United States and elsewhere.

[35] Reports 1903, pp.17-19.

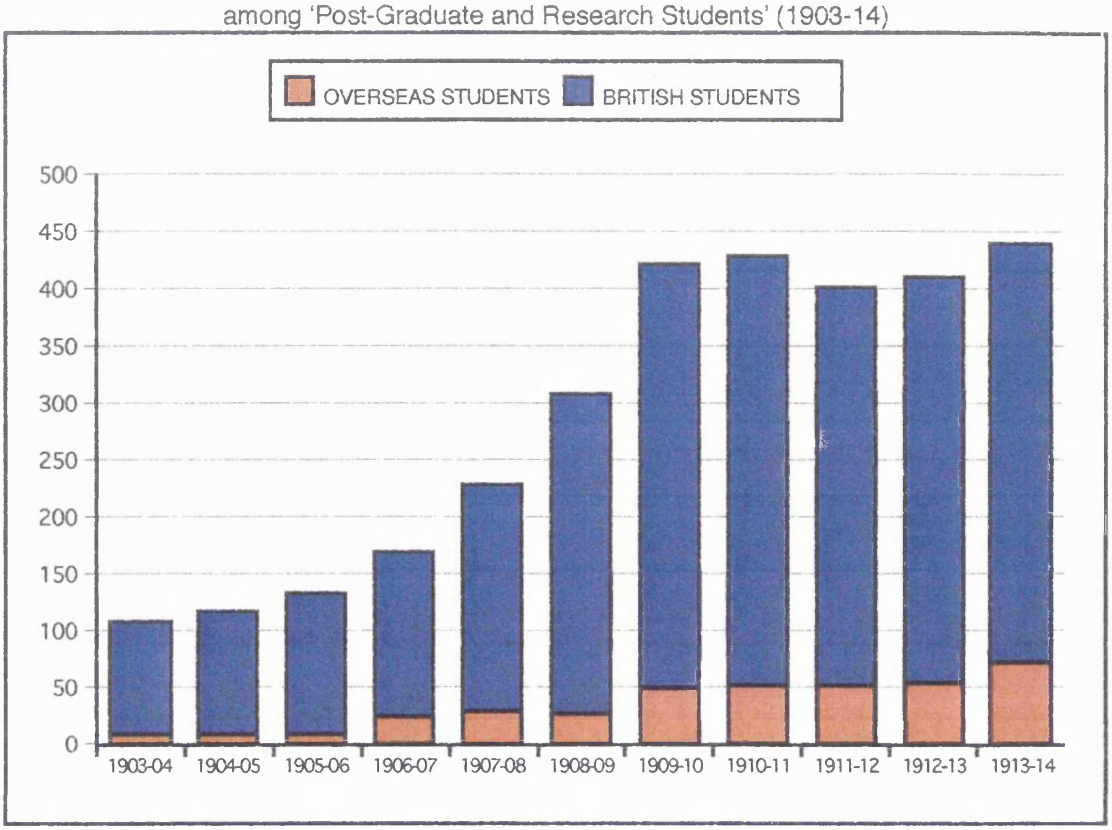
[36] Harte, Admission of Women, p.3.

Graph 4.4 'Post-Graduate and Research Students' and Undergraduates at UCL (1903-14)



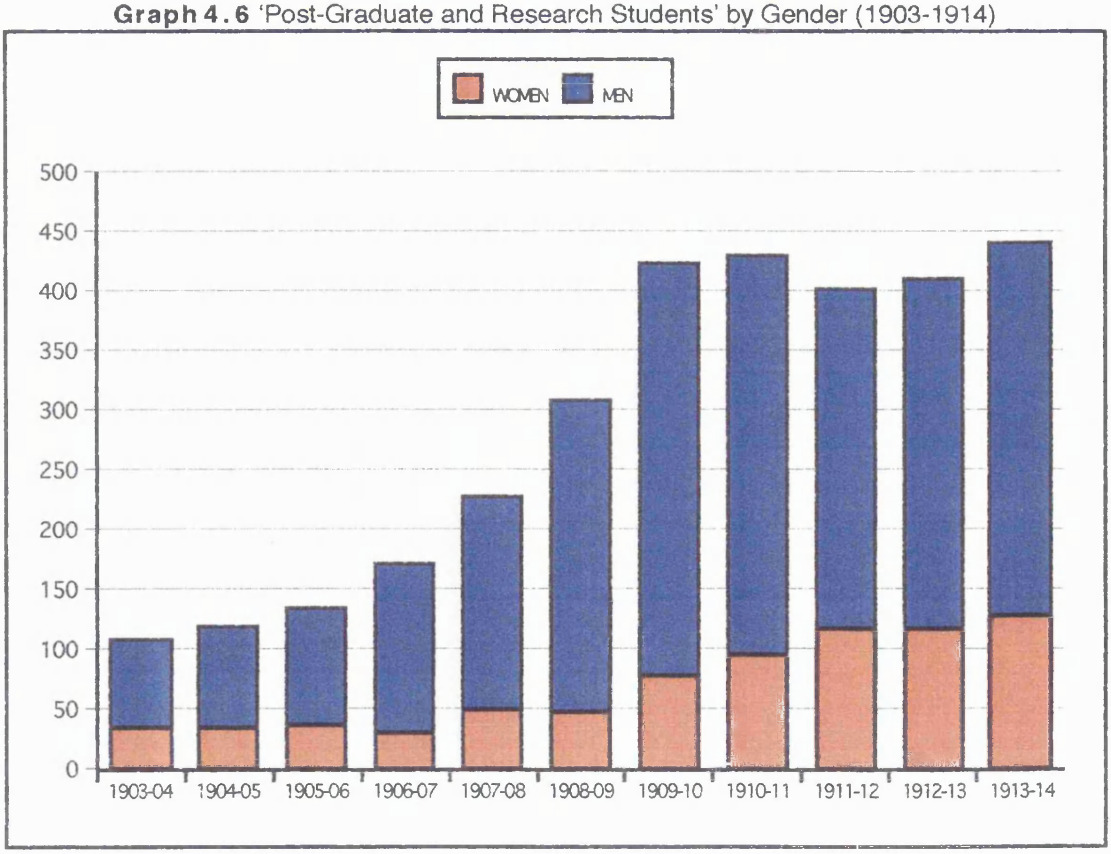
Source: University College London Calendars 1903-1914 (London: James Walton, 1903-1914).

Graph 4.5 Number of Overseas Students among 'Post-Graduate and Research Students' (1903-14)



Source: University College London Calendars 1903-1914 (London: James Walton, 1903-1914).

Graph 4.6 'Post-Graduate and Research Students' by Gender (1903-1914)



Source: University College London Calendars 1903-1914 (London: James Walton, 1903-1914).

students enrolled at University College were female (see Graph 4.6 and Appendix 4).[37] Julie Stevenson has discussed the significance of the growth of the female undergraduate population of the College in this period in her doctoral thesis on 'A Neglected Issue in the History of Education'.[38] Noting that 36.8% of the students who passed through UCL between 1873 and 1913 were women, Stevenson insists that, contrary to the assumptions implicit within much of the secondary literature on the history of university education in this country, these students formed a significant group and should not be awarded marginal status - 'Whilst overall student numbers were growing in this period; the number of women was rising even faster'. Through her analysis of the career paths and prospects of women educated at the College in this period, Stevenson demonstrates that female students formed a 'significant and successful group who embarked upon a range of successful careers after they left education'.[39] This account of the growth of the postgraduate population of the College supports Stevenson's hypothesis, extending her analysis to highlight the significance of the role played by the female postgraduates who passed through UCL between 1890 and 1914. This is significant not just in the context of UCL's pioneering role in the higher education of women, but also in terms of the impact of women on the structure and organization of postgraduate education in London. According to Michael Thompson, it was extremely common for male students to spend a year or two at UCL before moving on to take their degrees at Oxford or Cambridge in this period - 'Women students, by contrast, once they were inside the London colleges, could not realistically plan their education with the expectation of escaping to Oxford or Cambridge, for the number of places at the new women's colleges there were minute'. Thompson has therefore argued that, since female students were compelled to stay at UCL, they inevitably exerted a more profound influence over the development of undergraduate and postgraduate degree courses than their male counterparts, particularly in the Arts.[40]

[37] The great majority of postgraduates studying Botany were women, but, in general, female students tend to have favoured Arts subjects. By 1914 approximately half of the postgraduates reading History, and almost 70% of those studying Egyptology, were women (see Appendix 4). The first female members of staff at UCL were also based in the Departments of Egyptology and Botany. Margaret Murray took over the elementary teaching of hieroglyphics in 1898, and a year later Edith Chick was appointed Quain Student in Botany. Harte, Admission of Women, p.12. For more on London's female botanists see Bingham, Royal Holloway College, pp.100, 117, 148-9.

[38] Stevenson, 'A Neglected Issue in the History of Education', pp.57-91.

[39] Ibid, pp.63-4, 132-63, 383-8.

[40] Thompson, University of London, pp.68-72.

According to Renate Simpson only 5% of the students enrolled at British universities in 1925 were postgraduates,[41] and the total number of postgraduate and research students based at UCL at the beginning of the twentieth century is therefore surprisingly high. However, one does need to treat these figures with some caution, particularly since these students were described variously as 'Research Students', 'Postgraduates' and 'Post-Graduate and Research Students'. Moreover, the number of postgraduate degrees awarded to the students of the College was relatively small, especially compared to the total number of postgraduate students (see Appendix 6). This highlights a remarkable feature of the postgraduate population of the College in this period, which (again) reminds us that we must not allow modern assumptions about the role and function of Britain's universities and colleges to force us to make anachronistic assumptions about the organisation of teaching and research at UCL circa 1900: the vast majority of the postgraduate students who passed through University College London between 1890 and 1914 were not reading for University of London degrees. This was noted and remarked upon by the inspectors appointed to investigate the progress by the College in connection with the Parliamentary Grant in 1901:

> As [the] higher branches of study have developed, an increasing number of graduates, as well as *persons unconnected with any university*, have taken advantage of the opportunities which the College affords for advanced work, and especially for original research (my italics).[42]

Many of these persons unconnected with the College were students at other universities elsewhere in Britain or around the world, who simply spent a year or so at UCL pursuing a particular aspect of their research. This was a particularly common phenomenon in the History Department. During his tenure in the Chairs of Constitutional and English History from 1903-1931, A.F. Pollard and his colleagues played host to a number of students who were working towards degrees in other universities, but found themselves drawn to London and its archives. Such students often spent a considerable amount of time at University College, drawing on Pollard's experience and expertise, and taking a full part in the life of the Department.

[41] By 1950 this figure had risen to 10%, and in 1975 15% of the students enrolled at British universities and colleges were postgraduates. Simpson, Ph.D., p.162.
[42] 'Report by Woods and Hill', pp.19-22, PRO/ED24/82A.

For example, J.E. Neale was awarded an M.A. in Modern History at the University of Liverpool in 1915 for work conducted under Pollard's supervision in the History Department at UCL. Neale went on to enjoy a long association with the College. He was appointed assistant to Pollard in 1919, and, after a brief spell in Manchester, succeeded him as Astor Professor of English History in 1927, going on to preside over the Department for the next 30 years until his retirement in 1956.[43] This was also common practice in the scientific departments of the College. Frederick Soddy spent a year working alongside William Ramsay in the chemistry laboratories at UCL in the early 1900s, continuing the postgraduate research on radioactivity and sub-atomic change which he had started under Ernest Rutherford's supervision at the McGill University of Montreal. In this period Ramsay's laboratory was the only place in the world where the techniques required to deal experimentally with the minute quantity of radioactive gas available existed.[44] Chemists from all over the world therefore came to UCL to 'learn the technique of modern gas work from its begetter and master',[45] without (necessarily) going on to take a postgraduate degree in London.

This was also the era of the amateur devotee, and several of these 'Post-graduate and Research Students' were retired military men or doctors or amateur scientists of independent means, who took a keen interest in chemistry or history or Egyptology and followed it up in the libraries and laboratories of University College. Research students were not required to be university graduates or candidates for a postgraduate degree. They merely had to satisfy the head of the department in which they were hoping to carry out their research that they were capable of undertaking such work, and pay a small fee (in addition to meeting the cost of the materials used in the course of their experiments).[46] For example, it was noted in the first Postgraduate Prospectus that 'students whose qualifications [were] regarded by the Professor as satisfactory' were admitted to the Department of Zoology 'to do

[43] G.R.Elton, 'Sir John Ernest Neale (1890-1975)', Dictionary of National Biography 1971-1980 (Oxford: Oxford University Press, 1986), p.623.
[44] Morris W.Travers, A Life of William Ramsay (London: Edward Arnold, 1956), p.209.
[45] Note by Professor J.Irvine Masson, FRS, 20 March 1946, UCL/WR/16/1, p.48.
[46] Calendar 1905-6, p.20.

research work in the laboratory at a small fee'. The Professor was 'at all times ready to give advice and assistance to those engaged in original work', but did not (necessarily) supervise their work directly.[47] Meanwhile, in the Department of Applied Mathematics and Statistics medical men and civil servants - such as Major Ernest Roberts of the Indian Medical Service and Dr. F. Turner of the Metropolitan Asylums Board - were trained in the methods of statistical research so that they could pursue their own investigations, and the 'authors of statistical papers frequently [came] to the Laboratory for advice, or work[ed] two or three weeks there completing their memoirs'. The 'postgraduate students' of the Department also included numerous volunteers who assisted in the more routine computing and calculating work of the Biometric and Eugenics Laboratories, often out of a sense of national or racial 'duty'.[48]

Some of the most celebrated names in the history of the College were volunteers of this kind. As O'Connor explains, as 'the best research institution in London, the Physiology Department at University College attracted men who wished to do research in physiology and were able to provide their own financial support'.[49] Prominent examples include George Oliver and William Page May, who was appointed to an unpaid lectureship in the physiology of the nervous system in 1903, and went on to establish a small research department in neurology at his own expense. Clinicians from UCH and various other London hospitals often carried out research work in the physiology laboratories at UCL, and numerous papers published in the *Journal of Physiology* acknowledge the help and encouragement of Schaffer and other members of staff at University College London.[50] The most celebrated *amateur* physiologist associated with the College in this period was William Bayliss. As the son of a wealthy Wolverhampton iron manufacturer and a director of the family business, he had no need to compete for paid positions and spent 24 years working along side Schafer and Starling without an official position on

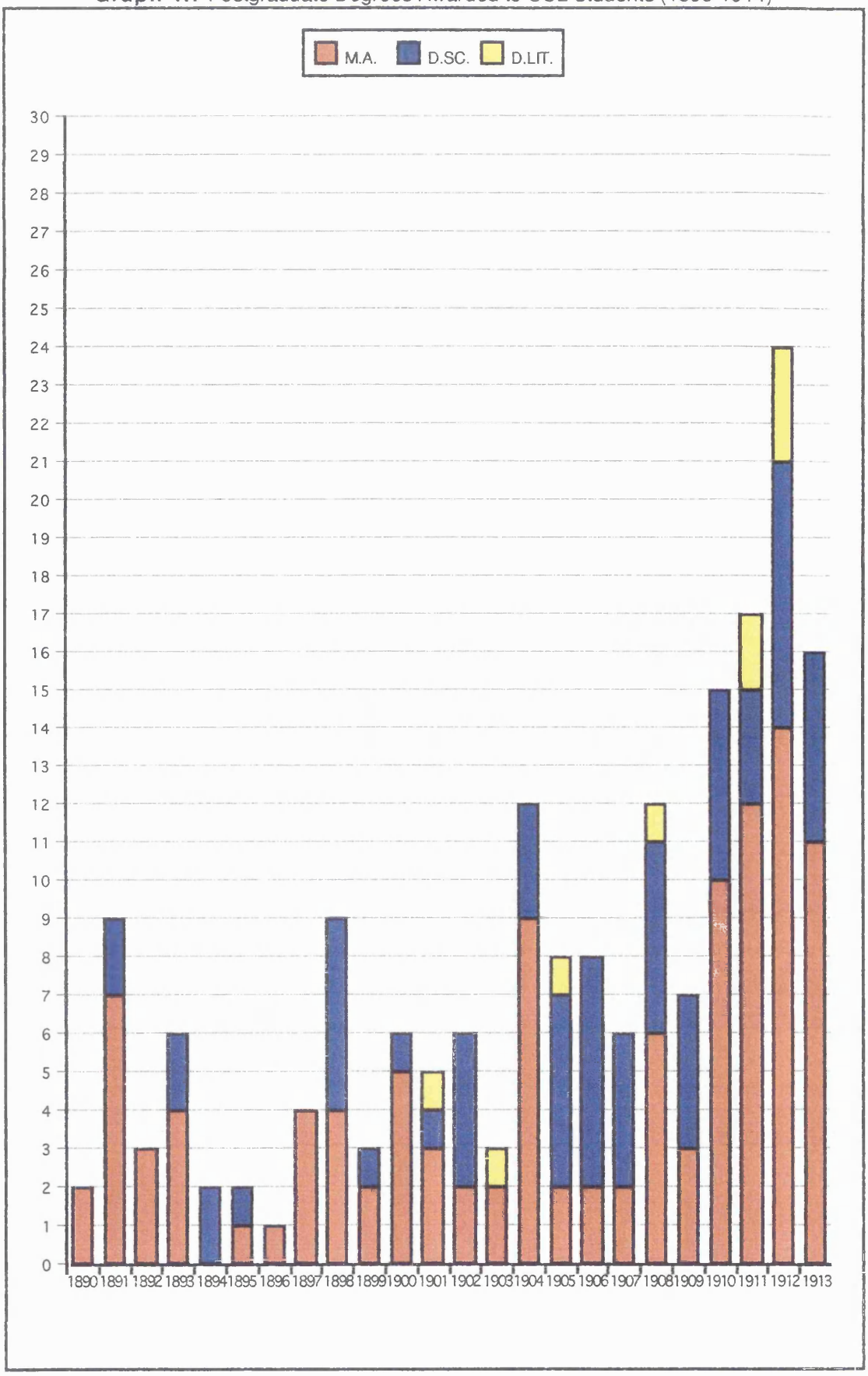
[47] Reports 1901, pp.13-16.
[48] Karl Pearson [hereafter KP] to G.C.Foster, 26 November 1904, KP/UCL/233.
[49] O'Connor, British Physiologists, p.123.
[50] Ibid, pp.122-3, 150-2.

the staff of the Department. During this period Bayliss held various nominal positions and did a good deal of teaching without payment, acting as Starling's assistant and where necessary deputising for him, before he was appointed to a specially created Chair of General Physiology in 1912. He also personally contributed 43 papers to the *Journal of Physiology,* and cooperated with Starling in his pioneering researches on the electrophysiology of the heart and principle of hormonal control mechanisms.[51]

Despite the prevalence of volunteers and amateur devotees, a growing number of postgraduate degrees were awarded to the staff and students of the College in this period (see Graph 4.7 and Appendix 6); and by the turn of the century, the London M.A., D.Lit. and D.Sc. all included a major research component.[52] The original London Doctorate in Science, introduced in 1860, was awarded solely on the basis of written and practical examinations, but in 1880, after discussion of 'the expediency of recognising Original Research as a qualification for the higher degrees of the University', the Senate agreed to permit candidates for the D.Sc. to submit 'a printed Dissertation, Thesis, Memoir, or other work' embodying 'properly authenticated Independent Research'. Doctoral candidates were still required to sit a series of exams, but the examiners were allowed to allocate to the dissertation or thesis 'such proportionate value in reference to the whole Examination as they think fit', accepting it 'in lieu of all or . . . [part] of the Written or Practical examination in the subject therein dealt with'.[53] Moreover, these regulations were revised in 1886, and London became the first British university to award a degree with a mandatory research component - the Senate insisting that the doctorate in science would only be awarded to candidates on the basis of the submission of 'an original printed Dissertation or Thesis treating scientifically some special department of the subject so named, embodying the result of independent research, or showing evidence of his own work, whether based on the discovery of new facts observed by himself,

[51] O'Connor, British Physiologists, pp.135-9.
[52] A London M.Sc. was not introduced until 1914-15.
[53] Simpson, Ph.D., pp.47-8.

Graph 4.7 Postgraduate Degrees Awarded to UCL Students (1890-1914)



Source: University College London Annual Reports 1891-1915 (London: UCL, 1891-1915).

or of new relations of facts observed by others, or, generally tending to the advancement of science'. Candidates were also permitted to 'specify any printed contribution(s) to the advancement of learning which they ha[d] previously published, which [were] considered and taken as part of qualification for the degree', and they were subsequently 'tested either orally or practically; or by printed questions, or by all those methods, and with special reference to [the] Essay or Thesis'.[54]

At the same time the regulations governing the Doctorate of Literature were amended so that D.Lit. candidates were required to submit a printed essay or thesis 'upon some special subject within the purview of Branch I, III of IV of the M.A. examination' (i.e. in the fields of Classics, Mental and Moral Science, Political Philosophy, History, Philosophy, Political Economy and Modern Languages), embodying the result of 'independent research or a critical review of what has been written on the subject'. The degree regulations stipulated:

> The essay or thesis so submitted shall have been written in view of candidature or shall not have been previously published. It shall be of not less length than 32 closely printed octavo pages, such as those of the 'Quarterly' or 'Edinburgh Review' and shall not be approved by the examiners unless it evinces thorough instruction in the subject and a power of treating it with independent judgment, a defined and clear conception, and an appropriate and intelligible style.

Successful candidates were subsequently tested, at the discretion of the examiners, 'either orally or by printed papers, or in both ways, and with special reference to his Essay or Thesis'.[55] In 1892 the regulations for both the D.Sc. and D.Lit. were amended to include the proviso that, if the dissertation was of particular excellence, the candidate could, at the examiners' discretion, be exempted from any form of examination.[56]

In the absence of a London M.Sc., a 'B.Sc. by Research' was introduced in 1902, which allowed the examiners to 'accept in place of . . . the final examination for the Degree of Bachelor of Science, the results of the study or research of any candidate who in the opinion of the Senate has thereby made a distinct contribution to the advancement of learning or science in any of the subjects in which these

[54] University of London Calendar 1890-91, pp.135-6. Candidates for the D.Sc. could not apply until 'Two Academical Years after obtaining the Degree of B.Sc. in this University'.
[55] University of London Calendar 1890-91, pp.92-3. Each candidate was required to have passed the M.A. in Branch I, III or IV, and could not apply within 'One Academical Year of his passing the M.A. examination' (p.91).
[56] University of London Calendar 1892-93 (London: University of London, 1892), p.94.

degrees are conferred'.[57] However, the Senate was insistent that the new degree would be permitted only as an 'exceptional and strictly supervised means of access to an honours degree, and not as an ordinary alternative to the pass examination'. The new degree was beset with problems and restrictions, and between 1902 and 1914 only 13 were awarded.[58] However, from 1902, M.A. candidates (except those studying Mathematics) were also required to submit a thesis or some other record of original work, and were subsequently examined 'viva-voce, especially in the subject of their Thesis'.[59] Renate Simpson has argued that the London M.A. was the precursor of the Ph.D., which was not introduced in Britain until after the First World War. In fact, London was actually the last British university to introduce a doctorate in philosophy, but Simpson insists:

> Her very modernity in introducing research masterships long before most other universities led to London's reluctance to introduce this new lower doctorate, which so closely resembled her already existing mastership.[60]

The Expansion and Redevelopment of the College

Crucially, the Edwardian era was also a period of massive growth and expansion; and nothing illustrates the growth of a new commitment to teaching and research at UCL during the first decade of the twentieth century more graphically than the physical transformation of the Gower Street site between 1890 and 1914 (see Figures 4.1-4). In February 1902 a joint committee of the Council and Senate was established to consider the needs of the College, and a statement was drawn up listing the developments that were considered most urgent in order for UCL to 'adequately fulfil its function as an institute for higher education and for research', highlighting in particular the need for a school of advanced medical studies and new chemical laboratories, 'particularly for research'. The total cost of the redevelopment

[57] University of London Calendar 1902-03. Volume II, pp.205-7.

[58] University of London Regulations and Courses for Internal Students (September 1907), p.19; Simpson, Ph.D., p.91.

[59] University of London Calendar 1902-03. Volume II, p.138. 'The Thesis shall be either a record of original work or an ordered and critical exposition of existing data with reference to a particular subject'. University of London Regulations and Courses for Internal Students (September 1909) (London: University of London, 1909), p.89.

[60] Simpson, Ph.D., pp.156-7.

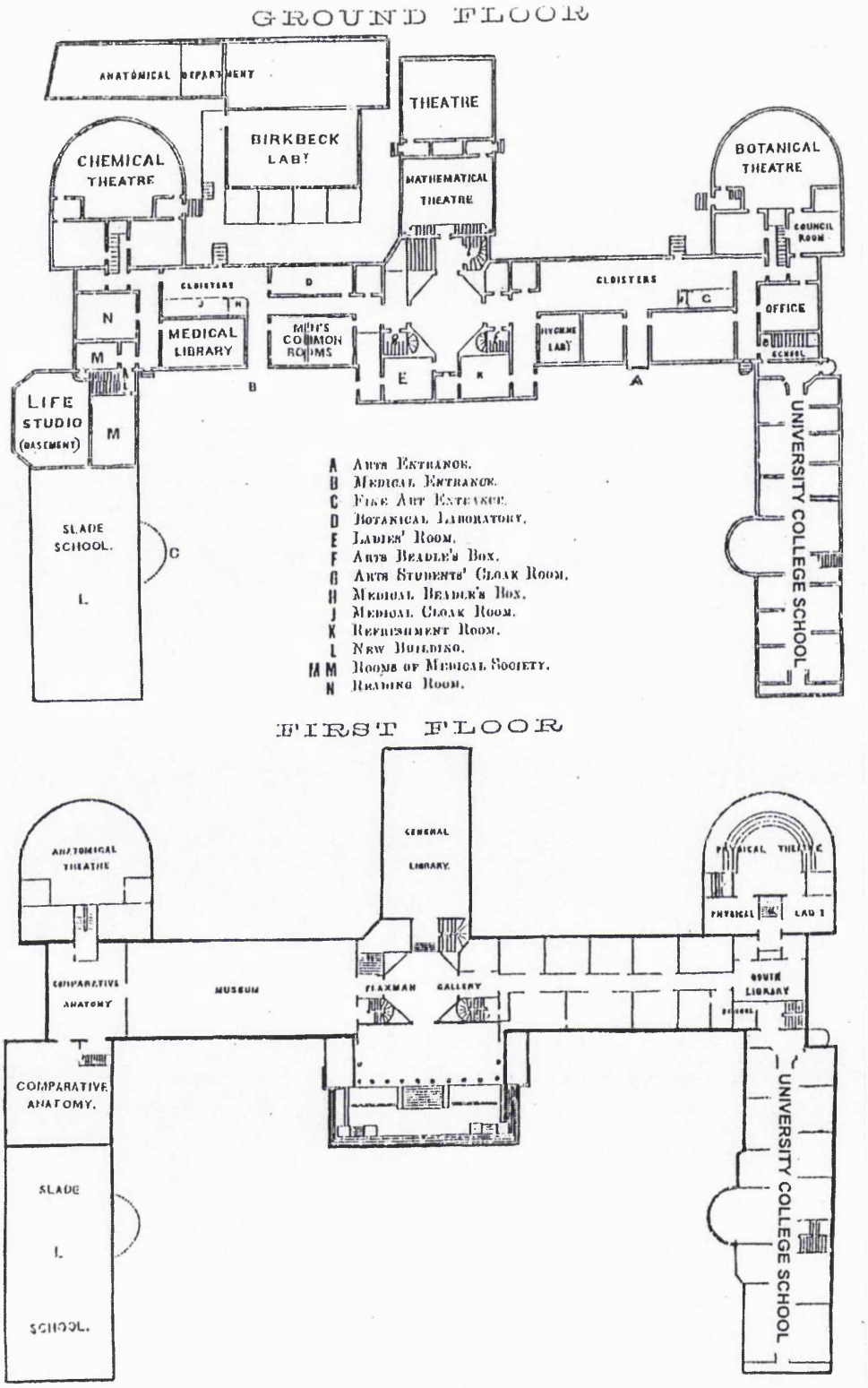


Figure 4.1 Plan of the Main UCL Site (c.1890) (Second Floor and Basement not shown)

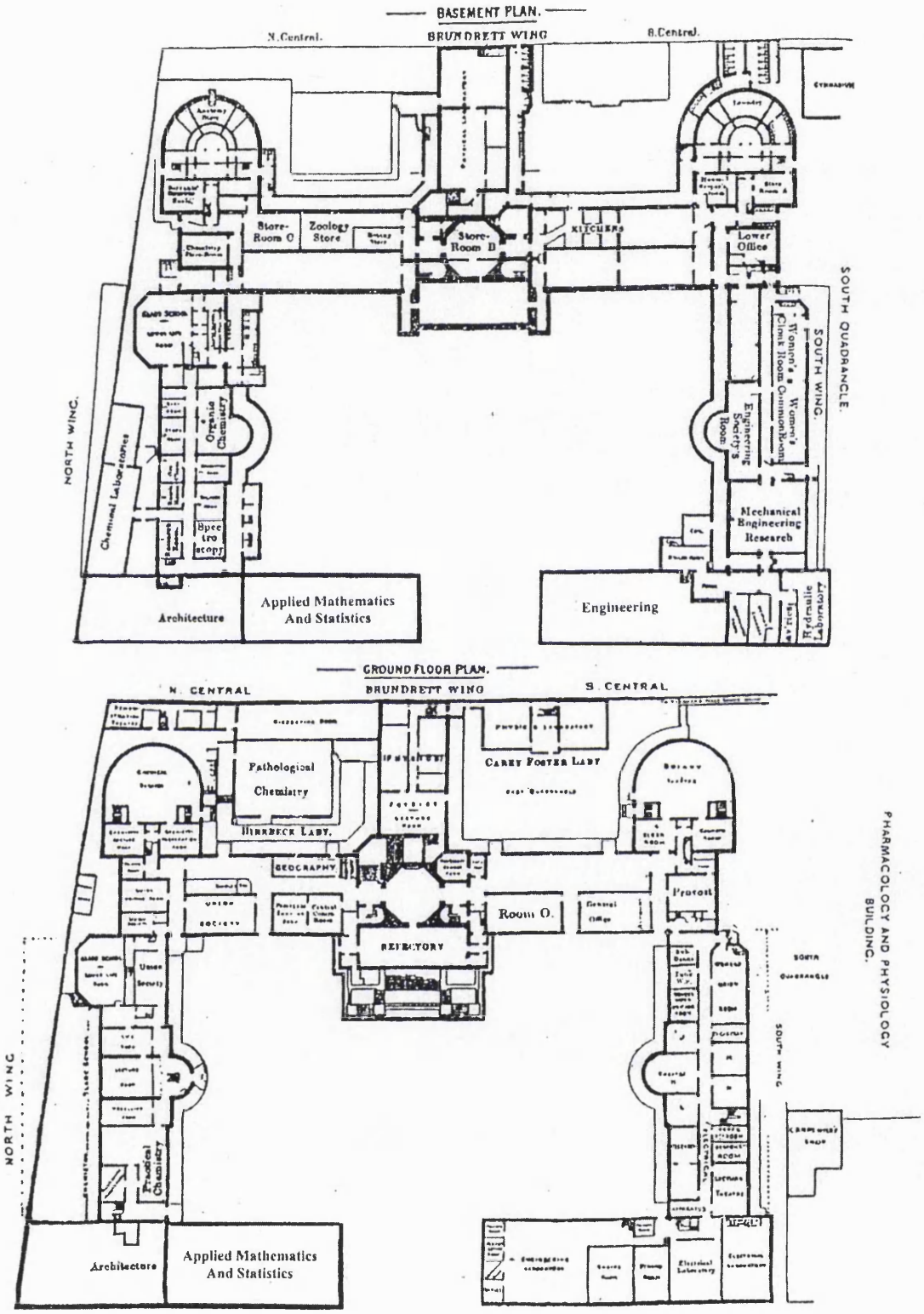


Figure 4.2 Plan of the Main UCL Site (Ground Floor and Basement) (c.1914)

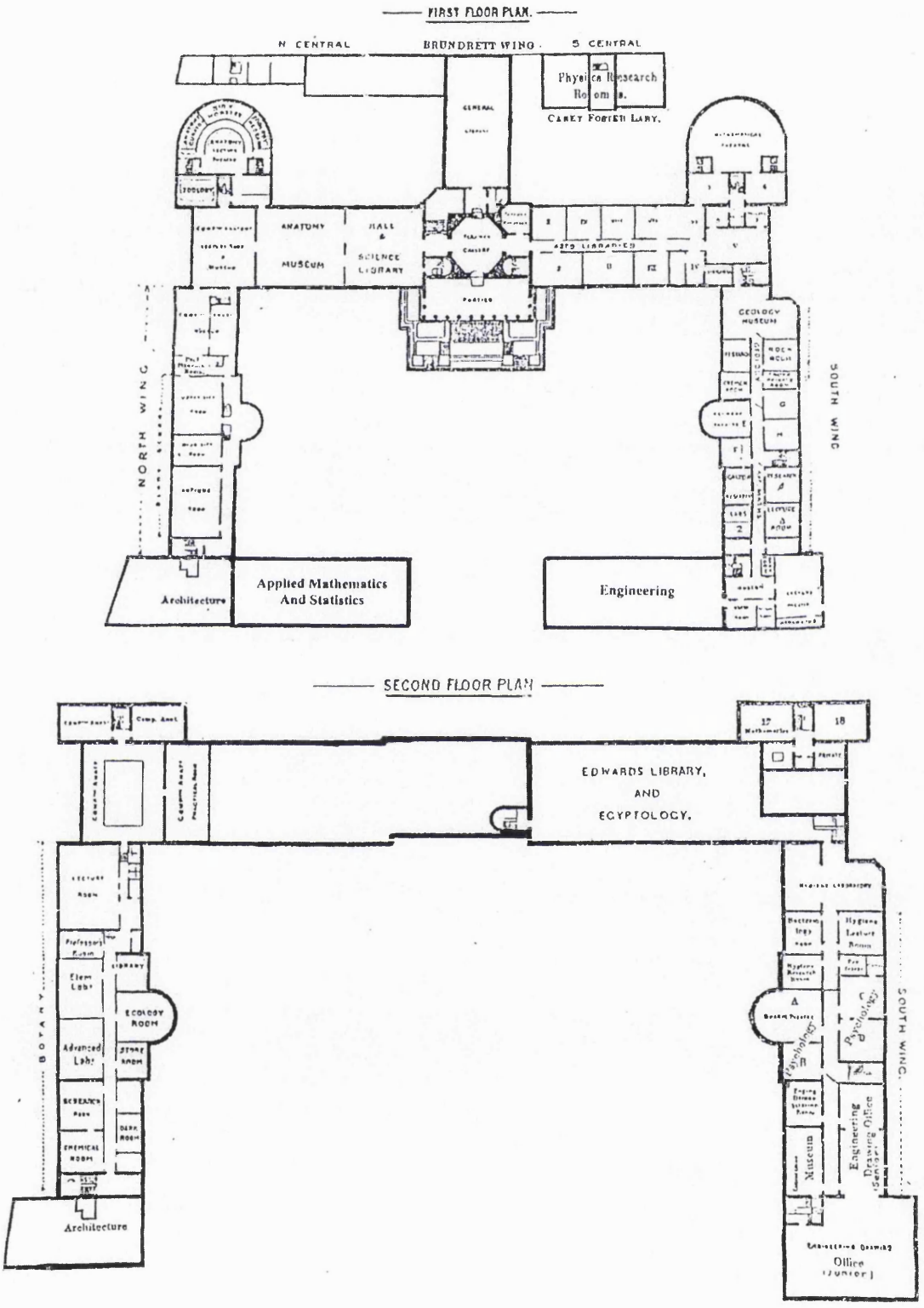


Figure 4.3 Plan of the Main UCL Site (First and Second Floors) (c.1914)

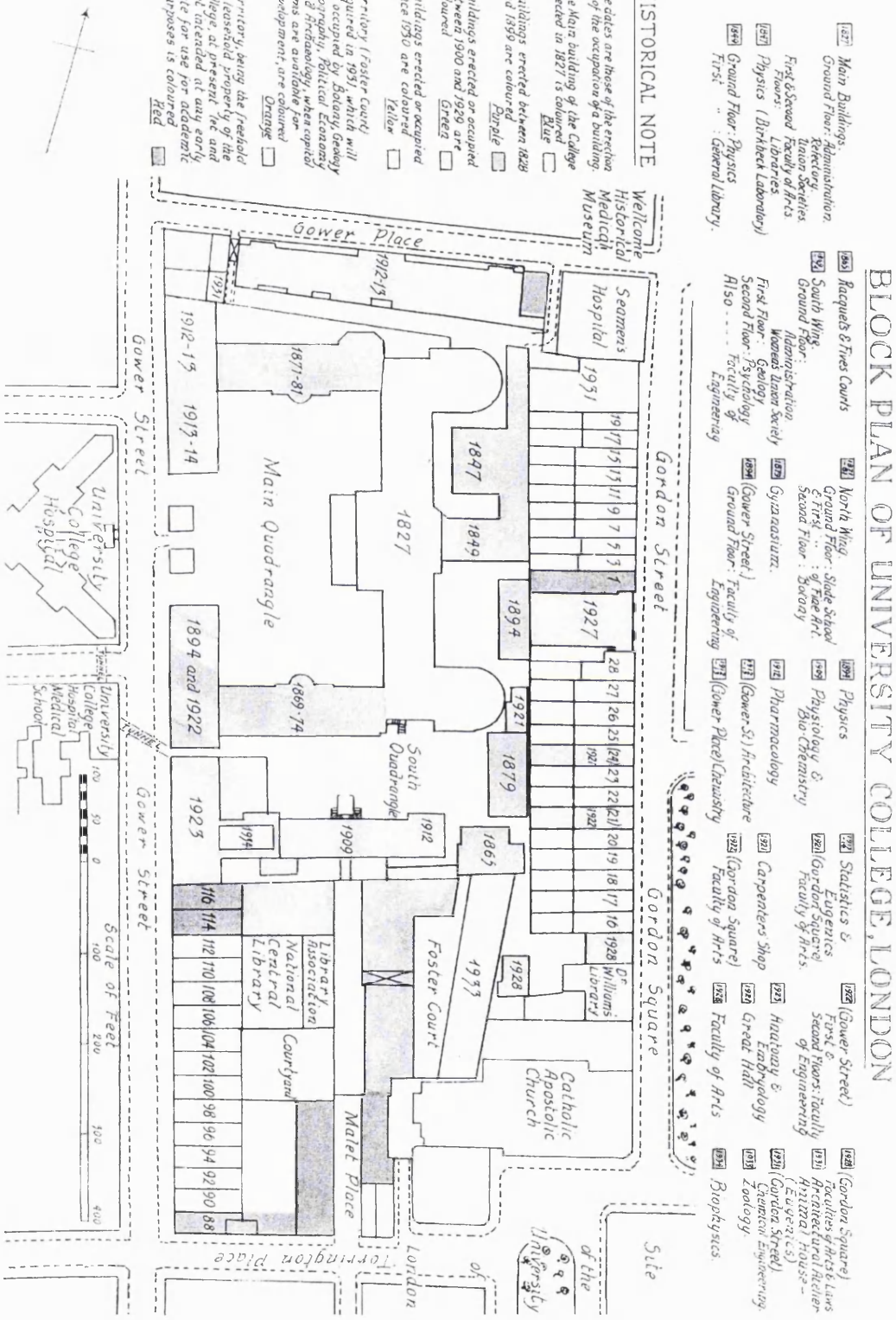


Figure 4.4 Block Plan of University College London (1932)

of the College was estimated at £1,000,000.[61] The Council was entirely dependent on external sources of funding - primarily private benefactions - to subsidise these developments. For example, in 1893 a new Physics Laboratory had been built at a cost of £20,000. Only £5,000 had been raised by the time the new building was finished, and the Council had therefore issued a desperate appeal for contributions to the buildings fund, going as far as to '*beg* those members who ha[d] not already done so, not only to subscribe themselves, but also to induce others to contribute' (my italics).[62]

As we saw in the previous chapter, the College Council's principal sources of income in this period were student fees and private grants, subscriptions and donations. In his account of the history of nineteenth-century academic philanthropy, David Owen explains that the early history of the College was 'blighted' by the Council's dependence on its income from student fees, which failed to keep pace with their expectations. By the end of the nineteenth century the College was in debt to its bankers to the tune of £30,000 - 'What saved the situation and enabled University College to enter on a period of development and expansion was a series of large benefactions in the decade 1902-12'.[63] It was estimated that the average cost of educating each student who passed through the College in this period amounted to between £50 and £70 a year 'if proper provision [was to be] made for higher teaching and research'. However, the average income from student fees was only £20-£30 a year per student. '[C]onsiderable endowments' were therefore necessary 'if the higher work, the training of researchers, which [was] of the greatest value to the nation, [was] not to be neglected'. The Council was also aware that with 'the recent growth of science the requirements of teaching [had] increased in leaps and bounds, and the buildings and endowments, which were not more than adequate for their purpose ten or twenty years ago, [would] no longer suffice'. Preying upon contemporary concerns about Britain's economic and industrial 'decline' and fears for her future as an imperial power, the Council therefore issued an 'Appeal for the Endowment of Advanced University Education and Research', drawing the attention of potential benefactors to the need for increased accommodation for teaching and research in the departments of Chemistry, Engineering, Botany,

[61] Reports 1902, pp.17-18, 35.
[62] Reports 1893, p.14.
[63] Owen, English Philanthropy, p.362.

Zoology, Anatomy, Physiology and Pathology, in which 'the greatest lack [was] in the provision of proper facilities for research'.[64]

This appeal was enormously successful. Writing in 1928, H. Hale Bellot could report that after the incorporation of the College in 1905, 'there began a period of renewed activity in building, which ha[d] continued almost without intermission ever since'.[65] The new laboratories, research institutes and other buildings established in this period were built on what David Owen has called 'subscription-list philanthropy',[66] but most of these projects were dependent upon the generosity of a single large-scale investor. For example, in 1904 Sir Donald Currie - the founder of the Castle Steamship Company, whose life had been saved by Dr. Batty Shaw, an assistant physician at University College Hospital - presented the Council with a donation of £100,000 to subsidise the erection of a new School of Advanced Medical Studies and nurses' home on a vacant plot of land at the corner of Gower Street and Huntley Street.[67] Work began the following year, and an impressive new building, which made 'ample provision for the work of advanced medical studies in all its departments and also for research laboratories in pathology, clinical medicine, and clinical surgery', was opened in 1907.[68] A year later the new cruciform University College Hospital building (designed by Alfred Waterhouse) opened on Gower Street opposite the main UCL site. It had been rebuilt thanks to the munificence of the furnishing shop millionaire, John Blundell Maple.[69] The boys school was relocated to Hampstead in 1906,[70] and the South Wing was taken over by the Departments of Hygiene, Geology, Applied Mathematics and Engineering, the Galton Eugenics Laboratory, and a new Department of Philosophy, complete with two lecture theatres and a psychological laboratory.[71] However, it was not only in the sciences

[64] In launching the appeal, they warned that Britain's chief rivals were all 'arming themselves in the peaceful struggle for supremacy' through the endowment of higher education and research, insisting: 'All civilised nations except England have recognised the fundamental importance of scientific studies and University education in promoting the material welfare of their citizens'. Needs, pp.2-4.

[65] Bellot, UCL, p.408.

[66] Owen, English Philanthropy, p.359.

[67] W.R.Merrington, University College Hospital and Its Medical School (London: University College London, 1926), pp.94-101.

[68] Reports 1905, p.27.

[69] Merrington, University College Hospital, pp.56-63.

[70] H.J.K.Usher, C.D.Black-Hawkins and G.J.Garrick, An Angel Without Wings: The History of University College School 1830-1980 (London: University College School, 1981), pp.57-9.

[71] Bellot, UCL, pp.408-9.

that facilities were provided for research. For example, in 1903 the Council reported:

> On the principle that a library should be to the student of Philology what the laboratory is to the science student, an effort has been made . . . to concentrate into a special collection all works on Germanic and Romance Philology and Literature . . . . It is hoped that the Library there formed will serve the purpose of a German 'seminar' as a training school for literary research.[72]

And as part of the programme of redevelopment instigated by the relocation of University College School, the Science Library was moved to the rooms to the north of the Flaxman Gallery on the first floor of the main College building, and the whole of the first floor of the south-west corridor was given over to 'seminar' libraries for arts subjects.[73]

Further donations made it possible to erect a new Physiological Institute in the old school playground. The new building, which was formally opened by Richard Haldane on 18 June 1909, contained eight rooms 'devoted to research in physiological chemistry, including two large laboratories with working places for eight students', a combustion room, preparation room, gas room, polarimeter room, balance room, and a private laboratory for Professor Starling. On the first floor there were five large rooms, designated the *Thomas Webb Research Laboratories*, which were devoted to research in experimental physiology, and there were also separate laboratories for research in histology and neurology. New botanical laboratories, complete with a private laboratory for the professor and 'a large room set apart for original investigations, especially in anatomical and microscopic work', were opened in the rooms vacated by the Physiology Department on the first floor of the North Wing in December 1909.[74] Meanwhile, additional space was also provided for Anatomy, Zoology, Physics and Geography, and a new building for Pharmacology opened as an extension of the Institute of Physiology in 1912.[75] Thanks to the munificence of Henry Bartlett and Ralph C.Forster, work also began on the erection of a new building to house the Departments of Architecture and Applied Statistics on the north-west corner of the main Gower Street site,[76] and elaborate new chemistry laboratories were built to the north-west of the main College buildings behind the Slade School in Gower Place.[77]

[72] Reports 1903, pp.39-41.
[73] 'Report on the Future Policy of the Library at UCL', pp.4-16, LU/AFP/32.
[74] The principal investors in the new Institute were Dr.R.H.A.Plimmer (£2,000), Ludwig Mond (£3,000), Thomas Webb (£5,000), the Worshipful Company of Mercers (£1,500), and an anonymous individual who personally contributed £60,000.Reports 1910, pp.27-34.
[75] Bellot, UCL, pp.409-10.
[76] On the Bartlett Building see below, Chapter 5, pp.156-8.
[77] On the new chemistry laboratories see below, Chapter 5, pp.163-4.

