Science and the New Universities

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In this paper I examine the teaching of, and research in, the sciences in the new universities of Sussex (1961), East Anglia (1963), York (1963), Lancaster (1964), Kent (1965), Essex (1965) and Warwick (1965). Since these were new foundations and had not passed through university college status, there was considerably greater freedom to design new disciplinary and interdisciplinary patterns. These were seized, to a greater and lesser degree, with implications for how subjects, including the sciences, were perceived, taught and to some extent researched. Scientific research at Sussex and East Anglia, as well as mathematics at Warwick, developed in comparatively important ways; this is less the case for the other four. But in terms of science teaching, the new utopianist universities were only part of a wider expansion of higher education in the sciences. Compared to other papers in this collection, I have to pay attention to the other great, contemporary wave of higher educational institution-building of the period: the granting, following the advice of the Robbins Report of 1963, of university status to the Colleges of Advanced Technology from the mid-1960s.

The paper proceeds as follows. After a discussion of the variety of higher educational institutional possibilities for science and technology in the 1950s, I will examine the broad development of the sciences as taught and researched in the new universities. I will examine the rhetoric and record of interdisciplinarity, the distinctive developments in science and mathematics at Sussex, East Anglia and Warwick, and the relevance of 'long 1960s' social and cultural movements to the sciences on campuses. I will also note in passing the consequences of the contingent availability and use of high-speed electronic stored-program computers (perhaps the major, common, new object of investment for the sciences encountered by nearly all universities in this period).

Institutional experiments

Among the keywords recurrent in discussion of the new universities – "community" and "spontaneity" are noted by Muthesius – "experiment" is an interesting one in the context of the sciences.[1] It was used by some protagonists in early planning[2], while *The Daily Mail* described the University of Sussex as "the great experiment".[3] 'Experiment' can convey novelty, a step into the unknown, but also an assay – a pitching and test of alternatives, to see what works and what does not. A variety of imaginative institutional arrangements for higher education were pitched in the 1950s and 1960s, especially concerning the provision of science and engineering teaching and research.

[1] Stefan Muthesius, *The Postwar University: Utopianist Campus and College*, New Haven: Yale University Press, 2000, p. 101, p. 5.
[2] Muthesius, op. cit., p. 3.
[3] *Daily Mail*, 24 May 1962, quoted in Fred Gray, *Making the Future: a History of the University of Sussex*, Falmer: University of Sussex, 2011.

The expansion of higher education of the 1950s and 1960s 'took place against the background of a vigorous and continuing debate on the appropriateness of the courses on offer to a swiftly changing industrial society'.[4] In particular, the 'clear distinction between the universities and the technical colleges', confirmed in the language of the 1945 Percy Report on *Higher Technological Education*, in which "Industry must look mainly to Universities for the training of scientists, … it must look mainly to Technical Colleges for technical assistants and craftsmen", continued to divide and shape the higher and further educational landscape.[5] The early post-war expansion of student numbers had marginally favoured the sciences. The Barlow Report (1946) had recommended a doubling of the annual output of science graduates, which was achieved in five years.[6] In 1950, of 64,000 students studying in English universities, 20% studied pure science (in 1939 the proportion had been 15%), although only 11% studied applied science.[7] The increase of numbers of science graduates took place in the existing universities and the university colleges (given charters in the 1940s and 1950s). Following the 1956 White Paper Technical Education ten technical colleges were upgraded to become Colleges of Advanced Technology (CATs).[8] In 1965 the CATs were given university status, while a year later a further group of technical colleges were designated polytechnics.

The vocational specialism of the technical colleges was sharply contrasted to the expectations of breadth in university studies, including the sciences. "In general the university courses should be more widely based on higher standards of fundamental science and contain a smaller element of training related to immediate or special work in industry" as rightly found in the technical colleges, noted the University Grants Committee in 1950.[9] Here, alongside a desire to bolster community through shared intellectual life, was one early contextual prompt for perhaps the strongest, distinctive feature of science in the new universities: interdisciplinarity. Interdisciplinarity was already being urged by the University Grants Committee in the 1950s as a response to the threat of over-specialisation.

In 1956, the University Grants Committee was pressing for a decision on the extent of expansion in the universities. Harold Macmillan, then Chancellor of the Exchequer, endorsed the Treasury view that one of the critical issues was how many more scientists and engineers would be trained. Already the planned increase from 84,000 students (1956) to

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[4] Roy Lowe, *Education in the Post-war Years: a Social History* (London: Routledge, 1988), p. 159.
[5] Percy Report quoted in Lowe, op. cit., p. 58.
[6] Michael Sanderson, *The Universities and British industry, 1850-1970*, London: Routledge and Kegan Paul, 1972, p. 351.
[7] Rowe, op. cit., pp. 60-61. W.A.C. Stewart, *Higher Education in Postwar Britain*. London: Macmillan, 1989, p. 61. By 1961-62, the figures stood at arts and social sciences 43%, pure science 25%, applied science 15%, medicine and dentistry 14%. This increase in pure and applied science was due to the drop in medicine and dentistry students not fewer arts and social sciences students.
[8] Stewart, op. cit., p.p. 83-84. Tyrell Burgess and John Pratt, *Policy and Practice: the Colleges of Advanced Technology*, London: Allen Lane, 1970. Peter Venables, *Higher Education Developments: the Technical Universities, 1956-76*. London: Faber and Faber, 1978.
[9] University Grants Committee, *Note on Technology in the Universities*, 1950, quoted in Rowe, op. cit., p. 159.