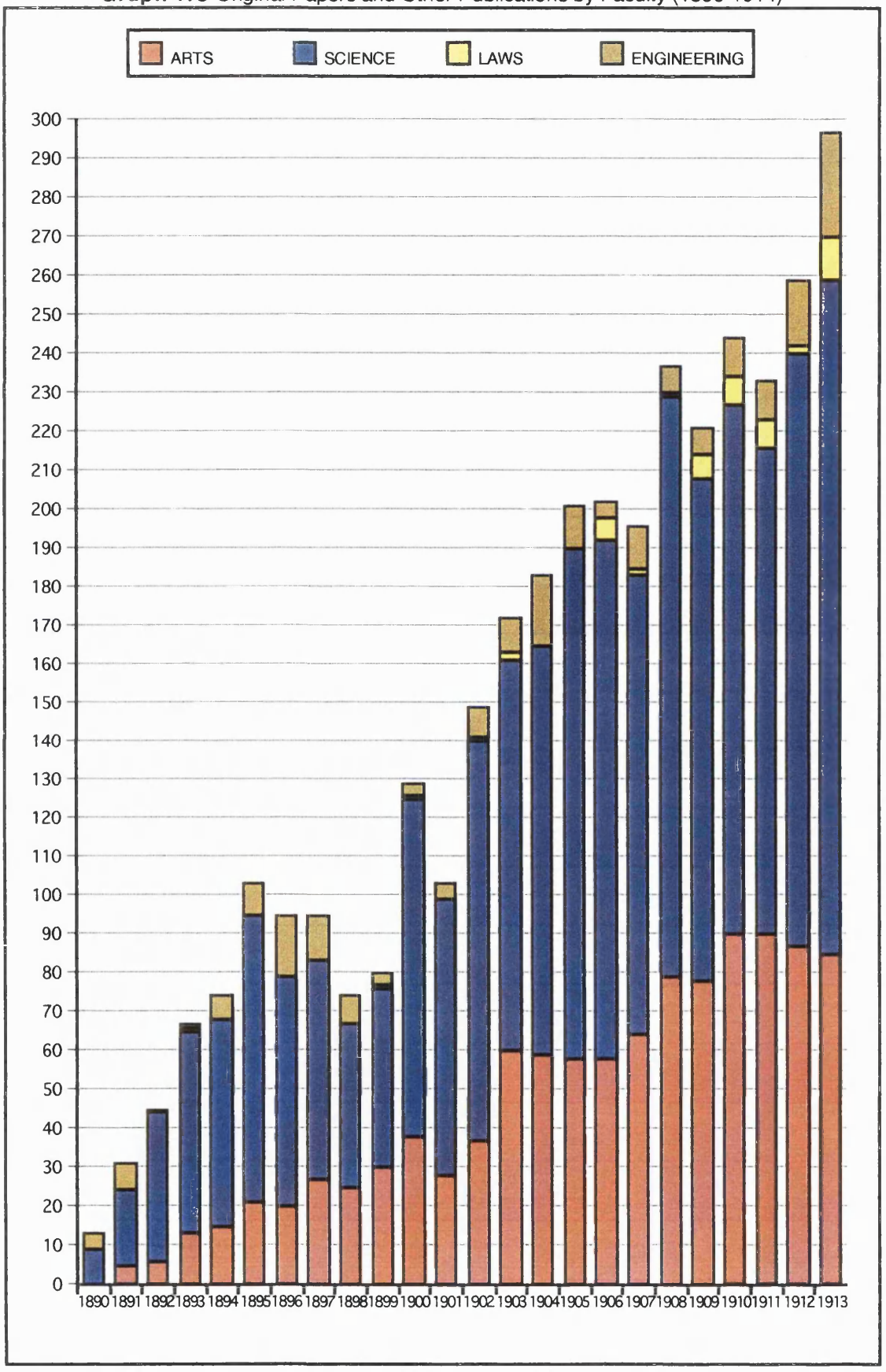
The Research Departments

The extensive rebuilding, redevelopment and expansion of the Gower Street site between 1907 and 1914 was the most tangible expression of the changing aims and objectives of the College Council in this period. However, one should not overestimate the scale and significance of these developments. At this stage the Council was committed, in principle, to the reorganisation and development of the College as a centre for teaching and research, but it would take several decades for its aims to be realised. In this period the 'research revolution' was led by a handful of pioneering professors and their pupils in certain (key) departments.

The publication statistics reveal that Applied Mathematics and Chemistry were by far the most productive departments of the College between 1890 and 1914 (see Appendix 5). Although a growing number of 'Original Papers and Other Publications' emerged from all four faculties in this period, the staff and students working in the scientific departments of the College were generally more active in this respect than their colleagues in the Faculties of Arts, Laws and Engineering (see Graph 4.8).[78] Very few publications emerged from the Faculty of Law, but the staff and students of the Engineering Faculty - especially those based in the Departments of Mechanical and Electrical Engineering - did produce a growing number of new books and journal articles in this period. Within the Faculty of Arts, the output of original work from the Oriental School and the Departments of Classics and Modern Languages remained low and fairly constant throughout this period, rising slightly from about 1903 onwards, and more dramatically after 1910. But, although no original work was published by the staff and students of the History Department before 1903, the publication rate rose extremely quickly thereafter (especially after 1910), and by 1914 History was by far the most active department in the Faculty of Arts. Under the direction of A.F. Pollard, it was even beginning to rival the most productive scientific departments of the College by the end of our period (see Appendix 5).

[78] Separate Faculties of Law and Engineering were not established until 1908, and a new Faculty of Medical Sciences was instituted in 1907. However, in order to facilitate comparison, the Faculty structure of the College in 1914 is assumed to have been in place throughout the period 1890-1914, and the original papers and other publications emerging from the scientific departments of the College have been grouped together.

Graph 4.8 Original Papers and Other Publications by Faculty (1890-1914)



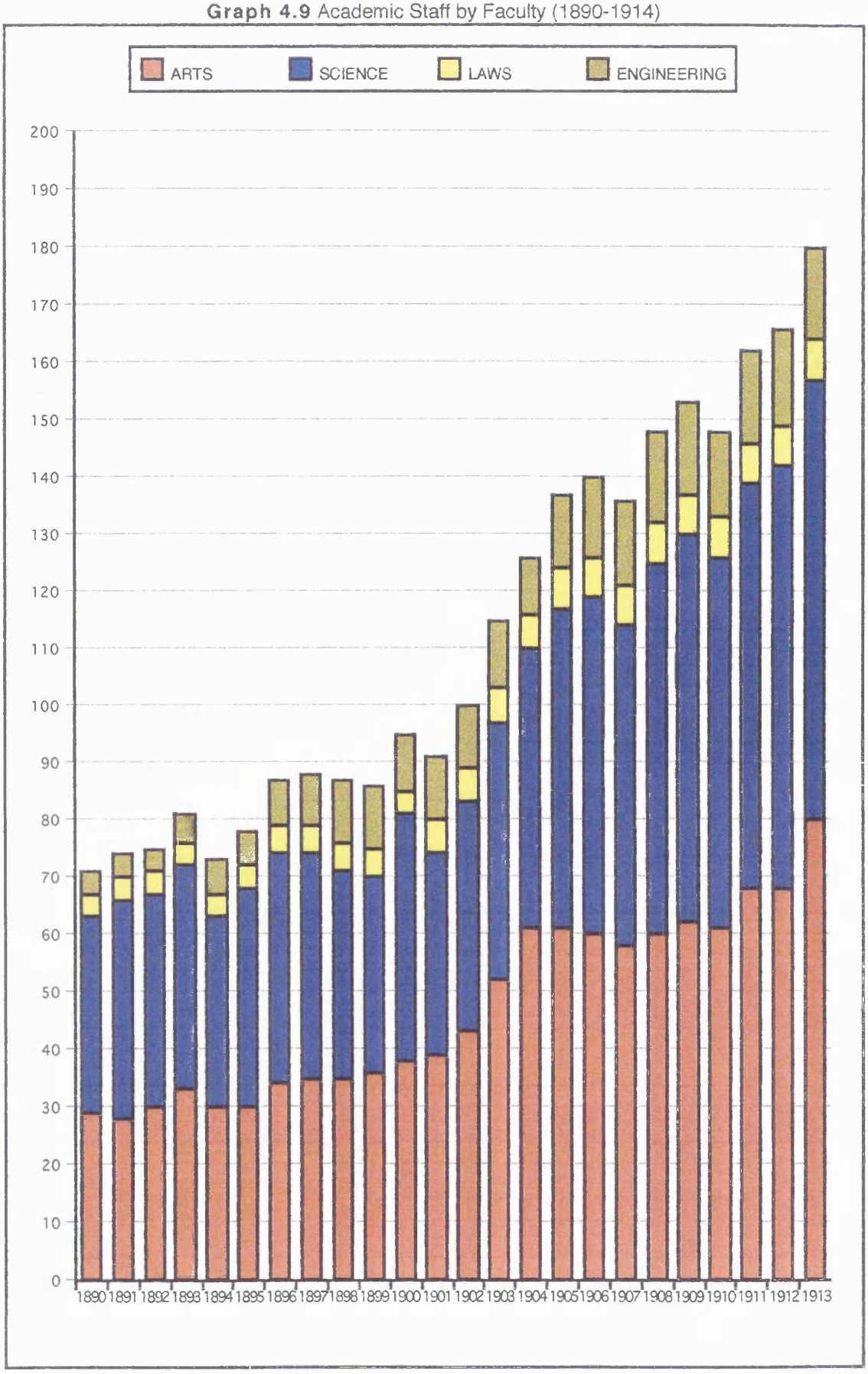
Source: The Needs of University College London (London: UCL, 1902); University College London Annual Reports 1901-1915 (London: UCL, 1901-1915).

Generally there were also more professors and other members of staff in the scientific departments of the College (see Appendix 1), most notably in the Department of Chemistry, which employed 18 full-time members of staff by the end of our period. However, although the majority of Arts departments had only one member of staff right up until 1914, the total number of professors, assistant professors, lecturers, assistants and demonstrators working in the Faculty of Arts was roughly comparable with the number based in the Faculty of Science (see Graph 4.9). Within the Faculty of Arts, the Departments of Fine Art and Architecture had the largest staffs throughout this period, but this should not (necessarily) be taken as evidence for a growing commitment to research in these departments. Although there was only one professor in History until as late as 1901, the academic staff of the Department grew rapidly thereafter, and even began to rival the numbers employed by the scientific departments of the College by 1914. There were also more postgraduate and research students working in the scientific departments, particularly in Chemistry and Applied Mathematics, and latterly (and most spectacularly) also in the Department of Hygiene and Public Health (see Appendix 2).[79] As a result, there were many more postgraduates based in the Faculty of Science, than in Arts, Laws and Engineering, at least up until 1911-12 (see Graph 4.10). There were relatively few postgraduates studying Law throughout this period, but there was a dramatic increase in the number of postgraduate and research students studying Engineering after 1907-08, principally as a result of the expansion of the Department of Electrical Engineering.[80] Postgraduate enrolments

[79] In the face of rising public concern about sanitation, hygiene and public health, the College Council established a new Chair of Hygiene and Public Health in 1869. W.H.Corfield, its first incumbent, opened the first laboratory for the practical teaching of hygiene to be established anywhere in London in 1875. The Chair was endowed by Edwin Chadwick in 1898, and the postgraduate population of the Department grew quickly through the first decade of the twentieth century, as it became renowned as a training school for medical officers of health and municipal engineers.

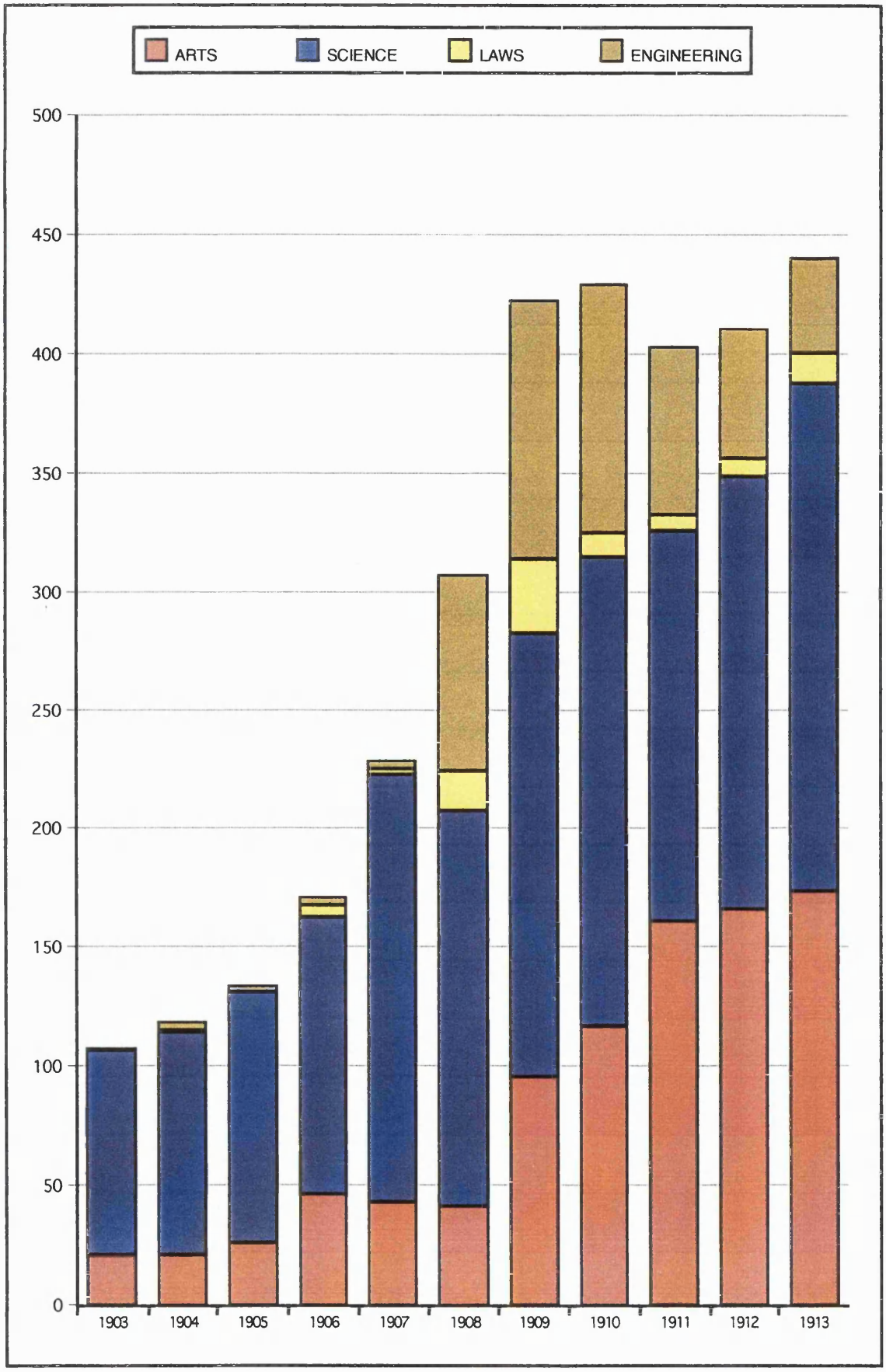
[80] Ambrose Fleming was appointed to the newly created Chair of Electrical Engineering in 1885, and went on to occupy the post for the next 45 years. The Chair was endowed as a memorial to Sir John Pender in 1896 (Reports 1897, p.14), and the Pender Electrical Engineering Laboratory was refurbished in 1906 (see 'The Pender Electrical Laboratory', The Electrician, LVIII (1906-7), 242-5). Thereafter a growing number of postgraduate and research students were drawn to the Department - and to Fleming,who, as the inventor of the thermionic valve, was responsible for some of the most important advances in electronics and wireless technology in this period, including the invention of the thermionic valve. On Fleming see J.A.Fleming, Memories of a Scientific Life (London, 1934); C.E.Gimson, The First Century of Electronics and Electrical Engineering at University College London (London: University College London, 1985); Sungook Hong 'Forging Scientific Electrical Engineering: John Ambrose Fleming and the Ferranti Effect', Isis, 86 (1995), 30-51, and J.T.Macgregor Morris, The Inventor of the Valve: A Biography of John Ambrose Fleming (London: The Television Society, 1954).

Graph 4.9 Academic Staff by Faculty (1890-1914)



Source: University College London Calendars 1890-1914 (London: James Walton, 1890-1914).

Graph 4.10 'Post-Graduate and Research Students' by Faculty (1903-1914)



Source: University College London Calendars 1903-1914 (London: James Walton, 1903-1914).

to the Faculty of Arts also rose sharply after 1910, and thereafter the number of postgraduates studying History and Egyptology was roughly comparable with the numbers working in the largest scientific departments of the College.

The scientific departments were generally more attractive to overseas students (see Appendix 4). A substantial and growing number of the postgraduates studying English (upwards of 50% for much of this period) were overseas students, and a significant number were based in the Department of Hygiene and Public Health; but the most popular departments were those, like William Ramsay's Department of Chemistry, which had achieved international recognition and success. There were also many more successful doctoral candidates in scientific subjects than in Arts, Laws and Engineering (see Appendix 6). In fact, only 12 D.Lit.s were awarded between 1890 and 1914. This reflects the fact that D.Lit. candidates already had to have passed the M.A. examination. According to Simpson, since there was no equivalent Master of Science degree, the regulations governing the D.Lit. were extremely 'stringent', and there was a much lower pass rate (approximately 25%).[81] The most popular M.A. subjects were Classics and English, followed by History, Mathematics and French, while the most popular scientific subjects were Chemistry, Physiology and Zoology - which together accounted for two-thirds of the total number of D.Sc.s awarded in this period.

Judged according to the principal indices of research activity, the Departments of Applied Mathematics, Chemistry, Egyptology, Electrical Engineering, History and Physiology are the only departments of University College that can legitimately claim to have been *places of teaching and research* in the period 1890-1914. However, the pattern of growth and development observed in these departments in this period formed the model for the subsequent reorganisation and development of the entire College as a centre for teaching and research, as the staff and students of these departments succeeded in persuading the College Council to accept a much broader definition of the aims and objectives of university education in London.

[81] Simpson, Ph.D., pp.51-2.

Conclusion

A systematic review of the Annual Reports compiled by the College Council (and later the College Committee) therefore reveals that, although UCL was initially conceived of simply as a teaching institution, a clear conception of the College as 'a place of teaching and research' had emerged by the eve of the First World War. This transformation in the Council's conception of the role and function of the College acted as a powerful stimulus to the original work already going on at UCL, and from about 1900 onwards the number of original publications produced in the College, the number of 'Post-Graduate and Research Students' and the number of postgraduate degrees awarded, all increased fairly rapidly. However, it is important to stress that it would take several decades for a genuine culture of teaching and research to emerge on a College-wide scale. In this period the 'research revolution' was led by a small number of pioneering professors in certain departments of the College. Despite the unfavourable institutional circumstances of the late-nineteenth century, these remarkable men managed to pursue successful research careers in the libraries and laboratories of University College, while simultaneously introducing the concept - and devising the methods - of research training for students. It therefore seems that the origins of the modern conception of UCL as a centre for the advancement and dissemination of knowledge are to be found within the individual departments of the College - in the efforts of certain individual professors, in certain individual departments, to conduct their own experiments and investigations, to train their pupils in the methods of academic research, and to secure the necessary financial and institutional support for their work.

Part Two of this thesis will therefore examine the emergence of research schools in three key departments of the College - Karl Pearson's Department of Applied Mathematics and Statistics, Sir William Ramsay's Chemistry Department, and A.F. Pollard's Department of History - in the period 1890-1914, using the Morrellian model and the existing secondary literature on the subject as a framework for investigating the complex web of intellectual, institutional, technical, psychological and financial factors which underlay the emergence of a successful research school; and also to explore the impact and implications of these developments on the institutional structure and character of UCL and the College Council's changing conception of the role and function of the College in this period.

Part 2. Three Departmental Case-Studies: Applied Mathematics and Statistics, Chemistry and History

5. Introduction: The Growth and Development of the Three Schools c.1890-1914

In my Laboratory I have built a school of Chemistry, and my friend, Karl Pearson, has established in his Department a school of mathematics.

William Ramsay, 1903.[1]

In Part One of this thesis it was argued that, contrary to the assumptions implicit within much of the existing secondary literature on Britain's universities and the rise of research, the origins of the 'research university' in this country are to be found not in the actions of the state, but within the individual universities and colleges themselves. More specifically, the preceding account of the emergence of an institutional commitment to teaching and research at UCL in the period 1890-1914 suggests that the origins of this 'modern' conception of the role and function of the College are to be found in the efforts of certain key professors - in certain key departments - to establish research schools in their respective fields and to secure the necessary financial and institutional support for their work. Part Two therefore focusses more closely on the work of three of these departments - using Jack Morrell's model of the 'ideal' research school as a framework for investigating the various factors which underlay the emergence of successful research schools in certain departments of the College, and also to investigate the impact and implications of these developments at UCL and elsewhere in the University of London. The Departments of Applied Mathematics and Statistics, Chemistry and History were particularly active in the area of original research in the period 1890-1914, together accounting for almost one-third of the original papers and other publications that were produced by the staff and students of the College during the first decade of the twentieth century. These subjects are also representative of the main lines of research pursued at UCL in this period; and in each case the principal architect and director of the school was heavily involved in the politics and administration of the College and University. Through their efforts to secure the requisite financial support and an institutional commitment to their work, Karl Pearson, Sir William Ramsay and A.F. Pollard all played an important part in shaping the College Council and University authorities's changing conception of the aims and objectives of University College London in this period.

[1] William Ramsay [hereafter WR] to Emil Fischer, 14 April 1903, UCL/WR/13, p.36.

Karl Pearson and the Department(s) of Applied Mathematics and Statistics

The Department of Applied Mathematics and Statistics, and the various other sub-departments and laboratories presided over by Karl Pearson between 1890 and 1914, were particularly active in the area of original research. By the eve of the First World War, Pearson, Goldsmid Professor of Applied Mathematics (1884-1911) and Galton Professor of Eugenics (1911-1933), had succeeded in establishing a major school of research in applied mathematics, statistics, biometry and eugenics at UCL, and had also made a vitally important contribution to the politics and administration of the College and the campaign to reform the University of London.

Most of the existing secondary literature on Pearson focuses on his association with Francis Galton and the eugenics movement, and the debate between the Biometricians and the members of the rival Mendelian school.[2] However, Eileen Magnello insists that his most important contributions were made in the field of mathematical statistics,[3] and Pearson always maintained that the principal aim of his school was:

> to make statistics a branch of applied mathematics with a technique and nomenclature of its own, to train statisticians as men of science, to extend, discard or justify the meagre processes of the older school of political and social statisticians, and in general to convert statistics in this country from being the playing field of *dilettanti* and controversialists into a serious branch of science, which no man could use effectively without adequate training.[4]

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[2] See, for example, Lyndsay A.Farrall, 'The Origins and Growth of the English Eugenics Movement 1865-1925' (Unpublished Ph.D. Thesis, University of Indiana, 1970); Lyndsay A.Farrall, 'Controversy and Conflict in Science: A Case Study - The English Biometric School and Mendel's Laws', Social Studies of Science, 5 (1975), 269-301; P.Froggatt and N.C.Nevin, 'The "Law of Ancestral Heredity" and the Mendelian - Ancestrian Controversy in England, 1889-1906', Journal of Medical Genetics, 8 (1971), 1-36; Donald Mackenzie, 'Statistical Theory and Social Interests: A Case-Study', Social Studies of Science, 8 (1978), 35-83; Donald Mackenzie, 'Karl Pearson and the Professional Middle Class', Annals of Science, 36 (1979), 125-43; Donald Mackenzie, Statistics in Britain 1856-1930: The Social Construction of Scientific Knowledge (Edinburgh: Edinburgh University Press, 1981); Bernard J.Norton, 'Biology and Philosophy: The Methodological Foundations of Biometry', Journal of the History of Biology, 8 (1975), 85-9 3; B.J.Norton, 'The Biometric Defence of Darwinism', History of Biology, 6/2 (1973), 283-316; Bernard J.Norton, 'Karl Pearson and Statistics: The Social Origins of Scientific Innovation', Social Studies of Science, 8 (1978), 3-34, and Kevles, In the Name of Eugenics, pp.20-40.

[3] Magnello, 'Pearson's Gresham Lectures'. For example, on his death in 1936, the Royal Statistical Society issued a statement in which it was recalled that 'To Pearson we owe not only the initial impulse to the whole development of statistical theory during the past forty years . . . . but large and important contributions to the theory of frequency curves, the great bulk of the theory of correlation, and many methods derived there from or cognate thereto, and important contributions also to the theory of sampling', KP/UCL/43.

[4] Pearson, 'History of the Biometric and Galton Laboratories', p.1, KP/UCL/247.

Magnello's work on the 'Non-Correlation of Biometrics and Eugenics' has involved some analysis of the structure and organisation of the Eugenics Laboratory and the Department of Applied Mathematics and Statistics at UCL,[5] drawing attention to Pearson's role as a pioneer school builder and the director of a successful research school. However, more work is needed in this area, and Pearson's contribution to the campaign to reform the University of London - and the wider debate about the role and function of university education in Britain - also demands further attention.

As we have already seen, when Pearson was first appointed to the Goldsmid Chair of Applied Mathematics in June 1884 he was not even provided with a laboratory, nor any instruments or apparatus; and there was little opportunity (or substantive incentive) for him to conduct his own experiments and investigations. As Goldsmid Professor, he was (merely) required to teach geometry, graphical drawing and general mechanics to engineering students. By 1897 Pearson was personally responsible for giving 16 hours of lectures each week, and for coordinating a further 20 hours of lectures with the help of an assistant professor and two demonstrators. He complained that these extensive teaching responsibilities 'practically precluded [his] completing any research work', and applied (unsuccessfully) for chairs in at least four other universities.[6] But Pearson stayed at UCL, and over the next 20 years he carried out a series of ground breaking investigations in the field of mathematical physics and statistics. Meanwhile, as his personal reputation as a successful researcher increased, Pearson was able to attract a growing number of volunteer workers and postgraduate students to join him in his work (see Graph 5.1). The academic staff of the Department also began to expand over the same period, with the appointment of a series of assistants and demonstrators (who were initially paid directly by Pearson himself); and they 'provided an opportunity for the development of a keen group of statistical workers' at the College (see Graph 5.1 and Appendix 1).[7] The individuals appointed

[5] Magnello, 'Non-Correlation'.

[6] For example, in 1897 he applied for the Savilian Chair of Geometry at Oxford, complaining: 'I find it a great physical strain to combine advanced teaching and private research with the very large amount of elementary teaching which a London post involves'. Pearson, 'To the Electors of the Savilian Professorship of Geometry', p.4, KP/UCL/11/9.

[7] Many of the papers published in this period were jointly written and 'in all of them reference is made to the help received in the discussion of theory or in computation'. Egon Sharpe Pearson, Karl Pearson: An Appreciation of Some Aspects of his Life and Work (Cambridge: Cambridge University Press, 1938), p.32.

to junior positions in the Department - men like Ebenezer Cunningham and George Udny Yule - were, moreover, mathematicians and statisticians of the very highest calibre.[8] Information concerning the number of postgraduate and research students based in the Department only survives for the period 1903-1914, but, writing in 1901, Pearson reported that 'on an average there ha[d] been for the last five or six years, four - six post-graduate research students working in connection with the Department'.[9] By 1903 there were 20 postgraduates studying under Pearson - considerably more than the number studying any subject other than chemistry - and applied statistics remained one of the most popular subjects among postgraduate and research students throughout the period 1890-1914 (see Appendix 2). Pearson was conscious of the need for 'each school of academic rank in the country [to publish] its own series of original researches',[10] and under his direction the Department of Applied Mathematics and Statistics was particularly active in this area. A growing number of original papers and other publications emerged from the Biometric and Eugenics Laboratories each year (see Graph 5.1), and a grand total of 444 books, journal articles and scientific memoirs were published by the staff and students of the Department between 1890 and 1914. This figure represents more than 10% of the total number of publications emanating from within the College in this period (see Appendix 5).

The work of the school crystallised around Pearson's attempt to make mathematical statistics a scientifically rigorous discipline, and what he and his colleague in the Jodrell Chair of Zoology, W.F.R. Weldon, christened 'biometrics' - the application of statistical methods to the study of biology, especially to the study

[8] Cunningham, who graduated from Cambridge with Honours in 1903 as Senior Wrangler and First Smith's Prizeman, became Pearson's chief teaching assistant in the Department (Magnello, 'Non-Correlation', p.87). His subsequent career is discussed in Warwick, 'Cambridge Mathematics and Cavendish Physic'. Yule, who became Pearson's demonstrator in 1893 and was later appointed Assistant Professor, carried out his own ground breaking research on regression and the theory of correlation, which represented a landmark in the history of statistics - a 'masterly step' towards the solution of the 'de Keverberg dilemma', which sadly drew him into a protracted dispute with Pearson. Stephen M.Stigler, The History of Statistics: The Measurement of Uncertainty Before 1900 (Cambridge, MA: The Belknapp Press (Harvard), 1986), pp.345-58.

[9] 'Application for the Chair in Natural Philosophy at the University of Edinburgh', p.4, KP/UCL/11/9.

[10] KP to George Carey Foster, 'Drapers' Company Grant', 26 November 1904, KP/UCL/233

of evolutionary theory and the process of natural selection.[11] In 1894 Pearson set up a small laboratory for biometric research in the Applied Mathematics Department, and in the summer of 1899 he established a 'biometric camp' at Peppard in the Chilterns, so that he and his colleagues could investigate various biometric problems in the field.[12] By the turn of the century 'an instrument room ha[d] been arranged for all forms of calculation, supplied with computing instruments, integrating machines, harmonic analysers, curve-plotters, dividing machines, etc.';[13] and in 1903 a grant from the Worshipful Company of Drapers enabled Pearson to set up a dedicated biometric research laboratory at the College. From its inception, the Drapers' Biometric Laboratory was conceived of as a postgraduate research school - 'a research laboratory and training school in the modern mathematical theory of statistics'.[14] It was intended to provide a 'complete training in modern statistical methods', and was especially arranged so as to 'assist research workers engaged on biometric problems'.[15] A year later the Drapers' Company gave Pearson a second grant so that he could establish an Astronomical Laboratory at the College, and two student laboratories - the Drapers' Company Transit House and Equatorial House - were erected on the South Lawn. These observatories were used primarily for the teaching of practical astronomy, and not for direct research work. Astronomical research was impossible in the middle of a large city, but students were introduced to the methods of practical astronomy with the specific intention of interesting them in original research.[16]

On 1 February 1907 the Eugenics Record Office, which had been established by Francis Galton in 1905, was relaunched under Pearson's voluntary direction as the Galton Eugenics Laboratory. At first Pearson retained the Goldsmid Chair and continued his work in Applied Mathematics at UCL, and the Eugenics Laboratory continued to occupy its own premises (at 50, and later 88, Gower

[11] Pearson first used the term *biometry* in a letter to Weldon written sometime in late November 1900 (KP/UCL/266/9). He had previously defined the aim of his work with Weldon as 'the development of a quantitative basis for the theory of evolution . . . . [and] the creation of an organon by aid of which biological workers [would] be able to more effectively test the truth or falsehood of the various theories of selection and heredity'. Pearson, 'To the Electors of the Savilian Professorship', p.5, KP/UCL/11/9.

[12] Magnello, 'Non-Correlation', p.90.

[13] Pearson, 'To the Electors of the Savilian Professorship', p.4, KP/UCL/11/9.

[14] Karl Pearson, 'History of the Biometric and Galton Laboratories', 1920, KP/UCL/247.

[15] Karl Pearson, Frontispiece, Annals of Eugenics, 1 (1926).

[16] 'Report by Professor Karl Pearson, MA, FRS, on the Work Done Owing to the Grant made by the Worshipful Company of Drapers to the Department of Applied Mathematics, University of London, University College London (1903-9)', p.7, KP/UCL/233. See Magnello, 'Non-Correlation', p.86.

Street). However, when Galton died in 1911 he left the residue of his estate to the University of London for the establishment and endowment of a Galton Chair of Eugenics, and instructions for the post to be offered to Pearson 'on such conditions as [would] give him the liberty to continue his Biometric Laboratory'.[17] At this point Pearson surrendered the Chair of Applied Mathematics to one of his former students, L.N.G. Filon. The Biometric and Eugenics Laboratories were subsequently incorporated into a new Department of Applied Statistics - which was conceived of entirely as a postgraduate research institute for 'investigating by statistical methods, social, economic, eugenic and medical problems' - and in 1912 work began on the erection of a 'fine' new building to house the Department with the financial backing of Sir Henry Bartlett.[18] The Bartlett Building was taken over by the government and used as a hospital during the First World War, but in June 1919 Pearson and his colleagues took possession of a spacious, modern building, fully equipped for all aspects of biometric research and housing both the Drapers' Biometric Laboratory and Galton Eugenics Laboratory (see Figures 5.1-2).[19]

Although he established a fourth laboratory - dedicated to anthropometric research - in 1922,[20] the completion of the Bartlett Building marked the culmination of Pearson's thirty year quest to found a school of research in applied statistics, biometry and eugenics at UCL. And under his direction the school was enormously successful. According to Bernard Norton, the Department(s) of Applied Mathematics and Statistics at University College came to be recognised as the centre of the English school of applied statistics, attracting 'students later to achieve fame and posts of importance, and producing publications that were to effect

[17] 'Codicil to the Will of Sir Francis Galton', 25 May 1909, reproduced in Karl Pearson, The Life, Letters and Labours of Francis Galton: Volume IIIa Correlation, Personal Identification and Eugenics (Cambridge: Cambridge University Press, 1930), pp.437-8.

[18] 'Report by Professor Karl Pearson, FRS, on the Work Done in his Department during the Period of the Grant made by the Worshipful Company of Drapers, 1909-14', p.1, KP/UCL/233. Papers and correspondence relating to the reorganisation of the Department(s) of Applied Mathematics and Statistics in the aftermath of the Galton bequest can be found in KP/UCL/242.

[19] Pearson, 'Position of Galton Laboratory at the End of the War', 1919, KP/UCL/247. The design, organisation and equipment of the new building is discussed in Pearson's 'Report to the Court of the Worshipful Company of Drapers For the Years 1922, 1923, and 1924', 29 February 1924, KP/UCL/233. See also Magnello, 'Non-Correlation', pp.141-3.

[20] The aim of the Anthropometric Laboratory, which was established with the financial backing of one of Pearson's students, Ethel Elderton, was to collect physical, mental and physiological data from the students of the College. Magnello, 'Non-Correlation', p.87.

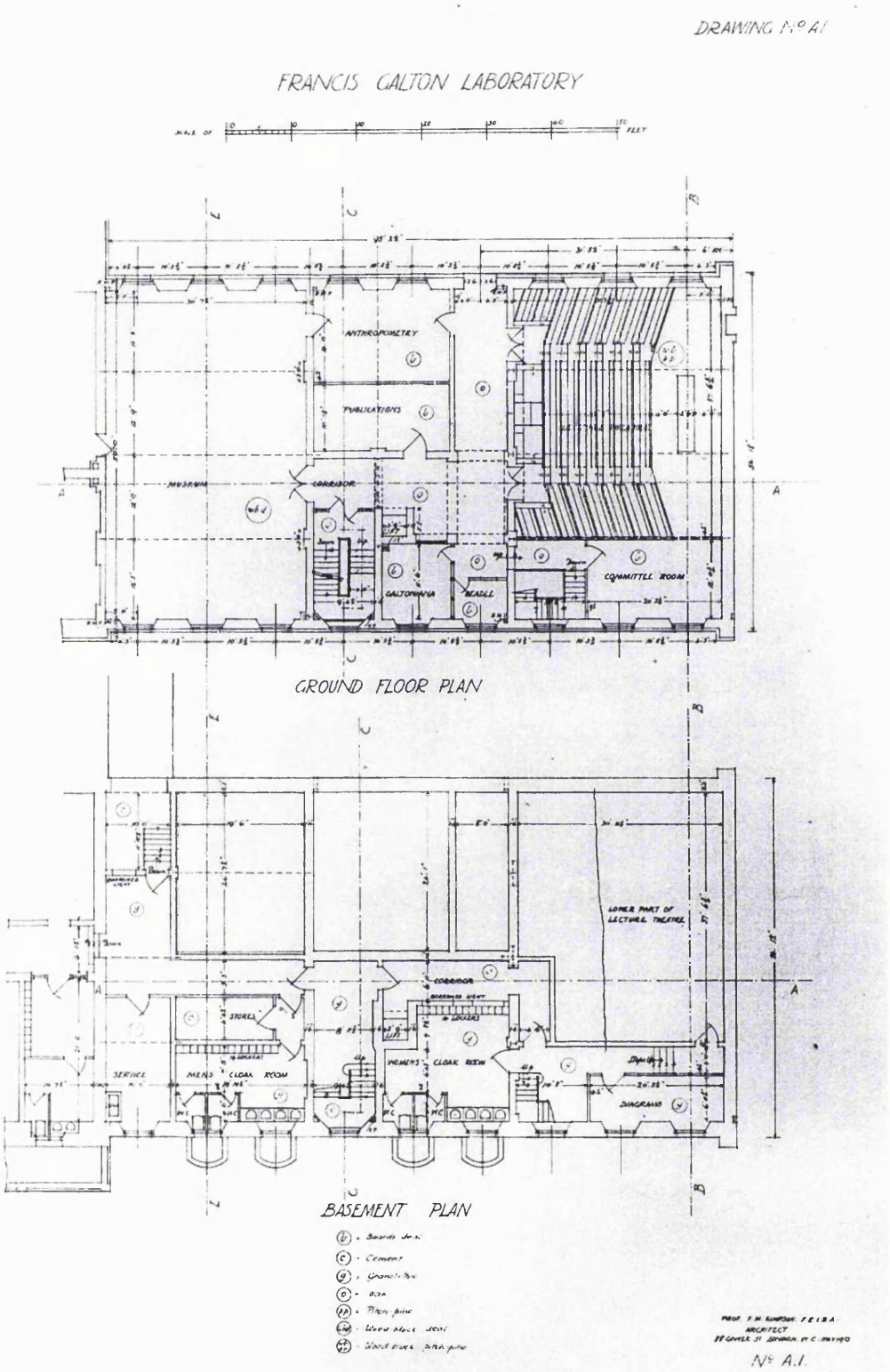

Figure 5.1 Architectural Plans of the Bartlett Building (Ground Floor and Basement) (1913)

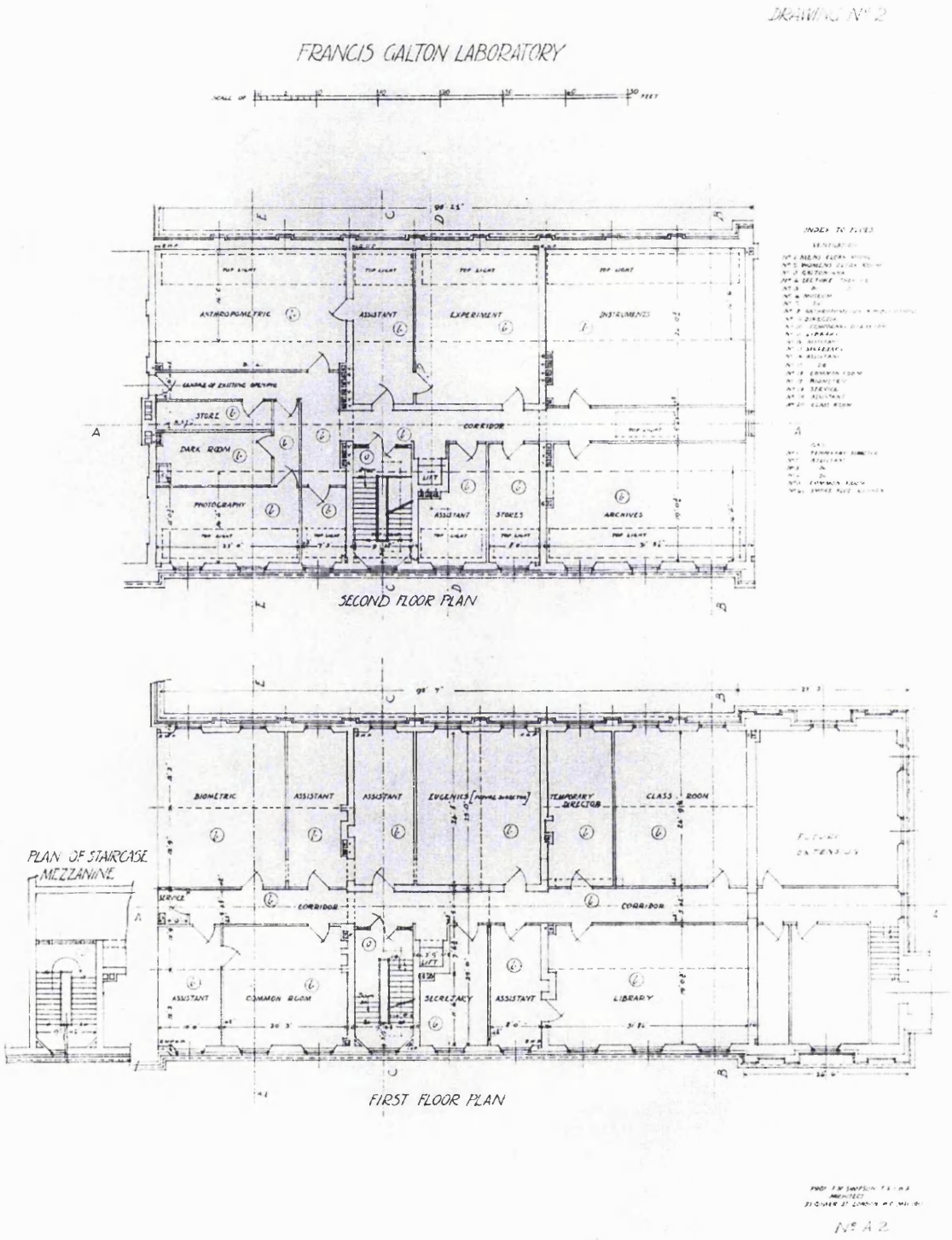

Figure 5.2 Architectural Plans of the Bartlett Building (First and Second Floors) (1913)

significantly the thought of biologists, psychologists, sociologists, and statisticians'. No fewer that 12 of the 26 leading members of the British statistical community in the period 1900-1914 were members of the biometric school, having close personal or institutional links with Pearson's laboratories,[21] and the Galton Laboratory was 'the sole British establishment for eugenic research, the principal source of authoritative eugenic science, [and] the scientific benchmark of all eugenic discussion in England in this period'.[22]

To a large extent the Astronomical and Anthropometric Laboratories were subsidiary to the Biometric Laboratory. They shared the same building space and some methodological techniques. But the Biometric and Eugenic Laboratories were entirely separate concerns. Writing in 1918, Pearson complained that there had been a 'misunderstanding of the relation between the two laboratories', stressing that when he took over the Eugenics Record Office 'it did not replace the Biometric Laboratory'. The work of the Eugenics Laboratory was 'confined to a very narrow field, having nothing to do with statistical theory or its general application to biology'.[23] Moreover, Eileen Magnello has recently demonstrated that:

> The work undertaken by Pearson and his assistants in the Biometric Laboratory was . . . very different from that in his Eugenics Laboratory. More than that, there was only a very small and practically negligible correlation in the methods of the Biometric and Eugenics Laboratories . . . . More importantly, there was, in every other respect, a complete lack of correlation in the laboratories on all points, including the principal methods, finances, personnel, architectural juxtaposition and the methodological style of the journals.[24]

However, most historians have assumed that there was an overall method and unifying approach in the two laboratories, and further that the work of the Biometric Laboratory grew out of Pearson's interest in eugenics.[25] This approach has both exaggerated the extent and significance of Pearson's commitment to eugenics, and, moreover, delayed recognition of his extraordinary achievement in founding successful schools of research in both biometry *and* eugenics at UCL in this period.

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[21] Norton, 'Karl Pearson and Statistics', p.5; Kevles, In the Name of Eugenics, p.38; Mackenzie, 'Statistical Theory and Social Interests', p.61.

[22] Kevles, In the Name of Eugenics, p.40.

[23] 'Report to the Court of the Worshipful Company of Drapers on the Present Position and Past History of the Laboratories to which their Annual Grant has been made', February 1918, p.3, KP/UCL/233.

[24] Magnello, 'Non-Correlation', pp.144-5.

[25] See, for example, Farrall, 'English Eugenics Movement'; Mackenzie, 'Statistical Theory and Social Interests'; Mackenzie, 'Pearson and the Professional Middle Class'; Mackenzie, Statistics in Britain; Norton, 'Biology and Philosophy', and Norton, 'Pearson and Statistics'.

William Ramsay and the Department of Chemistry

Chemistry was by far the most active research department at UCL in the period 1890-1914.[26] Approximately one-third of the postgraduate and research students who passed through the College between 1903 and 1914 were studying chemistry, and by 1910 the staff and postgraduate students based in the Department numbered more than 60. Almost 500 new books, journal articles and scientific memoirs were published by the staff and students of the Chemistry Department between 1890 and 1914, and this accounts for more than 30% of all the original papers and other publications that were produced within the College in this period.[27] During his tenure in the Chair of General and Inorganic Chemistry from 1887-1913, William Ramsay succeeded in establishing an internationally famous school of chemical research at UCL. In 1904 he was awarded the Nobel Prize for Chemistry for his discovery of five 'new' chemically inert gaseous elements - argon, helium, neon, krypton and xenon, which were found to be present in the atmosphere in minute quantities. This project involved the development of a revolutionary technique for dealing experimentally with gases and vapours in extremely small quantities, which was subsequently applied by Ramsay and his junior colleagues to a body of related problems, most notably to the study of radium and its emanation (radon), which led on in turn to pioneering work on atomic structure and disintegration, the 'transmutation' of elements, and the use of radium in the treatment of cancer.

On his death in 1916 Ramsay was widely acknowledged as the founder of a uniquely British school of chemistry.[28] This claim has been investigated by Katherine Watson in her doctoral thesis on 'Ramsay and the Chemical Community'. Watson argues that, perhaps uniquely, Ramsay's school was not built around a specific research programme or a theoretical concept, but around a particular set of techniques for dealing experimentally with gases and vapours in minute quantities. Her account focusses on a 'research group' made up of Ramsay and some of his junior colleagues and senior students who were united in the use of certain techniques

[26] See, for example, 'Report by Woods and Hill', pp.25-6, PRO/ED24/82A.
[27] Calendars 1890-1914; Reports 1891-1915. See below, Appendices 1-5.
[28] To note just one example, in his obituary tribute to Ramsay, Frederick Soddy, noted that 'It ha[d] been well remarked of Ramsay that he stood to the outside world for an essentially British school of chemistry'. Frederick Soddy, 'Sir William Ramsay, KCB, FRS', Nature, 97 (1916), 482-4, p.483.

of gas manipulation. Watson insists that only those students who worked closely with Ramsay, using these techniques, can be considered to have been members of his school.[29] She goes on to examine the careers of 14 of these students in some detail, noting their subsequent use of techniques that had been devised by Ramsay. Although his techniques of gas manipulation were sustained in the work of some of his students, many of his pupils went on to pursue research in fields unrelated to his work on gases and vapours, and even when their experiments did involve the handling of small quantities of gas, Ramsay's methods were eventually superseded. Watson therefore concludes that Ramsay was unable to create a widely extended research school of the type commonly associated with Liebig, and that his school at University College was ultimately 'short lived'.[30] However, when re-examined in the context of the history of UCL and the story of the emergence of the research university in this country, Ramsay's achievement appears to have been rather more significant. He succeeded in establishing a school of chemical research at UCL that survived his retirement in 1913 and death in 1916. Moreover, a remarkable number of his pupils went on to pursue successful academic careers, and through the example of his own Department, and his involvement in university politics at both a local and national level, Ramsay also played an important part in shaping the changing definition of the role and function of the College in this period.

Ramsay's predecessors in the Chemistry Chair at University College include Edward Turner (1828-37), Thomas Graham (1836-55) and A.W. Williamson (1849-87), all of whom had conducted research in their respective fields while at the College; and the Birkbeck Chemistry Laboratory at UCL, which was opened in January 1846, was arguably the first purpose-built chemistry teaching laboratory in Britain.[31] But according to his chief collaborator and biographer, by the time that

[29] Watson uses the term 'student' broadly, to describe all the members of Ramsay's school, including postgraduate students, graduates who remained at UCL after completing their degrees in order to carry on research which was not intended for a degree, post-doctoral research workers who were studying under Ramsay and acting as his research assistants, and junior members of staff, many of whom regarded themselves as his pupils or disciples. Watson, 'Aspects', pp.29-30.
[30] Ibid, pp.29-31, 54-73, 103-36.
[31] Harte and North, UCL, pp.60-1.

Ramsay arrived at UCL in the summer of 1887, 'the department was completely dead . . . as a research school'.[32] Williamson had 'abandoned research altogether' in the 1860s, and 'conditions were altogether inferior' to those which Ramsay had left behind at University College, Bristol. The Department consisted of a small, outdated and ill-equipped laboratory, housed in a long shed at basement level behind the North Wing of the College, a practical classroom, a library and '[s]ome rooms in the basement of the North Wing, filled with rubbish'.[33] Ramsay was provided with two assistants and a student demonstrator, but they had to be paid directly out of his own pocket. His salary, which initially totalled '£700 or thereabouts', was derived entirely from the fees paid by his students, and he was also personally responsible for providing all the materials, apparatus and equipment that he and his juniors used in the course of their teaching and research.[34] Moreover, his classes were dominated by medical students who were preparing for the Conjoint Board examinations, and a very large number of lectures had to be given each term, particularly since medical students, chemistry students and female students all had separate lecture courses. As a result, the same preliminary lectures had to be given three times a session, and the amount of time that Ramsay and his colleagues were able to devote to their researches was therefore extremely limited.[35]

The College Council's ambivalent attitude towards research during the early part of Ramsay's career at UCL is nicely illustrated by his chief assistant's account of the Committee of Management's reluctance to allow him access to the Chemistry

[32] Travers, 'Introduction to Volume VI', UCL/WR/6, p.v.

[33] Morris W.Travers, William Ramsay at UCL: 1852-1952 (London: University College London, 1952), p.2. Williamson appears never to have allowed anything to be thrown away, and Ramsay 'found in the laboratories the accumulated residues of forty years', including 'dozens of jars and bottles' and 'hundreds of paper packages covered with dust and without labels, all of which, amounting to several cart-loads, had to be examined and cleared away by the new professor'. William Augustus Tilden, Sir William Ramsay, KCB, FRS: Memorials of His Life and Work (London: Macmillan, 1918), p.105. On Williamson see J. Harris and W.H.Brock, 'From Giessen to Gower Street: Towards a Biography of A.W.Williamson (1824-1904)', Annals of Science, 31/2 (1974), 95-130.

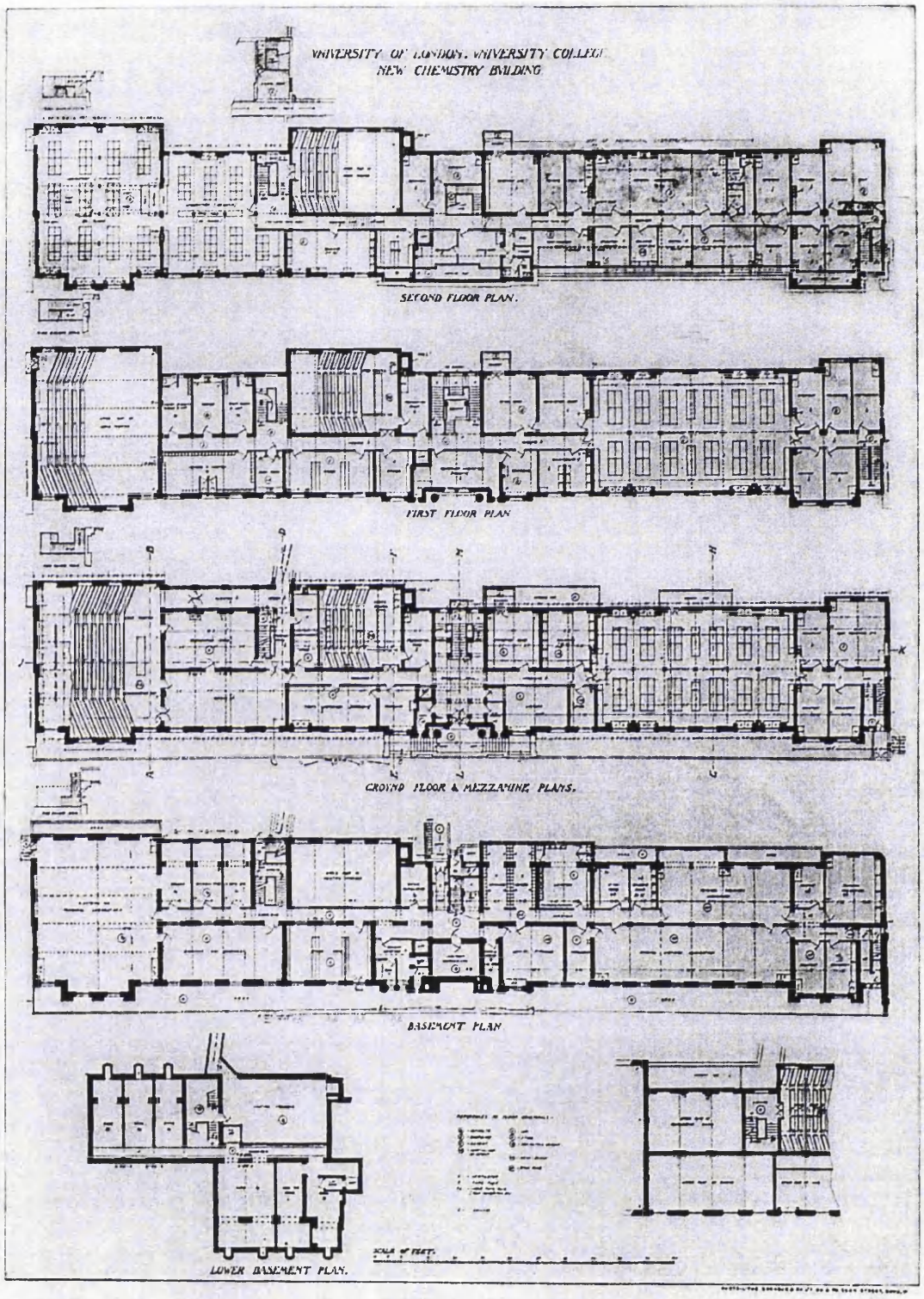
[34] By 1893 he had two assistants who were each paid £150 and a demonstrator who received £50, leaving him with £350 to subside his own research and support his wife and family. Travers, Life, p.84.

[35] Tilden, Ramsay, p.106.

Department after 5.00 p.m.. Morris Travers found himself locked out of the Department every evening because the Committee 'did not see why [he] should need to' return to the Laboratory having delivered his 4 o'clock lecture in the adjacent chemical theatre. Travers therefore had his own key cut, and when this was discovered he was summoned to appear before the Management Committee. At this point Ramsay intervened, assuring the Committee that Travers had legitimate reasons for wanting to spend his evenings in the Laboratory, and he subsequently received 'a polite note from the office informing [him] that [he] could have [his] key; the key made at [his] own expense, on payment of five shillings as a deposit'.[36]

Despite the attitude of the Council, Ramsay was nevertheless determined to establish a major school of chemical research at UCL, and he immediately set about reorganising the Department on 'research lines'. There are three key stages in the story of the growth and development of the school in this period. Between 1887 and 1894 Ramsay laid the foundations of a successful research school, assembling a talented team of postgraduate students and researchers and instigating a focussed programme of research in the field of gas chemistry. During the period 1894-1900 he and his colleagues carried out the ground breaking research on the gases of the atmosphere that made him famous, and consolidated the position and identity of his school. As a result, the Department began to attract postgraduate students from universities and colleges all over the world. Ramsay was also able to secure greater financial support and an institutional commitment to his enterprise, and the period 1900-1914 was therefore one of massive expansion. By the time of his retirement in 1913, Ramsay was the director of a flourishing research *department*, and his students and colleagues were about to move into an elaborate new building, housing advanced facilities for teaching and research in organic, inorganic, physical and pathological chemistry, spectroscopic work, spectrum analysis and mineralogical research, and 'all the minutiae that make for success in modern chemical research' (see Figure 5.3).[37]

[36] Travers, 'Account of Ramsay's Laboratory at University College London', UCL/WR/9/2, pp.4-5.
[37] Needs, pp.34-5. Correspondence and papers relating to the building and content of the new laboratories can be found in a box marked 'Dr.Tuck's Corr. on building of the new Chem. Labs 1911-16', UCL/CC.



Reprinted from "THE BUILDER" JANUARY 2, 1915.

Figure 5.3 Architectural Plans of the New Chemistry Laboratories (1914)

Ramsay was one of the most celebrated scientists of his day. He was knighted in 1902, honoured by the governments of France, Italy and Germany, and elected to the membership of most of the major European scientific societies and associations. As his personal fame and reputation increased, talented graduates flocked to UCL in order to apprentice themselves to Ramsay and 'learn the technique of modern gas work from its begetter and master' (see Table 5.1).[38] The staff of the Department grew steadily through the 1890s with the appointment of a series of assistants and demonstrators, and a more modern departmental structure began to emerge during the first decade of the twentieth century. A separate Professor of Organic Chemistry was appointed in 1902, and there were 11 full-time members of staff by 1907, and 18 by 1914 (see Graph 5.2 and Appendix 1). By 1903 there were 23 postgraduate and research students based in the Department; and there were more than 40 postgraduates studying chemistry at UCL by 1909 (see Graph 5.2 and Appendix 2).

Table 5.1 Postgraduate and Research Students in the Chemistry Department (1903-1914)

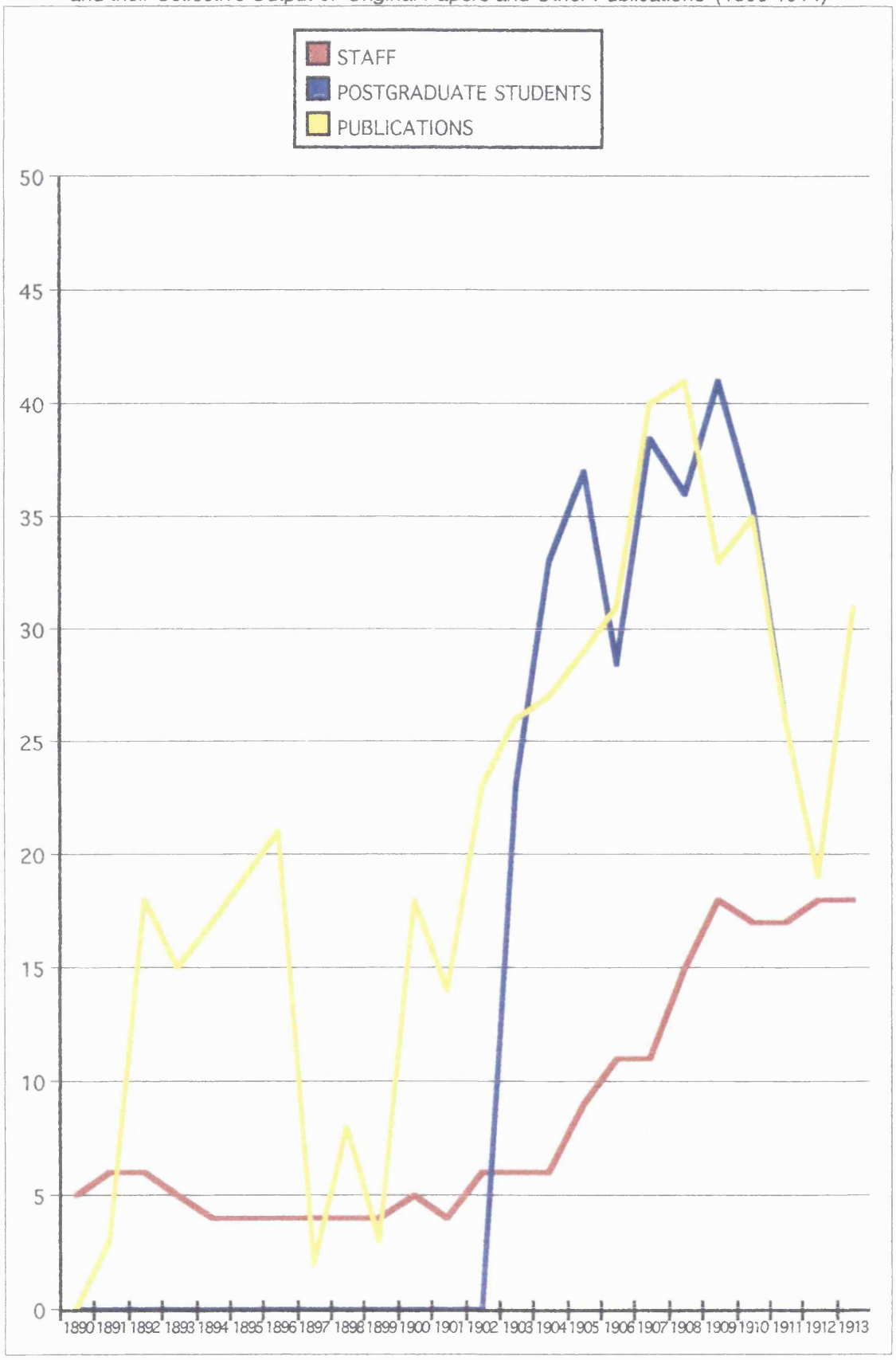
	Total	Female	Overseas
1903-04	23	3	6
1904-05	33	8	4
1905-06	7	8	5
1906-07	28.5	6	4
1907-08	38.5	7	7
1908-09	36	5.5	3
1909-10	41	9	3
1910-11	35.5	6	2
1911-12	26	1	6
1912-13	19	3	5
1913-14	31	2	5

(*Source:* University College London Calendars 1904-1914 (London: James Walton, 1903-1914)).[39]

[38] As one of his former students, Professor J.Irvine Masson, explained in a letter to Travers, 20 March 1946, UCL/WR/16/1, p.48. The first overseas students had actually arrived in the 1860s, Williamson playing host to a group of Japanese students who risked their lives by committing the capital offence of visiting a foreign country in order to study under him in London (Harris and Brock, 'From Giessen to Gower Street', pp.122-6), but, according to Travers, overseas students did not begin to arrive in significant numbers until about 1893 (Travers, Life, p.93).

[39] The fractional numbers refer to students who were jointly registered in one (or more) department of the College, or were reading for joint degrees.

Graph 5.2 Staff and Postgraduate Students of the Department of Chemistry and their Collective Output of 'Original Papers and Other Publications' (1890-1914)



Source: University College London Calendars 1890-1914 (London: James Walton, 1903-1914); University College London Annual Reports 1891-1915 (London: UCL, 1901-1915).

Several of these students held the most prestigious scientific scholarships available. For example, John Inglis, Richard Moore, Irvine Masson, Bertram Steele and John Shields were all 1851 Exhibition Scholars, and their decision to study under Ramsay is therefore highly significant, providing further evidence of the drawing power of his scientific reputation. Shields was actually the very first person to receive an 1851 Exhibition Research Scholarship. He spent the first year of the award with Ostwald in Leipzig and Arrhenius in Stockholm, and the second with Ramsay in London. Working with Ramsay was therefore seen as a desirable step in the pursuit of a career as an academic scientist, and the experience gained in his laboratory was generally accepted as being of the highest possible standard.[40] It is also interesting to note that a significant number of these students were women (see Table 5.1). Although Ramsay was not a political radical like Pearson, he did believe in offering equal opportunities to male and female students. However, he was principally driven by practical concerns and considerations. For example, at the end of his first session at the College he took the revolutionary step of admitting women to the same lectures as men, in order to reduce the amount of teaching and maximise the amount of time that he and his junior colleagues were able to devote to research.[41]

These students - male and female -were trained by Ramsay and his assistants, encouraged to conduct their own experiments and original investigations, and given the opportunity to publish the results, under their own names and at a relatively early stage in their careers. The result was an enormous output of new books and journal articles from the Department each year. The number of original papers and scientific memoirs that were produced and published by the staff and students of the Department fluctuated wildly, but grew steadily, throughout our period, dwarfing the output of every other department of the College (see Graph 5.2 and Appendix 5). Moreover, a significant number of Ramsay's pupils went on to become successful chemists in their own right (see Table 5.2). Ten of the fourteen individuals identified by Watson as being the leading members of the school were awarded doctoral degrees, either in London or Germany, and nine of them went on to become fellows of the Royal Society. By 1906 Ramsay's

[40] Watson, 'Aspects', p.54.
[41] Tilden, Ramsay, p.106.

students occupied eight of the 30 chemistry chairs then available in British universities and colleges,[42] and in his obituary tribute to his great friend and mentor, Norman Collie could claim with some justification:

> Ramsay's teaching has gone out into many lands, and . . . his students . . . now occupy every kind of responsible position, works managers, research chemists, analytical chemists, professors, lecturers, and teachers, and a good portion of their success is due to the teaching and undefinable scientific influence of Sir William Ramsay.[43]

Table 5.2 Career Patterns of a Select Group of Ramsay's Students

E.C.C.Baly	Grant Professor of Inorganic Chemistry, University of Liverpool, 1910-37.
F.G.Donnan	Professor of Physical Chemistry, University of Liverpool, 1904-13; Professor of General Chemistry, University College London, 1913-37.
A.C.G.Egerton	Instructor, Royal Military Academy, Woolwich,1909-13; Ministry of Munitions,1914-19; Reader in Thermodynamics, Oxford,1919-36; Professor of Chemical Technology, Imperial College London, 1936-52.
J.K.H.Inglis	Professor of Chemistry, University College, Reading, 1907-11; Professor of Chemistry in the University of Otago, New Zealand,1912-35.
J.I.O.Masson	Professor of Chemistry, University of Durham, 1924-38; Vice-Chancellor of the University of Sheffield from 1938-52.
R.B.Moore	Department of Chemistry, University of Missouri,1897-1905, Professor of Chemistry, Butler College, 1905-11; U.S. Bureau of Mines,1912-23, Head of the Department of Chemistry, Purdue University,1926-31.
E.P.Perman	Lecturer in Chemistry, University College, Cardiff, 1892-1904; Assistant Professor of Chemistry, University College, Cardiff, 1904-32.
J.Shields	Brunner, Mond and Co., 1893-8; Technical Adviser, Scottish Cyanide Co.,1898-1901; Chemical Engineer, Rio Tinto Co., 1903-19.
R.B.Steele	Assistant Professor of Chemistry, Herriot-Watt College,1903-6; Senior Lecturer in Chemistry,University of Melbourne, 1906-10; Professor of Chemistry, University of Queensland, 1910-31.
M.W.Travers	Professor of Chemistry, University College, Bristol, 1904-6; Director of the Indian Institute of Science, 1906-14;glass making industry, 1914-27; Honorary Professor of Chemistry, University College, Bristol, 1927-37.
J.Walker	Professor of Chemistry, University College, Dundee,1894-1908; Professor of Chemistry, University of Edinburgh,1908-28.
H.E.Watson	Assistant Professor of Chemistry, Indian Institute of Science,1911-16, Professor of Inorganic and Physical Chemistry, Indian Institute of Science, 1916-34; Professor of Chemical Engineering, University College London, 1934-51.
R.Whytlaw -Gray	Science Master, Eton, 1914-23; Professor of Inorganic Chemistry, University of Leeds,1923-45, Emeritus Professor of Chemistry, 1945-51.

(*Source:* Katherine D. Watson, 'Aspects of a Career in Science: Sir William Ramsay and the Chemical Community, 1890-1915' (Unpublished D. Phil. Thesis, Oxford, 1994), pp. 44-5).

[42] Watson, 'Aspects', pp.32-43.

[43] J.N.Collie, 'Obituary Notice of Sir William Ramsay, 1852-1916', Proceedings of the Royal Society, 93 (1917), xli-liv.

Albert Frederick Pollard and the Department of History

According to Hugh Hale Bellot's centenary history of University College London, the remarkable growth of the Faculty of Arts was 'one of the most striking developments' of the early years of the twentieth century.[44] This was nowhere more apparent than in the Department of History, which was revolutionised by the arrival of Albert Frederick Pollard in 1903. Under Pollard's direction, as Professor of Constitutional History from 1903 -1908, Professor of English History from 1908 to 1927, and Professor of Constitutional History from 1927-1931, the History Department at UCL became one of the leading schools of historical research in the country. Pollard was, moreover, also the chief architect and first director of the Institute of Historical Research, which was established in Malet Street in 1921 as a 'laboratory in which students [were] trained in the methods of historical research and the use of archives', and an unofficial 'headquarters and a refuge' for the many historians who were drawn to London and its various archives from universities and colleges all over Britain and, indeed the world.[45]

However, when Pollard first arrived at UCL in 1903 'there was no such thing as a school of history' at University College, nor indeed anywhere else in London. Until as late as 1901 there was only one full-time member of staff in the History Department at UCL, and no new books or journal articles were published by its staff and students between 1890 and 1905. The prevailing attitude towards history - and historical research in particular - may be illustrated by looking briefly at some of Pollard's predecessors in what became the History Department at University College. Although 'History, Ancient and Modern' was listed among the 'various branches of knowledge which [we]re to be taught in the University of London' in the original prospectus produced by the Council in 1827,[46] history was not among the subjects on offer when the first students began to arrive in October 1828. The first Professor of History, Benjamin Heath Malkin, a 61 year old headmaster, was not appointed until December 1829, and he was a 'disaster' according to Negley Harte.[47]

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[44] Bellot, UCL, p.405.

[45] Pamphlet published in 1921 explaining the layout of the first Institute building, reproduced in Debra J.Birch and Joyce M.Horn, The History Laboratory: The Institute of Historical Research 1921-96 (London: University of London Institute of Historical Research, 1996), p.13.

[46] Statement by the Council (1827), pp.10-11.

[47] Harte, History Teaching at UCL, pp.1-2.

Malkin resigned his post within seven weeks of taking it up in March 1830, and the Chair remained vacant until 1834. Over the next 70 years a disparate group of semi-professional historians, lawyers and 'miscellaneous writers' occupied the Chair, and struggled, with varying degrees of enthusiasm and success, to keep the study of history 'barely alive'.[48] For example, E.S. Creasy who presided over the Department for more than 20 years between 1839 and 1860, continued to practice law throughout his time at UCL, actively trying to keep student numbers down by lecturing at 8.00 a.m. before settling down to his legal day.[49] His successor, E.S. Beesly, did little more, contenting himself with 'appearing in College once or twice a week to deliver his lectures and walking away', leaving the subject just 'as he had found it, one of little importance'.[50] Tellingly, Beesly's chief rival for the post, George Harris, failed to secure the Chair specifically because of the emphasis that he had placed on research in his letter of application - the appointing committee concluding that the '*moral* side of History might . . . be neglected by him for mere *archaeology*, and special, fragmentary, new facts might receive with him an undue importance':

> Even in his letter of application, we are rather repelled than enticed by his proposal to 'make lectures interesting by illustrating them from new researches into original MSS' and to 'make them available for turning attention to the vast stores, public and private' of this nature which exist.[51]

The government inspectors who visited UCL in 1901 were extremely critical of the History Department, which they insisted was 'by no means in a flourishing state'. Beesly had been succeeded by F.C. Montague in 1893, and although the inspectors reported that the standard of teaching was generally high, they also noted that student numbers were very low and concluded that 'a system under which all lectures on history [we]re delivered on one day in the week [could] not be considered satisfactory'.[52] A year later, when the College Council issued its 'Appeal for the Endowment of Advanced Education and Research', they conceded that 'in Modern History very little ha[d] been done', but insisted that their aim was to 'create a great history school in London'.[53] However, Pollard's appointment and the creation

[48] Bellot, UCL, p.253.
[49] Harte, History Teaching at UCL, pp.6-9.
[50] Bellot, UCL, p.333.
[51] 'Report of the Committee of the Senate concerning the vacancy in the Historical Professorship', June 1860, AM/86 f.8.
[52] 'Report by Woods and Hill', 31 December 1901, p.23, PRO/ED24/82A.
[53] Needs, p.24.

of a new Chair of Constitutional History in 1903 did not mark a significant shift in the Council's attitude. He was one of two applicants for the post of Professor of Constitutional Law and History. The members of the appointing committee were equally impressed with both candidates, and therefore decided to appoint the eminent legal historian, Sir William Holdsworth, to the Chair of Constitutional Law and Pollard to a Chair of Constitutional History, reasoning that since there was no stipend it would 'cost the College no more to have two chairs than one'.[54] At this point there were no endowed chairs of history at UCL, nor anywhere else in London. There were no research fellowships or scholarships to attract students, and few students to be attracted. There were no postgraduate students based in the Department prior to 1903, and as one of Pollard's most eminent pupils, C.H. Williams, recalls, the undergraduates were not exactly 'troubling the College authorities with any difficulties of accommodation'.[55] A separate examination in History for the London B.A. had been introduced in 1896, but there had only been 16 successful candidates by 1903, of whom only two had been registered at UCL.[56]

Pollard was, nevertheless, determined to establish a major postgraduate school of historical research - an 'historical laboratory' - in London.[57] In his inaugural lecture on *The University of London and the Study of History*, which was delivered at the College in October 1904, Pollard outlined an ambitious plan for the reorganisation and revitalisation of history teaching within the University, and for the establishment of a postgraduate school of historical research. He began by conceding that the school was 'not in a healthy condition', and describing modern history as the 'Cinderella . . . of London University', awaiting the 'advent of some fairy prince to raise it to [its] proper station in life', and went on to consider the various obstacles that stood in the way of anyone seeking to establish a history school in London.[58] However, although the conditions under which Pollard set about founding

[54] Abstracts of Council Minutes Volume VII 1900-06, 29 June 1903, Item 184, and 6 July 1903, Item 200. The 'accidental origins' of Pollard's Chair are discussed in more detail in A.F.Pollard, 'The University of London and the Study of History', in Factors in Modern History (Third Edition) (London: Constable and Company, 1932), p.viii.

[55] Williams, 'Pollard', p.1.

[56] Pollard, Factors, pp.v-vi, 235-8. The first UCL honours graduate in history - C.H.Lockitt - got a third in 1896.

[57] Ibid, pp.234-54; Kenyon, History Men, p.205.

[58] Ibid, pp.234-7.

his school 'were on the surface not prepossessing', London enjoyed a monopoly of advantages which no other city in the Empire could boast. Perhaps most importantly, anyone who aspired to serious archival research in the field of modern history was compelled to report to London because the 'vast bulk of materials on which they must base their work' was housed in the Record Office and the British Museum, and in the capital's various other museums and repositories. Here was 'a void clamouring to be filled', Pollard insisted, 'herein [lay] the unique opportunity for a post-graduate school of research in London University'.[59]

Casting himself in the role of fairy tale prince, Pollard therefore laid out a detailed scheme for the establishment of a major school of historical research in London. His plan involved creating a demand for historical scholarship in the capital, laying the foundations of an undergraduate school at UCL, and building upon it an intercollegiate postgraduate research school with close links with the capital's various archives, repositories and museums.[60] Pollard realised that it would be impossible to build a 'purely postgraduate school' without extensive endowments. Moreover, since he was entirely dependent on the fees paid by his students, 'who were few and far between', his own need for 'bodily sustenance' compelled him to 'cast a wide net of teaching or he would get a small catch of fees'. He therefore resolved, in the short term, 'to make tentative advances' towards the achievement of his wider goals by beginning with more general forms of historical education, and attracting students whose numbers and fees might eventually form the basis of a research school:

> It was not till History had been made a popular subject with undergraduates and had thus attracted the notice of educational authorities, that any organisation for research could be superimposed.

His first task was to popularise history as a subject of undergraduate study, both within the College and University, and also 'in the schools which provided London with most of its students and drew from it most of their teachers'.[61] On the suggestion of Robert Blair, the Education Officer of the London County Council, he therefore instituted a course of evening lectures in history for school teachers in the Autumn of 1905. These lectures, which were delivered at UCL, were designed to keep school teachers in touch with recent advances in historical scholarship and instruction,

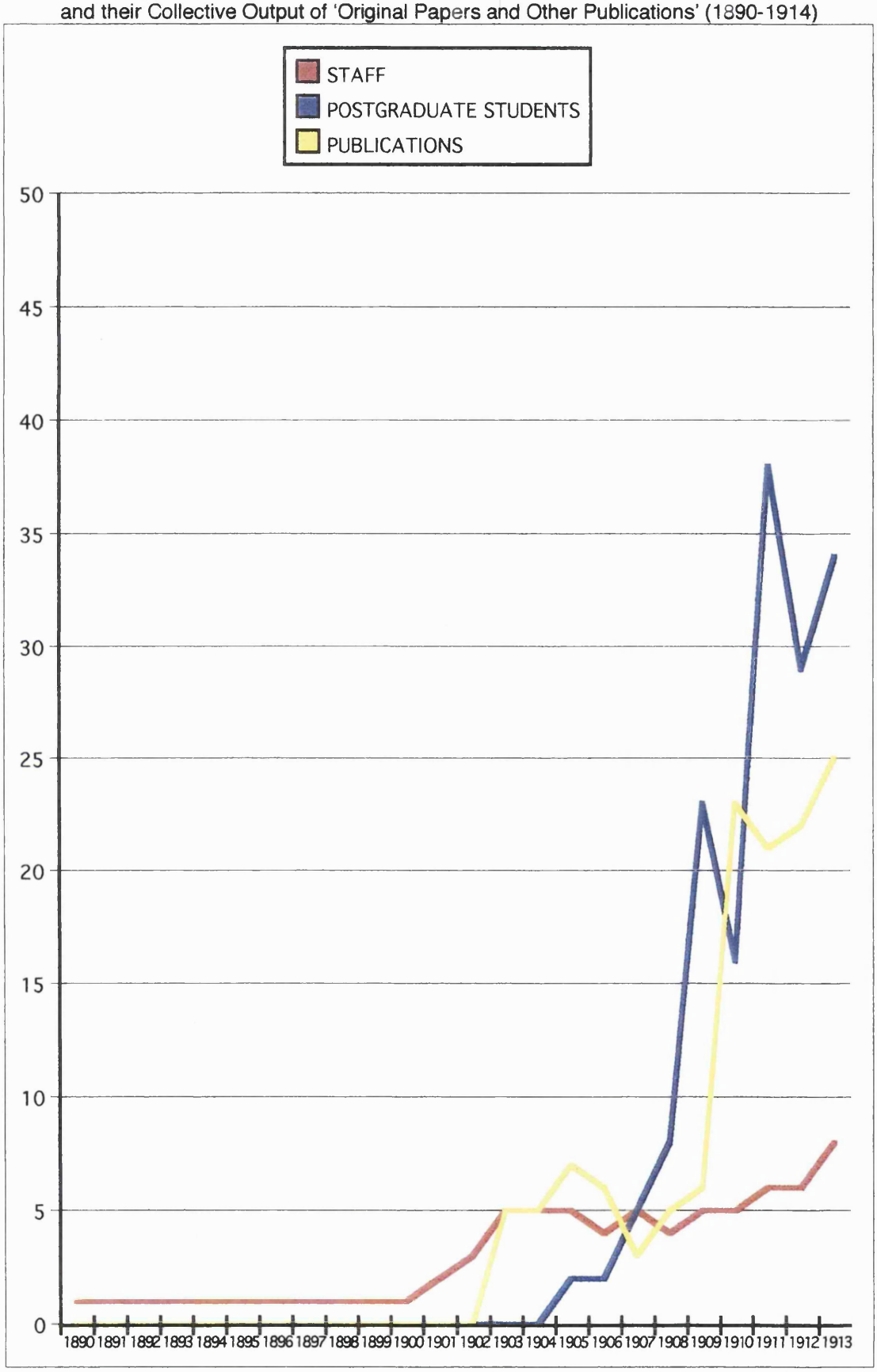
[59] Pollard, Factors, pp.v, 236, 244-7.
[60] Ibid, pp.247-51, 257-60.
[61] Ibid, pp.vii-viii, 258.

in the hope that London teachers would be inspired to train their pupils as recruits for the new history school in the University of London. To this end Pollard also took a leading role in the foundation of the Historical Association, as a vehicle for forging closer links between school and university teachers of history, in 1906.[62] These occasional lectures revealed the existence of 'a latent demand for further historical education' in London, and in 1909 the LCC was persuaded to establish a permanent Evening School of History at UCL. The new school was structured around a three-year general course in ancient, mediaeval and modern history, followed by 'a year's more intensive study of the sources for English History on the seminar method'. The Evening School was designed as an experiment in historical education for adults, but its most important role was as a training school for school teachers. Students who attended with sufficient regularity over a four year period, passing exams at the end of each year and a final examination on aspects of the entire course, were awarded a diploma which came to be recognised by education authorities as evidence of a 'special qualification to teach history'.

Largely as a result of Pollard's tireless efforts and the success of the Evening School of History, there were 186 men and women reading for the London History B.A. by 1911.[63] Moreover, as Pollard had hoped, there was a concomitant rise in the number of postgraduates studying history in London. The number of postgraduate and research students based in the History Department at UCL rose sharply after 1908-09 (see Graph 5.3), and by 1913-14 there were 34 postgraduate historians at University College. In fact, there were more postgraduates studying history than chemistry or applied mathematics by the end of our period (see Appendix 2). More than half of these students were women (see Table 5.3). A significant proportion of the full-time staff of the Department were also female, including, for example, Eliza Jeffries Davis - Pollard's 'devoted dogsbody in many of his enterprises' - who was appointed Reader in London History in 1921.[64]

[62] Pollard served as President of the Association from 1912-15, and edited its periodical, *History*, for six years between 1916 and 1922.
[63] Pollard, Factors, pp.254-60.
[64] Harte, History at UCL, p.17.

Graph 5.3 Staff and Postgraduate Students of the Department of History and their Collective Output of 'Original Papers and Other Publications' (1890-1914)



Source: University College London Calendars 1890-1914 (London: James Walton, 1903-1914); University College London Annual Reports 1891-1915 (London: UCL, 1901-1915).

Pollard attached particular significance to attracting foreign students to the school, but few overseas students had joined the postgraduate population of the Department by 1914 (see Table 5.3).[65]

The great majority of the postgraduates based in the Department - approximately 80% of them according to Pollard - were part-time students. There were no research fellowships available at UCL in this period, and many students therefore had to earn 'the whole or part of their living as teachers, etc., or by paid research work'. Pollard was insistent that all students would be equally welcome - 'whether or no[t] they [we]re seeking degrees in our university' - and, as in the Department of Applied Mathematics, many of these students were volunteers who were not working for a University of London degree. Some of them were working towards higher degrees in other universities and inevitably found themselves drawn to London and its archives, but, as Davis explained, 'more often' they were 'volunteers' or interested amateurs, whose 'object at first [was] simply to increase

Table 5.3 Postgraduate and Research Students in the History Department (1903-1914)

	Total	Female	Overseas
1903-04	0	0	0
1904-05	0	0	0
1905-06	2	1	0
1906-07	2	1	0
1907-08	5	4	0
1908-09	8	5	0
1909-10	23	13	0
1910-11	16	11	0
1911-12	38	25	0
1912-13	29	19	0
1913-14	34	17.5	4

(*Source:* University College London Calendars 1904-1914 (London: James Walton, 1903-1914)).[66]

[65] Birch, History Laboratory, p.7.

[66] The fractional numbers refer to students who were jointly registered in one (or more) department of the College, or were reading for joint honours degrees. In this case, Frances G.Davenport was studying History and Egyptology during the 1913-14 session. Calendar 1914, p.603.

their historical equipment by the study of original sources . . . and, later, by such research as they [had] time for, to help as far as they [could] in advancing historical knowledge'.[67]

By 1912 there were 38 postgraduates based in the Department, three of whom were reading for doctorates and 12 for the London M.A.. Pollard therefore decided that it was 'impossible on practical grounds, and undesirable on academic grounds, that [he] should continue the attempt to supervise in detail the work of all these students in every branch of modern history', and 'propose[d] therefore, while retaining a general supervision of all the postgraduate students of Modern History in the College, to allocate certain periods gradually to Dr. Reid and others'.[68] This was possible because the academic staff of the Department had also grown steadily over the previous decade (see Graph 5.3). An Assistantship in Ancient History had been established in 1902; Pollard arrived in 1903, and Max Caspari was appointed Reader in Ancient History in 1908. An Assistant in English History - Dr. Rachel Reid - was appointed in 1909, and another in 1911; and in 1913 a third chair - in Modern French History - was established jointly with the London School of Economics. A second Assistantship in Ancient History was established in 1913, and a year later A.P. Newton was appointed Lecturer in American and Colonial History.[69] Under the supervision of Pollard and his colleagues, the postgraduate and research students based in the Department were trained in the methods of professional historical investigation and encouraged to undertake their own archival researches. They were given the opportunity to discuss their progress in regular 'seminars', and encouraged to publish their work (under their own names and at a relatively early stage in their careers).

It was thus that the number of original papers and other publications emanating from within the Department began to rise sharply from about 1910 onwards (see Graph 5.3). Although no publications emerged from the Department at all between 1890 and 1903, 128 books and journal articles were produced and

[67] E.J.D. [Eliza Jeffries Davis], 'University of London. Memorandum of Some Existing Arrangements for a Two-Year Course of Training in Historical Research', June 1918, pp.2-3, LU/AFP/33.
[68] Letter from Pollard to the Provost, undated but headed 'Department of English History and Evening School of History', c.1911-12, p.3, LU/AFP/33.
[69] Harte, History at UCL, pp.16-17.

published by its staff and students between 1905 and 1914, making History one of the most productive departments in the College by the end of our period (see Appendix 5).[70] However, although a number of notable historians passed through Pollard's school, John Kenyon has argued that he 'left no school of historians behind him' and '[i]n the end . . . left a solitary heir' - J.E. Neale - who was a postgraduate student at UCL before the war, returning to the College as Pollard's assistant in 1918, and eventually succeeding him as Professor of Constitutional History in 1927.[71] However, there is some evidence to suggest that Pollard used his personal influence and the growing reputation and prestige of his school to try to advance the careers of some of his pupils. For example, in February 1914 he supported Eliza Jeffries Davis's application for the Lady Carlisle Research Fellowship at Somerville College, Oxford,[72] and in 1924 he nominated her as a Fellow of the Royal Historical Society.[73] Another of his pupils, Charles H. Williams, was Professor of History at Kings College London from 1945 to 1963, and (as we have already seen) Davis, who had been a research student at the College in the early 1900s, went on to teach at the Evening School of History and eventually to become Reader in the History of London in 1921. Moreover, as the principal founder and first director of the Institute of Historical Research, Pollard exerted a profound, if largely indirect, influence over the careers of countless young historians in this period, and it is also significant that the seminar system eventually became the dominant mode of historical education in university history departments throughout Britain.

By 1914 it was already clear to Pollard that the University could not do justice to itself and to London's unrivalled opportunities as a centre for historical research so long as it acted 'not as a unit but on the centrifugal principle of individualistic and competitive enterprise':

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[70] The work produced by Pollard and his colleagues in this period generally appeared in the *English Historical Review* or *American Historical Review*. However, in 1922 the IHR launched its own journal, the *Bulletin of the Institute of Historical Research*, and in April 1924 the Historical Association acquired the derelict periodical, *History*, and it was relaunched under Pollard's direction.

[71] Kenyon, History Men, p.215.

[72] E.Jeffries Davis to the Council of Somerville College, Oxford, 27 February 1914, Folder marked '6-9', containing prospectuses, memoranda and correspondence relating to the Evening School of History, c.1911-19, LU/AFP/33.

[73] Eliza Jeffries Davis, 'Form of Application to the Fellowship of the Royal Historical Society', February 1924, included among the membership records of the Royal Historical Society in the offices of the Society at University College London.

> Room, equipment, and expert guidance over the many fields of historical investigation could not be reduplicated in all the various colleges concerned in historical teaching; governments, learned societies, and private donors could not be expected to lavish gifts on half a dozen or a dozen rival applicants; neither men nor matter could gravitate towards a centre until there was a centre of gravitation.[74]

Ultimately, Pollard's aims could only be achieved on a University basis, and Neale has argued that the 'logical outcome of his lecture of 1904 was the establishment of the Institute of Historical Research in 1921.[75] By 1918 the accommodation for history students at UCL was 'hopelessly inadequate both for teachers and for students',[76] and at the beginning of 1920 Pollard therefore launched an appeal to raise the necessary funds for the erection and equipment of a University of London 'centre for Advanced Historical Studies'.[77] Within a year £24,000 had been raised. The bulk of the funds for the project came from private sources, principally from Pollard's neighbour, the export merchant and public benefactor, John Cecil Power. Thanks to his munificence, work began later that year on the erection of a new building to house the Institute behind the British Museum in Malet Street, and the London University Institute of Historical Research was formally opened on 8 July 1921.

The IHR was primarily conceived of as a training school for London University history graduates, but also as a meeting place for the students and teachers who were drawn to London and its various repositories and museums from universities and colleges all over the world. It contained seminar libraries for teaching and research in English, European, Dutch, French, Russian, Balkan, Colonial, Naval and London history. There was a separate room for palaeography, and a site had been set aside for an extension for American history (See Figure 5.4). Pollard also envisaged the creation of an adequate working library of source materials and the collection, classification and preservation of *corrigenda* for the *Dictionary of National Biography* and *New English Dictionary*. *The Bulletin of the Institute of Historical Research* was launched in 1922 as a medium for publishing the work of the

[74] Pollard, Factors, p.266.
[75] J.E.Neale, 'Albert Frederick Pollard', English Historical Review, LXIV (1949), 198-205, p.202.
[76] 'University of London. University College. Meeting of Committee of Arts Members of the Professorial Board on December 11th [1918] at 2 p.m. to consider the appended Reports relating to the accommodation for the Arts Departments', 6 December 1918, p.7, LU/AFP/33.
[77] Birch, History Laboratory, p.7.

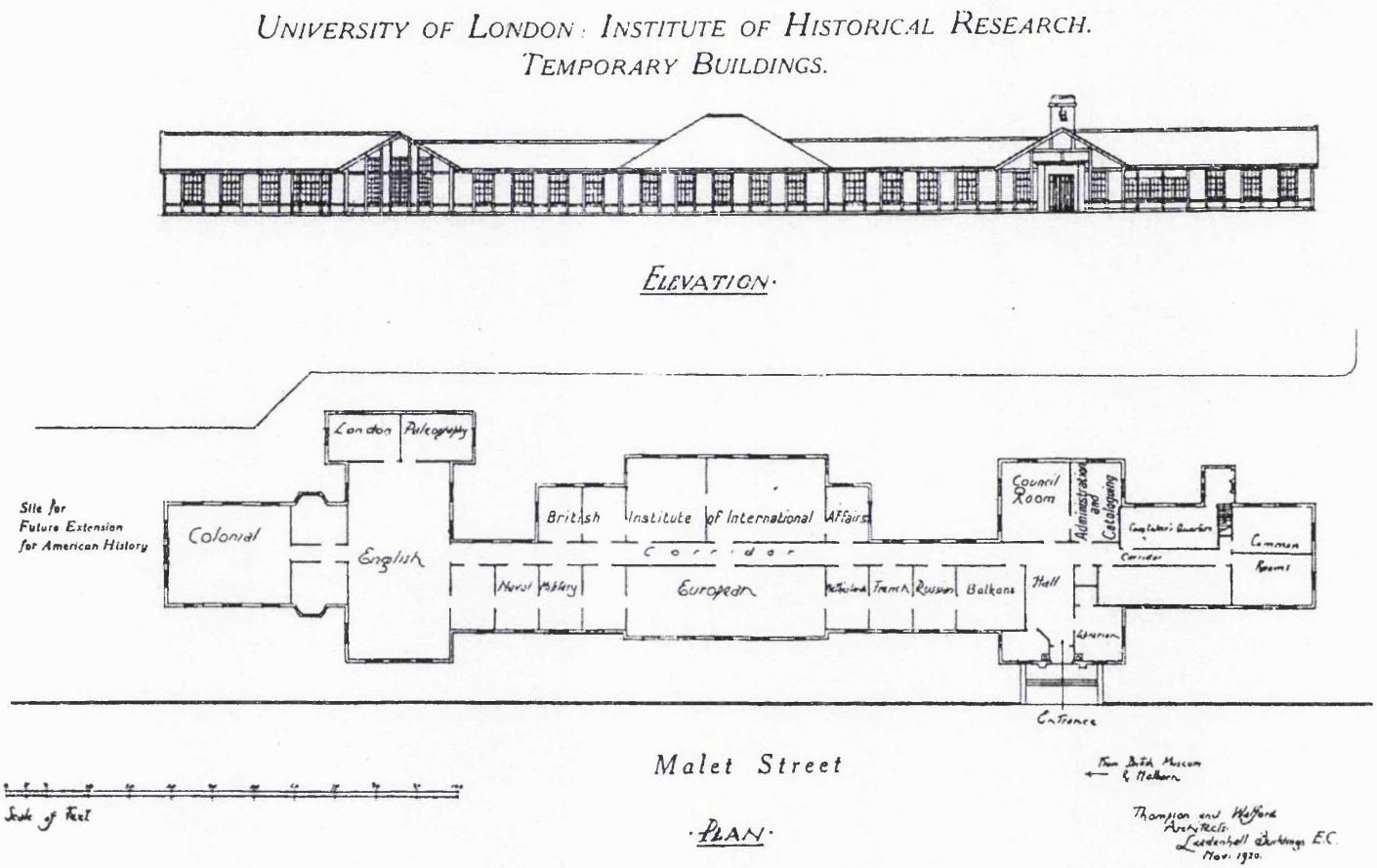

Figure 5.4 Architects' Elevation of and Plan of the Institute of Historical Research (1920)

members of the Institute, and for dealing with various problems connected with the materials and techniques of historical research, and the Institute later assumed responsibility for the completion of the *Victoria County History.* Writing in 1924, Pollard summarised the aims and objectives of the IHR as follows:

> The Institute aims at providing a comprehensive guide to historical knowledge, means of testing its value, and a method of training students to use them. Its Bulletin is devoted less to the product than to the technique of historical research, and the 'very pulse of the machine' beats with the hope of fostering a corporate spirit of research and a common tradition of art beyond the compass of one man's achievement.[78]

The opening of the Institute marked the culmination of Pollard's twenty year quest to establish a school of historical research in London, and under his direction from 1921-31 it was enormously successful. Writing in 1926, Pollard could already report:

> Historical consolidation . . . soon produced its natural effect . . . and the Institute of Historical Research became at once a centre of attraction unrivalled in any other sphere of university research. Not only did the British Government present it with collections it had refused to colleges, but every Dominion in the Empire, the Government of the United States, and many in Europe followed suit . . . . Other universities and university colleges, in the British Empire and in foreign countries, entered into arrangements by which their students might avail themselves of its facilities and guidance. The League of Nations sought its assistance for the higher purposes of intellectual co-operation . . . . [and] [v]isitors and students from all the chief countries of the world [came] to study its organisation, methods and equipment.[79]

The IHR stands as a lasting monument to Pollard's vision, determination and hard work, but it should not be forgotten that he is also the single most important figure in the history of the History Department at UCL.[80] From inauspicious beginnings, Pollard had succeeded in establishing a flourishing school of historical research at University College by the end of our period, largely, as John Kenyon explains, 'by his own unaided efforts'. This was 'a near incredible achievement', according to Kenyon, which 'displayed gifts of organisation, a capacity for political manoeuvre, powers of leadership and boldness which have taken other men to the leadership of great nations'.[81]

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[78] Pollard, Factors, p.273.
[79] Ibid, p.268.
[80] Harte, History Teaching at UCL, p.13.
[81] Kenyon, History Men, p.205.

Explaining the Growth and Development of the Three Schools

By 1914 there were therefore flourishing schools of research in the fields of applied mathematics and statistics, chemistry and history at University College London. But how does one explain the growth, development and success of these three schools, and what light do these case-studies shed on the origins and development of the modern conception of the College as a place of teaching and research? Kenyon's work on Pollard highlights the significance of the role played by the individual members of staff who presided over these 'research departments'. Ramsay, Pearson and Pollard all managed to pursue successful research careers during the last decade of the nineteenth century and early years of the twentieth century, while also finding time to train their students in the methods of research, and simultaneously involving themselves in the politics and administration of the College and University of London in order to secure the necessary financial and institutional support for their work. However, as Jack Morrell explains in his seminal essay on the research schools of Thomas Thompson and Justus Von Liebig, a complex web of personal, intellectual, institutional and financial factors underlay the emergence and development of a successful research school in this period.

According to Morrell, the 'ideal' research school requires an informal institutional setting and a charismatic leader or director, with an established (but usually not spectacular) research reputation, whose 'intellectual function was to offer and supervise a programme of work, too large for he himself to accomplish unaided, which his students implemented'. The director must conceive, and his school sustain, a focussed research programme, in which a distinctive approach is brought to bear upon a sharply delimited problem within a broader field, often a new or growing one. Generally, success is more likely if a set of simple, reliable and rapidly exploitable techniques, which can be steadily applied by both brilliant and ordinary students to the solution of significant problems in a new or growing field of inquiry, are devised and employed within the school, thereby enabling new recruits to make an easy transition from learning to independent research. The routine application of such techniques allows the systematic occupation and colonisation of particular areas of research, which may come to be recognised as the 'intellectual property' of the school. Moreover, if these techniques can be successfully applied to a body of related problems then the 'specific identity and reputation' of the school is

consolidated. A successful research school therefore also requires a readily available pool of motivated and talented potential recruits, who are 'keen to apprentice themselves to a recognized or emerging master of his subject', and depends upon the director's ability to inspire loyalty, social cohesion and *esprit de corps* among his students. To this end, the director of the school should control, or at least have access to, reputable outlets of publication, and should encourage his students to publish their work, under their own names, as early as possible in their careers. Finally, in order to achieve sustained success, the director must have sufficient power in the local and national setting to secure adequate financial support and an institutional commitment to his enterprise, and also 'placement power' within his discipline, so that he can facilitate the future employment of his students in 'a propitious academic setting, thereby extending the reputation and influence of his school'.[82]

The following chapters therefore examine the growth and development of the Departments of Applied Mathematics and Statistics, Chemistry and History in the period 1890-1914, focussing in particular on the organisation and ethos of the three schools, the 'intellectual property' of Ramsay, Pearson, Pollard and their pupils, and the institutional and financial context of teaching and research at UCL in this period.

[82] Morrell, ' Chemist Breeders', pp. 3-7. See also Geison, 'Scientific Change', especially pp.21-7.

6. Organisation and Ethos

[T]he chief object of an enthusiastic teacher . . . [is to] infuse into his pupils a love of the subject which both are at the same time teaching and learning . . . . there should be an atmosphere of the subject surrounding them - an umbra - [or] perhaps . . . an aura . . . . The object of both classes of students (for I count the teacher as student) should be to do their best to increase knowledge of the subject on which they are engaged.

William Ramsay, 1903.[1]

According to the Morrellian model, the most successful research schools are characterised by a very specific pattern of social organisation and intellectual interaction.[2] A research school is not simply a place where teaching and research happen to be conducted alongside each other. The pedagogical and research functions of a successful school are inextricably linked; so closely related, in fact, that 'the one informs the other'.[3] The best schools are characterised by a genuine *culture* of teaching and research, which Morrell insists is almost entirely dependent upon the personal 'charisma' of the director of the school, and his (or her) ability to inspire social cohesion, *espirit de corps* and an 'almost fanatical devotion to research' among his students and junior colleagues:

> Though the notion of 'charisma' has been subjected to criticism, the term is useful as it conveys the idea of extraordinarily effective, indeed messianic, leadership. Such charisma, which was most effectively exerted in informal pre-bureaucratic contexts, helped to draw students in sufficient numbers to make the school viable. It enforced the standards and style of the work adopted by the school. It extracted from the students an unflagging . . . devotion to research, particularly at times of intellectual failure and disappointment, and on occasion it also imposed fervent specialization. It contributed strongly to the school's sense of its own novel and distinctive identity and importance. And it compelled unquestioning and unswerving loyalty to the master and his school. Though a research school existed primarily to advance knowledge, its atmosphere could be highly evangelical as the prophet broke through accepted conventions and led his devoted followers into unexplored and promising lands of enquiry.[4]

This chapter therefore examines the structure, organisation and ethos of the Departments of Applied Mathematics and Statistics, Chemistry and History at University College London, looking for evidence of the emergence of a specific culture of teaching and research in the period 1890-1914.

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[1] Ramsay, 'Function', pp.244-45.
[2] Morrell, 'Chemist Breeders', pp.3-7.
[3] Clark, 'Graduate Education and Research Training' pp.138-9. See also Dennis, 'Accounting for Research', pp.496-506.
[4] Morrell, 'Chemist Breeders', pp.6-7. On the notion of 'charisma', also see H.Wolpe, 'A Critical Analysis of Some Aspects of Charisma', The Sociological Review, 16 (1968), 305-18.

The Department of Chemistry

The structure, organisation and ethos of the Chemistry Department at UCL was typical of the 'ideal' research school during Sir William Ramsay's tenure in the Chair of General and Inorganic Chemistry from 1887 to 1913. As we saw in Chapter Three, through his involvement in the campaign to secure state funding for Britain's universities and university colleges, Ramsay made a vitally important contribution to the debate about the role and function of university education in Britain in this period.[5] He maintained that the modern British university 'ought to be a place for the advancement of knowledge, for the training of philosophers, of those who love wisdom for its own sake';[6] and arrived at UCL with a distinct conception of the College as a place of teaching and research in mind, and the specific intention of establishing a major school of chemical research in London. He summarised his views on the organisation and ethos of a successful school in his Presidential Address to the Society of Chemical Industry in 1904, insisting:

> [E]very teacher from the senior professor to the youngest assistant must be occupied in research . . . . The junior staff in a school or college ought to be encouraged to do research, and their duties should be so arranged as to afford time and facilities for such work . . . . As to the Professor, . . . [t]he greater part of his time should be given to research, and this consideration leads to a review of the methods of selecting among candidates for such appointments, and generally to the government of universities.[7]

Ramsay had spent eighteen months as a postgraduate student in Rudolf Fittig's laboratory in Tubingen in the early 1870s, participating in a small tutorial group led by Fittig's assistant, the American, Ira Remsen. He was profoundly influenced by his experiences in Germany, developing a great admiration for the German system of technical and higher education, which was strengthened by his close contact and enduring friendship with a number of eminent German scientists, notably Wilhelm Ostwald and Emil Fischer.[8] Ramsay was particularly enthusiastic about the Philosophical Faculty of the typical German university, as he explained in a speech on 'The Functions of a University', which was delivered at UCL on 6 June 1901:

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[5] See above, Chapter 3, especially pp.80-2.

[6] William Ramsay, 'The Functions of a University', in William Ramsay, Essays Biographical and Chemical (London: Archibald Constable and Co., 1908), p.247.

[7] William Ramsay, 'President's Address', Journal of the Society of Chemical Industry, 23 (1904), 852-7.

[8] George B.Kauffman and Paul M.Priebe, 'The Emil Fischer-William Ramsay Friendship: The Tragedy of Scientists in War', Journal of Chemical Education, 67/2 (1990), 93-101.

> [T]his phrase is to be accepted in the derivational meaning of the word - a faculty which loves wisdom or learning. The watchword for the members of this faculty is Research; the searching out of the secrets of Nature, to use a current phrase, or the attempt to create knowledge. The whole machinery of the Philosophical Faculty is devised to achieve this end; the selection of the teachers, the equipment of the laboratories and libraries, the awarding of the degrees.[9]

This was also the guiding philosophy of the laboratories that Ramsay established in Bristol and London. During his tenure in the Chemistry Chair at University College, Bristol, from 1880 to 1887, he had succeeded in building up a small, but fairly successful, school. Ramsay and his colleague, Sydney Young, had published a series of papers dealing with vapour-densities, critical constants, evaporation and dissociation, and within a few years 'a number of students in his laboratory were . . . working on research problems'.[10] However, their efforts had been hampered by the grave financial difficulties experienced by the College in this period. Ramsay was actually compelled to become Principal of the College in 1881, and this 'demon of responsibility' had 'preyed like an incubus on [his] vitals', severely restricting the amount of time that he was able to devote to research. He therefore welcomed the opportunity to move to University College London in the summer of 1887, and did so with the intention of founding a major chemical research school in the capital.[11]

Ramsay's first task on arriving at UCL was to divide his private room in two, in order to create a small laboratory in which he could conduct his own experiments and investigations.[12] He then set about reorganising the teaching staff of the Department. In doing so, Ramsay paid particular attention to the research interests and achievements of prospective members of staff, insisting that 'the utmost importance should be attached to the nature and quality of this work; for it must never be forgotten that the power of advancing knowledge is the CHIEF requisite in a professor'.[13] He believed that successful research chemists made the best teachers, and, similarly, that it was 'conducive to the furtherance of knowledge that an investigator should be entirely engaged in teaching'. Teachers of chemistry who were not actively engaged in carrying out their own research were 'neither interested nor interesting', and they were unable to stimulate their pupils to the same degree as those who were. He therefore maintained that the teaching staff of the Department

[9] Ramsay, 'Functions', p.231.
[10] Travers, Ramsay at UCL, p.3.
[11] WR to his Aunt Louisa, 3 December 1887, UCL/WR/6, p.48.
[12] Travers, Ramsay and UCL, pp.2-3.
[13] WR to Michael Foster, undated, UCL/WR/12/2, pp.7-8.

should only be selected from among 'those who [we]re themselves contributing to the advancement of knowledge; for if they ha[d] not the spirit of research in them, how [should] they instil it in others'.[14] Williamson's assistant professor, Foster Morley, was therefore dismissed because he was also working on a new edition of *Watt's Dictionary of Chemistry*, and could therefore 'give no time to the Laboratory'. He was replaced by J.Norman Collie, 'a delightful fellow with a genius for research . . . . and a very good teacher'. Morely's salary had been £270 a year, but Collie 'would come for £150, and everyone would be the gainer, Collie by increased opportunity, Morely by being obliged to make himself a name, and the College by having a man willing to add to his name by research'.[15]

Subsequently, all the undergraduate teaching within the Department was remodelled on 'experimental lines'. Ramsay maintained that the best way to train a professional academic chemist was to ensure that 'original research . . . play[ed] as large a part as possible, and as early as possible, in the life of a chemical student'.[16] As he told his pupil, Robert Whytlaw-Gray in 1906:

> You know . . . what is expected of you: you must make your name by research.[17]

During his years in Bristol Ramsay had written a small text-book, describing simple quantitative experiments illustrating fundamental laws, for use in junior classes. The basic idea was that each student would be given a series of simple experiments to perform in turn, through which they would familiarise themselves with 'the subjects treated in the first term of an ordinary course of lectures'. This system also had the great advantage of giving the student practice in the construction of apparatus, and also of 'making him perform calculations with a definite object, instead of as merely theoretical problems'.[18] This system was employed with some success in Bristol, but it required too much preparation for use in a school with a large number of students and a small staff (like the Chemistry Department at UCL). However, Ramsay continued to encourage his students to conduct their own experiments and investigations when he moved to London. As Travers explains, at first 'the teaching

[14] Ramsay, 'Functions', pp.238-9.
[15] WR to Mrs. Buchanan, 15 June 1887, UC/WR/6/1.
[16] UCL/WR/16/1, p.xlvii.
[17] WR to R.Whytlaw-Gray, 8 August 1906, UCL/WR/14/1.
[18] William Ramsay, Experimental Proofs of Chemical Theory for Beginners (London: Macmillan, 1884), quoted in Tilden, Ramsay, p.109.

could include no more than test-tubing, and the carrying out of simple experiments with small beakers and basins', but later students were encouraged to find their own experimental solutions to difficulties they were experiencing, and to repeat work which had recently been published (with occasional variations and improvements suggested by Ramsay).[19] As a result of this emphasis on research, Ramsay's students were often unprepared for the more pedestrian requirements of the University examinations, and they 'sometimes did badly'.[20] But Ramsay was unrepentant. In a letter to Professor Worthington, dated 12 November 1888, he insisted:

> My classes are in good order and work well. I am therefore happy so far as they go, we have just had five men through the B.Sc.. Of these four are going in for honours next week, and when they have been sufficiently tortured, they will begin research. So now we are in a fair way to get a 'school'.[21]

As we have already seen, Ramsay was a great admirer of the German 'seminar' system, and he was therefore adamant that his own laboratory would be *a place of teaching and research*:

> The object of both classes of students (for I count the teacher as student) should be to do their best to increase knowledge of the subject on which they are engaged. That this is possible, many teachers can testify to by experience; and it is the chief lesson learned by a sojourn in a German laboratory. Where each student is himself engaged in research, interest is taken by the students in each others' work; numerous discussions are raised regarding each questionable point; and the combined intelligence of the whole laboratory is focussed on the elucidation of some difficult problem.

'There is nothing more painful to witness', he went on, rather melodramatically, 'than a dull and decorous laboratory where each student keeps to his own bench, does not communicate with his fellow students, does not take an interest in their work, and expects them to manifest no interest in his'.[22] From the second year onwards, all the undergraduate students based in the Chemistry Department at UCL therefore worked at benches in the main laboratory, side by side with the research students and junior members of staff (see Figure 6.1). As Travers recalls:

> A second-year student might find him, or herself, working at a bench next to a research worker, to take an extreme example, to whom he or she could turn for help. An intelligent junior could learn much from seeing what was going on around him.[23]

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[19] Travers, Life, pp.85-7, Morris W.Travers, 'Introduction to Volume VI', UCL/WR/6, pp.xxvi-xxx.
[20] Tilden, Ramsay, p.111.
[21] WR to Professor Worthington, 12 November 1888, UCL/WR/6/1.
[22] Ramsay, 'Function', pp.244-45.
[23] Travers, Ramsay and UCL, p.6.

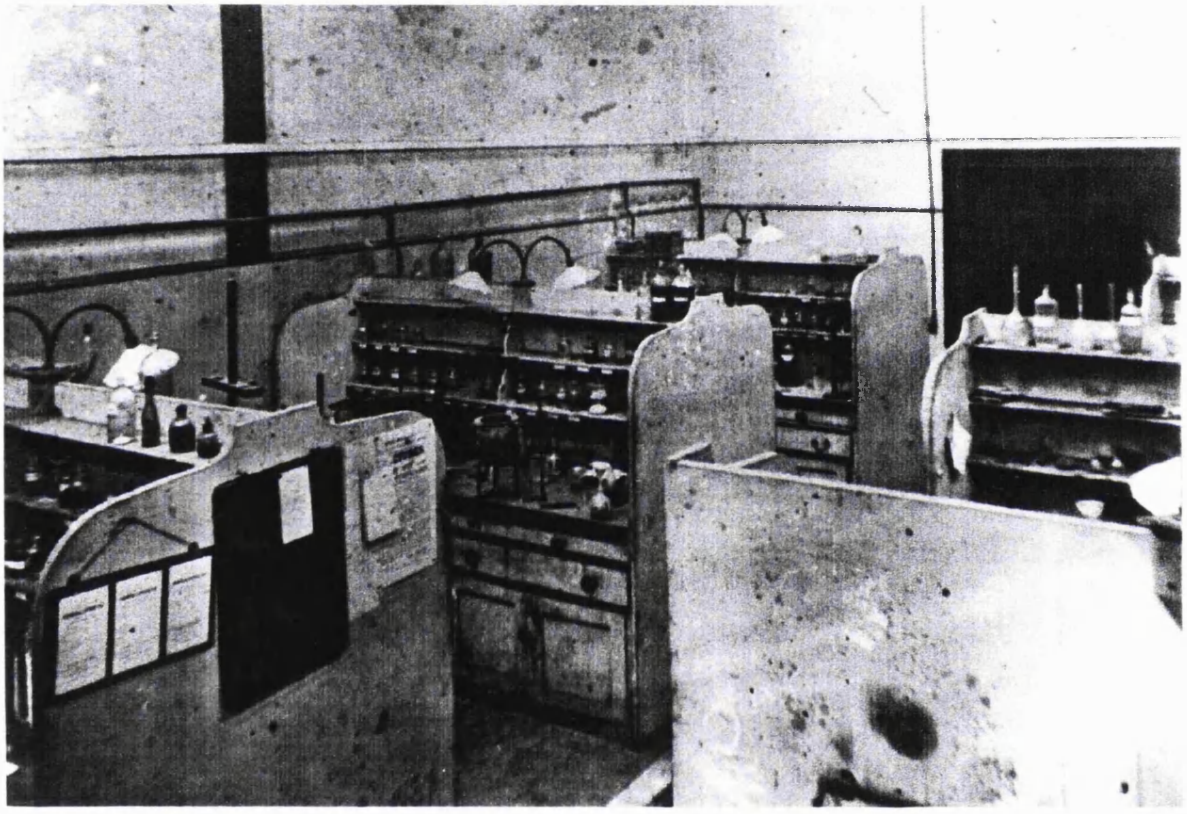

Figure 6.1 The Main Laboratory in the Chemistry Department at UCL (c.1887)

In this way all students were expected to learn not only particular techniques, but something of the art of scientific research. Such an arrangement was also essential for the passing on of tacit knowledge and the 'two-way transmission of innovation in the actual "craft" of research', in other words, for the development of a genuine culture of teaching and research.[24]

Ramsay expected everyone to know what was going on elsewhere in the laboratory. There was therefore only one question on the 1906 Tufnell Scholarship Examination:

> Give an account of any researches in progress in this Laboratory with which you are acquainted.[25]

Ramsay made every effort to integrate the results of his own research into his undergraduate teaching, and to keep all his students abreast of his latest investigations and discoveries, and he encouraged his assistants to do likewise.[26] A.C. Egerton therefore recalls: 'One somehow felt very much in touch with all the exciting work that was going on'.[27] As Ramsay explained in a letter to his wife, dated 16 November 1894, he introduced his undergraduate students to his work on the inert gases at a relatively early stage of the project:

> To-morrow I am going to show the absorption of nitrogen by magnesium to my class. I believe there is going to be a crowd . . . . I think that one's students deserve the first of everything.[28]

Occasionally he also invited some of his more promising undergraduates to assist him in his researches. Egerton recalls that during his undergraduate career at UCL, Ramsay 'used to bring things for [him] to do specially for him; one was an investigation of the crystallisation of copper sulphate containing traces of lithium' in connection with his work on the transmutation of copper into lithium.[29] Robert Whytlaw-Gray and Samuel Smiles were even invited to 'lend a hand' with the experiments which eventually resulted in the isolation of neon, krypton and xenon, and their contribution was fully acknowledged in the Royal Society paper describing the results.[30]

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[24] Watson, 'Aspects', pp.25-6.
[25] UCL/WR/6, p.xxxix .
[26] 'Post-Graduate Courses', Reports 1901, pp.13-16.
[27] Note by Professor Sir A.C.Egerton, Secretary of the Royal Society, 25 March 1946, UCL/WR/16/1, p.50.
[28] WR to Margaret Ramsay, 14 November 1894, UCL/WR/7/1.
[29] Note by Egerton, 25 March 1946, UCL/WR/16/1, p.50.
[30] Note by Professor Whytlaw-Gray, UCL/WR/16/1, pp.42-4.

Most of Ramsay's great work was undertaken in collaboration with one or more of his assistants or senior students. According to Travers, Ramsay was a born leader with the ability to inspire tremendous confidence in his juniors, and a genius for cooperation and the delegation of work.[31] He 'quite unconsciously understood the technique of cooperation' and was 'never happy when working by himself', preferring instead 'to associate with himself some junior, whom he treated as a colleague, and whose name he joined to his own when publishing results'.[32] For example, a senior student called Donald Matthews, who was acting as a temporary assistant to Ramsay, was actually responsible for the discovery of helium,[33] and the experiment which resulted in the discovery of neon was carried out by Travers, E.C.C. Baly and J. Wallace Walker, because Ramsay had accepted an invitation to attend a river party.[34] The collaborative nature of the entire project is highlighted by the 'curious nature' of the paper on the separation of neon, krypton and xenon and the properties of the new gases, which was jointly written by Ramsay and Travers at the beginning of the 1900-01 session:

> While the paper was being written, students were arriving, wishing to see the professor. Some of these he wished to talk to himself, some he was able to hand over to Travers . . . . But whichever of the two of them remained at the desk, picked up the pen and carried on the story, it had been so frequently discussed that it practically wrote itself; so that, though the handwriting sometimes changes in the middle of a sentence, the printed paper follows the draft manuscript exactly.[35]

Ramsay subsequently encouraged his juniors to pursue their own independent investigations,[36] and collaborated with a new generation of postgraduates - notably Frederick Soddy, Otto Hahn and Robert Whytlaw-Gray - in his subsequent work on radium and the transmutation of the elements.[37]

This practice had a profound effect on Ramsay's pupils, enabling him to turn many of them into successful research chemists in their own right. As Mason recalls:

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[31] Travers, Ramsay at UCL, pp.4-5.
[32] Note by Travers, UCL/WR/16/1, p.35.
[33] Travers, Life, p.137.
[34] Ibid, pp.175-6.
[35] Ibid, p.192. The project is discussed in more detail in Ramsay and Travers, 'Argon and its Companions', and Travers, Life, pp.184-93.
[36] As Travers explains, the 'three members of his staff, Travers, Baly and Donnan, were now men of thirty years of age, and Ramsay preferred that they should follow completely independent lines of work and did not even suggest collaboration', but he followed their work with great interest. Ibid, p.206.
[37] Ibid, pp.209-30, 251-73.

> His way of entrusting a junior with the responsibility for some crucial part of a joint research wrought any such junior up to the highest pitch of care lest his chief be let down: it was an ordeal, but it was generous training.[38]

In the more short term, the principal result was a remarkable output of original papers and scientific memoirs from the school. In all, nearly 500 books and journal articles were produced and published by the staff and students of the Department between 1890 and 1914 (see Graph 5.2 and Appendix 5). These papers were, moreover, the work of a growing number of individual authors. This reflects the fact that Ramsay encouraged his students to publish their work, under their own names, at a relatively early stage in their careers. Although he did not found or control any specific periodicals or journals, Ramsay was able to ensure that his own work - and the fledgling efforts of his junior colleagues and senior students - was published; and the school was therefore able 'to convert private work into public knowledge', long term success and enduring 'fame'.[39]

The more informal aspects of the life of the department were also important. Morrell and Geison have both highlighted the significance of the close social and intellectual interaction between the members of a research school, stressing that success was more likely if the director had an informal leadership style, and was able to foster loyalty, social cohesion and a strong *espirit de corps* among his pupils.[40] According to his colleagues and contemporaries, Ramsay was a 'truly lovable man',[41] an 'original' with whom it had been a 'sheer delight' to work; and he inspired great loyalty and affection among his pupils.[42] It was his custom to tour the laboratories once a day, seeing every single student in turn, and getting to know each of them intimately.[43] He was amazed to find that many of his colleagues knew 'almost nothing of [their] students, and [didn't] seem to be ashamed of the fact'.[44] On Saturday evenings during the winter months Ramsay and his wife would entertain his students in groups of eight or so at their own home. As Morris Travers recalls, these dinners were 'the least formal affairs':

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[38] Note by Masson, 20 March 1946, UCL/WR/16/1, p.48.
[39] Morrell, 'Chemist Breeders', p.5.
[40] Ibid pp.4-6; Geison, 'Research Schools', p.23.
[41] 'Note on Ramsay's character written by Professor Arthur Smithells immediately after Ramsay's funeral, July 26 1916', UCL/WR/16/1, 27-30, p.29.
[42] Soddy, 'Ramsay', p.483; Note by Egerton, UCL/WR/16/1, p.50.
[43] Tilden, Ramsay, p.107.
[44] Travers, Ramsay and UCL, p.6.

> After dinner the guests remained for a cigarette in the dining-room with Ramsay, and then they moved to the drawing room, and signed their names in a book kept by Mrs. Ramsay. Turning back the pages, the names of former students were often mentioned and their doings discussed. Ramsay, who corresponded with a number of old students, knew what had happened to most of them.[45]

In return, the laboratory students organised a dinner party each year at the end of the first term. According to Tilden, Ramsay was the 'moving spirit' at these dinners, 'making speeches, singing songs, whistling and joking with everyone'.[46] Ramsay's informal style and amiable personality was the key to the development of a strong *espirit de corps* within the school, which was crucial to its success. As his pupil and eventual successor, Frederick Donnan, concludes:

> His great example of a life devoted to research, and his cheerful optimism and encouragement spurred his students to try to follow in his footsteps, and enabled him to build up a great school of chemical research at University College.[47]

The Department(s) of Applied Mathematics and Statistics

Karl Pearson shared many of Ramsay's views about the proper role and function of Britain's universities and the organisation and ethos of a successful research school. Like Ramsay, he also wrote extensively about his views on university education and reform, and played a leading role in the politics and administration of the College and University of London. Pearson maintained that the aims and objectives of the University should include both 'the spread of old, and the discovery of new knowledge', and that its constituent colleges should be characterised by 'the closest possible contact between teacher and student'. His conception of the role and function of the modern British university and university college was based on his understanding of the mediaeval concept of *universitas*. As he explained in his 1892 book on the reform of the University of London:

> The union of teachers and students working to a common end, which is essentially involved in the mediaeval *universitas* is the best possible ideal which can be formed even in the present day of a true university. The common end is intellectual development. This intellectual development involves not only the influence of teachers upon students, but of students upon teachers - namely, the mental growth which takes place even in the most developed mind as it assists the growth of others.[48]

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[45] UCL/WR/6, p.xxxi.
[46] Tilden, Ramsay, p.107.
[47] F.G.Donnan, 'Sir William Ramsay, 1852-1916', Dictionary of National Biography 1912-1921 (Oxford: Oxford University Press, 1927), p.446.
[48] Pearson, New University for London, p.26.

This was the guiding philosophy of the Biometric and Eugenics Laboratories at UCL. Pearson tried to integrate the results of his own research into his undergraduate teaching, and his students 'often had the privilege of listening to the first tentative steps in work which afterwards took shape in memoirs'.[49] He was also one of the pioneers of the concept - and methods - of research training for students, and was able 'to convert several of his advanced pupils into enthusiastic original investigators by associating them with himself in his own researches'.[50]

A polymath, Pearson's interests included astronomy, mechanics, meteorology, metaphysics, engineering, anthropology, evolutionary biology, medicine, mediaeval languages, German literature, law and history. He also wrote extensively on philosophy, religion, political science and 'sexual politics'; and under the influence of Spinoza and Johann Fichte, he developed his own rationalist philosophy - a complex blend of agnosticism, idealism, romanticism and his own brand of Darwinian socialism. Pearson's socio-political and philosophical beliefs are interesting because they exerted a significant influence on his mathematical and statistical work.[51] Moreover, through his lectures and writing, Pearson made a significant contribution to the political thought of late-Victorian and Edwardian Britain.[52] Indeed, when he died, an anonymous obituary writer in *The Lancet* (probably his former student, Major Greenwood) remarked:

> It is safe to say that no English man of science of the last fifty years has more profoundly influenced the thought of his time;[53]

and according to J.B.S. Haldane, Lenin regarded Pearson as 'the ablest of his political opponents'.[54] In Morrellian terms, he was a truly 'charismatic' figure, possessed of a 'demonic energy', a 'moral determination . . . to serve science from love as men in great religious epochs . . . served the church', and an enormous capacity for hard work.[55] During his remarkable 50 year career at UCL he founded

[49] Yule, 'Pearson', pp.427-8, KP/UCL/43.
[50] 'Testimonial by G.Carey Foster', KP/UCL/11/9.
[51] See, for example, Mackenzie, 'Pearson and the Professional Middle Class'; Mackenzie, 'Statistical Theory and Social Interests', and Norton, 'Biology and Philosophy'.
[52] Particularly through the public lectures he delivered at the South Place Institute between 1883 and 1887, which were published collectively as The Ethic of Freethought (London: T.Fisher Unwin, 1888), his later work on The Grammar of Science (London: Walter Scott, 1892), and his eugenic researches.
[53] 'Karl Pearson (1857-1936)', The Lancet, 2 May 1936, KP/UCL/43.
[54] J.B.S.Haldane, 'Karl Pearson (1857-1936)', UCL Magazine, June 1936, KP/UCL/43.
[55] E.S.Pearson, Karl Pearson, pp.1-2.

four separate laboratories and seven academic journals, published more than 700 academic books and articles,[56] revolutionised the study of mathematical statistics, and established an entirely new discipline. It is a measure of Pearson's extraordinary impact on the College that when he retired, three separate chairs were created in the Department of Applied Statistics - R.A. Fisher was appointed to the Chair of Eugenics, Pearson's son, Egon Sharpe Pearson, succeeded him as Professor of Statistics, and J.B.S. Haldane was appointed to the Weldon Chair of Biometry. A new Chair was created from his work in graphics in the Department of Physics; a new Department of Structural (now Civil) Engineering was also established, and a Readership was set up in Astronomy.[57]

Pearson was, then, a truly remarkable man, and he inevitably exerted a very powerful - almost 'magical' - influence over the staff and students of the Department of Applied Mathematics and Statistics.[58] Writing in 1936, one H. Deansesly, who had studied engineering under Pearson from 1886 to 1889, assured Egon Sharpe Pearson that his 'contact with K.P. for those three years ha[d] influenced [him] almost daily for the last 30 years';[59] and, in his obituary tribute, Major Greenwood also described the remarkable influence that Pearson had had on him:

> I saw him for the first time in 1902 and since then there can hardly have been a day in which the thought of K.P. has not passed through my mind and there have been long periods when what he did, advised or suggested was a dominant motive. In youth and manhood a word of encouragement from him has made me glow with pride or rebuke redden with shame. Even now, nearer sixty than fifty, I cannot, emotionally, picture any other man as of his intellectual stature, or hear him spoken of slightingly without a childish feeling of rage.[60]

Pearson's energy, enthusiasm and captivating personality were central to the success of the school. By all accounts, he was also a gifted teacher, at both an undergraduate and postgraduate level, 'fortunate in his power of lucid exposition' and the ability to 'say what he ha[d] to say, both logically and attractively'.[61] He had no difficulty in maintaining order in 'a class of 80 or 100 high spirited young men', and

[56] Pearson's publications are listed in G.M.Morant, A Bibliography of the Statistical and Other Writings of Karl Pearson (London: Biometrika Office, University College, London, 1939).
[57] Magnello, 'Non-Correlation', p.144.
[58] 'Karl Pearson (1857-1936)', The Sunday Times, 4 May 1936, KP/UCL/43.
[59] E.S.Pearson, Karl Pearson, pp.16-17.
[60] Major Greenwood, 'English Death Rates, Past, Present and Future. A Valedictory Address Given Before the Royal Statistical Society, June 16th 1936', KP/UCL/43.
[61] Testimonial by M.J.M.Hill, Astor Professor of Mathematics at UCL (1884-1924), 'Application and Testimonials of Karl Pearson, MA, FRS, Formerly Fellow of King's College, Cambridge, and Now Professor of Applied Mathematics in University College London, For the Chair of Natural Philosophy in the University of Edinburgh, 28 May 1901', KP/UCL/11/9.

took a keen personal interest in each of his students and their work, which enabled him to command tremendous loyalty and affection among his students (particularly his research students), 'in spite of a certain austerity of manner'.[62] It was Pearson's habit to tour his laboratories every morning at 9.00 a.m. and visit each of his research students in turn to discuss their progress. Ethel Elderton recalls that although the Professor was 'tremendously busy', he 'always had time to sit down and discuss an individual problem',[63] and according to G.Udny Yule:

> He could keep the work of ten to twenty students all engaged on different problems, absolutely clear in his mind, remembering their difficulties and the stage they had reached, and what he had to think out for them, or what information bearing on the same problem had to be obtained.[64]

This was the key to the development of a strong *espirit de corps* within the school. Pearson was, moreover, blessed with 'the power of awakening in young men an enthusiasm for science', which enabled him 'to convert several of his advanced pupils into enthusiastic original investigators'.[65] By virtue of his 'arresting and dominating personality . . . and his tireless enthusiasm',[66] Pearson was able to impose his research programme on the school, inspire his junior colleagues and advanced students to join him in his work, and also to persuade a vast army of volunteers and 'weekend workers' to assist him in carrying out some of the more laborious and mundane computing and calculating work of the Department.

The vast majority of the 'postgraduate and research students' who passed through the Department between 1890 and 1914 were not studying for a University of London degree or any other formal academic qualification. Many of them were volunteers who were keen to assist in Pearson's ground breaking biometric and eugenic researches. Others simply wanted to be trained in the methods of Pearsonian statistics or biometric research, and to conduct their own experiments and investigations under his supervision. They were not charged a fee, but were required to 'place their services for a definite period at the service of the director', and expected 'to give their time and work, precisely as paid members of the staff do, for

[62] E.S.Pearson, Karl Pearson, pp.16, 76.
[63] Ibid, pp.70-1.
[64] G.Udny Yule, 'Karl Pearson, 1857-1936', p.100, KP/UCL/43.
[65] Testimonials by M.J.M.Hill and G.Carey Foster, Professor of Physics at UCL from 1867-1898, and Provost of the College from 1900-1904, 'Application and Testimonials of Karl Pearson For the Chair of Natural Philosophy in the University of Edinburgh, 28 May 1901', KP/UCL/11/9.
[66] Yule, 'Karl Pearson', pp.100-1.

the general progress of the department'.[67] Volunteers also assisted in the more routine computing and calculating work of the Laboratory. In fact, according to Pearson, 'all the work of computing undertaken in [the] Department before the Drapers' Grant was made was done by volunteer workers'.[68] The Eugenics Laboratory also relied heavily on the voluntary assistance of medical men, teachers and social workers, who gathered material bearing upon the inheritance of various physical and psychological conditions from schools, hospitals and ordinary homes around the country. In all 72 'workers co-operat[ed] with or stud[ied] in the Department of Applied Statistics' between 1902 and 1914,[69] and Pearson insisted:

> The list could be considerably extended by numerous schoolmasters and mistresses who have worked in the Laboratory for longer and shorter periods, and the record would be incomplete without mention of the medical officers of health who have consulted the Laboratory on various special points, of the Government officials who have repeatedly done so, or the Continental, American and Japanese scientists who have made short visits to study the Laboratory methods or to use its specialist library.[70]

It is particularly significant that a growing number of these students had come to UCL from universities in Europe and the United States, and one should also note that a relatively high proportion of them were women (See Appendices 3 and 4). About one-third of the full-time staff of the department were also female. Notable examples include Alice Lee and Ethel Elderton, who each devoted more than 30 years to the work of the Laboratory.[71] Pearson treated them as professional equals in rank, publication credit and position in the staff hierarchy, and maintained that their work was 'equal at the very least to the men . . . in many cases [they had] taken higher academic honours . . . and [were] intellectually their peers'.[72] Pearson was a fervent believer in the equality of the sexes,[73] but the main reason why he

[67] 'Prospectus 1910-11', p.4, KP/UCL/248.
[68] KP to Foster, 26 November 1904, KP/UCL/233.
[69] 'List of workers in the Department of Applied Statistics' (1902-14), KP/UCL/233.
[70] 'Report to the Worshipful Company of Drapers', February 1918, pp.1-3, KP/UCL/233.
[71] Alice Lee was a part-time lecturer in applied mathematics at the Bedford College for Women, who assisted Pearson in the Biometric Laboratory as a postgraduate student and unpaid assistant from 1895 to 1927. She was awarded a D.Sc. for craniometric work conducted within the Laboratory in 1901, and when she retired Pearson said of her: 'Few, if any, of the . . . workers of her period have accomplished as large a bulk of first class research as Dr.Lee'. Her pupil at Bedford College, Ethel Elderton, was appointed Galton Scholar and assistant to Edgar Schuster in 1905. Later she was appointed Galton Fellow, and as Dr.Elderton she was Assistant Professor in the Eugenics Laboratory until her retirement in 1933. Rosaleen Love, '"Alice in Eugenics - Land": Feminism and Eugenics in the Scientific Careers of Alice Lee and Ethel Elderton', Annals of Science, 36 (1979), 145-58.
[72] KP to Francis Galton, 15 December 1908, reproduced in Pearson, Galton, p.359.
[73] In 1885 he and Olive Schreiner had set up a small private discussion group, The Men and Women's Club, dedicated to the study of human sexuality and the 'woman question'. See Kevles, In the Name of Eugenics, pp.24-6, and Norton, 'Karl Pearson and Statistics', pp.26-9.

employed so many women was that they could be hired more cheaply than their male counterparts.[74] Out of the £500 Galton gave to the Eugenics Record Office each year, a research fellow was appointed at a salary of £250 and an assistant at a salary of £100 (with the remainder allocated for miscellaneous expenses). Pearson admitted that he would not be able to 'get for this the services of a man', but £100 a year was a more competitive wage for a woman. Pearson was acutely aware that he was not paying his female staff well, but his willingness to take on women workers nevertheless gave him a devoted group of assistants who put in long, low paid or unpaid hours, often to the more routine work of the Department. They were grateful to Pearson for giving them the opportunity to do something useful with their qualifications in an academic world that was largely hostile to women, and there was also an indirect, but obvious, link between the work of the Eugenics Laboratory and feminism, as Rosaleen Love explains:

> These women were convinced that their 'inborn qualities' were not innately different from those of men; to this end they were concerned with the education of women and their participation in new fields of labour . . . . Clearly the waste of human potential entailed in denying basic freedom to women was against the best interests of the race and must be resisted. The future of the race lay with women, too, assisting in the evolutionary process.[75]

Interestingly, Marsha L. Richmond has recently discussed the prevalence of women among the members of the rival Mendelian school, acknowledging the significance of the contributions made by Cambridge women - such as Edith Rebecca Saunders, Muriel Wheldale Onslow and Emma Nora Darwin Barlow - to the Mendelian research programme under the direction of William Bateson between 1900 and 1910. Richmond highlights the fact that these women were dependent on a male mentor - Bateson - who 'not only helped guide their research but also mediated between them and the wider scientific culture, both within and outside the University'. As Richmond explains:

> The benefits of the mentoring relationship were mutual. Relying on the work of eager and competent young women allowed certain male biologists in marginal circumstances to advance their fledgling fields as well as their own careers. A serious disadvantage was that sometimes a woman's contribution became associated with the name of her mentor, minimizing recognition of her efforts in the historical record. But the trade-off was probably worth it. Women were thereby given the opportunity to make valuable contributions to an emerging scientific discipline at a critical stage in its development and to establish their credentials as research scientists.[76]

[74] Kevles, In the Name of Eugenics, p.39; Love, 'Alice in Eugenics -Land', pp.156-7; KP to Francis Galton, 'Final Form of Scheme for a Eugenics Laboratory for the University of London', 22 December 1906, reproduced in Pearson, Galton, pp.304-7.

[75] Love, 'Alice in Eugenics-Land', p.158.

[76] Richmond, 'Women in the Early History of Genetics', p.90.

It appears that Pearson played a similar role in the careers of Alice Lee, Ethel Elderton, Amy Barrington and the other women on the staff of the Department of Applied Mathematics and Statistics at UCL.

Pearson did all he could to encourage his senior students and junior colleagues to conduct their own investigations and publish the results, either jointly with him or under their own names. To this end he founded (and edited) seven journals during the course of his career at UCL: *Biometrika;* the *Drapers' Company Research Memoirs: Biometric Series*, *Technical Series* and *Studies in National Deterioration* series; the *Eugenics Laboratory Lecture Series*; the *Treasury of Human Inheritance* and the *Annals of Eugenics*. *Biometrika* was founded by Pearson and Weldon in 1900 as a vehicle for publishing their statistical work after a dispute with the Mendelians in the Royal Society.[77] The *Drapers' Company Research Memoirs: Biometric Series* was launched with money from the Drapers' Company grant in 1903, and a separate *Technical Series* was launched in 1904. This enabled Pearson and his colleagues to publish some of the more technical and purely mathematical work of the Department of Applied Mathematics and Mechanics, and 'to get things well printed which could not otherwise have been published effectively' (and illustrated 'in a manner which we should hardly have achieved in any other method of publication).[78] The *Eugenics Laboratory Lecture Series* contained reprints of lectures given at the Eugenics Laboratory between 1909 and 1912, while the *Annals of Eugenics* contained reprints of public lectures given by Pearson and his colleagues between 1928 and 1933. The *Studies in National Deterioration* series was launched in 1909 as a medium for publishing the results of a series of studies of lunacy, alcoholism and tuberculosis which were carried out in the Eugenics Laboratory at the request of the government. The *Treasury of Human Inheritance*, a thesaurus of family pedigrees also published for the first time in 1909, was intended primarily as a tool for medical professionals and actuaries. It was designed to provide students of

[77] Prior to 1900 the majority of Pearson's papers appeared in the *Transactions of the Royal Society*. In November 1900 Pearson read an abstract of a paper on homotyposis at a meeting of the Society. It was heavily criticised by William Bateson, and when the Society published Bateson's critique before Pearson's finished paper appeared, he gave up all hope of getting his biometric work published by the Society, and resolved to launch his own journal,with the backing of Galton and Weldon. KP to Weldon, November 1900, KP/UCL/266/9; Farrall, 'Controversy and Conflict in Science', pp.287-9.

[78] KP to Foster, 26 November 1904,KP/UCL/233.

eugenics and sociology, medical men and others with an organ where their investigations could be published'.[79]

More than two-thirds of the memoirs and papers published by those working in the Department appeared in organs that Pearson controlled,[80] the vast majority of them in *Biometrika* - some 177 papers out of a total of 291 between 1903 and 1918.[81] *Biometrika* has been described as 'the most personally edited journal that was ever published', and Pearson clearly exerted a profound influence over its style and content.[82] As Morant recalls, 'K.P. was not only the principal contributor to the journals and series of occasional publications for which he was responsible, but he also edited them in a way peculiarly of his own', taking it upon himself to correct and 'improve' articles before they were published.[83] However, one should also stress that (like the other publications that emerged from the Department), *Biometrika* was a properly accredited academic journal, which had an international readership, and it included contributions from universities throughout Britain and the world. Some of Pearson's colleagues and co-workers were nevertheless critical of his excessive 'desire for domination, for everything to be just how he wanted it', complaining that 'his dominance even in his very eagerness to help could be a disadvantage'. For example, Yule claimed that the emphasis on cooperative work and joint publication which came to characterise the Department was 'a negation of individualism and a discouragement to independent thought'. Pearson was, by his very nature, 'tenacious in his views', and those 'who left him and began to think for themselves were apt, as happened painfully, in more instances than one, to find that . . . the maintenance of friendly relations became difficult, [and] after express criticism impossible'.[84]

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[79] Karl Pearson, *The Treasury of Human Inheritance* issued by the Francis Galton Laboratory for National Eugenics, (Cambridge: Cambridge University Press, 1910), frontispiece.

[80] Kevles, In the Name of Eugenics, p.3.

[81] Pearson, 'Report to the Worshipful Company of Drapers' (February 1918), p.1, KP/UCL/233.

[82] Yule, 'Pearson', p.101. Pearson was co-editor with Weldon from 1901 to 1906, principal editor from 1906-33, and co-editor with his son until 1936. (Thereafter Egon Sharpe Pearson edited it on his own until 1982).

[83] G.M.Morant, 'Obituary Professor Karl Pearson', Man, XXXVI/118-141 (June 1936), 89-92, KP/UCL/43.

[84] In his obituary tribute to Pearson, Yule recalled: 'I have seen him livid with anger over an intellectual difference, and the man from whom he differed he could receive with a chill repellent hostility'. Yule, 'Karl Pearson', pp.100-1. See also W.P.Elderton, 'Karl Pearson (1857-1936)', Journal of the Institute of Actuaries, LXVIII, 1/3 (1936), 1-3, KP/UCL/43.

However, one should also note that Pearson's single-mindedness, passionate belief in his work and forceful personality, were the very qualities that enabled him to found and sustain a successful school of research in the Department of Applied Mathematics and Statistics at UCL in this period.

The Department of History

A.F. Pollard was a similarly dominant figure in the History Department, and many of his former pupils have also criticised him and his teaching methods, complaining that he 'relied rather on force than on sympathy'.[85] However, according to J.E. Neale, Pollard 'won respect, deep respect' (though 'rarely affection') among his students, despite his 'somewhat gruff exterior'; and he was remembered fondly by many of them as an exhilarating and inspiring teacher, who was able to command the 'devotion of others'.[86] C.H. Williams describes Pollard as 'a kind and wise friend'. Conceding that he could be excessively self-confident and critical of others, he nevertheless insists that 'to work under [his] influence was an experience and a privilege not easy to forget'.[87] Pollard's strangely charismatic personality was the key to the development of a strong *espirit de corps* within the school, and, as Morrell explains, this was crucial to the long term development and success of any research school.

However, the origins of the London history school are to be found in Pollard's personal determination to establish a major school of historical research in the capital. He outlined his plans for the reorganisation and revitalisation of history teaching within the University, and for the establishment of a postgraduate school of historical research, in his inaugural lecture on *The University of London and the Study of History*. The most significant feature of Pollard's programme was his insistence that his school would 'naturally' offer competent instruction in the meaning and use of original sources. But he also maintained that it should 'not merely be the business of a school of history to make historians, but to discover and spread historical knowledge'. The school had an 'internal' duty to itself to train historians, but also an 'external' duty to the nation to make 'History' and 'expand the national mind'. This

[85] G.N.Clark, 'Albert Frederick Pollard (1869-1948)', Dictionary of National Biography 1941-1950 (Oxford: Oxford University Press, 1959), p.681.
[86] Neale, 'Pollard', p.202.
[87] Williams, 'Pollard', pp.9-10.

was entirely in keeping with Pollard's wider views about the proper role and function of university education. He believed that a 'University teacher should always be one who is adding not merely to the persons who know but to the things that are known', and was insistent that 'as soon as one ceases to learn one becomes unfit to teach'.[88] Moreover, 'natural researchers' made the best teachers, and involvement in both teaching and research would enable the professional historian to overcome the problem of over-specialisation.[89] The London history school would therefore be a place of teaching and research - it would be 'fatal' to divorce the one from the other.[90]

Pollard's attempt to found a history school in London was part of a wider movement among historians in Oxford, Cambridge, London and Manchester, led by T.F. Tout, C.H. Firth and J.B. Bury. They were all champions of what they called the 'scientific study' of history, and the idea that history students should receive a 'proper professional training . . . in the methods of investigation, in the use of original authorities and in those auxiliary sciences which the Germans call "Hilfswissenschaften"'.[91] These ideas were expressed most forcibly between 1903 (when Bury delivered his infamous inaugural lecture on 'The Science of History') and 1906 (when Tout gave a celebrated lecture on 'Schools of History' at Newnham College, Cambridge) - during the very period in which Pollard set about establishing a school of historical research in London; and A.T. Milne has demonstrated that there was a very 'close liaison' between Firth, Tout and Pollard, particularly in the formation and administration of the Historical Association.[92] However, the origins of the 'Pollard programme' are to be found in his experiences as an undergraduate at Jesus College, Oxford, where he was heavily influenced by R.L. Poole, who taught him that a training in the methods of historical research constituted 'the most valuable, if not indispensable, preliminary qualification' for a professional historian.[93] According to

[88] Pollard, Factors, pp.247-51, 257-60.
[89] 'The special investigation must always be viewed in its relation to a more general problem. But the specialist cannot very well lose himself in his research when he is tied to teaching large parts of general history; it is the general practitioner who is more likely to lose himself in generalities when he is not attached to any specific research'. Ibid, pp.ix-x., 267-9.
[90] Ibid, p.267.
[91] Firth, Plea for Historical Teaching of History; Bury, Science of History; Tout, 'Schools of History'.
[92] Slee, Liberal Education, p.130; A.T.Milne, 'History at the Universities: Then and Now', History, 59 (1974), 33-46, p.42. Firth was the first President of the Historical Association, Tout its second, and Pollard its third.
[93] Testimonial by Poole, LU/AFP/12.

his tutor, W.M. Lindsay, Pollard 'soon outdistanced his competitors' in the study of history; and his record at Oxford was 'an unusually brilliant one'. He graduated in 1891 with a first in modern history and the prestigious Marques of Lothian Historical Essay Prize, but failed to secure an Oxford fellowship. A year later he made an unsuccessful application for the vacant post of Lecturer in History and Political Economy at the University College of South Wales and Monmouthshire, and in 1893 he was appointed Assistant Editor of the Dictionary of National Biography. Pollard worked for the Dictionary for the next eight years, personally contributing more than 500 entries, mostly on figures from the fifteenth and sixteenth centuries. According to John Kenyon, the best training in writing and research then available was provided in the offices of the DNB,[94] and Neale has argued that Pollard was profoundly influenced by his experiences in the Dictionary office:

> The Dictionary office, with its team of workers mastering a technique that they handed on to new recruits, and with its well-equipped, specialised library, gave him the idea from which ultimately was to come his conception of a postgraduate seminar as a group of scholars, young and old, meeting in a library, as scientists in a laboratory, to discuss their work and aid each other by the incidental dissemination of both method and knowledge.[95]

Pollard's aim was to create a specialist class of professional historians, properly trained in the methods of historical research and the use of archival sources - as distinct from the 'amateurs who regard[ed] as research their skimming of others' results'. Such men were, in fact, 'only adding to their own knowledge, while real research mean[t] revealing what ha[d] not been hitherto known by anyone'. Pollard believed that history was both a science and an art requiring a 'scientific analysis of materials and an artistic synthesis of results'. In his school, the study of history would involve 'constant reference to the canons of evidential criticism and to the methods of historical investigation' (which would provide 'the scientific element in historical study'), but also an attempt to cultivate 'the imagination and sympathy necessary for the construction of historical synthesis' (which would provide the artistic factor).[96] Insisting that 'no honours students should leave the University without some grasp of the methods of investigation, of the nature of evidence, and of the principles of criticism',[97] Pollard strove to ensure that all London history undergraduates were taught by

[94] Kenyon, History Men, p.203.
[95] Neale, 'Pollard', p.198.
[96] Pollard, Factors, pp.ix, 11-12.
[97] 'Report of the Library Committee on the Future Policy of the Library at UCL', p.14, LU/AFP/32.

'professional' historians who were engaged in carrying out their own specialist archival researches. They were encouraged to integrate the results of their research into their undergraduate teaching, and also to introduce their students to the methods of historical investigation. To this end, Pollard also instituted a new 'special subject' paper, based entirely on the study of primary sources, which all students were required to take during the third year of the undergraduate course.[98]

Subsequently, postgraduate students were given a more thorough training in the methods of research and encouraged to carry out their own source-based investigations. History first appeared on the official list of 'Postgraduate Courses of Lectures and Laboratory Work' at the beginning of the 1904-05 session,[99] and over the next decade Pollard devised a rigorous two-year intercollegiate course for postgraduate historians, which was designed to introduce them to the methods of historical investigation and give them an opportunity to carry out their own archival research. He discussed his methodological approach to training graduate historians in an article which appeared in the first issue of the *Bulletin of the the Institute of Historical Research*. Pollard explained that the postgraduate history course at UCL involved a 'varied training in [the] methods of discovering new facts, of interpreting evidence and of probing the work of human minds as recorded in what men have written and influenced by material, moral and other considerations'. He began by reiterating the fact that there were vast repositories of archival sources in London, but acknowledged that they housed collections of documents and manuscripts which were 'undecipherable and unintelligible to students who [we]re familiar only with printed pages and narrative histories'. Moreover, they were 'contained in archives in which the student [was] lost until he ha[d] learnt how to find his way'. The postgraduate historian therefore had to be introduced to the various catalogues, calendars and guides to London's archives, and then taught how to use them properly. He or she also had to be given 'some idea of the meaning and value of original evidence', and taught how to test its date and authenticity. The would-be historian had to 'learn how to weigh the conflicting evidence according to the source

[98] The University Board of Studies in History produced a printed series of documentary source-books for use in 'special subject' classes, the first of which - a three volume source-book on the reign of Henry VII, edited by Pollard - was published in 1913-14. Pollard, Factors, p.265.
[99] Reports 1905, pp.42-50.

from which it [came], and how to get at the human or official mind behind the parchment and the paper on which it [had been] imperfectly expressed'. Finally, when he had collected, sifted and tested his materials, he also had to learn how to construct and present his results. Training in these skills and techniques was provided by 'individual conference' between student and teacher, occasional meetings with officials and archivists in the capital's various repositories, and by 'cooperative research and discussions in a group commonly called a seminar'.[100]

During the first year of the course students attended Pollard's seminar on fourteenth to sixteenth century English constitutional history; Hubert Hall's palaeography class at the London School of Economics, and a class in the methods of historical research, which included 'lectures on the nature of historical evidence, and on the great collections, printed and MS., of sources, with their apparatus of catalogues, etc.; work in the Library of the Department at University College, the British Museum, and the Record Office; and some practice in written exposition'. During the second year students were required to produce a dissertation or thesis based on primary source material. They continued to attend Pollard's seminar and Hall's palaeography class, participated in Professor Priebsch's seminar in palaeography at UCL, and were also encouraged to attend classes in other departments which were relevant to their research interests.[101] Since so many of the postgraduates based in the Department were part-time students, Pollard also instituted a separate part-time course for those 'often more experienced, but either unable to give their full-time or no longer needing so much assistance'. Most classes were therefore held on Saturdays or after 5.00 p.m. in order to accommodate these students. They usually spent one year in the methods class and then passed on to Pollard's seminar. A few of them took Hall's palaeography class, and those who could not do so 'learn[t] to read MSS. for themselves with a little informal help'.[102]

[100] A.F.Pollard, 'Training in Historical Research', Bulletin of the Institute of Historical Research, 1 (1924), 31-2.
[101] For example, during the 1917-18 session one student attended classes in the Departments of Geography and Engineering in preparation for a thesis on historical geography. 'Arrangements for Course of Training in Historical Research', pp.1-2, LU/AFP/33.
[102] 'Arrangements for Course of Training in Historical Research', p.3, LU/AFP/33.

By 1919 London history postgraduates had a choice of fifteen intercollegiate seminars on sources and methods, and various periods and aspects of English history (see Table 6.1). Moreover, a 'History Circle' made up of the staff and students of the school, archivists and officials from the Record Office and British Museum, and visiting scholars from universities elsewhere in the country and overseas, met at UCL every Thursday evening to 'discuss knotty points' and act as 'a sort of clearing house for questions raised in the various seminars'.[103]

Table 6.1. Postgraduate History Courses in the London History School (c.1919).

1. Preliminary Seminars	
a. Preliminary Seminar on the Sources of British History	Rachel Reid (UCL)
b. Preliminary Seminar on the History of the Empire	A.P.Newton (UCL)
c. Palaeography and Diplomatic	Hubert Hall (LSE)
d. Palaeography	R.Priebsch (UCL)
e. Methods of Historical Research	E.Jeffries Davis (UCL)
2. Seminars on Various Periods and Aspects of English History	
a. A Seminar on Anglo-Saxon History	R.W.Chambers (UCL)
b. A Seminar on 12th and 13th Century History	H.Jenkinson (KCL)
c. A Seminar on the 14th Century	Hilda Johnstone (KCL)
d. A Seminar on the 15th Century	J.F.Hearnshaw (KCL)
e. A Seminar on Historical Sources	Hubert Hall (LSE)
f. A. Seminar on English Constitutional History in the 14th, 15th and 16th Centuries	A.F.Pollard (UCL)
g. A Seminar on Colonial History with special reference to the 16th and 17th Centuries	A.P.Newton (UCL)
h. A Seminar on Economic History	Lillian Knowles (LSE)
i. A Seminar on Political Science	Graham Wallas (LSE)
j. A Seminar on Ecclesiastical History	Claude Jenkins (KCL)

(*Source:* A.F.Pollard, 'The Needs of Historical Studies in University College', c.1919 (LU/AFP/33)).

[103] Untitled memorandum on 'the means which the University of London is providing to guide, train and assist students in the prosecution of their researches', pp.2-3. Contained in folder with Pollard's memorandum on 'The Needs of Historical Studies in University College', c.1919, in LU/AFP/33.

In many ways the most distinctive feature of the school was the emphasis that Pollard placed upon archival research. However, the principal methodological innovation that came to be associated with his department at UCL (and later the IHR) - 'the London method', as it was sometimes known - was the seminar system. The seminar was essentially a round table discussion group, made up of both staff and students, who were individually and independently dealing with different aspects of a particular historical problem or working at different categories of historical material. The members of the group met regularly in a semi-formal context to discuss common problems arising from their work and more general 'problems alike of research and historical organisation'.[104] Pollard maintained that historical research should be a cooperative, collaborative enterprise:

> The exigencies of historical research . . . demand in the interests of teachers and students alike, a certain degree of co-ordination, co-operation, and concentration. Isolation is fatal to the comparative method which is the essence of historical inquiry and induction . . . . Contact with other teachers and with other students is essential both for teachers and for students.[105]

The professional study of history was (and is) a solitary pursuit. Much of the postgraduate student's time is inevitably spent working alone in libraries, archives and record offices, under the (occasional) supervision of a single professor. The subject of a thesis or particular research project can never be more than a small part of a larger whole, and it is therefore vital that all the students working on different aspects of a particular problem are brought into regular contact with each other. 'Otherwise', Pollard explains, 'the sense of proportion, of perspective, and even of meaning is lost'. Moreover, the most valuable archival discoveries are often made incidentally:

> Historical investigations are constantly lighting on references, documents, facts which might take weeks and months to trace by direct pursuit; and these discoveries may have little bearing on the finders' particular thesis, but be of great importance to someone else.[106]

This emphasis on casual, informal social interaction is a characteristic feature of the Morrellian model, and is typified by the seminar system and Thursday evening conference of historians and archivists at UCL. As J.E. Neale recalls:

> Those who knew it at its best are not likely to doubt its value, nor its subtle influence in creating high standards of historical scholarship. The interplay of expert minds in more or less casual 'shop' talk had a worth quite distinct from that of lectures or papers.[107]

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[104] Pollard, Factors, pp.264-5.
[105] Quoted in Birch, History Laboratory, p.5.
[106] Pollard, 'Training in Historical Research', pp.31-2.
[107] Neale, 'Pollard', pp.198-9.

Conclusion

Although the requirements of teaching and research in the arts, sciences and social sciences are very different, the structure, organisation and ethos of the Departments of Applied Mathematics and Statistics, Chemistry and History at UCL were essentially very similar in the period 1890-1914. Ramsay, Pearson and Pollard were not officially required, expected or even encouraged to conduct their own research by the College Council and University authorities, but all three of them were determined to devote as much time as could possibly be spared from their teaching and other official duties to the prosecution of original research in their respective fields. Moreover, they tried to integrate their results and findings into their undergraduate teaching, and also to break down the distinction between teaching and research by training their pupils in the methods of academic research. Ramsay and Pearson invited their students and junior colleagues to assist them in their researches, and also to conduct their own experiments and investigations, while Pollard's students were encouraged to pursue their own archival researches in the capital's various museums and repositories. Furthermore, all three of them gave their students an opportunity to publish their work, under their own names and at a remarkably early stage in their academic careers. The more informal aspects of the life of these three departments was also extremely important. Ramsay, Pearson and Pollard all stressed the need for close social and intellectual interaction between the members of a research school - either through collaborative work and the close interaction between members of staff, research students and undergraduates in the same laboratory space, or regular attendance at the seminars and more informal social gatherings favoured by Ramsay and Pollard - and this was crucial, both for the passing on of tacit knowledge, and the development of a strong espirit de corps among the members of a school. This account has therefore highlighted the significance of personal and psychological factors in explaining the growth and development of a successful research school, and has also drawn attention to the role played by the principal architect or director of the school in question. In their different ways, Ramsay, Pearson and Pollard were all 'charismatic' figures, blessed with the ability to inspire tremendous loyalty and 'disciple fetishism' among their pupils; and, as Morrell has argued, this was absolutely crucial to the long term growth, development and success of any research school.[108]

[108] Morrell, 'Chemist Breeders', pp.6-7.

7. Intellectual Property

The object of this school was to make statistics a branch of applied mathematics with a technique and nomenclature of its own, to train statisticians as men of science, to extend, discard or justify the meagre processes of the older school of political and social statisticians, and in general to convert statistics in this country from being the playing field of dilettanti and controversialists into a serious branch of science, which no man could use effectively without adequate training.

Karl Pearson, 1920.[1]

The preceding account of the structure, organisation and ethos of the Departments of Applied Mathematics and Statistics, Chemistry and History has highlighted the significance of Pearson, Ramsay and Pollard's organisational skills, powers of leadership and personal 'charisma'. However, Jack Morrell has argued that in order for a research school to achieve long term success, it was also necessary for its director to instigate a focussed programme of research, in which a distinctive methodological approach was brought to bear upon a sharply delimited problem within a broader field of inquiry or investigation, which might eventually come to be recognised as the 'intellectual property' of the members of the school. This was crucial in enabling the director of an embryonic school to attract 'student-acolytes' in significant numbers, and also to secure the necessary financial and institutional support for his work.[2] At UCL, Pollard's growing reputation as a specialist in the fields of Tudor and constitutional history and development of a distinctive methodological approach to the training of postgraduate historians, Pearson's pioneering attempt to apply statistical methods to the study of evolutionary biology, and Ramsay's Nobel Prize-winning researches on the inert gases and development of a revolutionary experimental technique for dealing with gases and vapours in extremely small quantities, was therefore crucial to the long term growth, development and success of the Departments of Applied Mathematics, Chemistry and History in the period 1890-1914.

The Department(s) of Applied Mathematics and Statistics

During Karl Pearson's tenure in the Chairs of Applied Mathematics and Eugenics from 1884-1933, work in three quite distinct (but closely related) fields - biometry, eugenics and mathematical statistics - came to be recognised as the intellectual property of the staff and students of the Department(s) of Applied Mathematics and Statistics.

[1] Pearson, 'History of the Biometric and Galton Laboratories', p.1, KP/UCL/247.
[2] Morrell, 'Chemist Breeders', pp.3-5.

Pearson's earliest investigations and publications had focussed primarily on traditional problems in the field of pure and applied mathematics, such as the theory of elasticity, atomic theory and the wave theory of light.[3] But in the 1890s, under the influence of W.F.R. Weldon and (to a lesser extent) Francis Galton,[4] he became more interested in applied statistics and the correlation of biological (and sociological) data. In the course of his researches in the field of evolutionary biology, Weldon had become dissatisfied with the morphological methods that were traditionally used to describe and explain biological variation and heredity in the late nineteenth century. Following on from Darwin, he maintained that evolution was brought about by natural selection acting upon the slightest of variations between successive generations of a particular species. Evolution was therefore a 'population phenomenon', which could only be demonstrated through the analysis of large, random samples of naturally occurring populations. Statistical methods were necessary for the analysis of such populations, and Weldon was therefore convinced that statistical analysis was the key to the demonstration of natural selection at work.[5] However, his first attempts to use statistical methods drew a great deal of criticism, and in the summer of 1893, he therefore invited Pearson - a 'first rate mathematician' - to assist him in his attempt to measure and compare physical characteristics in several large samples of common wild shrimp *(Crangon Vulgaris)*.[6]

Pearson was fascinated by Weldon's work and captivated by his personality,[7] and he also found that many aspects of his colleague's programme struck a chord with his own ideas.[8] Between 1893 and 1899 (when Weldon was appointed to the Linacre Chair of Comparative Anatomy at Oxford), they carried out

[3] See, for example, Karl Pearson, 'On a Certain Atomic Hypothesis', Transactions of the Cambridge Philosophical Society, 14/2 (1887), 71-120, and Karl Pearson, 'On the Generalised Equations of Elasticity and their Application to the Wave Theory of Light', Proceedings of the London Mathematical Society, 20 (1889), 297-350.

[4] See Magnello, 'Pearson's Gresham Lectures', especially pp.45-7.

[5] See Farrall, 'Controversy and Conflict in Science'; Froggatt and Nevin, 'The Mendelian-Ancestrian Controversy', and Norton, 'Biometric Defence of Darwinism'.

[6] Karl Pearson, 'Contributions to the Mathematical Theory of Evolution', Philosophical Transactions of the Royal Society, Series A, 185 (1894), 71-110; Farrall, 'Controversy and Conflict in Science', pp.281-2.

[7] E.S.Pearson, Karl Pearson, p.19.

[8] Bernard Norton has argued that Pearson had already independently developed a pattern of social, political and philosophical thought which predisposed him to find Weldon's programme attractive because of its positivistic determination to deal with directly observable quantities, to give measurable operational meaning to evolutionary change, and to avoid speculative theorising about unproveable evolutionary mechanisms. In short, 'he saw Biometry as an exemplar of of his philosophy put into operation'. Norton, 'Karl Pearson and Statistics', pp.5-7, 13-15.

a series of experiments designed to test the theory of natural selection by the careful statistical analysis of inherited characteristics among various species, notably in samples of crab *(Carcinus Moenas)* collected in Portsmouth Bay and the Bay of Naples, and later in the snail *Clausilia Laminata*.[9] Pearson defined the problems of heredity and biological variation in purely mathematical terms, insisting:

> Given any organ in a parent and the same organ in its offspring, the mathematical measure of heredity is the correlation of these organs for pairs of parent and offspring.[10]

The aim of much of his subsequent work was the development, and application, of statistical methods for the study of the problems of heredity and evolution, most particularly the testing of Galton's Law of Ancestral Heredity and the development of a theory regarding the influence of selection on the correlation and variability of organs.[11]

This was by its very definition a 'programme of work, too large for he himself to accomplish unaided', and Pearson therefore increasingly incorporated his biometric work into his teaching and research at UCL. For example, in October 1894 he launched a new lecture course on 'The Theory and Practice of Statistics' for those 'desiring to study animal variation, to deal with errors of physical variations or to become actuaries'.[12] These lectures were not delivered as part of Pearson's regular duties as Professor of Applied Mathematics, but were 'solely instituted because [he] was interested in developing a modern theory of statistics, and [his] own research work lay largely in that sphere'.[13] He also instituted a programme of research in the

[9] On Pearson and Weldon's work in this period see W.F.R.Weldon, 'An Attempt to Measure the Death-Rate due to Selective Destruction of *Carcinus Moenas* with Respect to a Particular Dimension', Proceedings of the Royal Society, 57 (1894-95), 360-79; W.F.R.Weldon, 'Presidential Address to Section D', Report of the British Association for the Advancement of Science (1898), 887-902; W.F.R.Weldon, 'A First Study of Natural Selection', Biometrika, 1 (1901), 109-24; E.S.Pearson, Karl Pearson, pp.24-31; Magnello, 'Pearson's Gresham Lectures', and Norton, 'Biometric Defence of Darwinism', pp.297-316.

[10] 'The word organ here must be taken to include any characteristic which can be quantitatively measured'. Karl Pearson, 'Mathematical Contributions to the Theory of Evolution. III. Regression, Heredity and Panmixia', Philosophical Transactions of the Royal Society of London, Series A, 187 (1896), 253-318.

[11] E.S.Pearson, Karl Pearson, p.27. See also Karl Pearson, Alice Lee, Ernest Warren, Agnes Fry, and Cicely Fawcett, 'Mathematical Contributions to the Theory of Evolution. IX. On the Principle of Homotyposis and its relation to Heredity, to the Variability of the Individual and to that of the Race, Part I. Homotyposis in the Vegetable Kingdom', Philosophical Transactions of the Royal Society of London, Series A, 197 (1901), 285-379.

[12] 'The Retirement of Karl Pearson', UCL Magazine (Summer 1933),166. See also, G.U.Yule, 'Summary of Subjects dealt with by Karl Pearson in his two Lecture Courses on the Theory of Statistics given at University College, London, during the Sessions 1894-95 and 1895-96', in E.S.Pearson, Karl Pearson, Appendix III, pp. 154-9.

[13] Karl Pearson, 'Report on the Galton and Biometric Laboratories Especially with Regard to their Income and Expenditure', c.1926-27, p.1, KP/UCL/233.

Department which was designed to extend his own work on the statistical analysis of biological variation and the theory of natural selection. The principal aim of much of this work was to test Pearson's theory of 'homotyposis' and measure 'the quantitative degree of resemblance to be found on the average between the like parts of organisms'.[14] Working within the parameters of this general problem, a number of separate research projects were undertaken by Pearson, his various assistants and research students, and the large number of volunteer workers who congregated in the Biometric Laboratory. Many of these investigations concerned the statistical analysis of inherited characteristics among successive generations of various biological species, including, for example, Shirley poppies, bees and wasps, various breeds of dog and cattle, and human beings.[15] Other work involved the measurement and comparison of skeletons and skulls in order to investigate the process of human evolution. For example, in 1895 Pearson, Yule, Ernest Warren, Alice Lee and Cicely Fawcett began working on a collection of skulls that had been brought back to the College from Upper Egypt by Flinders Petrie;[16] while other craniometric work involved the comparison of skull size and intellectual ability.[17]

It is highly significant that Pearson and his colleagues in the Biometric Laboratory developed a distinctive methodological approach to the study of evolutionary biology at UCL in this period. Although Galton and others had previously applied statistical methods to the study of biological problems, Pearson and Weldon's conceptualisation of the problem of natural selection in population

[14] Pearson et al, 'Mathematical Contributions IX. On the Principle of Homotyposis'.

[15] See, for example, Karl Pearson, 'Cooperative Investigations on Plants. I. On Inheritance in the Shirley Poppy', Biometrika,2 (1902), 66-100; Karl Pearson, Alexandra Wright and Alice Lee, 'A Cooperative Study of Queens, Drones and Workers in "Vespa Vulgaris"', Biometrika, 5 (1907), 407-22; Karl Pearson, Amy Barrington and Alice Lee, 'On the Inheritance of Coat-Colour in the Greyhound', Biometrika, 3 (1904), 245-98; Karl Pearson and Amy Barrington, 'On the Inheritance of Coat-Colour in Cattle. I. Shorthorn Crosses and Pure Shorthorns', Biometrika, 4 (1906), 427-64; Karl Pearson and M.A.Whitely, 'Data for the Problem of Evolution in Man. I. A First Study of the Variability and Correlation of the Hand', Proceedings of the Royal Society of London, 65 (1899), 126-51, and Karl Pearson and Mary Beeton, 'Data for the Problem of Evolution in Man. II. A First Study of the inheritance of Longevity and the Selective Death-rate in Man', Proceedings of the Royal Society of London, 65 (1899), 290-305. For a complete list of Pearson's publications in this period see Morant, Bibliography of the Writings of Karl Pearson.

[16] Ernest Warren, 'An Investigation on the Variability of Human Skeletons with special reference to the Naqada Race discovered by Professor Flinders Petrie in his Explorations in Egypt', Philosophical Transactions of the Royal Society of London, Series B, CLXXXIX (1898),135-227; Karl Pearson, Cicely D.Fawcett and Alice Lee, 'A Second Study of the Variation and Correlation of the Human Skull, with special reference to the Naqada Crania', Biometrika, I (1902), 408-67.

[17] See, for example, Alice Lee, 'Data for the Problem of Evolution in Man. A First Study of the Correlation of the Human Skull', Philosophical Transactions of the Royal Society of London, Series A, 196 (1902), 225-64.

terms, and determination to investigate the question using rigorous mathematical-statistical techniques made them unique among their colleagues working in the field of evolutionary biology.[18] The methodological approach pioneered in the school was also very different from the dominant Mendelian approach to the analysis of biological variation and heredity, which was championed by William Bateson and his colleagues in Cambridge. While the biometricians held that natural selection was a 'continuous' process, acting upon the slightest of differences between successive generations of particular species, Bateson and his disciples maintained that evolution was 'discontinuous' and was due entirely to the sudden appearance of variant individuals.[19] The fundamental theoretical and methodological differences between the two schools involved the biometricians in a protracted and extremely acrimonious dispute with the Mendelians.[20] The rivalry between the two schools was crucial to the long term growth and development of the Department of Applied Mathematics and Statistics at UCL. For example, in 1900 following a lengthy debate over the membership of the Royal Society Committee for Conducting Statistical Inquiries into Measurable Characteristics of Plants and Animals, Pearson, Weldon and Galton were forced to resign. As Farrall explains, this 'represented a withdrawal of facilities and approval from the incipient speciality', and the biometricians were subsequently forced to establish their own independent organs and institutions, thereby consolidating the identity of the school.[21] Moreover, as Egon Sharpe Pearson explains, the dispute with the Mendelians also heightened the strong *espirit de corps* that existed within the school:

> There runs . . . through the written accounts and the memories of these years a spirit of comradeship in battle, whether against the assaults of human foes or the perverseness of Nature, unwilling to disclose her Laws.[22]

[18] Farrall, 'Controversy and Conflict in Science', p.283.
[19] Ibid, p.282; Norton, 'Biometric Defence of Darwinism', pp.293-7. See also, William Bateson, Materials for the Study of Variation, Treated with Special Regard to the Discontinuity in The Origin of Species (London: Macmillan, 1894), and William Bateson, Mendel's Principles of Heredity: A Defence (Cambridge: Cambridge University Press, 1902). Bateson's work and ideas are discussed in more detail in William Coleman, 'Bateson and Chromosomes, Conservative Thought in Science', Centaurus, 15 (1970), 228-314.
[20] The dispute is discussed in more detail in Froggatt and Nevin, 'Law of Ancestral Heredity'; Farrall, 'Controversy and Conflict in Science', pp.22-98; Norton, 'Biology and Philosophy'; Bernard Norton, 'Metaphysics and Population Genetics: Karl Pearson and the Background to Fisher's Multi-factorial Inheritance', Annals of Science, 32 (1975), 537-53, and E.S.Pearson, Karl Pearson, pp.34-42.
[21] Farrall, 'Controversy and Conflict in Science', p.287.
[22] E.S.Pearson, Karl Pearson, pp.34-42.

In many ways, the most important work conducted in the Department was statistical. The underlying aim of all Pearson's work was to make statistics a mathematically and scientifically rigorous discipline - 'a serious branch of science, which no man could use effectively without adequate training' - and this, too, came to be recognised as the intellectual property of his school.[23] In the course of his work with Weldon in the 1890s Pearson devised a number of important new statistical methods and techniques, which were later used routinely in both the Biometric and Eugenics Laboratories. By 1900 he had not only established methods to measure linear relationships for continuous variables, but had also begun to develop techniques for measuring relationships for discrete variables, such as the phi-coefficient and tetrachoric correlation.[24] These statistical methods and techniques were devised and developed almost as a sideline to his biometric work, as he tried to solve particular problems. For example, Pearson's earliest statistical ideas on skew curves grew out of his work with Weldon on shrimps and crabs,[25] and his later researches on the revised law of ancestral heredity prompted his ground breaking work on simple and multiple regression and correlation theory.[26] Norton has therefore described biometry as the 'midwife of statistics',[27] and most historians trace the origins of the modern theory of mathematical statistics and the emergence of statistics as an independent academic discipline to the school.[28]

[23] Pearson, 'History of the Biometric and Galton Laboratories', p.1, KP/UCL/247.

[24] According to Magnello, Pearson had devised 17 different correlational methods by 1918. The principal statistical methods used in the Biometric Laboratory involved curve-fitting and goodness of fit testing. Pearsonian methods of measuring correlation and regression were also used, in addition to his standard deviation and coefficient of variation, but the most commonly used technique was his chi-square goodness of fit test. His statistical techniques and innovations are discussed in more detail in Magnello, 'Non-Correlation', pp.91-4, Magnello, 'Pearson's Mathematization of Inheritance', and Stigler, History of Statistics, pp.326-58.

[25] Pearson, 'Contributions to the Mathematical Theory of Evolution'; Karl Pearson, 'Contributions to the Mathematical Theory of Evolution. II. Skew Variation in Homogeneous Material', Philosophical Transactions of the Royal Society of London, Series A, 186 (1895), 343-414.

[26] Karl Pearson, 'Mathematical Contributions to the Theory of Evolution. III. Regression, Heredity and Panmixia', Philosophical Transactions of the Royal Society of London, Series A, 187 (1896), 253-318; Karl Pearson and L.N.G.Filon, 'Mathematical Contributions to the Theory of Evolution. IV. On the Probable Errors of Frequency Constants and on the Influence of Random Selection on Variation and Correlation',Philosophical Transactions of the Royal Society of London, Series A, 191 (1898), 229-311.

[27] Norton, 'Social Studies of Science', p.6.

[28] As Stephen Stigler concludes, 'there was no sharp moment of birth; but with Pearson and Yule and the growing number of students in Pearson's laboratory, the infant discipline may be said to have arrived'. Stigler, History of Statistics, p.361.

Much of the work conducted in the Department concerned more traditional problems in the field of mathematical physics and statistics, such as the stability of masonry dams for water reservoirs, the design of railway and crane coupling hooks, and the stresses and deflections observed in different types of bridge.[29] The staff of the Biometric Laboratory were 'always prepared to give aid and advice in researches connected with biological statistics and problems in heredity',[30] and they 'constantly' received requests for 'statistical aid' from external bodies and individual investigators. For example, during the academic session 1903-04 Pearson and his colleagues published reports on time fuses for the Royal Artillery,[31] on the cancer statistics of the Cancer Research Laboratory,[32] and on the effects of inoculation against enteric fever among British soldiers serving in India and South Africa.[33] Later the Department and its staff were put at the service of the government for 'work in the national cause' during the First World War, and Pearson and his colleagues rendered 'very valuable assistance' to the Ministry of Munitions in carrying out various investigations concerning, for example, the measurement of stresses in aeroplane propellers and the calculation of gun trajectories.[34] The biometricians were also involved in the preparation of a series of tables for mathematical statistics, designed to 'reduce the labour of statistical arithmetic' by enabling the user to draw general conclusions from observational data in terms of probabilities. These tables were published periodically in *Biometrika*, and collected together in a separate volume of *Tables for Statisticians and Biometricians* in 1914.[35]

[29] KP to Foster, 26 November 1904, KP/UCL/233. See, for example, Karl Pearson and E.S.Andrews, On a Theory of the Stresses in Crane and Coupling Hooks with Experimental Comparison with Existing Theory, *Drapers' Company Research Memoirs. Technical Series I* (Cambridge: Cambridge University Press, 1904), and Karl Pearson, A.F.Campbell-Pollard, C.W.Wheen, and L.F.Richardson, An Experimental Study of the Stresses in Masonry Dams, *Drapers' Company Research Memoirs. Technical Series V* (Cambridge: Cambridge University Press, 1907).

[30] Prospectus 1910 -11, KP/UCL/248.

[31] KP to Foster, 26 November 1904.

[32] Karl Pearson, 'Report on Certain Cancer Statistics of Mssrs W.T.Hillier and I.Tritsch of the Cancer Research Laboratories, Middlesex Hospital', Archives of the Middlesex Hospital, 2 (1904), 127-37.

[33] Karl Pearson, 'Report on Certain Enteric Fever Inoculation Statistics', British Medical Journal, 2 (1904), 1243-6.

[34] R.H.Bacon (Vice-Admiral and Controller, Munitions Inventions, Ministry of Munitions) to KP, 14 February 1918, reproduced in Pearson, 'Report to the Drapers on the Present Position and Past History of the Laboratories', p.8, KP/UCL/233.

[35] Karl Pearson, ed., Tables for Statisticians and Biometricians (Cambridge: Cambridge University Press, 1914). The development of mathematical tables for use in problems relating to mathematical statistics is discussed in A.C.Warwick, 'The Laboratory of Theory or What's Exact about the Exact Sciences?', in M.Norton Wise, ed., The Values of Precision (Princeton: Princeton University Press, 1995).

Pearson and his co-workers also developed a distinctive approach to the study of craniometry in the Biometric Laboratory in this period. In 1895 Pearson, Yule and Lee had calculated the 'constants of variability' - the characteristic features of the human skull which could be measured and compared with other skulls, in order to investigate racial differences and the process of human evolution.[36] Subsequent work involved the measurement and comparison of the cephalic index, which was obtained by dividing the breadth of a skull by its length.[37] A range of instruments were developed and utilised in the Laboratory to obtain craniometric measurements, including a Broca Osteometer, a Hepburn Osteometer, callipers of various kinds, a modified Klaatsch cranial contour tracer, a torsiometer, and a special camera with a Goerz astigmatic lens;[38] and in the 1920s Pearson and his colleagues devised an ingenious method, involving the comparison of silhouettes traced from photographs, for use in their craniometric work.[39]

However, the Department of Applied Mathematics and Statistics at UCL is probably more famous - or perhaps infamous - for Pearson's work on eugenics; and in this period, his school also came to be recognised as 'the principal source of authoritative eugenic science . . . [and] sole British establishment for eugenic research'.[40] Although he occasionally endorsed some of the more radical aspects of Sir Francis Galton's programme,[41] it should be stressed that Pearson championed a rather more moderate and scientifically rigorous approach to the subject than most historians and critics allow - insisting that there could be 'no safe progress in eugenics' unless it was based on 'sound statistical theory; and on quantitative study of both heredity and

[36] Karl Pearson, The Chances of Death and Other Studies in Evolution Volume I (London: Edward Arnold, 1897), pp.256-7.

[37] Karl Pearson and Cicely D.Fawcett, 'Mathematical Contributions to the Theory of Evolution. On the Inheritance of the Cephalic Index', Proceedings of the Royal Society of London, 62 (1898), 413-17.

[38] Karl Pearson and Julia Bell, A Study of the Long Bones of the English Skeleton. Part 1: The Femur, *Drapers' Company Research Memoirs. Biometric Series X* (Cambridge: Cambridge University Press, 1919), p.3.

[39] Karl Pearson with Ida McLearn and G.M.Morant, 'On the Importance of the Type Silhouette for Racial Characterisation in Anthropology, Biometrika, 20B (1928), 389-400.

[40] Kevles, In the Name of Eugenics, p.40.

[41] See, for example, Pearson, Scope and Importance, pp.24-37.

environment'.[42] Pearson's aim was merely to 'explore scientifically the theories - particularly those regarding the relative weights of nature and nurture - on which a sound eugenic policy should be built', by examining 'everything that contributed to human character . . . under the statistical microscope'.[43] The Galton Eugenics Laboratory was therefore conceived of as a postgraduate research institute in which Pearson and his co-workers would investigate the influence of heredity and the environment on national and social welfare, through the observational study of heredity in man and the experimental study of heredity in animals.[44] The routine work of the Laboratory involved the continuous collection of family histories, which were to be published in a thesaurus of family pedigrees of pathological, physical and mental characteristics.[45] To form an effective pedigree it was necessary to make 'inquiries in all parts of the country, possibly abroad, and to journey about seeing innumerable people . . . often in strange environments'. Contact was made with Medical Officers of Health in large towns throughout the country, the staff of hospitals, schools and other institutions, and the members of various voluntary and philanthropic associations, and they provided raw data which was subsequently reduced by the staff of the Eugenics Laboratory. The results were eventually published in the *Treasury of Human Inheritance,* which appeared in three volumes beginning in March 1910 and ending in 1930.[46] The staff of the Laboratory also examined the inheritance of particular conditions, traits and characteristics, and investigated various 'Questions of the Day and of the Fray', notably the incidence of pulmonary tuberculosis, the inheritance of insanity and 'feeble-mindedness', and the 'Influence of

[42] Karl Pearson, 'History of the Biometric and Galton Laboratories' (1920), KP/UCL/247.
[43] KP to Francis Galton, 14 October 1908, quoted in Kevles, In the Name of Eugenics, p.34.
[44] 'Codicil to the Will of Sir Francis Galton', Pearson, Galton, pp.437-8.
[45] Karl Pearson, 'Report to the Galton Laboratory Committee on the Work of the Francis Galton Laboratory for National Eugenics, February 1908 - June 1909', p.4. KP/UCL/235.
[46] Karl Pearson, 'On the Inheritance of Mental Disease. Being a Lecture delivered in the Galton Lab-oratory on March 20, 1930, to the Staff of the Board of Control', Annals of Eugenics, 4 (1932), 362-80. See also K.Pearson, *The Treasury of Human Inheritance* issued by the Francis Galton Laboratory for National Eugenics, *Drapers' Company Research Memoirs. Studies in National Deterioration I* (Cambridge: Cambridge University Press, 1910), and Magnello, 'Non-correlation', pp.127-31.

Parental Alcoholism on the Physique and Ability of the Offspring',[47] while other investigations concerned the inheritance of visual problems, dwarfism, albinism in man, and the 'Deformity known as Split-Foot or Lobster Claw'.[48]

Pearson also developed some new statistical techniques in the course of his work in the Eugenics Laboratory. For example, in 1913 he introduced and correctly fitted the model of quasi-independence to an incomplete contingency table, in the course of a cooperative investigation into 'The Correlation of Fertility with Social Value' undertaken by Pearson and five of his junior colleagues, including the Oxford undergraduate Harold Laski.[49] But 'in the years following the foundation of the Eugenics Laboratory Pearson made few major contributions to statistical theory'.[50] He derived his methodological approach in eugenics directly from Galton, and the Eugenics Laboratory was much less innovative in terms of the methods and techniques employed.[51] The work of the staff of the Laboratory consisted primarily of the construction and analysis of family pedigrees. These were simple family tree diagrams showing networks of kinship across several generations of the same family, consisting of as many as 400 ascendants and collaterals, and 'demonstrating inheritance of defect in terms of the biological connections within a social class'.[52]

[47] See, for example, Karl Pearson, A First Study of the Statistics of Pulmonary Tuberculosis, *Drapers' Company Research Memoirs. Studies in National Deterioration II* (Cambridge: Cambridge University Press, 1907); David Heron, A First Study of the Statistics of Insanity and the Inheritance of the Insane Diathesis *Eugenics Laboratory Memoirs II* (Cambridge: Cambridge University Press, 1907), and Ethel M.Elderton and Karl Pearson, A First Study of the Influence of Parental Alcoholism on the Physique and Ability of the Offspring, *Eugenics Laboratory Memoirs X*(London: Dulau, 1910).

[48] Karl Pearson and Amy Barrington, A First Study of the Inheritance of Vision and the Relative Influence of Heredity and Environment on Sight, *Eugenics Laboratory Memoirs V* (Cambridge: Cambridge University Press, 1909); H.Rischbieth, Amy Barrington and Karl Pearson, Treasury of Human Inheritance. Parts VII and VIII. Section XV a. Dwarfism, *Eugenics Laboratory Memoirs XV* (Cambridge: Cambridge University Press, 1912); Karl Pearson, E.Nettleship and C.H.Usher, A Monograph on Albinism in Man. Part I, *Drapers' Company Research Memoirs. Biometric Series VI* (Cambridge: Cambridge University Press, 1911); Karl Pearson, 'On the Inheritance of the Deformity known as Split-Foot or Lobster Claw', Biometrika, 6 (1908), 69-79.

[49] Ethel M.Elderton, Amy Barrington, H.Gertrude Jones, Edith M.M.De G.Lamotte, H.J.Laski and Karl Pearson, On the Correlation of Fertility with Social Value. A Cooperative Study, *Eugenics Laboratory Memoirs XVIII* (London: Dulau,1913). See also Stephen M.Stigler, 'Studies in the History of Probability and Statistics XLIII. Karl Pearson and Quasi-Independence', Biometrika, 79 (1992), 563-75.

[50] E.S.Pearson, Karl Pearson, p.69.

[51] Magnello explains the Laboratory was already up and running when Pearson took over, and he did not have time to develop completely new methods. In any case, he considered the less sophisticated methods of the Laboratory entirely appropriate to its work. Magnello, 'Non-Correlation', p.125.

[52] Pearson, 'Inheritance of Mental Disease', pp.103-4; Mazumdar, Eugenics, p.87.

However, Pearson and his colleagues did develop 'special methods of forming, drawing and engraving pedigrees, and of briefly describing the character of individuals'.[53] Moreover, although Galton assumed that the hereditary transmission of 'defects' of various kinds was 'made obvious at a glance',[54] Pearson and his co-workers then used simple statistical techniques - and some of the more sophisticated methods devised in the Biometric Laboratory (such as Pearson's product-moment correlation coefficient, the point-biserial correlation coefficient, the tetrachoric correlation coefficient, the phi-coefficient and the chi-square goodness of fit test) - to analyse the data with a view to establishing the 'average degree of resemblance of kinship'.[55]

Finally, although Pearson tried to distance himself from the political wing of the eugenics movement, one should also note that there was also a significant propaganda element to the work of the Galton Laboratory. Pearson and his colleagues gave illustrated talks and public lectures on their work at venues all over the country, and published a regular series of papers 'which place[d] in a simpler form the results of research work conducted in the Laboratory'.[56] As Geoffrey Searle has demonstrated, in its Edwardian heyday 'eugenics was by no means a peripheral concern, appealing to a small coterie of enthusiasts and cranks'.[57] These talks were attended by politicians, civil servants, medical men, social workers, teachers, journalists and other eminent figures and architects of public opinion, and the wider socio-political impact of the work of the Laboratory was crucially important in enabling Pearson to attract staff, students, and, perhaps even more importantly, funding. Moreover, it was principally thus that Pearson and his colleagues were able to establish research on the 'science of national eugenics' as the intellectual property of the staff and students of the Department of Applied Mathematics and Statistics at University College London.

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[53] 'Report on the Work Done Owing to the Grant made by the Drapers (1903-9)', p.7, KP/UCL/233.
[54] Mazumdar, Eugenics, p.87.
[55] Occasionally, the Galton research workers also used instruments and rooms belonging to the Biometric Laboratory, and provision was made for them to be trained and assisted by biometricians. Magnello, 'Non-Correlation', pp.125-33.
[56] Pearson, 'Report to the Galton Laboratory Committee' 1909, p.4, KP/UCL/235. See, for example, Karl Pearson, The Groundwork of Eugenics, *Eugenics Laboratory Lecture Series II* (London: Dulau, 1909), and Karl Pearson, The Problem of Practical Eugenics, *Eugenics Laboratory Lecture Series V* (London: Dulau, 1909).
[57] Searle, Eugenics and Politics, pp.2,11-13,107-8. See also, Geoffrey Searle, 'Eugenics and Politics in Britain in the 1930s', Annals of Science, 36 (1979), 159-69.

The Department of Chemistry

William Ramsay's work in the Department of Chemistry was equally distinctive and original, but, as we saw in Chapter Five, in his case the origins of his school are to be found in his personal determination to establish a major school of chemical research in London - the specific programme of research around which the school developed came later. By the time of his appointment to the Chemistry Chair at UCL, Ramsay was the acknowledged leader of a very small band of British scientists involved in the experimental study of gases and vapours. In fact, with the one exception of his old laboratory in Bristol, which was now presided over by Sydney Young, the Department of Chemistry at UCL was the one place in the country where students could receive expert instruction in the investigation of gas and vapour phenomena, and participate in a major programme of research into the behaviour and properties of gases.[58] During the first phase of his career at University College, he continued to pursue the physio-chemical investigations which had occupied his attention in Bristol, focussing in particular on the analysis of the critical states of liquids and vapours. Subsequent researches involved the study of 'pseudo-solutions', molecular association and disassociation, and the molecular weights of metals.[59] But it was his remarkable work on the gases of the atmosphere that made Ramsay's name, and consolidated the identity and position of his school. This work also led to the development of a distinctive technique for dealing experimentally with extremely small quantities of gases and vapours, which rapidly came to be associated with the Chemistry Department at UCL, and led on directly to much of the research undertaken by the staff and students of the Department over the next 20 years.

This project had its origins in Lord Rayleigh's work on the relative densities of various gases, and his discovery that the density of nitrogen obtained from the atmosphere was always greater than that of nitrogen obtained from its chemical compounds.[60] With Rayleigh's permission, Ramsay determined to find out why, and

[58] Watson, 'Aspects', pp.74-6.
[59] Travers, Ramsay at UCL, pp.7-10; Travers, Life, pp.88-97.
[60] John William Strutt Rayleigh, 'Density of Nitrogen', Nature, 46 (1892), 512-3; Travers, Life, pp.100-2.

in the summer of 1894 he established that the progressive removal of nitrogen from air concentrated in the residue an unknown, chemically inert gas, which he christened 'argon'.[61] Ramsay realised that if there was one inert gas, there ought to be others, and he and his junior colleagues launched 'an intensive research for the missing gas[es]'.[62] The eventual result was the discovery of helium in 1895, and neon, krypton and xenon in 1898. Like argon, these gases were all colourless, odourless, monatomic, chemically inert and non-valent. They are known collectively as the noble gases, and make up an entire column of the periodic table of elements.[63] From 1894 onwards the researches carried out in the chemistry laboratories at UCL focussed mainly (but not exclusively) on the noble gases and their properties. Research in this field quickly came to be recognised by chemists throughout the world as the 'intellectual property' of Ramsay's school. He and his pupils determined all the physical properties of the new gases, and they were collectively responsible for producing nearly 70% of the papers dealing with the rarer gases (neon, krypton and xenon) that were published between 1903 and 1912. For ten years after its discovery in 1898 the world's entire supply of pure neon was contained in two small tubes on Ramsay's desk at UCL, and by the time of his death in 1916 krypton and xenon had never been prepared outside his Laboratory. Chemists who had not been trained by Ramsay simply lacked the experimental technique to obtain samples of the rarer noble gases, and those who wished to work with neon, krypton or xenon either borrowed samples directly from Ramsay or enlisted the help and assistance of one of his pupils.[64]

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[61] John William Strutt Rayleigh and William Ramsay, 'Argon, A New Constituent of the Atmosphere', Philosophical Transactions of the Royal Society, 185A (1895), 187-241. Ramsay's correspondence and papers relating to the discovery of argon have been collected together in UCL/WR/7. See also William Ramsay, The Gases of the Atmosphere (London: Macmillan, 1896), Morris W.Travers, The Discovery of the Rare Gases (London: Edward Arnold, 1928), and Travers, Life,pp.102-32. The reaction to the discovery and its implications are discussed in Richard F.Hirsch, 'A Conflict of Principles: The Discovery of Argon and the Debate over its Existence', Ambix, 28/3 (1981), 121-30.

[62] Travers, Life, p.160.

[63] William Ramsay and Morris W.Travers, 'Argon and its Companions', Philosophical Transactions of the Royal Society, 197A (1901), 47-89. Ramsay's correspondence and papers relating to the discovery of helium, neon, krypton and xenon are to be found in UCL/WR/8-10. See also, Travers, Life, pp.133-93.

[64] Watson, 'Aspects', p.125. See for example, F.W.Aston and H.E.Watson, 'On the Relation Between Current, Voltage, Pressure and the Length of the Dark Space in Different Gases', Proceedings of the Royal Society, 86 (1912), 168-80.

The techniques devised and employed by Ramsay and his students in the course of their work on the noble gases were subsequently applied to a body of related problems - including the analysis of radium and its emanation and the transmutation of the elements - and the specific identity and reputation of his school was therefore consolidated. Ramsay's work on radium and atomic structure had its origins in Ernest Rutherford and Frederick Soddy's work on radioactivity and sub-atomic change at the McGill University of Montreal. Their results suggested that the emanation which radioactive compounds 'emitted continually into the surrounding atmosphere under ordinary conditions . . . possessed the property of inertness which characterises the gases of the argon family'.[65] At this point in time Ramsay's Laboratory at UCL was the only place in the world where the techniques required to deal experimentally with the minute quantity of radioactive gas available existed. Soddy therefore gave up his appointment at McGill and travelled to London to continue his work in collaboration with Ramsay. Within a year they had proved that helium is indeed a product of the disintegration of radium.[66] This discovery led Ramsay to the conclusion that 'radio-active changes might be made use of to effect the transmutation of the common elements'. He believed that by using radium energy in an enormously concentrated form, 'fundamental changes might be produced in normal elementary atoms', indeed that it might even be possible 'in the near future, to change some elements into some others'.[67] Ramsay therefore instigated a programme of research in his school designed to test the effects of radium and its emanation on various substances and compounds.[68] On the suggestion of his friend Sir Thomas Lauder-Brunton, he also carried out a series of experiments with E.H. Starling (his colleague in the Jodrell Chair of Physiology) on

[65] Ernest Rutherford and Frederick Soddy, 'The Radioactivity of Thorium Compounds, II: The Cause and Nature of Radioactivity', Journal of the Chemistry Society, 81 (1902), 859-60.
[66] Correspondence and papers relating to Ramsay's work on radium are included in UCL/WR/13 and UCL/WR/14. This work is discussed in more detail in Travers, Life, pp.209-21.
[67] Manuscript of lecture on 'Transmutation' delivered by Ramsay at the Royal Institution on 25 or 28 January 1907, UCL/WR/14/1, pp.105-20.
[68] See, for example, A.T.Cameron and W.Ramsay, 'The Chemical Action of the Radium Emanation. Part II. On Solutions Containing Copper and Lead, and on Water', Journal of the Chemistry Society, 91 (1907), 1593-1606, and J.N.Collie and H.S.Patterson, 'The Presence of Neon in Hydrogen after the Passage of the Electric Discharge through the Latter at Low Pressures', Journal of the Chemistry Society, 103 (1913), 419-26. Ramsay's work on 'Atoms, Molecules and Transmutations' is discussed in more detail in Travers, Life, pp.251-64; A.T.Cameron, Radiochemistry (London, 1910), pp.109-37, and Thaddeus J.Trenn, 'The Justification of Transmutation: Speculations of Ramsay and Experiments of Rutherford', Ambix, 21 (1974), 53-77.

the use of the radium emanation in the treatment of cancer, and for many years Ramsay's laboratory at UCL was the only source of radioactive products for this purpose.[69] Subsequent work concerned the attempt to determine the atomic weight, density and properties of radium and radon, and involved the development of experimental methods which made it possible to work with quantities of gas which were minute, even compared with those which had been dealt with in previous researches.[70]

Katherine Watson has therefore argued that the core programme around which Ramsay's school developed involved the design, development and use of a set of revolutionary techniques for dealing experimentally with very small quantities of gases and vapours, and not the investigation of a particular set of research problems. Although the discovery of the inert gases was a remarkable achievement, the success of the school was built on the basis of these techniques, rather than a particular programme of research. Ramsay's work on radium and the noble gases was just part of 'a wider process of developing and perfecting a number of intricate techniques of gas manipulation, which themselves formed the basis of several smaller research programmes':

> [His] principal research programme concerned the noble gases, but his school began to form earlier, around a set of specialised techniques of gas manipulation. In effect, the development and refinement of those techniques were Ramsay's lifelong research programme: the discovery of the noble gases, together with the studies of vapour pressures and densities and all of Ramsay's other research topics, were a consequence of the role of those techniques in shaping the directions which his research took.[71]

As we have already seen, Ramsay's interest in the behaviour and properties of gases and vapours made him unique among British chemists in this period, but it was not only the subject of his work that was unusual, the methods and techniques employed were also unique to his laboratory.

As his pupil and successor in the Chair of Inorganic Chemistry at UCL, Frederick Donnan, recalls, 'Ramsay was the possessor of a most wonderful skill and dexterity in the devising, constructing and use of apparatus for the delicate and exact investigation of gases'. He developed the techniques of gas manipulation to the

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[69] Travers, Life, pp.227-30.

[70] Robert Whytlaw-Gray and William Ramsay, 'The Density of Niton ("Radium Emanation") and the Disintegration Theory', Proceedings of the Royal Society, 84 (1911), 536-50; Robert Whytlaw-Gray and William Ramsay, 'The Atomic Weight of Radium', Proceedings of the Royal Society, 86 (1911-12), 270-90. See also UCL/WR/15 and Travers, Life, pp.265-73.

[71] Watson, 'Aspects', pp.20-5.

'ultimate pitch of perfection'.[72] Ramsay continually devised new techniques to meet the needs of his research, and his investigations were 'never halted by the lack of an existing method'. Moreover, 'all of his techniques were characteristic to the members of his school; at least at first they were not commonly used by any chemists other than those he personally had trained'.[73] Ramsay's methods were frequently cited and described in academic textbooks, but these techniques - and the more routinely used (but no less distinctive) methods that Ramsay devised for manipulating and measuring gases and vapours in extremely small quantities, for designing and building apparatus,[74] and also for carrying out more general experimental procedures - were 'largely a matter of experience and know-how', and depended on the passing on of tacit knowledge:

> No one could get a full picture of the skill and delicacy of technique that Ramsay was known for, apart from those who had actually worked with him . . . . Textbooks and published accounts cannot take the place of the familiarity gained by observation and practice. In Ramsay's case, several of his techniques did come into general use, but many others did not, and remained a set of specialized and highly complex methods that were shared by the members of [his] research school.[75]

These techniques therefore came to be recognised as the intellectual property of the members of Ramsay's school, and students of gas chemistry were drawn to the Chemistry Department at UCL from universities and colleges all over the world. This was the principal reason for the growth and expansion of Ramsay's school in the 1890s and early years of the twentieth century. By 1895 his laboratory was seen by potential students as the best school of gas related chemistry in Britain. Talented graduates flocked to UCL in order to apprentice themselves to Ramsay, and by 1908 the College Council was having to turn prospective chemistry postgraduates away because there was not enough room to accommodate them in the Department.[76]

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[72] Donnan, 'Ramsay', pp.444-6. Similarly, Norman Collie insists: 'Can any praise be adequate for the discoverer who detects and isolates one part of a substance in about 170 million parts of the medium in which it occurs? Yet this is what Ramsay had done when he isolated xenon from the air'. J.N.Collie, A Century of Chemistry at University College (London: University College London, 1928), p.21.

[73] Watson, 'Aspects', pp.74-5.

[74] Ramsay's laboratory was particularly unusual in this respect. He was insistent that 'the building of required apparatus should not be the responsibility of a technician but of the chemists who used it. To that end, glass blowing played an important role in his work, as much of the apparatus that he used he designed and constructed himself'. Ibid, pp.34-5.

[75] Ibid, pp.82-5.

[76] Reports 1909, p.35.

Ramsay's pupils and junior colleagues were expected to assist him with his work on the noble gases, radium and the transmutation of the elements, but they were also encouraged to conduct their own independent experiments and investigations. As Katherine Watson explains, Ramsay 'did not overwhelm his "disciples" so much as he allowed them to find their own niche in the chemical community'.[77] As the school grew, the scope of its work therefore widened beyond the narrow focus of his own work in the field of gas chemistry. For example, E.C.C. Baly's principal interests lay in the field of spectroscopy. As an undergraduate and postgraduate student in the Department in the 1890s he carried out a series of investigations on the emission spectra of the rare gases, and went on to establish a spectroscopic laboratory at University College. He was appointed University of London Lecturer in Spectroscopy in 1903, by which time his attention had turned to the selective absorption spectra of organic compounds in liquid systems.[78] In the previous year Norman Collie had returned to the College as Professor of Organic Chemistry, having spent six years as Professor of Chemistry at the Pharmaceutical College in London. During the course of his long career at UCL, Collie published more than 75 papers. His most important work concerned the action of heat on organic materials and gases, the structures and reactions of dehydroacetic acid, and the role of polyketomethylene compounds in biosynthesis. He also constructed the first neon lamp, and pioneered the use of x-ray photography for surgical purposes in this country.[79] The establishment of Baly's spectroscopic laboratory and growth of interest in organic chemistry after Collie returned to the College contributed not only to a remarkable increase in the output of original papers and other publications, but also to the growing diversification of the work of the school (see table 7.1). In this period, the Chemistry Department at UCL therefore became renowned as a centre for teaching and research in fields other than gas chemistry, particularly as Ramsay was able to devote less time to the work of the laboratory as his consultative and

[77] Watson, 'Aspects', p.134.
[78] Ibid, pp.57-9.
[79] On Collie see Ronald Bentley, 'Norman Collie: Chemist and Mountaineer', Journal of Chemical Education, 76/1 (1999), 41-7, and Christine Mill, Norman Collie: A Life in Two Worlds: Mountain Explorer and Scientist 1859-1942 (Aberdeen: Aberdeen University Press, 1987.

Table 7.1 Departmental Publication Patterns (1891-1913)

	Total Number of Papers	Papers on Gases	Papers on Noble Gases
1891-1900	111	45 (40.5%)	27 (24.3%)
1901-1913	359	71 (19.2%)	43 (12.8%)

(*Source:* Katherine D. Watson, 'Aspects of a Career in Science: Sir William Ramsay and the Chemical Community, 1890-1915' (Unpublished D. Phil. Thesis, Oxford, 1994), p.135).

administrative work increased from about 1904 onwards.[80] By the time of his retirement in 1913 Ramsay was therefore the director of a flourishing research department, made up of a number of semiautonomous, but interdependent, research schools; and in 1915 his colleagues and successors moved into an elaborate new building complete with facilities for teaching and research in all aspects of organic, inorganic, physical and pathological chemistry.

The Department of History

Methodology was also crucial in the History Department. During his tenure in the Chair of Constitutional and English History, A.F. Pollard and his colleagues developed a distinctive methodological approach to the study of history and the training of postgraduate historians, centring on the seminar - or 'London' - system. The emphasis that Pollard placed on archival research and semi-formal gatherings of scholars working on different aspects of a particular historical topic or theme made the London history school unique in Britain in this period; and in the years preceding the outbreak of the First World War these methodological innovations gave the Department of History at UCL its 'specific identity' and reputation. Graduate historians were therefore drawn to the College and the regular Thursday evening conference of historians and archivists - and later to the IHR - and this approach to the training of professional historians eventually became the dominant mode of historical education in university history departments throughout the country.

The development of a distinctive *programme* of research appears to have been less significant than in the Departments of Applied Mathematics and Chemistry. By the time of his appointment to the Chair of Constitutional History, Pollard had already established himself as a specialist in the fields of Tudor and constitutional history. During his years as assistant editor of the *Dictionary of National*

[80] Travers, Introduction to UCL/WR/12, p.11; Watson, 'Chemist as Expert', p.156.

Biography, he had published two biographical volumes on Protector Somerset and Henry VIII,[81] and produced more than 30 articles and reviews which had appeared in the *English Historical Review*. In making his application for the Chair of Constitutional Law, Pollard had tentatively explained that 'should circumstances permit [his] undertaking unrenumerative research, it [was his] hope and intention to attempt some more detailed exposition than ha[d] yet been published of the working of the English constitution from the sixteenth century onwards',[82] and during the course of his long career at UCL he published a series of works on Parliamentary and constitutional history. A number of the students who passed through the History Department in this period also did interesting and important work in this field. By 1918 they had produced fourteen M.A. dissertations, one doctoral thesis and ten journal articles dealing with fourteenth to early seventeenth century English history.[83]

However, with the growth and expansion of the Department and the establishment of an intercollegiate London history school, Pollard's students were given the opportunity to investigate more diverse fields and aspects of English history. As a result, the study of Tudor history and the history of Parliament never came to be recognised as the intellectual property of the members of Pollard's school, in the way that the study of the noble gases was regarded as being the exclusive preserve of Ramsay and his colleagues in the Chemistry Department. Nor was that Pollard's intention. As he explained in his inaugural lecture, the London history school was conceived of as a centre for teaching and research on various aspects of English history, especially imperial, military and naval history, contemporary history and the history of London. But Pollard also advocated an attempt to 'broaden the meaning and increase the uses' of history:

> For history should record the whole life and not merely the political life of nations; it should devote as much space to the evolution of thought as to the development of events . . . . I should like to see a History which gave as much space, for instance, to the story of the foundation of the Royal Society as to the Popish Plot, as much to the discoveries of Joseph Priestley as to the speeches of Edmund Burke.[84]

[81] A.F.Pollard, England Under Protector Somerset (London: Kegan Paul and Co., 1900); A.F.Pollard, Henry VIII (London: Kegan Paul and Co., 1902).

[82] 'Application of A.F.Pollard, MA (Oxon), for election to the Chair of Constitutional Law and History at University College London', 8 May 1903, LU/AFP/12.

[83] Handwritten list headed 'Theses and Publications on English History to December 1918', LU/AFP/32.

[84] Pollard, Factors, pp.247-51, 257-60.

His aim was to establish a broadly based school of research in all the fields of historical investigation that it was possible to explore in the capital's various repositories and museums. As Deborah Birch explains:

> It should be noticed that the Institute [of Historical Research] was not called 'The Pollard Institute', or 'An Institute of Tudor Systems', or some other such title to indicate that it was a school under one 'master'. As originally planned, the Institute had room for as many schools as there were professors ready to lead them. As Pollard saw it, the Institute ought to be an institute of institutes, or as he might have said a 'communitas communitarum'.[85]

Conclusion

Although the Morrellian model stipulates that there should be a very close relationship between the director's own work and the work of his students, these three departmental case-studies suggest that this is not necessarily the case. As Stella Butler has argued, 'there is no simple formula for a successful research school . . . . Problems may be approached collectively or particular themes may be developed into research "programs" . . . . [but] research schools generally gain their reputations from the quality of work produced by key individuals'.[86] In her study of 'centers and peripheries' in the development of British physiology between 1870 and 1914, Butler summarises the approaches favoured by the individuals who presided over the Jodrell Physiology Laboratory at UCL in this period. While Michael Foster exercised a significant degree of control over the work of his junior colleagues and students, suggesting problems for them to investigate and encouraging them to pursue researches connected with his own work on the physiology of the human heart,[87] his successor, John Burdon Sanderson, was 'less concerned to mount an attack on a central problem than to pursue his own, well-established interests and to encourage his students, staff and associates to develop their own talents'. Later, under Ernest Starling, 'the pattern of research did, for a time, center on a single problem, the hormone theory. However, because the Laboratory already had an international reputation, this program was not as critical to ensuring continued success as cardiology was to the establishment of Foster's department' in Cambridge.[88]

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[85] Birch, History Laboratory, p.10.
[86] Butler, 'Centers and Peripheries', pp.477-81.
[87] Geison, Foster, p.235.
[88] Butler, 'Centers and Peripheries', pp.479-81.

The History Department at UCL is another example of a successful research school in which the director did not institute a specific, narrowly focussed, programme of research, but encouraged his pupils to develop their own interests in a wide range of historical topics. However, in general terms, Pollard's advancing reputation in his subject was, nevertheless, one of the most important factors underlying the growth and expansion of the Department in the formative period between 1904 and 1914. As his personal reputation as a successful researcher increased, and he became known as the pioneer of a distinctive methodological approach to the training of postgraduate historians, Pollard was able to attract a growing number of students to the Department, and also to secure the necessary financial support for his projected postgraduate school of historical research. However, Karl Pearson's pioneering attempt to make statistics a scientifically rigorous academic discipline, and William Ramsay's Nobel Prize-winning researches on the gases of the atmosphere, had a rather more direct impact on the development of the Departments of Applied Mathematics and Chemistry in this period.

In Pearson's case, the origins of his school are to be found in his pioneering work on the statistical analysis of biological variation and the theory of natural selection. In Morrellian terms, this was a 'programme of work, too large for he himself to accomplish unaided',[89] and Pearson therefore instigated a programme of research designed to continue and extend his own biometric researches in the Department of Applied Mathematics. He assembled a talented and enthusiastic team of postgraduate students and volunteer workers to assist him in his research; and the work of the school began to crystallise around this central problem and Pearson's later researches on 'the science of national eugenics'. In Ramsay's case, his determination to establish a major school of chemical research in London came first, and sustained his school during the early years of its existence; the specific programme of research which made Ramsay - and the Chemistry Department at UCL - famous came later. However, Ramsay's work on gas chemistry made him unique among British chemists in this period, and as a result of his development of a revolutionary technique for dealing with gases and vapours in minute quantities and remarkable work on the inert gases, students of gas chemistry were drawn

[89] Morrell, 'Chemist Breeders', p.3.

to UCL from universities and colleges all over the world, and Ramsay was also able to secure greater financial support and an institutional commitment to his work at University College. The period 1904-1914 was therefore one of massive expansion, during which the work of the Department grew increasingly diverse, as Ramsay's methodological innovations led on to work on atomic structure and disintegration, and the work of his students and junior colleagues branched out in various directions under the influence of Norman Collie, E.C.C. Baly and Frederick Donnan.

8. Institutional and Financial Context

Our University is a positive hindrance to scientific work. In my Laboratory I have built a school of Chemistry, and my friend, Karl Pearson, has established in his Department a school of mathematics; but this has been done, in spite of, rather than with the help of the University.
William Ramsay, 1903.[1]

In his account of the research schools of Liebig and Thomson, Jack Morrell drew particular attention to the institutional context in which the ambitious director of an embryonic school was working:

> For a potentially valid programme to be implemented power was necessary. Quite simply the director had to posses or be rapidly gaining sufficient power within his institution to realize his ambition. Such power allowed or produced effective control by him of his research enterprise . . . . [and] was desirable to allow the director to run his school on a regular and permanent basis.[2]

As Stella Butler explains, 'departments committed to research programs clearly require some base level of funding to facilitate students' experiments, and the harnessing of increased financial support could clearly be a factor in transforming a department into a thriving academic enterprise'. However, noting the example of the cramped conditions endured by Michael Foster at Cambridge in the 1870s and by the staff and students of the Physiology Department at UCL right up until 1906, she insists that 'good laboratory facilities and generous research grants were not always necessary to ensure innovative research of a high quality'.[3]

University College London did offer certain advantages to the would-be researcher in the period 1890-1914, but the institutional context in which Pearson, Ramsay and Pollard set about founding their schools was hardly ideal. As we have already seen, when Ramsay and Pearson arrived at UCL in the 1880s they were not provided with their own laboratories, nor any apparatus and equipment. They were expected to derive their income entirely from the fees paid by the students who attended their lectures, and there was little opportunity or incentive for them to conduct their own research and experimental investigations. Similarly, Pollard was only appointed to the newly created Chair of Constitutional History in 1903 because there was no salary attached to the post, and as he repeatedly complained, 'a few odd bricks had to stand for a school of history' in London well into the twentieth

[1] WR to Emil Fischer, 14 April 1903, UCL/WR/13.
[2] Morrell, 'Chemist Breeders', pp.5-6.
[3] Butler, 'Centers and peripheries', pp.487-8.

century.[4] In the absence of significant financial and institutional support from the College Council and University authorities, the growth and expansion of the Departments of Applied Mathematics and Statistics, Chemistry and History between 1890 and 1914 was largely the result of the personal determination, ambition, entrepreneurial skills and hard work of these three remarkable men.

The Funding of Research

Despite the introduction of personal stipends for professors and more generous research grants in the early 1900s, most members of staff - particularly those with active research careers - were forced to seek alternative employment outside the College in order to supplement their income and subsidise their teaching and research at UCL in this period. For example, Pollard's income from the fees paid by his students amounted to a paltry £25 14s 6d during his first year at the College, and for many years he was therefore forced to supplement his income by teaching at the Wren's Coaching Establishment.[5] Similarly, according to Katherine Watson, Pollard's colleague in the Chair of General and Inorganic Chemistry was 'always looking for new ways to earn money'.[6] William Ramsay's chief source of external funding was his income from his extensive consultancy practice. During the course of his long career at UCL Ramsay established himself as 'a sort of "all purpose" chemical authority', acting as an expert witness in a number of high profile legal cases and advising various industrial clients and companies on an 'enormously diverse range of projects'.[7] He was generally able to command a fee of 100 guineas for appearing in Court, and typically charged each industrial client between

[4] Pollard, Factors, p.v.

[5] Neale, 'Pollard', p.199. As Pollard explained in 1904, the 'first requisite' for a historian in England in this period was 'neither skill nor industry, neither a knowledge of documents nor a faculty for turning them into literature, but the command of financial resources, independent of those which [could] be derived from writing history'. Pollard, Factors, pp.v-vi, 235-8.

[6] Watson, 'Chemist as Expert', p.149.

[7] For example, he worked for the Scottish Cyanide Company from 1893-9, and was later hired by the Workington Iron Company to advise on the extraction of zinc from the refuse of their iron works, and by the Government of Australia to advise them on the water supply of the Coolgardie gold fields. As Katherine Watson explains, he 'obviously developed a reputation for being quite capable of tackling many challenging scientific obstacles. Furthermore, his expertise was not specific to his work as a research chemist. Rather, he successfully applied his general talents as a research chemist to a wide variety of problems . . . . he was often engaged because of his position within the scientific community, as a voice of authority, rather than as an expert in particular aspects of the chemical industry'. Ibid, pp.144-56.

£150 and £300. In 1904 Ramsay estimated that his income from consultancy work amounted to more than £900 per annum, and on his death in 1916 his personal assets were valued at £17,896.[8] According to Watson, Ramsay's personal wealth 'surpassed that which an ordinary scientist could expect to accumulate'. He was therefore able to employ an unprecedented number of assistants, demonstrators and other junior members of staff, and also to subsidise much of the research that was carried out by the staff and students of the Chemistry Department at UCL.[9] However, his personal resources were not limitless, and Ramsay and his pupils therefore designed and built most of their own apparatus and equipment. To note just one example, Travers personally designed and built the hydrogen liquefier that he and Ramsay used in the course of their work on the inert gases.[10] The school was also dependent on the voluntary donation of machinery, apparatus, equipment and materials. For example, Ludwig Mond provided the £100 necessary to purchase the air compressor and motor which Ramsay and Travers used in their work on the isolation of neon, krypton and xenon, and the liquid air used in these experiments was supplied by Dr. W.Hampson of the Brins' Oxygen Company Ltd..[11]

As Jack Morrell explains, provided that he had sufficient money from the fees paid by his students (and his own pocket) to equip and maintain a laboratory, 'it was of course possible for an ambitious man to build up a relatively small research school'. But 'a financial crisis almost invariably occurred when the financial loss he incurred in meeting the necessary costs of running a laboratory became intolerable'. At this point it was crucial that 'his institution reacted generously to his pleas and his threats by, for instance, increasing his salary and by paying his necessary expenses such as capital outlay, materials, apparatus and assistance'.[12] By the turn of the century Ramsay and Pearson had laid the foundations of small, but extremely successful, schools of research in their respective fields, but both schools had already reached the 'crisis' point beyond which they could not continue to develop

[8] Watson, 'Chemist as Expert', pp.144-9.
[9] Travers, Life, p.202.
[10] Ibid, pp.188-9.
[11] Ibid, pp.172-3, 184-5.
[12] Morrell, 'Chemist Breeders', p.7.

and expand without greater financial and institutional support from the College Council and University authorities. By this point, Ramsay was having to devote so much time to his consultancy work that he was beginning to 'neglect' his teaching and research at UCL,[13] and the Council was having to turn prospective chemistry postgraduates away because there was not enough room to accommodate them in the laboratories behind the Slade School.[14]

As we have already seen, when Ramsay arrived at UCL the Chemistry Department consisted of an out-dated and ill-equipped laboratory(housed in a shed behind the North Wing of the main College buildings) and a few rooms in the basement of the Slade School. There was some expansion. When Travers joined the staff of the Department in 1894 he was given the task of clearing the accumulated boxes, packages and bottles out of the basement, in order to create space for a balance and combustion room, and for additional accommodation for students.[15] But the need for improved accommodation for the chemical laboratories was noted by the inspectors appointed to investigate the College in connection with the Parliamentary Grant two years later,[16] and in 1901 the government inspectors again highlighted the 'striking discrepancy between the work which [was] being done in them, and the narrowness and inconvenience of the quarters in which it [was] carried on'.[17] Ramsay had first drawn the attention of the College Council to the overcrowded and unsatisfactory condition of the laboratory in 1893, and the Council had agreed to 'consider favourably the proposal to build new chemistry laboratories, provided the requisite finance be obtained'.[18] But it took more than 20 years to raise the necessary funds, and Ramsay had retired by the time that the new buildings were complete.

The emergence of an institutional commitment to the promotion of research in the period 1890-1914 and formal reconstitution of the College as a place of teaching and research was nevertheless crucial to the long term growth, development and enduring success of all three schools. By 1903 the College Council was insistent

[13] Watson, 'Chemist as Expert', p.144. See also Travers' introduction to UCL/WR/12, p.11.
[14] Reports 1908, p.35.
[15] Travers, Life, p.6.
[16] 'Report by Warren and Liveing', 31 December 1896, p.12, PRO/ED24/81.
[17] 'Report by Woods and Hill', 31 December 1901, pp.8, 25-6, PRO/ED24/82A.
[18] Abstracts of Council Minutes Volume V 1890-95, 1 July 1893, Item 170, p.5.

that it attached the 'greatest importance to the original work done by the teaching staff and students',[19] and, as we saw in Chapter Four, it therefore began to offer greater support to the staff and students who were engaged in producing advanced work of this nature. For example, Ramsay had been awarded £200 out of UCL's share of the Parliamentary Grant in November 1892,[20] and from 1894 onwards he was also in receipt of an annual grant of £200 for assistance and apparatus from the College Council.[21] In 1896 he became one of the first professors to receive a fixed stipend from the Council (in addition to a quarter share of the fees from his classes),[22] and when UCL was reincorporated into the University of London Ramsay was appointed University Professor of Chemistry on a fixed salary of £1,000 per annum. However, one should note that most of the funds available to him in this period came from external sources - principally from the Technical Education Board of the London County Council, which established itself as the 'main financier' of the Chemistry Department at UCL during the first decade of the twentieth century.[23] In May 1892 Ramsay had applied - on behalf of the College - for a share of the grant available for the promotion of technical education in the capital under the terms of the 1889 Technical Instruction Act,[24] and from 1894 to 1901 he received an annual grant of £250 out of the £1,000 allocated to the College by the LCC for the purchasing of 'material and apparatus in the technical departments of the College'.[25] Moreover, after 1902 Ramsay's salary was actually paid by the Technical Education Board of the LCC through the University of London, and the Board also paid for the establishment of a separate Chair in Organic Chemistry (for Norman Collie) and for the employment of two full-time assistants in the Department, at a total cost of £2,500 per annum.[26]

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[19] Reports 1903, p.24.
[20] Abstracts of Council Minutes Volume V 1890-95, 5 November 1892, Item 5.
[21] Handwritten list headed 'University College London. Grants Made for the Session 1894-95', dated November 1895, in box marked 'Financial 1890s Misc. Printed Papers', UCL/CC.
[22] Abstracts of Council Minutes Volume VI 1895-1900, 6 June 1896, Item 135.
[23] Watson, 'Aspects', p.300.
[24] Ibid, pp.272-3. On the origins and implications of the Technical Instruction Act of 1889 see Cardwell, Organisation of Science, pp.156-60.
[25] Reports 1895, p.14. See also 'Report on the Distribution of the LCC Grant', November 1895, in box marked 'Financial 1890s Misc. Printed Papers', UCL/CC.
[26] Watson, 'Aspects', pp.299-300.

From the second year of his tenure in the Chair of Constitutional History onwards, A.F. Pollard was also in receipt of a modest stipend of £50 a year (in addition to his income from the fees paid by his students). A year later his salary was increased to £200 per annum, when the Council, prompted by the 1905 increase in the Parliamentary Grant, decided to pay all members of staff a fixed stipend, on the grounds that a 'Professor or Assistant, whose salary [was] not sufficient to keep him in moderate comfort, [was] driven to extend his work either inside or outside the College until there [was] left to him neither time nor energy to do full justice to his students or to keep himself abreast of the latest developments of the branch of learning which he represent[ed]'.[27] Moreover, as 'Pollard's vigour was felt throughout the College and University', so his academic and financial position improved,[28] and from 1907 onwards his total income from stipend and fees was guaranteed to reach a minimum of £500 a year. The Council had hoped to secure the full services of both Pollard and Montague. However, there were insufficient funds to employ both men full-time, and it was therefore decided that Pollard's salary should rise to £500 a year in order to free him from the necessity of coaching at Wren's. Ostensibly this was because Montague's teaching at Oxford 'harmonised' with his work at UCL, while Pollard's teaching at Wren's was thought to 'distract him from . . . true university work'.[29] But this effectively amounted to an official endorsement of the 'Pollard programme'. The Council had decided to charge Pollard with the task of creating 'a great history school in London'. As J.E. Neale explains:

> Pollard was, and indeed remained, the junior of the two professors of history. To leave the senior a part-time professor while preserving the junior was a delicate step. But the decision was wise. If the History Department had not been built round Pollard, the character of historical studies in London - nay more, the shape of the University itself would surely have been very different.[30]

Perhaps most importantly, the Council also launched an appeal to raise £1,000,000 to subsidise an extensive programme of rebuilding and redevelopment, so that the College could more 'adequately fulfil its function as an

[27] 'University College London. Grants Committee. Report on the Renumeration of the Teaching Staff in Connection with the Parliamentary Grant. Adopted by the Council in its present form on July 3rd, 1905', p.1, contained in folder marked '6-9', containing material relating to the Evening School of History, c.1911-19, in LU/AFP/33.
[28] Neale, 'Pollard', p.199.
[29] Gregory Foster to AFP, 3 June 1907, LU/AFP/32.
[30] Neale, 'Pollard', p.201.

institute for . . . advanced university education and research'.[31] The period 1900-1920 was therefore an era of massive growth and expansion during which the staff and students of the College - particularly those based in the scientific departments - were provided with increasingly sophisticated, elaborate and expensive facilities for teaching and research. An impressive new building housing laboratories for research in organic, inorganic, physical and pathological chemistry, and special rooms for work involving balances, gas analysis, combustion and distillation experiments, spectroscopic work and mineralogical research, was formally opened in 1915 (see Figure 5.3),[32] and in 1919 Pearson and his colleagues (finally) took possession of the new Bartlett Building, which was fully equipped for all aspects of research in applied mathematics, statistics, anthropometry, biometry and eugenics (see Figures 5.1-2).[33]

Entrepreneurial Professors and Private Benefactors

The emergence of a formal institutional commitment to teaching and research in the period 1890-1914 was therefore crucial to the long term growth, development and success of all three schools. A cursory glance at Graphs 5.1-3 reveals that the administrative reforms of the early 1900s coincided with a period of significant growth and expansion in the Departments of Applied Mathematics, Chemistry and History. The academic staff and postgraduate population of all three departments, and their collective output of original papers and other publications, all rose sharply from this point onwards. However, it is important to stress that Pearson and Ramsay's most celebrated achievements predate the institutional revolution of the early 1900s, and that Pollard was ultimately only able to achieve his aim of establishing a major school of historical research in London on a intercollegiate or University basis. Ramsay had retired by the time that the new chemistry laboratories in Gower Place were finally complete, and Pearson was in his sixties when he at last acquired a building and laboratories commensurate with his ambitions. They were therefore both highly critical of the College Council and University authorities in this period, insisting that

[31] Reports 1902, pp.17-18, 35.
[32] 'On building of the new Chem. Labs 1911-16', UCL/CC.
[33] Karl Pearson, 'Report to the Court of the Worshipful Company of Drapers for the Years 1922, 1923 and 1924', 29 February 1924, KP/UCL/233.

their schools had been built 'in spite of, rather than with the help of the University'.[34] Writing in 1927, Pearson was adamant that his school 'owed . . . in its initiation and conception nothing' to UCL and the University of London:

> Its workers were not provided by the College and of the many postgraduates who [came] to it in the course of 35 years, not 4% [were] persons graduating at University College . . . . The Laboratories [were] run on funds to which neither the College nor University [could] legitimately be said to [have] contribute[d].[35]

The majority of the funds that underpinned the growth and expansion of the Department of Applied Mathematics and Statistics between 1890 and 1914 came from private sources, principally from the Worshipful Company of Drapers. Prompted by the attacks of the municipal reformers, the great City Companies were beginning, in this period, 'to buy less turtle, and to endow schools, colleges, chairs and charities',[36] and the Drapers' Company had already established itself as one of UCL's most generous supporters, donating £30,000 to pay off the College's outstanding debts in 1902.[37] When the Drapers announced their intention to grant an additional £1,000 to the University of London for the 'furtherance of research or higher work' at University College in March 1903, the University and College authorities decided to present the money to Pearson to assist the statistical work and higher teaching of the Department of Applied Mathematics.[38] The grant was given over entirely to the maintenance of 'a statistical school for *post-graduate* work'.[39] It enabled Pearson to turn the small laboratory he had started in 1900 in a 'slip of a room, inadequately lighted' and ill-equipped, into a dedicated Biometric Laboratory.[40] Approximately £110 was devoted to the purchasing of vital equipment and apparatus,[41] and Pearson was also able to employ a permanent computator (Alice Lee) and two microscopists (Marion Radford and Alexandra Wright). He was able

[34] WR to Emil Fischer, 14 April 1903, UCL/WR/13.
[35] Pearson, 'Report on the Galton and Biometric Laboratories', c.1926-27, p.1, KP/UCL/223.
[36] Hearnshaw, King's College London, p.285.
[37] Bellot, UCL, p.401.
[38] Pearson, 'Report on the Galton and Biometric Laboratories', c.1926-27, p.1, KP/UCL/223.
[39] Pearson, 'Report to the Worshipful Company of Drapers', 1918, p.1, KP/UCL/233.
[40] 'Report on the Work Done Owing to the Grant made by the Drapers (1903-9)', p.5, KP/UCL/233.
[41] Including one Tate's Calculating machine (£40), a 'very good reading microscope' for making fine measurements (£24), a Leitz Microscope (£29) and a Coradi Parabolagraph (£14). KP to Foster, 26 November 1904, KP/UCL/233.

to procure the services of two Cambridge Wranglers, Clerk Maxwell Garnett and John Blakeman - to 'give assistance to those working in the Department, to revise for press mathematical and other memoirs, [and] to solve mathematical problems arising in the course of [their] statistical research' - and hire additional assistants, such as Miss F. Cave of Girton College, Cambridge, on a more casual basis. The grant also enabled Pearson to employ Ebenezer Cunningham as a teaching assistant, and thereby double the amount of time that he was able to devote to his own research and 'more directly attend to the research work of the laboratories'; while the 'ability to provide a higher type of man . . . [also] brought additional research powers to the department'. Moreover, Pearson was also able to launch three new journals: the *Drapers' Company Research Memoirs: Biometric Series*, *Technical Series*, and *Studies in National Deterioration* series.[42]

The grant came as a 'complete surprise' to Pearson - he 'neither made application directly or indirectly for any share of it. He was led to believe that it was 'allotted to [his] department by the College Council . . . on the ground of its contributions to scientific research'.[43] The initial grant was allocated to cover a two year period, and in November 1904 Pearson wrote to the Drapers', outlining some of the work that had been carried out thanks to their generosity and asking for a renewal of the grant. In 1905 a further grant of £2,000 was made for a five year period, and the grant, afterwards fixed at £500 per annum, continued until 1932. According to Egon Sharpe Pearson, the 'value of this financial contribution was considerable', giving 'increased vigour and activity to every part of the many-sided work which was being carried on' under his father's direction;[44] and when he presented his final report to the Drapers in 1930, Pearson expressed his 'full sense of all that the Company ha[d] done for thirty years to enable [him] to carry out the aim of [his] scientific life, the realisation of [his] dream of forty years ago'.[45]

[42] KP to Foster, 26 November 1904,KP/UCL/233.
[43] Pearson, 'Report on the Galton and Biometric Laboratories', c.1926-27, p.1, KP/UCL/223.
[44] E.S.Pearson, Karl Pearson, p.46.
[45] Karl Pearson, 'Report to the Court of the Worshipful Company of Drapers', 1930, p.1, KP/UCL/233.

The support and financial backing of Sir Francis Galton was also crucial. Galton has been described as 'the last of the gentlemen scientists'.[46] He was independently wealthy, and used his personal fortune to finance research in his chosen field - the 'study of agencies under human control which may improve or impair the future of the race'.[47] In 1904 he established a Eugenics Record Office with an initial grant of £1,000 for 'the furtherance during three years of the scientific study of eugenics'.[48] At this stage Pearson had 'practically nothing whatever' to do with the Office,[49] but Galton found that 'it was only possible to obtain his research workers from those trained in the Biometric Laboratory'.[50] When Arthur Schuster, the Galton Research Fellow, retired in 1906, he therefore asked Pearson if the Record Office could 'somehow . . . be worked into [the] Biometric Laboratory'.[51] Rather reluctantly, Pearson agreed,[52] and the ERO was renamed the Galton Eugenics Laboratory and relaunched under his voluntary direction. Galton provided £500 a year for the running of the Laboratory during his lifetime,[53] and made a will bequeathing the residue of his estate of £30,000 to the university for the establishment and endowment of a Galton

[46] Stigler, History of Statistics, p.265.

[47] Eugenics was based on the conviction that the Darwinian hypothesis could be applied purposively to improve the human race. Galton defined it as 'the science of improving stock, which . . . , especially in the case of man takes cognisance of all influences that tend . . . to give the more suitable races or strains of blood a better chance of prevailing speedily over the less suitable than they otherwise would have had'. Francis Galton, Inquiries into Human Faculty and its Development (London: Macmillan, 1883), pp.24-5. See also Francis Galton, Hereditary Genius: An Inquiry into its Laws and Consequences (London: Macmillan, 1869); Francis Galton, 'Eugenics, its Definition, Scope and Aims', Sociological Papers, 1 (1904) 43-99.; Francis Galton, 'Eugenics', Sociological Papers, 2 (1905), 1-54, and Pearson, Galton. The origins and development of eugenics and the eugenics movement are discussed in more detail in C.P.Blacker, Eugenics: Galton and After (London: Gerald Duckworth, 1952); Farrall, 'Origins and Growth of the English Eugenics Movement'; Lyndsay A.Farrall, 'The History of Eugenics: A Bibliographic Review', History of Science, 36 (1979),11-23; Kevles, In the Name of Eugenics; Donald Mackenzie, 'Eugenics in Britain', Social Studies of Science, 6 (1976), 499-532, and Pauline Mazumdar, Eugenics, Human Genetics and Human Failings (London: Routledge, 1992).

[48] The origins and development of the Eugenics Record Office are discussed in more detail in Pearson, Galton, pp.222-3, 258-66.

[49] Pearson, 'Report on the Galton and Biometric Laboratories', c.1926-27, p.1, KP/UCL/223. As Pearson later explained, Galton 'wanted his Eugenic Office to show immediate results; and just for this reason I stood as far as possible aloof from it, except when he or his assistants directly consulted me on statistical points'. Pearson, Galton, p.297.

[50] Pearson, 'Report to the Worshipful Company of Drapers', 1918, p.3, KP/UCL/233.

[51] Francis Galton to KP, 24 October 1906, reproduced in Pearson, Galton, p.297.

[52] Magnello, 'Non-Correlation', pp.123-4.

[53] The Galton Fellow (David Heron) was paid £250 a year, the Galton Scholar (Elderton) received £130, and £100 was devoted to publishing the work of the Laboratory, leaving £20 to pay for 'petty expenses'. Pearson, 'Report on the Galton and Biometric Laboratories', 1926-27, p.2, KP/UCL/223.

Chair of Eugenics. He was convinced that Pearson was 'the most suitable man for the first Galton Professor', but Pearson was 'wholly unwilling to give up his superintendence of the Biometric Laboratory' and confine his work to eugenics.[54] Galton therefore added a codicil stipulating that the Chair should be offered to Pearson 'on such conditions as [would] give him the liberty to continue his Biometric Laboratory'.[55]

The Galton bequest transformed his position within the College. As we have already seen, when Galton died in 1911 Pearson resigned his Chair in Applied Mathematics and took up the Galton Professorship, and the Biometric and Eugenics Laboratories were incorporated into a new Department of Applied Statistics under his direction (although they continued to be run separately). Pearson later explained that the main significance of Galton's benefaction was that it enabled him to 'give up the undergraduate teaching of applied mathematics and devote [him]self solely to what had been the main element of [his] researches, the advancement of the modern theory of statistics'. He was also able to 'greatly increase' the output of the Biometric Laboratory and 'look[ed] forward as soon as a building could be obtained to organising a complete school of research in higher statistics'.[56] However, the Galton bequest was inadequate for 'the complete carrying out of his scheme'. Galton did not provide any money for a new building, but expressed the hope that the College would provide 'adequate housing for the laboratory that was to bear his name' and the Drapers' Biometric Laboratory.[57] According to Pearson, the existing accommodation for his Department was 'wholly inadequate', and 'quite insufficient for the business of the Laboratory'.[58] 'Setting the pace for a new breed of empire builders in science',[59] he therefore issued a public 'Appeal for Funds to Build the Sir

[54] Pearson, Galton, p.436.
[55] 'Codicil to the Will of Sir Francis Galton', reproduced in Ibid, pp.437-8.
[56] Pearson, 'Report to the Worshipful Company of Drapers', 1918, p.4, KP/UCL/233.
[57] 'Codicil to the Will of Sir Francis Galton' reproduced in.Pearson, Galton, pp.437-8.
[58] 'University of London. Memorial to the Late Sir Francis Galton, FRS. An Appeal for Funds to Build the Francis Galton Laboratory for the Study of National Eugenics. Issued by the Francis Galton Laboratory Committee with the Approval of the Senate of the University', 24 May 1911, KP/UCL/238.
[59] Kevles, In the Name of Eugenics, p.38.

Francis Galton Laboratory for National Eugenics' on 24 May 1911.[60] The target was £15,000, but by November only £2,590 had been raised.[61] However, on Saturday 7 October *The Times* had 'heartily recommended' the appeal to its readers,[62] and on 30 November Lord Rosebery, the Chancellor of the University of London, received an anonymous letter, pledging £30,000 for the erection of a new building. The mystery benefactor - later revealed to be Sir Herbert Bartlett - announced that it was his intention to subsidise a new building to house the combined Kings College and UCL schools of architecture, as he was 'interested in promoting the study of architecture' and 'anxious to do what [he could] to help in completing one of the most beautiful of London buildings'. The proposed buildings on the north-west front of the UCL site would also contain studios for the teaching of sculpture and fine art, and a new building for 'the Department of Applied Statistics, including the Laboratory of Eugenics'.[63]

Most of the funds for the new chemistry laboratories also came from private sources. The building of a new laboratory had been listed as a priority by the Joint Committee of the Council and Senate appointed to consider the needs of the College in 1901,[64] but no real progress was made for another decade. In 1908 the Council launched an appeal to raise £70,000 for the building of new laboratories,[65] and work finally began on a new building in Gower Place in 1911, thanks, primarily, to the munificence of Sir Ralph C. Forster, who donated £30,000 to the fund 'with a view of aiding the developments for higher education and research within the University of London, and more especially of facilitating the erection of the proposed new Chemical Laboratories'.[66] The story of the growth and development of the London history school and the origins of the Institute of Historical Research also highlights the significance of the role played by enterprising and entrepreneurial professors, and the generous patronage of individual donors and benefactors, in this period. By 1914 Pollard had succeeded in establishing a small, but fairly successful,

[60] 'Appeal for Funds to Build the Galton Laboratory', p.4, KP/UCL/238; Reports 1912 ,pp.27-8.
[61] 'List of Subscribers to the Galton Laboratory Appeal Fund', 20 November 1911, KP/UCL/238.
[62] The Times, Saturday 7 October 1911, KP/UCL/238.
[63] Anonymous letter to Rosebery, 30 November 1911, KP/UCL/239.
[64] Reports 1901, pp.17-18.
[65] Reports 1910, pp.42-3.
[66] Reports 1912, pp.26-7.

school in the History Department at UCL, but it was already clear to him that the University could not do justice to itself and to London's unrivalled opportunities as a centre for historical research so long as it acted 'not as a unit but on the centrifugal principle of individualistic and competitive enterprise':[67] In his 1919 memorandum on *The Needs of Historical Studies in University College*, Pollard reiterated his belief that the London history school had to be organised on a university scale owing to the 'endemic loss of efficiency produced by perennial reduplication, conflict and competition' between London's rival colleges,[68] and at the beginning of 1920 a Joint Committee made up of representatives from UCL, Kings College London and the London School of Economics was appointed to consider the question of further provision for historical studies in the capital. On 12 February they reported in favour of establishing 'a centre for Advanced Historical Studies',[69] and launched an appeal to raise the funds necessary for the erection and equipment of a University of London Institute of Historical Research. As in the case of the Departments of Applied Statistics and Chemistry, most of the funds for the project came from private sources. Pollard personally donated £100 to the appeal, and other contributors included Eliza Jeffries Davis, Hubert Hall, F.J.C. Hearnshaw, F.C. Montague, George Prothero, R.W. Seton-Watson and G.M. Trevelyan.[70] However, the bulk of the funds were donated by Pollard's neighbour, the export merchant John Cecil Power. He was persuaded to invest in the scheme after hearing the President of the Board of Education, H.A.L. Fisher's ringing endorsement of the project at a dinner at the Athenaeum on 30 June 1920. He therefore wrote to his friend and neighbour, Pollard, insisting:

> The absence of some such organisation for the study of our unrivalled archives and for bringing the experience of the past to bear on the problems of the present, is a reproach not merely to the capital of the Empire but [also to] the nation at large.[71]

Power offered to donate £20,000 to the fund, and thanks to his generosity work began on the erection of a new building to house the Institute in Malet Street in 1921 (see Figure 5.4).

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[67] Pollard, Factors, p.266.
[68] Pollard, 'Needs of Historical Research', p.6, LU/AFP/33.
[69] J.Goronwy Edwards, Director of the Institute (1948-60), quoted in Birch, History Laboratory, p.7.
[70] A full list of the contributors to the appeal is reproduced in Ibid, pp.9-10.
[71] J.Cecil Power to AFP, 12 July 1920, reproduced in Ibid.p.8. For more on the origins and development of the IHR see Ibid,pp.1-26.

Much more work is necessary on the motives of these benefactors. Often they had a particular reason for choosing to invest in UCL. For example, having decided to endow a Chair of Egyptology, Amelia Edwards chose University College London specifically because of the College Council's enlightened policy with regard to the admission of female students.[72] Conversely, Francis Galton's association with the College has been described as 'more geographical than anything else',[73] and Daniel J. Kevles insists that the Drapers' Company was 'more interested in general good works than in any particular line of research'.[74] In his account of the development of academic philanthropy in the nineteenth century, David Owen suggests that the principal motives of these patrons and benefactors included their religious beliefs and social aspirations, and, perhaps most importantly, the fact that they belonged to 'a culture which regard[ed] such actions as worthy'.[75] However, while these factors might explain the philanthropic impulse, this account highlights the significance of the personal relationships that existed between the donor and the intended beneficiary of his or her generosity - including, for example, Power and Pollard, Edwards and Petrie, Galton and Pearson, and Sir Donald Currie and the staff and students of University College Hospital.

The Reform and Reorganisation of the University of London

While acknowledging that the funds that underpinned the emergence of an institutional commitment to teaching and research at UCL in this period came primarily from private sources, one should also note that through their efforts to secure the necessary financial support and an institutional commitment to their work, Ramsay, Pearson and Pollard all played an important part in shaping the College Council and University authorities' changing conception of the role and function of the College. This was a result of the impact and implications of their own work on the structure, organisation and ethos of the College, and their growing involvement in the politics and administration of the College and University of London. Crucially, Ramsay, Pearson and Pollard were all heavily involved in the campaign to reform the University of London as a 'teaching' or 'professorial' university in this period.

[72] Bellot, UCL, p.384.
[73] Hermann Bondi, 'The Sciences', in Thompson, University of London, p.120.
[74] Kevles, In the Name of Eugenics, p.37.
[75] Owen, English Philanthropy, p.6. See also pp. 361-7.

The University of London and its various constituent colleges have a long and extremely complicated institutional history, but the period 1890-1914 was one of almost continual controversy and change, during which the structure and organisation of higher education in London was intensely discussed, debated and fought over. The principal complaint of the various groups seeking to reform the University in this period was simple: the University of London was neither a university, nor indeed 'of London'. As Pearson explained in his treatise on the need for a *New University for London* in 1892:

> London does not possess any University at all. The nearest approaches to such an institution are University and Kings Colleges, together with the medical schools. To term the body which examines at Burlington House a University is a perversion of language; to which no charter or Act of Parliament can give a real sanction.[76]

According to the Royal Charter granted to the University of London in 1836, its primary aim was 'to hold forth to all classes and denominations . . . an encouragement for pursuing a regular and liberal course of Education', to determine, 'by means of examinations, the persons who ha[d] acquired proficiency in Literature, Science and Art, by the pursuit of such courses of education', and to reward the successful candidates with 'Academical Degrees'.[77] In other words, the Senate of the University was to act as an examining board, principally for UCL and Kings, but also for various other 'recognised' (metropolitan) institutions. Candidates for the degrees of the University were required to present a certificate confirming that they had completed the course of instruction at University or Kings College, or at 'such other institution . . . as now is, or hereafter shall be established for the purpose of Education, whether in the Metropolis or elsewhere in our United Kingdom'. By 1850 there were more than 100 'recognised' schools and colleges whose students were examined and awarded degrees by the Senate of the University of London, and in that year it was granted a supplementary Charter which enabled students from institutions throughout the Empire to offer themselves as candidates for London degrees. Under the terms of the 1858 Act that reconstituted the University, candidates were no longer even required to present a certificate of study at an affiliated institution, and the examinations for University of London degrees were effectively 'thrown open to all-comers'.[78] Moreover, the Senate insisted on the complete separation of the teaching and examining functions of the University. Under the terms of the 1836 Charter, the

[76] Pearson, New University for London, pp.7-8.
[77] University of London Charter (1836), Historical Record, pp.26-30.
[78] Harte, University of London, p.104.

38 members of the Senate were personally responsible for examining candidates for London University degrees. They set the examination for each course, marked each exam script and awarded degrees to 'such persons as . . . appear[ed] duly qualified'.[79] The various teachers responsible for preparing students to sit these exams - including the professorial staff of UCL and Kings - were not represented on the Senate and were not allowed to become 'external' examiners.[80] They therefore had no control over the curricula of the courses they taught and the examination of candidates for London degrees. Their role was merely to teach the material required by the Senate, and then hand their students over to the University to be examined.

In the 1870s and 80s it came to be widely accepted that in neglecting teaching in favour of examining, the University of London was not carrying out the proper duties of a university. As Sir William Allchin, Dean of the Westminster Medical School, explained, the University was 'an Examining Board . . . divorced both in principle and process from teaching and from teachers'. As a result, the University had not kept abreast of the latest discoveries and developments, particularly in the sciences, 'even in its own province of examination, and . . . the syllabuses [were] in some cases antiquated and effete. Nor could it well be otherwise when teachers as such ha[d] no voice in the arrangements, and the control [was] vested in a Senate, many of whom ha[d] never been teachers and others ha[d] long since ceased to instruct'.[81] In May 1884 the critics of the University formed an Association for Promoting a Teaching University for London, with the aim of securing 'a substantive voice in the government of the University [for] those engaged in the work of University Teaching and Examination', and the recognition of the 'existing institutions in London of University rank as the bases or component parts of the University'.[82] By 1887 there were more than 250 members of the Association, including members of the academic and administrative staff of both UCL and Kings, their colleagues and counterparts in universities and colleges throughout Britain (and indeed the world), students and graduates of the University, and

[79] Thomas Spring Rice to George Airy, 24 September 1835, quoted in Ibid, p.81.
[80] Up until 1858 the members of the Senate were personally responsible for examining the students. Thereafter external examiners (chosen from among applicants responding to public advertisements) were appointed, but College teachers were still not allowed to become examiners.
[81] Allchin, Reconstruction, Vol. I, p.18.
[82] Aims of the Society for Promoting a Teaching University for London, quoted in Harte, University of London, p.142.

representatives from the London medical schools.[83] But the nucleus of the Association was made up of members of staff at the London colleges - men like Pearson, Ramsay, Weldon, George Carey Foster,[84] and E. Ray Lankester,[85] who were simultaneously trying to reconstitute their own departments as *places of teaching and research.*

The supporters of the campaign to reform the University maintained that the professorial staff of UCL and Kings should have more control over the curricula of the courses they taught and the examination of candidates for University of London degrees, either through representation on the Senate or the establishment of intercollegiate boards of study. They complained that teachers who were not engaged in research and administrators who had ceased even to instruct, had too much control over the content of London degree courses and the examination of students, insisting that this had 'an injurious effect upon University Education', tending to 'deprive instruction and study of that power of transforming the mind of the learner which is their most valuable function'.[86] Effectively, the members of the Association were calling for the formal recognition of the professional status of London professors who combined teaching and research, and did not simply prepare students to take exams. They insisted that only those engaged in full-time teaching and research should be involved in devising the curricula for London degree courses and examining candidates for London degrees, so that teaching in the London colleges could keep pace with the latest developments and discoveries in each discipline - including the results of their own experiments and investigations. It was but a small step from here to the demand that the Senate and College Council should assume some responsibility for subsidising and coordinating the original work undertaken by the staff (and students) of the College.

In 1892 Pearson launched a new Association for Promoting a *Professorial* University of London, whose members included Foster, Lankester, Roscoe and Weldon. They advocated an expansion of the aims and objectives of the University, insisting that its objects should also include the 'promotion of research and

[83] Allchin, Reconstruction, Vol. I, p.191.
[84] Professor of Physics at UCL (1865-98), and subsequently first Principal of the College (1900-4).
[85] Professor of Zoology and Comparative Anatomy at UCL (1874-91). On his role in the campaign to reform the University of Oxford see Howarth, 'Oxford for Arts', pp.483-4.
[86] Quoted in Harte, University of London, p.144.

the advancement of science and learning'.[87] Pearson expanded upon his personal vision for the reorganisation of the University in a *New University for London*, damning the existing University as a mere 'examining body', and insisting:

> Every true university essentially represents a guild of learning. It has not only to educate its junior members but to progress itself, the advancement of learning and original research are characteristic parts of university life. There must be an unbroken chain from the recognised scientist and scholar to the veriest apprentice or yearling. There must be that *espirit de corps*, and that freshness which can only arise from a diversity of minds united for a common end.[88]

This was the ideal which Pearson aspired to in his own Department, and over the next twenty years he did 'all in [his] power to push forward the movement for such a university' in London.[89]

Similarly, though A.F. Pollard arrived at UCL too late to take a leading role in the campaign that eventually saw the College reconstituted as a place of teaching and research, he also made a significant contribution to the politics and administration of the College and University throughout his long career in London, striving to ensure that the principles embodied in the 1905 Act were translated into practice. Pollard wrote at length about his conception of the proper role and function of university education, insisting that the 'advancement of knowledge and understanding [was] the true function of universities', and defining a 'true' university as 'a permanent association of men and women for the advancement of learning'.[90] To quote Neale, 'judged either by his ideas or by what he accomplished, Pollard must be accounted one of the outstanding statesmen of the University of London'.[91] He was a member of the Senate from 1910-15, Director of the Institute of Historical Research from 1921 to 1931 (and Honorary Director until 1939), and later served on the Government Committee on the University of London. Through his involvement in the politics and administration of the College and University, Pollard was not only

[87] 'Association for Promoting a Professorial University of London. Proposals Adopted at a Meeting held on June 14th 1892', signed by F.V. Dickens, G.Carey Foster, R.S.Heath, E Ray Lankester, Karl Pearson, H.E.Roscoe, A.W.Rucker, T.E.Thorpe, W.C.Unwin and W.F.R.Weldon; 'Scheme of Organisation of the New University of London Adopted by a General Meeting of the Association for Promoting a Professorial University of London, held March 23rd, 1893', KP/UCL/12. Various pamphlets, circulars and other documents relating to Pearson's involvement with the Association have been collected together in KP/UCL/12.
[88] Pearson, New University for London, pp.7-9.
[89] 'Notes of Evidence [to Royal Commission on University Education in London]',1892, KP/UCL/12.
[90] Pollard, Factors, p.260.
[91] Neale, 'Pollard', p.202.

able to secure a significant institutional commitment to his work, but like Ramsay and Pearson, he also exerted a profound influence upon the College's expanding conception of its role and function in the early years of the twentieth century. Pollard was, for example, the principal architect and chairman of the University of London Board of Studies in History, which was responsible for organising and coordinating teaching throughout the University, and for shaping its policy in historical studies. In this capacity he played a central role in devising the curricula and regulations for London degree courses, striving to raise the standard of London undergraduate history degrees until they ranked 'with or above the highest', and to introduce doctoral degrees in history which recognised 'solid contributions to historical knowledge based upon original research among published and unpublished sources'.[92] As a member of the Library Committee at UCL, Pollard also presided over the expansion and reorganisation of the Library in 1907, insisting that it should be redesigned and reorganised as a 'Seminar' or 'Training Library';[93] and the Institute of Historical Research was itself 'partly designed as a model of the way in which the Bloomsbury site might have been used to solve the general problem of higher university education in London'.[94]

William Ramsay also played an important role in persuading the College to accept an expanded view of its aims and objectives in this period. As we have already seen, he made a very significant contribution to the debates surrounding the role and function of university education in Britain in the last years of the nineteenth century and early 1900s. As Principal of University College, Bristol, he led the campaign to secure state funding for Britain's universities and university colleges in the 1880s,[95] and he continued to play a major role in the campaign to secure an

[92] Pollard, Factors, p.253.

[93] Pollard was insistent that 'Just as the kernel of a scientific department is its laboratory, so the kernel of a History Department is its seminar library or workshop in which students are trained to understand, use and test the materials and methods of investigation . . . . the seminar or workshop is to the historical student and researcher everything and more than all that the laboratory is to the scientist'. Pollard, 'Needs of Historical Research', p.11, LU/AFP/33.

[94] Pollard, Factors, p.267.

[95] The Parliamentary Grant and its origins are discussed in more detail in Chapter Three. Ramsay both instigated and coordinated the activities of a powerful group of academics, politicians, civic authorities and local magnates who lobbied Parliament for more than two years in the late 1880s. As government policy on the question began to shift in 1887, Ramsay wrote to his mother and admitted 'I feel a little cocky about it, seeing I have engineered it all'. WR to his mother, 11 May 1887, UCL/WR/6/1.

increase in the grant throughout his career at UCL.[96] Given his reputation as a champion of university reform, Ramsay inevitably became a prominent figure in the politics and administration of both UCL and the University of London. He was appointed Dean of the Faculty of Science in 1890, and became a member of the College Senate (later the Professorial Board) in 1900. In 1905 he was offered the Vice-Chancellorship of the newly reconstituted University of London (but he declined the post in light of his experience in Bristol). Moreover, as his scientific achievements brought great honour to the College,[97] he was able to secure further power and influence, at both a local and national level.

Ramsay used his growing institutional power to campaign for the reform and reorganisation of the University of London, insisting:

> We must make the Univ[ersity] a real teaching univ[ersity] - including a research univ[ersity].[98]

Shortly after his arrival at the College, he joined the Association for Promoting a Teaching University for London, and also became a member of Pearson's Association for Promoting a Professorial University. Ramsay played an active role in lobbying Parliament and in organising the members of the scientific and university communities into an effective voice, to which policy makers were eventually forced to listen.[99] Between 1893 and 1899 he entered into an extensive correspondence with some of the leading champions of university reform and the endowment of research, including Sir Norman Lockyer, T.H. Huxley and Lyon Playfair.[100] He also canvassed the support and opinions of his German and American colleagues, and encouraged them to write to the Commissioners indicating their support for the reform and reorganisation of the University.[101] Perhaps most importantly, he also wrote to various M.P.s and government ministers - notably Sir Alfred Milner, Sir James Bryce, Joseph Chamberlain and A.J. Balfour - urging them to support the campaign

[96] He continued to lobby Parliament and various individual members of the government, 'praying for an increase in the grant', from 1887 to at least 1905. For example, in 1893 he coordinated a letter-writing campaign and drafted a petition to the Chancellor of the Exchequer urging him to raise the grant. Ramsay's correspondence and papers relating to this episode are contained in two boxes marked 'Petitions returns University Colleges (1890s)' and 'Grants in aid to Univ. Coll.', UCL/CC.

[97] See, for example, Abstracts of Council Minutes Volume VII 1900-06, 16 January 1905, Item 57, p.5.

[98] WR to Sir Norman Lockyer, 16 April 1902, UCL/WR/12, p.45.

[99] Watson, 'Aspects', p.268.

[100] See UCL/WR/10/2.

[101] See, for example, George B.Kauffman and Paul M.Priebe, 'Emil Fischer (1852-1919) - William Ramsay (1852-1916): Their Correspondence from 1892 to 1914', Archives Internationales d'Histoire des Sciences, 30 (1980), 137-61, letters 1 and 2.

to reform the University. As Katherine Watson explains, 'Ramsay selected the right key to change: a consistent and persuasive approach to the few men in Parliament who could influence their parties ensured that the relevant legislation would eventually be passed'.[102]

Ramsay laid out his personal position on the question of the reorganisation of the University in two articles which appeared in *The Times* under the heading 'Universities Abroad' on 8 and 9 June 1892. In the first piece Ramsay compared the University of London unfavourably with most other European universities, which, he insisted, 'pursue[d] the smooth paths of increasing knowledge by research and by the training of students'. He went on to present a (somewhat idealised) view of the Continental system, which he suggested should form a model for the reorganisation of the University of London. Ramsay believed that the financial position of the College - and, by extension, his own Department - would be improved if it could be incorporated into the University. However, his main aim was to secure a revision of the degree regulations in order to ensure that original research was both recognised and rewarded, in the hope that UCL might become a centre for the advancement of knowledge and the training of professional scientists and academics.[103] He reiterated these views in a speech on 'The Functions of a University', which he delivered at the College on 6 June 1901. In response to the Vice-Chancellor of the University, Lord Rosebery's assertion that the University should teach but have 'nothing to do with research',[104] Ramsay insisted:

> [T]he traditions of University College have always been that it is not merely a place where known facts and theories should be administered in daily doses to young men and young women, but that the duty of Professors, Assistant Professors, Teachers and Advanced Students is to increase knowledge. That is *the chief function of a university - to increase knowledge* (my italics).[105]

The structure and organisation of higher education in London was interminably discussed and debated by the College Council, the Senate, Convocation (the administrative body made up of graduates of the University) and countless other College and University bodies throughout the 1880 and 90s. Numerous schemes for the reorganisation and reform of the University were drawn up, two Royal

[102] Watson, 'Aspects', pp.285-94.
[103] Quoted in Tilden, Ramsay, pp.120-21.
[104] Quoted in Ibid, p.212.
[105] Ramsay, 'Functions', pp.227-8.

Commissions investigated the question,[106] and four bills seeking to reconstitute the University were introduced into the House of Commons. Finally in July 1898 a new University of London Act was passed, thanks, very largely, to the efforts of Richard Haldane.[107] Under the terms of the new Act, UCL and Kings became schools of the University, alongside various other metropolitan institutions which were admitted to the University as schools in particular faculties.[108] Seven commissioners were subsequently appointed to draft new regulations for the government of the University. One of these commissioners was the former Professor of Physiology at UCL, Sir Michael Foster.[109] In 1899 Ramsay wrote to Foster, addressing every single point raised in the Bill in some detail, and stressing, in particular:

> Research is of equal importance with teaching, and they should go hand in hand.

Although he was not entirely satisfied with the final form of the amended Bill, several of Ramsay's suggestions were put into effect. Perhaps most importantly the new University of London Act embodied the principle that teaching and research should go 'hand in hand', and in 1905 University College London was formally reconstituted as *a place of teaching and research.*[110]

On 1 January 1907 - under the terms of the University College London (Transfer) Act of 1905 - the College was formally incorporated into the University of London. At this point UCL effectively ceased to exist as a separate legal entity, the assets of the College were formally vested in the University, and all its actions and activities were subsequently carried out under the auspices of the University of London. Moreover, in accordance with the demands of the Association for the Promotion of a Teaching University for London, the professorial staff of UCL and Kings College were given representation on the Senate and on the Boards of

[106] The Selbourne Commission, which sat from 1888-89, and the Gresham Commission which investigated the proposed 'Gresham University for London' between April 1892 and January 1894. See Report of the Royal Commission to Inquire Whether Any and What Kind of New University or Powers is or are Required for the Advancement of Higher Education in London (Cd.5709) (London: HMSO, 1889), and Report of the Commissioners Appointed to Consider the Draft Charter for the Proposed Gresham University in London (Cd.7259, 7425) (London: HMSO, 1894).

[107] Harte, University of London, pp.156-9.

[108] These institutions included the ten London medical schools, eight theological training colleges, the various women's colleges, the scientific and technical colleges based in South Kensington, the South Eastern Agricultural College at Wye, and the new London School of Economics.

[109] See Geison, Foster. See also University of London Statutes, Historical Record, pp.70-99.

[110] WR to Michael Foster, undated, UCL/WR/12/2, p.13. Ramsay later wrote at the top of the letter: it 'produced a certain effect'.

Study set up to control each subject area, and the aims and objectives of the University were widened to include a commitment to both teaching and the promotion of original research:

> The purposes of the . . . University of London are to hold forth to all classes and denominations both in the United Kingdom and elsewhere without any distinction whatsoever an encouragement for pursuing a regular and liberal course of education; *to promote research and the advancement of science and learning*; and to organise, improve and extend higher education (my italics).[111]

In many ways the institutionalisation of this dual commitment to teaching and research was the most significant outcome of the campaign to reform the University of London in this period. The constitutional reforms introduced between 1898 and 1907 were ultimately short lived, and the debate over the structure and organisation of the University and its relationship with its various constituent colleges continues to this day. But it was quickly accepted that the aims of the University should include both the advancement and dissemination of knowledge, and in the twentieth century University College London did become a centre for teaching and research. However, although the prelude to the 1898 University of London Act has been been described, discussed and debated at length on numerous occasions, most accounts have concentrated on the administrative reforms introduced in this period, focussing in some detail on the various (abortive) plans for the reconstitution of the University that were drawn up between 1884 and 1898.[112] This reflects the fact that the debate between contemporary critics of the University and those seeking to preserve its traditional role and structure focussed primarily on the administrative structure and organisation of higher education in London. There appears to have been very little (public) debate and disagreement about the extension of the aims and objectives of the University to include both teaching and research. Thanks to the efforts of a handful of pioneering professors in certain key departments of the College, it was already widely accepted that the aims of both UCL and the University of London should include undergraduate teaching, the promotion and organisation of research, the advancement of knowledge, and the training of graduate students in the methods of research.

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[111] University of London Act (1898), Historical Record, pp.62-70.

[112] See, for example, Allchin, Reconstruction of the University of London; Harte, University of London, pp.77-160, and Humberstone, University Reform in London.

Conclusion

Ultimately, this chapter has again highlighted the significance of the role played by the individual members of staff who presided over the most active 'research departments' in this period - striving to pursue their own pioneering researches in various fields, training their students in the methods of research, and fighting to secure the necessary financial support and an institutional commitment to their work. The institutional context in which Pearson, Ramsay and Pollard set about founding their schools was hardly ideal, and the growth and development of the Departments of Applied Mathematics and Statistics, Chemistry and History in the period 1890-1914 was largely the result of their personal determination, ambition and hard work. Principally as a result of their own advancing reputations as successful scholars, they were all able to secure positions of authority and influence within their own disciplines and the British academic community in this period, and their growing involvement in the politics and administration of the College and University of London also enabled them to secure significant power and influence at an institutional level and access to local networks of patronage. Having laid the foundations of successful research schools, they were therefore able to secure significant institutional and financial support at both a local and national level, and take advantage of the College Council's growing commitment to the promotion of original research. The first decade of the twentieth century was therefore a period of massive expansion, during which all three men were able to turn successful research schools into flourishing *research departments.* However, one should also note that the majority of the funds that underpinned the growth and development of these departments came from private sources, and it is also highly significant that Pearson, Ramsay and Pollard played a crucial role in shaping the College Council's changing definition of the role and function of the College in this period, both through their efforts to secure greater financial and institutional support for their work, and their involvement in the politics and administration of the College and the campaign to reform the University of London.

9. Conclusion: A Revolution from Below

[University College London] was planned upon a noble scale; it subsisted for many years in penury; [and] what it is, it owes in the main to a long line of unrequited benefactors, among whom the professors are conspicuous.

H. Hale Bellot, 1927.[1]

This account is the first of its kind to openly address the question of the origins of the research university in this country. A number of significant conclusions emerge from this study, principally concerning the emergence of an institutional commitment to 'teaching and research' at University College London in the period 1890-1914. Ultimately, however, it is little more than a pilot study, highlighting the weakness of the existing secondary literature on this subject and the need for further work on the origins and development of the modern conception of the British university as 'a place of teaching and research', but also suggesting a novel approach to the subject based on similar 'local' studies of individual university colleges, research schools laboratories and departments.

The Turning Point c.1890-1914

In the absence of a satisfactory account of the origins of the research university in Britain, the principal conclusion that emerges from this thesis is simply that the origins of the modern conception of the role and function of University College as a centre for the advancement and dissemination of knowledge are to be found in the period 1890-1914. Moreover, although this is one of a number of conclusions that need to be followed up in similar studies of other British universities and university colleges, it appears that the events that culminated in this revolution in the official conception of the role and function of UCL were mirrored by similar developments in universities and colleges throughout Britain in this period. The new universities and colleges that were established between 1890 and 1914 - Imperial College London and the London School of Economics, for example - were, from their very inception, officially designated centres of teaching and research; and this dual commitment to the advancement and diffusion of knowledge also found expression among the aims of the 'civic' university colleges as they were reconstituted as independent universities during the first decade of the twentieth century. There is also some evidence to suggest that the ancient universities were beginning to reinvent themselves as

[1] Bellot, UCL, p.417.

places of teaching and research in this period;[2] and it therefore seems that the turn of the century marked an important turning point, both in the history of UCL, and more generally in the history of university education in this country.

However, it is important to stress that the process which eventually culminated in the formal reconstitution of the College as a place of teaching and research actually began in the 1860s and 70s (or perhaps even earlier). Initially, at least, this was a revolution from below - led by the individual members of staff who managed to pursue successful research careers in the Mid-Victorian period, in the absence of a formal, institutional commitment to research. Although they were paid to teach and not to conduct their own experiments and investigations, there had always been individual members of staff at UCL who were prepared to devote the time that could be spared from their teaching and other official duties to the prosecution of original research. For example, during the early years of the history of the College, men like Charles Bell, Anthony Todd Thompson, Edward Turner and William Sharpey all conducted interesting and important research in their respective fields. In the second-half of the nineteenth century this tradition was upheld by men like Michael Foster, John Burdon Sanderson, Alexander Williamson, George Carey Foster, Ray Lankester and Alexander Kennedy, who were also active in training their students in the methods of research and encouraging them to conduct their own experiments and investigations. Embryonic research schools were therefore established in the Departments of Physiology, Chemistry, Physics, Zoology and Mechanical Engineering in the 1870s and 80s. But, in the absence of a significant institutional commitment to research and adequate financial support, their efforts were doomed to fail. Williamson 'abandoned research altogether' in the 1860s;[3] Michael Foster surrendered the Jodrell Chair of Physiology in 1870, complaining that his teaching commitments left him with insufficient time to devote to his own experiments and investigations;[4] and Carey Foster spent the best part of 30 years campaigning for the 'recognition of his laboratory teaching and research in the curricular and

[2] See, for example, 'Report by Warren and Liveing' (PRO/ED25/81); Brock and Curthoys, eds, Oxford, pp.457-97; Brooke, Cambridge, pp.151-209, and Geison, Foster, especially pp.81-115.
[3] Travers, Ramsay at UCL, p.2.
[4] Reports 1873, pp.14-15.

architectural hierarchies of the College', but ultimately failed in his attempt to establish a school of research in experimental physics at UCL.[5]

However, the institutional context of teaching and research at University College began to change significantly during the last quarter of the nineteenth century. From about 1870 onwards the College Council and University authorities took a growing pride and interest in the research activities and achievements of the professorial staff of the College, as they began to win international recognition and acclaim for their efforts, 'necessarily conferr[ing great] honour and distinction' on both the College and University of London.[6] As a result, the public face of the College became increasingly sympathetic to research in this period, and the Council began to offer significant financial and institutional support to the staff and students of the College who were engaged in producing original work of this nature. The arrangements for paying the professorial staff and their junior colleagues were revised in order to recognise and reward their efforts in this direction,[7] and they were also provided with increasingly generous grants for materials, apparatus and assistance. A special postgraduate prospectus, highlighting the opportunities for students to learn the methods of research and conduct their own experiments and investigations, was produced for the first time in 1901,[8] and the regulations governing the administration of postgraduate degrees were revised in order to include a mandatory research component.[9] Perhaps most importantly, in 1902 the Council also launched an 'Appeal for the Endowment of Advanced University Education and

[5] Gooday, 'Precision Measurement', Chapter 4, p.2. Carey Foster arrived at UCL in 1865, intent on establishing a research school in experimental physics, centring around his own work on precision measurement and the determination of electrical standards, at the College. But, as Graeme Gooday explains, his plans were frustrated because research remained 'institutionally subservient to the requirements of undergraduate teaching' throughout his long career in London. Experimental physics was not a compulsory element in the undergraduate natural philosophy course at UCL, and Carey Foster was therefore unable to attract students in sufficient numbers to form the nucleus of a postgraduate research school. Moreover, it proved difficult - and eventually impossible - for him to carry out the delicate measurements required by his work on the determination of standards of electrical resistance in the laboratory provided for his purposes by the College Council, which was subject to frequent disturbances from external sources of mechanical and electromagnetic activity. This placed significant limitations on Carey Foster's programme, ultimately scuppering his attempt to establish a school of experimental physics at University College. Gooday, 'Precision Measurement', Chapter 4, pp.17-49.

[6] Reports 1887, p.14.

[7] 'Report on the Renumeration of Teaching Staff', 1905, UCL/CC.

[8] Reports 1901, p.13.

[9] University of London Calendar 1890-91, pp.135-6.

Research', in order to raise the funds necessary for the erection and equipment of new research laboratories in the scientific departments of the College and 'seminar libraries' on the arts side.[10]

By the turn of the century the Council could therefore claim, with some justification, that it attached the 'greatest importance to the original work done by the teaching staff and students',[11] and there was a general consensus that the aims and objectives of the College should include a formal commitment to both teaching and research. The remarkable public response to the appeal of 1902 - and the rapid growth of central and local government expenditure on higher education - removed the last barriers to the development of large scale research schools at UCL, and a genuine culture of teaching and research came to pervade the entire College in the Edwardian period.

The principal result was a remarkable increase in the output of original papers and other publications during the first decade of the twentieth century. 129 books, journal articles and scientific memoirs were produced by the staff and students of the College during the 1900-01 academic session. But the annual rate of publication had doubled to reach more than 200 a year by 1905; and a grand total of 297 new books and journal articles were produced and published during the 1913-14 session (see Graph 4.1 and Appendix 5). In the meantime, postgraduate students flocked to UCL in unprecedented numbers - the postgraduate population of the College rising from 108 in 1903 to 441 in 1914, and thus accounting for more than 10% of the total student body in 1905, and 25% by 1914 (see Graph 4.4 and Appendix 2). Crucially, the Edwardian period was also an era of massive growth and expansion; and nothing illustrates the emergence of a new commitment to teaching and research more clearly than the physical transformation of the Gower Street site between 1907 and 1914 (see Figure 4.4). A new physiological research institute was opened in 1909; the Biometric and Eugenics Laboratories were combined and incorporated into a new purpose-built Department of Applied Statistics, and new chemistry laboratories - housing advanced facilities for teaching and research in organic, inorganic, physical and pathological chemistry - were erected to the north-west of the main College buildings in Gower Place.

[10] Needs, pp.2-4.
[11] Reports 1903, p.24.

It is important to stress that the 'research revolution' was not confined to one or two individual departments of the College in this period; its impact was general - and almost universal. The Departments of Chemistry, Physiology and Applied Mathematics were by far the most active in the area of original research in this period, but they only account for about one-third of the original papers and other publications that emerged from within the College during the first decade of the twentieth century, and a similar proportion of the postgraduate and research students who passed through UCL between 1903 and 1914. By the end of our period, original work was being produced and published in almost every single department of the College - from German to Geology, and Botany to Buddhist Literature (see Appendix 5).

However, as we have repeatedly seen, one should not exaggerate the speed, scale and significance of the events that took place in this period. Although this was an era of monumental change, the research revolution was far from complete. Other - older - forms of intellectual life and activity continued to survive and flourish at UCL well into the twentieth century. Ramsay, Pearson and Pollard's achievements were emulated - perhaps even exceeded - by some of their colleagues in other departments of the College, notably by Schafer, Starling and Bayliss in Physiology. But they were also working alongside individuals such as Flinders Petrie, Ambrose Fleming and the Reverend T.G. Bonney, who shared their commitment to research, but lacked the necessary vision, ambition and determination to establish their own schools. Moreover, the Departments of Comparative Law, Constitutional Law, Roman Dutch Law, Architecture, Hygiene and Public Health were conceived of as professional training schools, and their staff and students did little in the way of original research. Elsewhere there were individual members of staff who devoted themselves entirely to the business of undergraduate teaching, and continued to regard research as an indulgent luxury. For example, Pollard's professorial colleague in the History Department, F.C. Montague, was the very epitome of the early Victorian College professor. As Negley Harte explains:

> Under Montague, the nineteenth century in the Department was prolonged until 1927 when he was eventually to retire aged nearly seventy. For year after year he had jogged along - if that is not too energetic a term, dallied along is perhaps better - travelling down from Oxford each week to offer readings from his own books by way of lectures. In the 1920s he was still giving the same lectures as in the 1890s, allegedly pausing occasionally to alter remarks like '. . . as Mr. Gladstone *says*. . .' to '. . . as Mr. Gladstone *said*. . .'.[12]

[12] Harte, History Teaching at UCL, p.12.

The last years of the nineteenth century and early 1900s merely witnessed the birth of a concept. It would be several decades before UCL could legitimately claim to be a *research university* - and the implications of the decisions reached in this period have not yet been fully realised - but the origins of the modern *conception* of the College as a place of teaching and research are, nevertheless, to be found in this period.

An 'Indirect Endowment of Research'

Turning to the forces that shaped this revolution in the official conception of the role and function of Britain's universities and colleges, this account suggests that - contrary to the assumptions implicit within much of the existing secondary literature on the subject - the origins of the modern conception of the British university as a centre for teaching and research are to be found within the individual universities and colleges in question. Although we still lack a comprehensive account of the origins of the research university in this country, it is commonly assumed that they are to be found in the late nineteenth-century transformation in public and government attitudes towards science and research, and the concurrent transformation in the relationship between the universities and the state.[13] It has been argued that the launching of the annual Parliamentary Grant-in-Aid to University Colleges in Great Britain in 1889 was essential for the development of their research function - inevitably acting as 'an indirect endowment of research'.[14] However, while it is undoubtedly true that the late nineteenth-century revolution in public attitudes and government policy towards science and the promotion of research was, in fairly general terms, a necessary prerequisite for the emergence of an institutional commitment to teaching and research at the beginning of the twentieth century, a systematic review of the government papers relating to the grant does not support this hypothesis.

Although the origins of the grant are to be found in the campaign for the endowment of research and the government's faltering attempts to endow (scientific) research, its stated aim was not to subsidise research, but merely to assist those colleges which gave 'teaching of a university standard in arts and science'.[15] Moreover, although a substantial - and growing - proportion of the income of Britain's

[13] See, for example, Cardwell, Organisation of Science, especially pp.111-67, MacLeod, 'Resources of Science', and Alter, Reluctant Patron, especially pp.22-35.
[14] Simpson, PhD, p.85; MacLeod, 'Resources', p.161.
[15] 'Memorandum on the Grant to University Colleges',1 March 1889, PRO/ED24/77.

universities and colleges came from the state in this period, most of the funds available to the staff and students of UCL came from student fees and private endowments (see Graph 3.1). Crucially, private endowments and benefactions paid for the expansion and redevelopment of the Gower Street site, and the installation of increasingly elaborate and expensive facilities for teaching and research in the scientific departments of the College. It is also highly significant that the College authorities retained a great deal of autonomy in deciding how to spend the money that they did receive from the government. The Treasury's definition of the institutions and sort of work that the grant was intended to assist was sufficiently vague to allow those responsible for its administration - the ad hoc advisory committee, the government inspectors, and ultimately the university colleges themselves - a great deal of freedom and independence in deciding how the money was spent. And they appear to have been in general agreement that the 'making of knowledge', and the training of students in the methods of original research, was 'work of a university character and stamp' - that it was, in fact, *the* defining characteristic of the modern British university. While the grant may have acted as an 'indirect endowment of research' in this period, ultimately its role was merely to consolidate the effect of various developments that were taking place within Britain's universities and colleges.

The Official Conception of the Role and Function of the College

Chapter Four therefore focusses more closely on the College Council and its changing conception of the role and function of UCL. As we have already seen, the emergence of an institutional commitment to teaching and research at the beginning of the twentieth century did result in a significant increase in the postgraduate population of the College, in the number of postgraduate degrees awarded, and in the number of new books and journal articles produced and published by the staff and students each year (see Graphs 4.1-7). However, the careful *statistical* analysis of the official publication statistics, student roll and annual degree results highlights the fact that there was already a significant amount of research going on at UCL prior to the formal reconstitution of the College as a place of teaching and research. These figures also suggest that the 'research revolution' was led by certain individual

professors and their pupils - in certain key departments of the College - in this period. The staff and students working in the scientific departments were generally more active in this area than their colleagues in the Faculties of Arts, Laws and Engineering (see Graphs 4.8-10). Most of the postgraduate and research students who passed through UCL in this period were studying scientific subjects, predominantly Applied Mathematics and Chemistry (see Appendix 2). As a result, there were many more successful doctoral candidates in scientific subjects than in Arts, Laws and Engineering - the most popular subjects being Chemistry, Physiology and Zoology (see Appendix 6). Moreover, the publication statistics reveal that the staff and students of the Departments of Applied Mathematics and Chemistry were far more productive than their colleagues in any other department, together accounting for more than a quarter of the new books, journal articles and scientific memoirs produced and published between 1890 and 1914 (see Appendix 5).

The Morrellian Model

Part Two of this thesis therefore focusses more closely on three of the most active research departments, using Jack Morrell's model of the 'ideal' research school as a framework for investigating the various factors that underlay the emergence of successful schools of research in the Departments of Applied Mathematics and Statistics, Chemistry and History between 1890 and 1914. Building on Katherine Watson and Eileen Magnello's recent work,[16] these chapters investigate Ramsay, Pearson and Pollard's working methods, the structure, organisation and ethos of their laboratories and departments at UCL, their involvement in the politics and administration of the College and University of London, and their entrepreneurial role as pioneer school builders, in unprecedented detail. Although critics have indicated just how 'idealised' the notion of the research school becomes in Morrell's study,[17] these case studies demonstrate that 30 years after its inception, the Morrellian model still constitutes a useful analytical tool for investigating the organisation and development of a (successful) research school, and suggest that it can usefully be

[16] Magnello, 'Pearson, Evolutionary Biology and the Emergence of a Modern Theory of Statistics', Magnello, 'Non-Correlation', Watson, 'Aspects', and Watson, 'Chemist as Consultant'.
[17] Butler, 'Centers and Peripheries', p.473; Geison, 'Scientific Change'.

applied to schools of research in the arts and social sciences, as well as in the more traditional experimental science subjects. However, one should also note that this thesis champions a novel approach to the investigation and analysis of research school development, based on the comparative study of school development in a broad range of departments within a single university institution. As we saw in Chapter One, most of the existing literature on research schools takes the form of comparative studies of the work and development of rival schools within a particular discipline.[18] The more *integrative* approach favoured here highlights the significance of the institutional context in which Ramsay, Pearson and Pollard were working, drawing particular attention to the impact and implications of the emergence of an institutional commitment to research at UCL during the first decade of the twentieth century.

These departmental case studies also highlight a number of significant features about the structure, organisation, ethos and work of the College in this period. The first and most basic conclusion that emerges from a detailed investigation of these various sources, is that - contrary to the complaints of the declinists - a great deal of original research was conducted by the staff and students of University College London in this period. A growing number of postgraduate students passed through UCL between 1890 and 1914, a growing number of postgraduate degrees were awarded, and a growing number of new books, journal articles and scientific memoirs were produced and published (see Graphs 4.1-6 and Appendices 1-6). Although Michael Sanderson highlighted the significance of the role played by the University of London as the principal centre for teaching and research relating to British industry prior to the First World War as long ago as 1972,[19] London University is still largely absent from the secondary literature dealing with the universities and the rise of research. Moreover, although the history of both UCL and the University of London has been extensively documented, there has been little discussion of the emergence of an institutional commitment to teaching and research in this period, and there is a pressing need for a post-declinist account to update Bellot's centenary history of the College. This thesis therefore also has a number of significant implications for the student of the history of UCL and the University of London.

[18] See above pp.24-30.
[19] Sanderson, Universities, pp.189-90.

Visiting Scholars, Volunteers and 'Amateur Devotees'

Perhaps the most startling conclusion to emerge from this study is the revelation that in an era when less than 5% of British university students were postgraduates,[20] more than 25% of the students enrolled at UCL were registered as 'Postgraduate and Research Students' (See Graph 4.4). These figures highlight the strength of the commitment to research that began to emerge at UCL in this period, and the fact that the great majority of these research 'students' were volunteers or 'amateur devotees'. A tiny proportion of the postgraduate and research students who passed through the College in this period were reading for postgraduate degrees in London. Some of them were registered at other universities, and simply spent a year or two at UCL pursuing a particular aspect of their research under the supervision of Starling or Petrie or Pollard. But, in a period when it was not necessarily expected for a serious scholar to have a postgraduate qualification, others were simply volunteers pursuing a 'leisurely' interest in chemistry, Egyptology or physiology in the libraries and laboratories of UCL.

Some of the most celebrated figures associated with the College in this period were not working for University of London degrees and did not have official positions on the staff of the College. The most prominent example is probably that of William Bayliss, who spent 24 years working alongside Edward Sharpey-Schafer and Ernest Starling in the Physiology Department, without an official position on the staff of the Jodrell Laboratory. He nevertheless played a full part in the life of the Department, personally contributing more than 40 papers to the *Journal of Physiology* and collaborating with Starling in his pioneering work on hormone theory and the electrophysiology of the heart.[21] These 'volunteers' therefore played a vitally important role in the development of the modern conception of the College as a centre for teaching and research. Long before University College was formally reconstituted as a place of teaching and research, and began to offer significant financial and institutional support to the research staff and students of the College, there were already large numbers of research 'students' at UCL, working under the supervision of those individual members of staff who were willing to devote the time that could be spared from their teaching and other official duties to the prosecution of original research in their respective fields.

[20] Simpson, Ph.D., p.162.
[21] O'Connor, British Physiologists, pp.121-4.

The Role of Women

This account also highlights the significance of the role played by the newly 'liberated' and highly educated middle-class women who sought useful employment as research students and assistants in the libraries and laboratories of UCL in this period. No less than 24% of the postgraduate and research students who passed through University College between 1903 and 1914 were women (see Graph 4.6 and Appendix 4). In fact, by the end of our period, around 50% of the postgraduates based in the History Department and 70% of those studying Egyptology were female - including a significant proportion of the 'special' students who spent their winters 'digging' in Egypt with Petrie. A similarly high proportion of Pearson's students - and about one-third of the full-time staff of the Department of Applied Mathematics and Statistics - were women. This thesis therefore builds upon Julie Stevenson's recent work on the female undergraduates of the period,[22] extending her analysis to highlight the significance of the role played by female postgraduate and research students in the Edwardian era. The abundance of female postgraduates at UCL is also interesting in the context of Morrell's work on 'charismatic' professors and 'disciple fetishism', but it is important to stress that these relationships were reciprocal. Through their reliance on competent and enthusiastic young women, men like Pearson and Petrie were able to instigate large-scale research programmes and advance their own careers; but, at the same time, these women were given a unique opportunity to make a significant contribution to an emerging discipline at a crucial stage in its development, and also to establish themselves as successful researchers in their own right.[23]

Entrepreneurial Professors and Private Benefactors

The significance of the 'voluntary' tradition discussed above also becomes apparent when one considers the financial history of the College. As we saw in the sections of this thesis dealing with the impact of the launching of the Parliamentary Grant, most of the funds available to the staff and students of UCL in this period came from student fees and private donations and benefactions of various kinds. In his account of the development of academic philanthropy in Britain, David Owen argues that one should not exaggerate 'the relative weight pulled by private

[22] Stevenson, 'A Neglected Issue in the History of Education', pp.57-91.
[23] Richmond, 'Women in the Early History of Genetics', p.90.

philanthropy in university education', citing figures from the 1950s which suggest that more than 70% of the total income of Britain's universities came from Treasury grants, with only 11% coming from sources other than student fees and government and local authority grants.[24] However, despite the significance generally attached to public money and the state, this account demonstrates that state subsidies account for only 12% of the total income of University College London in the period 1890-1914. In 1908 the Council acknowledged 'to what a large extent' it was dependent upon private subscriptions and donations, and 'the generosity of some of the great City companies',[25] and Graph 3.1 clearly demonstrates that the majority of the funds available to the Council in the last years of the nineteenth century and early 1900s came from student fees and private donations, subscriptions and benefactions. Moreover, the money that the College was receiving from central and local government in this period was not specifically targeted for research; much of the money received from private sources was.

In the absence of significant financial and institutional support from the College Council and University authorities, individual members of staff were forced to subsidise their own work and the researches of their junior colleagues and students out of their own pocket, and to take on a new *entrepreneurial* role in order to secure the necessary financial support for their work from private benefactors. The new 'research chairs' established in this period were all endowed by individual patrons. T.J. Philips Jodrell presented the College with the sum of £7,500 for the permanent endowment of a research chair in physiology in 1870; Amelia Edwards paid for Petrie's Chair in Egyptology, under the terms of which he was required to spend six months a year 'digging' in Egypt, and Pearson's work was subsidised by the Drapers' Company and Sir Francis Galton. Perhaps most importantly, private endowments and benefactions also paid for the new research laboratories and institutes that were established in this period. The new chemical laboratories in Gower Place, the Bartlett Building on Gower Street, and the new Institute of Physiology that was built in the old school playground, were all paid for by private benefactions and subscriptions.

[24] Owen, English Philanthropy, pp.366-7.
[25] Reports 1908, pp.10-12. For example, the Drapers' Company, Mercers' Company, Grocers's Company and Worshipful Company of Fishmongers all leant the College significant financial support in the period 1890-1914.

The Institutional Dynamic

Finally, one should also note that although they were eventually able to secure the necessary financial and institutional support for their work in London, Ramsay and Pearson's most important achievements and discoveries predate the institutional revolution of the early 1900s, while Pollard was only able to achieve his ambitions on an intercollegiate basis, and the funds that underpinned the growth and expansion of all three departments in this period came primarily form personal and private sources. Although a certain base level of funding was necessary in order to run an effective research school, it was not always necessary for the director of an ambitious school to have significant institutional support and generous research grants at his disposal.[26] At UCL, Ramsay and Pearson's personal resources - and resourcefulness - enabled them to found and sustain small, but remarkably successful, schools of research in the 1890s. But, there was also a significant institutional dynamic at work. As Morrell explains, a financial crisis inevitably occurred when the financial losses incurred by the director in meeting the necessary costs of running his school became 'intolerable', and at this point it was crucial that he was able to secure greater financial and institutional support from his parent institution.[27] It was therefore vitally important that Ramsay, Pearson and Pollard were eventually able to secure an institutional commitment to their work and significant financial support. Ultimately it was this that enabled them to succeed where Foster, Sanderson and Carey Foster had failed, and turn successful research schools into flourishing research departments.

However, it is also important to stress that there was a significant degree of reciprocity in the relationships that existed between these pioneering professors and their patrons. Pearson, Ramsay and Pollard clearly benefited from the institutional reforms of the Edwardian period and the growth of public and private investment in research, but they were all active on various fronts - at both a local and national level - in seeking to secure the necessary financial support for their work. Ramsay was the leading figure in the campaign to secure central government funding for Britain's universities and colleges; Pollard was able to persuade the Technical Education Board of the LCC to subsidise his Evening School of History, and Pearson was able to exploit various personal contacts to secure a significant level of private

[26] Butler, 'Centers and Peripheries', pp.487-8.
[27] Morrell, 'Chemist Breeders', p.7.

investment in the Department of Applied Mathematics and Statistics. Moreover, through their efforts to secure an institutional commitment to their work at UCL, they played a central role in stimulating the efforts of their colleagues in 'laggard' departments and shaping the College's changing conception of its role and function in this period. Pearson and Ramsay led the campaign to reform the University of London in the 1890s, insisting that the University should be reconstituted as a place of teaching and research; and Pollard was intimately involved in the politics and administration of both the College and University as Chairman of the Board of Studies in History and Director of the Institute of Historical Research, striving to ensure that the principles embodied in the 1905 University College London (Transfer) Act were translated into practice.

A Revolution from Below

Ultimately, therefore, this account suggests that this revolution in the official conception of the role and function of UCL was a 'revolution from below'. The origins of the modern conception of the College as a centre for teaching and research are to be found in the period 1890-1914. During this period the aims and objectives of most of Britain's major universities and university colleges came to include a formal commitment to teaching and research. This revolution in the official conception of the role and function of university education in Britain can only be understood in the context of the concurrent transformation in the attitude of the British people and government towards science and research, and in the relationship between the universities and the state. But the role of central government was (merely) to consolidate the effects of developments that were taking place within the universities and colleges themselves. This account has therefore highlighted the significance of the role played by the individual professors who managed to pursue successful research careers at UCL in this period, while training their students in the methods of research, and encouraging them to conduct their own experiments and investigations. Through the example of their own work, the financial implications of their successful researches, and their growing involvement in the politics and administration of the College, the University and College authorities were slowly forced to accept an expanded conception of the aims and objectives of the College in this period, and in 1905 University College London was formally reconstituted as 'a place of teaching and research'.

Notes:

1. The numbers in brackets in Appendix 1 refer to the total number of posts available in each Department, including those which were unfilled at the start of the academic year. Where I have been unable to establish whether or not these posts were filled during the course of the year they have not been included in the totals at the bottom of each column.

2. The fractional numbers in Appendices 2-4 refer to students who were jointly registered in one or more department, and students reading for joint honours degrees.

Appendix 1. Academic Staff by Department (1890-1914)

	1890-91	1891-92	1892-93	1893-94	1894-95	1895-96	1896-97	1897-98	1898-99	1899-1900	1900-01	1901-02
AESTHETICS												
ANATOMY	7	7	8	6	5	6	5	6	6	5	5	5
APPLIED MATHEMATICS	1	1	1	2	2	2	3	3 (4)	3	2 (3)	5	3
APPLIED STATISTICS												
ARABIC	1	2	2	2	2	1	1	1	1	1	1	1
ARCHAEOLOGY	1	1	1	1	(1)	(1)	1	1	1	1	1	1
ARCHITECTURE	1	1	3	3	3	4	4	4	4	4	3	4
ASSYRIOLOGY				1	1	1	1	1	1	1	1	1
BENGALI	1	1	1	1	1	1	1	1	1	1	1	1
BOTANY	2	3	2	2	2	3	3	3	3	4	4	4
BURMESE	1	1	1	1			1	1	1	1	1	1
CHEMISTRY	5	6	6	5	4	4	4	4	4	4	5	4
PATHOLOGICAL CHEMISTRY							1	2	2	2	2	2
ECONOMIC GEOGRAPHY												
EGYPTOLOGY				1	1	1	1	1	1	2	2	1
CIVIL ENGINEERING	1	1	1	1	1	1	1	1	1	1	1	2
ELECTRICAL ENGINEERING	1	1	1	1	2	2	2	3	3	3	2	2
MECHANICAL ENGINEERING	2	2	2 (3)	3	3	3	5	5	4	4	4	4
MUNICIPAL ENGINEERING & SURVEYING									3	3	3	3
ENGINEERING (HEATING & VENTILATION)												
ENGLISH	1	2	2	2	2	2	2	2	2	3	3	3
EXPERIMENTAL NEUROLOGY												
EXPERIMENTAL PSYCHOLOGY												
FINE ARTS	4	3	3	4	3	4	4	4	4	4	4	4
FRENCH	1	1	1	1	1	1	1	1	1	1	2	1
GEOLOGY AND MINERALOGY	1	1	1	1	1	1	1	1	1	1	1	1
GERMAN	1	1	1	1	1	1	1	1	1	1	1	1
GUJARATI	1	1	1	1	1	1	1	1	1	1	1	1
GREEK	1	1	1	1	1	1	1	1	1	1	1	1
HEBREW	1	1	1	1	1	1	1	1	1	1	1	1
HINDI (AND HINDUSTANI)	1	1	1	1	1	1	1	1	1	1	1	1
HISTORY	1	1	1	1	1	1	1	1	1	1	1	2
HYGIENE AND PUBLIC HEALTH	2	2	2	2	2	2	3	3	3	3	3	3
ITALIAN	2	1	1	1	1	(1)	2	2	1	2	2	2
JURISPRUDENCE	1	1	1	1	1	1	1	1	1	1	1	1
LATIN	1	1	1	1	1	1	1	1	1	1	1	1
COMPARATIVE LAW							1	1	1	1	(1)	1
CONSTITUTIONAL LAW	1	1	1	1	1	1	1	1	1	1	(1)	1
ENGLISH LAW											1	1
INDIAN LAW	1	1	1	1	1	1	1	1	1	1	1	1
ROMAN LAW	1	1	1	1	1	1	1	1	1	1	1	1
ROMAN DUTCH LAW												
MARATHI	1	1	1	1	1	1	1	1	1	1	1	1
MATHEMATICS	2	3	2	2	2	2	2	2	2	2	2	2
MILITARY SCIENCE												
NORTH SEMITIC EPIGRAPHY												
PALI AND BUDDHIST LITERATURE	1	1	1	1	1	1	1	1	1	1	1	1
PATHOLOGY AND MORBID ANATOMY	2	2	2	3	2	2	1	2	2	2	2	2
PERSIAN	1	1	1	1	1	1	1	1	1	1	1	1
PHARMACOLOGY												
PHILOLOGY	1	1	1	1	1	1	1	1	1	1	1	1
PHILOSOPHY	1	1	1	1	1	1	1	2	3	1	3	4
PHONETICS												
PHYSICS	4	5	5	4	5	5	4	4	4	4	4	3
PHYSIOLOGY	6	5	6	10	5	8	10	6	3 (4)	3	7	3
POLITICAL ECONOMY	1	1	1	1	1	1	1	1	1	1	1	1
SANSKRIT	1	1	1	1	1	1	1	1	1	1	1	1
SPECTROSCOPY												
TAMIL AND TELUGU	2	1	1	1	1	1	1	1	1	1	1	1
TIBETAN												
VOICE PRODUCTION AND ELOCUTION												
ZOOLOGY	2	3	2	2	3	3	3	3	3	2 (3)	3	3
TOTAL	71	74	75	81	73	78	87	88	87	86	95	91

Source: University College London Calendars 1890-1914 (London: UCL, 1890-1914)

Appendix 1. Academic Staff by Department (1890-1914)

	1902-03	1903-04	1904-05	1905-06	1906-07	1907-08	1908-09	1909-10	1910-11	1911-12	1912-13	1913-14
AESTHETICS		1	1	1	1	1	1	1	1	1	1	1
ANATOMY	4	5	5	5	5	6	6	6	6	6	6	6
APPLIED MATHEMATICS	5	5	4	5	6	5	8	7	6 (7)	2 (3)	3	4
APPLIED STATISTICS										10	9	9
ARABIC	1	1	1	1	1	1	1	1	1	1	1	1
ARCHAEOLOGY	1	2	1	1	1	1	1	1	1	1	1	1
ARCHITECTURE	3	3	4	4	5	2	3	3	2	3	3	7
ASSYRIOLOGY	1	1	1	1	1	1	1	1	1	1	1	1
BENGALI	1	1	1	1	1	1	1	1	1	1	1	1
BOTANY	4	5	5	6	6	5	6	6	6	5	5 (6)	8
BURMESE	1	1	1	1	1	1	1	1	1	1	1	1
CHEMISTRY	6	6	6	9	11	11	15	18	17	17	18	18
PATHOLOGICAL CHEMISTRY	2	2	2	2	2	2	2	2	2	2	2	2
ECONOMIC GEOGRAPHY		1	1	1	1	1	1	1	1	1	1	1
EGYPTOLOGY	1	1	2	2	2	2	2	3	3	3	3	3
CIVIL ENGINEERING	2	2	1	3	4	4	4	4	4	4	4	3
ELECTRICAL ENGINEERING	2	2	2	2	2	3	4	4	4	4	4	4
MECHANICAL ENGINEERING	4	5	4	5	5	5	5	5	4 (5)	4 (5)	7	7
MUNICIPAL ENGINEERING & SURVEYING	3	3	3	3	3	3	3	3	3	3	1 (3)	1 (3)
ENGINEERING (HEATING & VENTILATION)										1	1	1
ENGLISH	3	3	4	4	4	4	4	4	4	4	5	5
EXPERIMENTAL NEUROLOGY											1	
EXPERIMENTAL PSYCHOLOGY		1	1	1	1	1	1	1	2			
FINE ARTS	4	4	6	6	6	6	7	7	7	8	8	9
FRENCH	2	2	2	2	2	2	2	2	2	2	2	3
GEOLOGY AND MINERALOGY	1	1	1	2	2	2	3	3	3	3	3	3
GERMAN	1	3	4	4	4	3	4	4	5	5	5	5
GUJARATI	1	1	1	1	1	1	1	1	1	1	1	1
GREEK	1	1	1	1	1	1	1	1	1	1	1	2
HEBREW	1	1	1	1	1	1	1	1	1	1	1	1
HINDI (AND HINDUSTANI)	1	1	1	1	1	1	1	1	1	1	1	1
HISTORY	3	5	5	5	4	4 (5)	4	5	5	6	6	8
HYGIENE AND PUBLIC HEALTH	3	2 (3)	3	3	2	2	2	2	2	2	2	2
ITALIAN	2	2	2	2	2	2	2	2	2	2	2	2
JURISPRUDENCE	1	1	1	1	1	1	1	1	1	1	1	1
LATIN	1	1	2	2	2	2	2	2	2	2	2	1
COMPARATIVE LAW	1	1	1	1	1	1	1	1	1	1	1	1
CONSTITUTIONAL LAW	1	1	1	1	1	1	1	1	1	1	1	1
ENGLISH LAW	1	1	1	1	1	1	1	1	1	1	1	1
INDIAN LAW	1	1	1	1	1	1	1	1	1	1	1	1
ROMAN LAW	1	1	1	1	1	1	1	1	1	1	1	1
ROMAN DUTCH LAW				1	1	1	1	1	1	1	1	1
MARATHI	1	1	1	1	1	1	1	1	1	1	1	1
MATHEMATICS	3	3	4	4	4	5	5	5	6	6	6	6
MILITARY SCIENCE											1	1
NORTH SEMITIC EPIGRAPHY		1	1	1	1	1	1	1	1	1	1	1
PALI AND BUDDHIST LITERATURE	1	1	1	1	1	1	1	1	1	1	1	1
PATHOLOGY AND MORBID ANATOMY	2	3	3	3	3							
PERSIAN	1	1	1	1	1	1	1	1	1	1	1	1
PHARMACOLOGY			(1)	1	1	1	1	1	1	1	2	1 (2)
PHILOLOGY	1	3	3	3	3	3	4	4	3	3	3	3
PHILOSOPHY	4	3	4	5	3	3	3	3	4	8	7	9
PHONETICS			1	(1)	1	1	1	1	1	1	2	3
PHYSICS	3	3	4	4	4	4	4	4	5	5	5	5
PHYSIOLOGY	4	5	7	7	8	8	8	9	6	7	7	8
POLITICAL ECONOMY	4	4	5	5	4	4	3	3	2	2	2	2
SANSKRIT	1	1	1	1	1	1	1	2	2	2	1	2
SPECTROSCOPY		1	1	1	1	1	1	1				
TAMIL AND TELUGU	1	1	1	1	1	1	1	1	1	1	1	1
TIBETAN						1	1	1	1	1	1	1
VOICE PRODUCTION AND ELOCUTION					1	1	1					
ZOOLOGY	3	3	3	3	3	3 (4)	3	3	3	5	4	4 (5)
TOTAL	100	115	126	137	140	136	148	153	148	162	166	180

Source: University College London Calendars 1890-1914 (London: UCL, 1890-1914)

Appendix 2. 'Post-Graduate and Research Students' by Department (1903-1914)

	1903-04	1904-05	1905-06	1906-07	1907-08	1908-09	1909-10	1910-11	1911-12	1912-13	1913-14
ANATOMY								1	3	4	3
ANTHROPOLOGY											1
APPLIED MATHEMATICS	20	12.5	14.5	12.5	10.67	16.67	22	18	5	6	2
APPLIED STATISTICS									7	4	19
ARABIC							1	2.5			1
ARCHAEOLOGY	6	5	7	1	5	6	4	7	4	8	6
ARCHITECTURE											2
ASSYRIOLOGY				1	2	1	1				0.5
ASTRONOMY					2						
BENGALI								1			
BOTANY	7	11	7	9	7.5	9	9	10.5	11	8	7
BURMESE					1	5	1	1			
CELTIC								11		13.5	2
CHEMISTRY	23	33	37	28.5	38.5	36	41	35.5	26	19	31
BIOLOGICAL CHEMISTRY									2	3	
PATHOLOGICAL CHEMISTRY	9	9	6	11	13	11.5	7.5	14.5	6.5	3	3
PHYSIOLOGICAL CHEMISTRY									1		
CLASSICS								4	5	4	2.5
COMPARATIVE PHILOLOGY									1	1	
COPTIC								1	1		
ECONOMICS				2	1	1	2	1	2	1	1
EGYPTOLOGY	3	2	2	2	1	1	13	20	53	49.5	64
ENGINEERING											1
CIVIL ENGINEERING					1	1		0.5	2	1	1
ELECTRICAL ENGINEERING	1	1	1.5	2	1	80.5	75	74	36	40	35
MECHANICAL ENGINEERING	0.5	3	1	1		1	34	30	32	13	3
ENGLISH		3	1	2	1.5	1	8	9	11.5	14	22.5
ETHIOPIC					1						
EXPERIMENTAL NEUROLOGY									2	1	
FRENCH	2	4	9	8	7	7	9	10	10	12	13
GEOGRAPHY								1	1		
GEOLOGY						1	4	5	1	1	2.5
GERMAN	5	3.5	3	7	5.5	3	5	5	6.5	2	2.5
GREEK							1				
HEBREW							2				1
HISTORY			2	2	5	8	23	16	38	29	34
ANCIENT HISTORY		1	1					1	1	1	
HISTORY OF ART								1			
HYGIENE			2	17	60	46	59	70	57	68	75
INDIAN SCHOOL				13	10						
LATIN				0.5							
LAWS											2
COMPARATIVE LAW					2	15	29	5	1	1	1
CONSTITUTIONAL LAW				1				4	4	3	6
ENGLISH LAW					1	2	1	1	1	3	3
INDIAN LAW		0.5	0.5	0.5					1	1	1
INTERNATIONAL LAW				1			1				
ROMAN DUTCH LAW				3							
MATHEMATICS	3.5	3	2	3	4.67	7.167	4	3	4	18	15
MORAL PHILOSOPHY						3	5	3			
ORIENTAL SCHOOL							14	10	18	16	4
PALI				1		4		1			1.5
PATHOLOGY		4	9								
PERSIAN							1	1	1		
PHARMACOLOGY			1.5	2.5	2.5	1.5	4	3	2	4	6
PHILOSOPHY	3	2		2.5	2	0.5	1.5	5	7	5	9
PHYSICS	2	4	7	5.5	6.167	4.167	7	9	8	7	9
PHYSICAL ANTHROPOLOGY										2	
PHYSIOLOGY	7	7	6.5	17.5	19.5	17	10.5	12	13.5	13	8
PHONETICS								1		8	4.5
POLITICAL ECONOMY			1	1	1	1	3	1			
PSYCHOLOGY							1		3	16	28
EXPERIMENTAL PSYCHOLOGY	2	2	2	2.5	7.5	9	11.5	9	5	2	2
SANSKRIT	2	0.5	0.5	2.5	2	1	1	2.5	1		1.5
SEMITIC EPIGRAPHY				1							
STATISTICS	3										
TELUGU								1			
ZOOLOGY	9	8	10	7	7	7	7	8	8	6	4
TOTAL POSTGRADUATE STUDENTS	108	119	134	171	229	308	423	430	403	411	441
TOTAL UCL STUDENTS	1246	1323	1396	1191	1361	1448	1572	1600	1679	1589	1607

Source: University College London Calendars 1903-1914 (London: James Walton, 1903-1914)

Appendix 3. Overseas 'Post-Graduate and Research Students' by Department (1903-1914)

	1903-04	1904-05	1905-06	1906-07	1907-08	1908-09	1909-10	1910-11	1911-12	1912-13	1913-14
ANATOMY										1	
ANTHROPOLOGY											1
APPLIED MATHEMATICS	1	1	2	1		1	5	1	2		
APPLIED STATISTICS									1	2	
ARABIC								1.5			1
ARCHAEOLOGY											1
ARCHITECTURE											
ASSYRIOLOGY											
ASTRONOMY											
BENGALI											
BOTANY		1		2							
BURMESE					0.5						
CELTIC											
CHEMISTRY	6	4	5	4	7	3	3	2	6	5	5
BIOLOGICAL CHEMISTRY											
PATHOLOGICAL CHEMISTRY	1	1	1	1	1	3	2	6	2		
PHYSIOLOGICAL CHEMISTRY									1		
CLASSICS										1	
COMPARATIVE PHILOLOGY											
COPTIC											
ECONOMICS				1							
EGYPTOLOGY								1	2	2	1.5
ENGINEERING											
CIVIL ENGINEERING					1	1					
ELECTRICAL ENGINEERING				1				2	2	4	1
MECHANICAL ENGINEERING							2	1	1		
ENGLISH		1		1	1	1	3	6.5	5.5	7	9.5
ETHIOPIC											
EXPERIMENTAL NEUROLOGY									2	1	
FRENCH	1				1		1	1.5	1.5	1	
GEOGRAPHY											
GEOLOGY								1			0.5
GERMAN				2							
GREEK											
HEBREW											
HISTORY											4
ANCIENT HISTORY											
HISTORY OF ART											
HYGIENE				1	7	11	18	15	8	15	19
INDIAN SCHOOL				1	1.5						
LATIN											
LAWS											2
COMPARATIVE LAW						1	2				
CONSTITUTIONAL LAW											1
ENGLISH LAW					1		1	1	1	1	
INDIAN LAW		0.5	0.5	0.5					1	1	1
INTERNATIONAL LAW											
ROMAN DUTCH LAW				2							
MATHEMATICS										2	3
MORAL PHILOSOPHY							1				
ORIENTAL SCHOOL									5	3	
PALI								1			0.5
PATHOLOGY											
PERSIAN											
PHARMACOLOGY							1	2		2	4
PHILOSOPHY								2	3	3	3
PHYSICS			1				3	1			2
PHYSICAL ANTHROPOLOGY											
PHYSIOLOGY	1	1		7	7	7	4	5	6	3	5
PHONETICS											3.5
POLITICAL ECONOMY							2	1			
PSYCHOLOGY										1	2
EXPERIMENTAL PSYCHOLOGY					1		1				
SANSKRIT		0.5	0.5	0.5				0.5			1.5
SEMITIC EPIGRAPHY											
STATISTICS											
TELUGU											
ZOOLOGY									2		
TOTAL	10	10	10	25	29	28	49	52	52	55	72

Source: University College London Calendars 1903-1914 (London: James Walton, 1903-1914)

Appendix 4. Female 'Post-Graduate and Research Students' by Department (1890-1914)

	1903-04	1904-05	1905-06	1906-07	1907-08	1908-09	1909-10	1910-11	1911-12	1912-13	1913-14
ANATOMY											
ANTHROPOLOGY											
APPLIED MATHEMATICS	8	4.5	6	5	5	6	7	6		2	
APPLIED STATISTICS									2		5
ARABIC								1			
ARCHAEOLOGY	4	3	4		3	4	3	4	2	4	4
ARCHITECTURE											
ASSYRIOLOGY											0.5
ASTRONOMY					1						
BENGALI								1			
BOTANY	6	8	6	7	5	6	8	8	9	8	6
BURMESE						1	1	1			
CELTIC								4		6.5	2
CHEMISTRY	3	8	8	6	7	5.5	9	6	1	3	2
BIOLOGICAL CHEMISTRY						0.5			2	2	1
PATHOLOGICAL CHEMISTRY											
PHYSIOLOGICAL CHEMISTRY											
CLASSICS								2	2	2	1.5
COMPARATIVE PHILOLOGY									1	1	
COPTIC								1	1		
ECONOMICS								1	1	1	1
EGYPTOLOGY	1	1	1	1	1	1	9	12	38	30.5	44.5
ENGINEERING											
CIVIL ENGINEERING											
ELECTRICAL ENGINEERING						1		1	1		
MECHANICAL ENGINEERING											
ENGLISH		1					5	4	6	5	8
ETHIOPIC											
EXPERIMENTAL NEUROLOGY											
FRENCH	2	3	3	3	4			1	2	3	5
GEOGRAPHY								1	1		
GEOLOGY						1	2	3	1	1	1
GERMAN	5	1.5	1	2	2		1	2	3		
GREEK							1				
HEBREW											
HISTORY			1	1	4	5	13	11	25	19	17.5
ANCIENT HISTORY		1	1								
HISTORY OF ART											
HYGIENE				4	7	7	6	8	9	7	7
INDIAN SCHOOL											
LATIN											
LAWS											
COMPARATIVE LAW											
CONSTITUTIONAL LAW											
ENGLISH LAW											
INDIAN LAW	0.5										
INTERNATIONAL LAW											
ROMAN DUTCH LAW											
MATHEMATICS			1			2	2	1		2	1
MORAL PHILOSOPHY							3	2			
ORIENTAL SCHOOL								1	1	3	
PALI						1					0.5
PATHOLOGY											
PERSIAN											
PHARMACOLOGY											
PHILOSOPHY		1			0.5		0.5	5	2	2	3
PHYSICS										1	
PHYSICAL ANTHROPOLOGY											
PHYSIOLOGY	1	1	1	2	5	1		1	2	2	3
PHONETICS										2	1
POLITICAL ECONOMY											
PSYCHOLOGY										3	8
EXPERIMENTAL PSYCHOLOGY					1.5	2	3.5	2	2	4	1
SANSKRIT	0.5				1						0.5
SEMITIC EPIGRAPHY											
STATISTICS	2										
TELUGU								1			
ZOOLOGY	1	1	3	3	3	3	4	5	3	3	4
TOTAL	34	34	36	34	50	47	78	96	117	117	128

Source: University College London Calendars 1903-1914 (London: James Walton, 1903-1914)

Appendix 5. 'Original Papers and Other Publications' by Department (1890-1914)

	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900
ANATOMY											
APPLIED MATHEMATICS			1	5	1	7	7	9	5	9	9
APPLIED STATISTICS											
ARCHAEOLOGY								3	1	4	1
ARCHITECTURE											
ASSYRIOLOGY											
BOTANY	1	3	2	2	1	3	1		1	1	
CHEMISTRY		3	18	15	17	19	21	2	8	3	18
PATHOLOGICAL CHEMISTRY							6	6	9	6	7
COMPARATIVE PHILOLOGY			2	3	3	3	5	5	5	6	9
EGYPTOLOGY		2	2		2	2	2	1	3		3
CIVIL ENGINEERING	1	2			1	2	2	2	4	2	2
ELECTRICAL ENGINEERING	3	2	1	1		4	13	10	3	1	
MECHANICAL ENGINEERING		3			5	2	1				
MUNICIPAL ENGINEERING AND SURVEYING											
ENGLISH		1		1	2	4	1	4	3	2	2
EXPERIMENTAL PSYCHOLOGY											
FRENCH											
GEOGRAPHY											
GEOLOGY AND MINERALOGY			8	2	5	4	7	13	4	8	10
GERMAN						1	1		1	1	
GREEK				1	1	5	5	6	2	3	1
HEBREW											
HINDUSTANI, BENGALI & HINDI										1	1
HISTORY											
HYGIENE AND PUBLIC HEALTH				1	2	2	2	3		1	1
INDIAN SCHOOL											
ITALIAN										1	1
JURISPRUDENCE				1							
LATIN					1	2	2	2	2	2	3
COMPARATIVE LAW											
CONSTITUTIONAL LAW										1	1
ROMAN DUTCH LAW											
MATHEMATICS		1	2	1	1	3	3				
NORTH SEMITIC EPIGRAPHY											
PALI & BUDDHIST LITERATURE			1		1		2			2	
PATHOLOGY				16	11	13	1	1			
PERSIAN									1	1	1
PHARMACOLOGY											
PHILOSOPHY						1		1			2
PHONETICS											
PHYSICS		1	1	1	1	1	2	1	4	6	3
PHYSIOLOGY	8	11	4	4	9	18	4	12	8	11	12
POLITICAL ECONOMY		2	1	6	4	3	2	4	6	6	3
SANSKRIT				2	1			1	1	1	1
TAMIL AND TELEGU											
ZOOLOGY			2	5	5	4	5	9	3	1	8
TOTAL	13	31	45	67	74	103	95	95	74	80	99

Source: The Needs of University College London (London: UCL, 1902); UCL Annual Reports 1901-1915 (London: UCL, 1901-1915)

Appendix 5. 'Original Papers and Other Publications' by Department (1890-1914)

	1900-01	1901-02	1902-03	1903-04	1904-05	1905-06	1906-07	1907-08	1908-09	1909-10	1910-11	1911-12	1912-13	1913-14
ANATOMY													3	3
APPLIED MATHEMATICS	8	18	28	28	19	22	28	27	37	33	34	32	1	2
APPLIED STATISTICS													19	25
ARCHAEOLOGY	1	7	3	5	4	4	8	7	5	6	2	4	3	2
ARCHITECTURE					2	1		2	2					
ASSYRIOLOGY							2	2	4	5	3	5	6	
BOTANY	1	7	13	12	14	9	16	9	11	7	12	10	17	15
CHEMISTRY	14	14	23	26	27	29	31	40	41	33	35	26	19	31
PATHOLOGICAL CHEMISTRY	12	9	5	1	9		3	4	4			2	2	
COMPARATIVE PHILOLOGY	9	9	8	5	7	7	8	4	9	6				
EGYPTOLOGY	9	1	2	3	5	4	4	6	4	4	7	6	5	5
CIVIL ENGINEERING	4	1	2	3	6									
ELECTRICAL ENGINEERING		1	4	5	12	5	4	7	6	5	8	3	7	11
MECHANICAL ENGINEERING		2	2	1		6		2	1	2	2	7	10	16
MUNICIPAL ENGINEERING AND SURVEYING								2						
ENGLISH	5		2	4	1	2	1	4	7	5	3	7	5	7
EXPERIMENTAL PSYCHOLOGY					2	6	2	1		5	5	7	24	21
FRENCH			1	9	9	4	6	4	2	4	5	4	8	8
GEOGRAPHY				1	1	1			2	2	2	1	1	1
GEOLOGY AND MINERALOGY	13		3	1		2	3		2	3			3	3
GERMAN	3		7	8	3	6	6	5	6	5	10	4	11	11
GREEK			2	2	1				1	4	11	7	3	3
HEBREW			2	2	1			1	3	1	1	1	1	1
HINDUSTANI, BENGALI & HINDI					2									
HISTORY				5	5	7	6	3	5	6	23	21	22	25
HYGIENE AND PUBLIC HEALTH	1	2	4	5	4	6	4	6	5	9	5	10	8	7
INDIAN SCHOOL				1										
ITALIAN	1				1						5	10	8	7
JURISPRUDENCE			1								1			
LATIN	3	3	2	3	3	4	2	8	3	3	2		2	1
COMPARATIVE LAW							1							
CONSTITUTIONAL LAW	1			2			2	1		4	4	4	2	6
ROMAN DUTCH LAW							3	1	1	2	2	3		5
MATHEMATICS	1		4	1	1	2	2	2	4	1	4	2	6	5
NORTH SEMITIC EPIGRAPHY					2	3	3	2	2	3	4	3	3	3
PALI & BUDDHIST LITERATURE		2	1						1	1	1	1		
PATHOLOGY			4	2		6								
PERSIAN	3	1									1			
PHARMACOLOGY					2	5	5	6	4	3	14	3	10	9
PHILOSOPHY	4	5	4	5	6	7	5	9	10	10	4	9	2	2
PHONETICS								6	5	2	3	3	5	2
PHYSICS	7	5	6	8	7	8	13	14	9	15	6	10	14	18
PHYSIOLOGY	23	11	8	13	9	18	15		27	11	13	19	18	20
POLITICAL ECONOMY			3	4	2	4	5		5	8	1	2		3
SANSKRIT				3	4	4	2	1	2	3	2	2	2	4
TAMIL AND TELEGU									1					
ZOOLOGY	5	5	5	4	12	19	12	10	6	10	9	5	9	15
TOTAL	128	103	149	172	183	201	202	196	237	221	244	233	259	297

Source: The Needs of University College London (London: UCL, 1902); UCL Annual Reports 1901-1915 (London: UCL, 1901-1915)

Appendix 6. Postgraduate Degrees by Department (1890-1914)

	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902
M.A.													
CLASSICS	1	3	2	1		1		1	2	1	2	1	1
CLASSICS (ARCHAEOLOGY)													
CLASSICS (PHILOSOPHY)													
ENGLISH	1	3	1	2			1	3			2	1	1
ENGLISH AND FRENCH		1							1				
FRENCH													
GERMAN													
GERMAN AND FRENCH													
HISTORY													
MATHEMATICS				1					1				
MENTAL AND MORAL SCIENCE										1	1		
PHILOSOPHY													
POLITICAL ECONOMY												1	
TOTAL (MAs)	2	7	3	4	0	1	1	4	4	2	5	3	2
D.SC.													
APPLIED STATISTICS										1			
BOTANY					1								1
CHEMISTRY		1							2			1	1
MIXED MATHEMATICS													1
PHYSICAL GEOG. AND GEOLOGY		1		1					1				
PHYSICS													
PHYSIOLOGY				1					1				1
EXPERIMENTAL PSYCHOLOGY													
STATISTICS													
ZOOLOGY					1	1			1		1		
ENGINEERING													
TOTAL (D.SCs)	0	2	0	2	2	1	0	0	5	1	1	1	4
D.LIT.													
CLASSICS												1	
CLASSICAL ARCHAEOLOGY													
ENGLISH													
HISTORY													
PHILOSOPHY													
PSYCHOLOGY													
TOTAL (D.LITs)	0	0	0	0	0	0	0	0	0	0	0	1	0
LL.D.	1	0	0	0	0	0	0	0	0	0	0	0	0
M.D.	10	10	18	16	3	7	11	12	7	8	2	3	5
M.S.	0	0	0	1	1	0	1	1	0	0	2	0	1
D.MUS.	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL POSTGRADUATE DEGREES	13	19	21	23	6	9	13	17	16	11	10	8	12

Source: University College London Annual Reports 1891-1915 (London: UCL, 1891-1915)

Appendix 6. Postgraduate Degrees by Department (1890-1914)

	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	TOTAL
M.A.													
CLASSICS		1		1				1		3			22
CLASSICS (ARCHAEOLOGY)							1	1		1	1		4
CLASSICS (PHILOSOPHY)							1		1	1			3
ENGLISH	2	1			1			1	1	1	2	2	26
ENGLISH AND FRENCH													2
FRENCH		1	1	1		1		1	2	3	2	1	13
GERMAN		1				3			1	3		1	9
GERMAN AND FRENCH		1											1
HISTORY		1				1		3	4	1	2	3	15
MATHEMATICS								1	2	1	3	4	13
MENTAL AND MORAL SCIENCE		1	1										4
PHILOSOPHY					1	1	1	2	1		1		7
POLITICAL ECONOMY													1
TOTAL (MAs)	2	7	2	2	2	6	3	10	12	14	11	11	120
D.SC.													
APPLIED STATISTICS										1			2
BOTANY			3						1	1	1	1	9
CHEMISTRY			1	4		1	1	3	1	1	1		18
MIXED MATHEMATICS													1
PHYSICAL GEOG. AND GEOLOGY				1							1		5
PHYSICS							2	1					3
PHYSIOLOGY		3			3	2	1			2	2		16
EXPERIMENTAL PSYCHOLOGY									1				1
STATISTICS										1			1
ZOOLOGY			1	1	1	2		1		1			11
ENGINEERING												1	1
TOTAL (D.SCs)	0	3	5	6	4	5	4	5	3	7	5	2	68
D.LIT.													
CLASSICS										1		1	3
CLASSICAL ARCHAEOLOGY	1												1
ENGLISH										1		1	2
HISTORY									1	1		1	3
PHILOSOPHY			1			1							2
PSYCHOLOGY									1				1
TOTAL (D.LITs)	1	0	1	0	0	1	0	0	2	3	0	3	12
LL.D.	0	0	0	0	0	0	0	0	0	0	1	3	5
M.D.	10	6	6	5	0	9	6	8	10	12	12	3	199
M.S.	0	1	0	0	0	2	0	1	2	1	1	1	16
D.MUS.	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL POSTGRADUATE DEGREES	13	17	14	13	6	23	13	24	29	37	30	23	420

Source: University College London Annual Reports 1891-1915 (London: UCL, 1891-1915)

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