106,000 (1964) would be 2/3 scientists and engineers; but now, with the UGC saying that 168,000 students should be anticipated by 1968 it was hoped 'that the proportion of the increase which would be Science and Technology could be raised above two-thirds'.[10] Why was this? Partly it was expected that industrial growth would be in areas that relied on such expertise; but the Treasury's framing of this expectation also tells us about the visions of the future it held:

> In an age of atomic development and automation much larger numbers of University trained graduates in science and technology must be provided … [The] broad conclusion is that output of scientists and technologists … should be nearly doubled by the latter part of the 1960s.

The Treasury hoped that this expansion would take place in the (cheaper-per-student) Colleges of Advanced Technology. But as Roger Quirk, under-secretary at the Office of the Lord President of the Council, observed: this might be 'naturally attractive to the Treasury … but will it not perpetuate the subtle bias by which engineering studies suffer under a heavy disadvantage from the snob point of view?'.[11] He advised the Lord President of the Council, the Marquess of Salisbury, to 'strongly back the expansion in "higher" science and technology', continuing:

> Good engineers are perhaps our country's most desperate shortage and … a policy of trying to produce them "on the cheap" (as the Treasury seem inclined to favour) might be almost suicidal. In this connection, and generally, you may perhaps like to look through the attached article on "New minds for old" which appeared recently as a supplement in the "New Statesman" … It is no secret, though he said it should not be broadcast, that the author is Dr C.P. Snow … The article may be a little over-provocative but I think it is rather important.[12]

This is a very early, and immediately influential, sighting of Snow's "two cultures" thesis and associated widely discussed arguments supporting the education system must support more scientists and engineers and fewer arts graduates. (Snow's Rede lectures would be delivered three years later, and published as *The Two Cultures and the Scientific Revolution*, in 1959.[13] We can read the two cultures sentiment at work in A.J.P. Taylor's, highly inaccurate, comment:

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[10] TNA CAB 124/2040. 'The universities building programme', enclosed in Macmillan to Salisbury, 23 August 1956,

[11] TNA CAB 124/2040. Quirk, 'Universities building programme', 28 August 1956.

[12] TNA CAB 124/2040. Quirk to Lord President, 'The university building programme', 3 October 1956. The Snow article had a slightly different title to that quoted: C.P. Snow, 'New minds for the new world', *New Statesman* (1956), 8 September 1956, pp. 279-282;

[13] Guy Ortalano, *The Two Cultures Controversy: Science, Literature and Cultural Politics in Postwar Britain* (Cambridge: Cambridge University Press).

> Of the new universities, Norwich will teach scientific subjects. The others will have no science departments at all. The students will not even receive a rigorous discipline in their own subjects. They will receive a general "arts" education, a smattering of culture which enables you to do the crosswords in The Times newspaper.
>
> Scientists are to be provided for also, but they will go to Colleges of Technology in great cities. No gracious living here. No Latin prayers, no array of silver. Just good training and hard work.
>
> The future of our country depends on these scientists. But they are second-class citizens, with no gifts in the choice of port.
>
> Our rulers, our masters, will be men who can chatter about ideas and who cannot mend a fuse.[14]

A further argument that expansion in science and technology must be made in universities, not merely technical colleges, was offered by Solly Zuckerman, the government adviser and, as we shall see below, a key figure in the sciences at one of the new universities:

> The central weakness of our whole approach has been the differentiation we have necessarily made between men trained in the basic [sciences] and those trained in the engineering sciences… All our figuring has assumed that we can segregate the two classes. … [But] there can be no question of the universities expanding their engineering departments without a concomitant expansion in the basic sciences. To lose sight of this fact would be equivalent to increasing the power of an aircraft, without any commensurate adjustments in fuel supplies or air-frame.[15]

In other words, university engineering research and teaching was necessary, and should be expanded, but because basic science fed engineering as fuel feeds an engine, so university science should be proportionately expanded too.

Therefore there were several problems identified: the snobbish attitude to technical education, the apparently desperate need for experts for future industry, the intimate relation of basic science to engineering applications, and so on. A variety of solutions were offered. One was the wish for a British MIT, a high-status, innovative, technological university. Ortolano dates the origin of the suggestion to a moment 'over a brandy in Sicily in 1955, a fortnight after his resignation as Prime Minister', when Winston Churchill 'lamented not having done more to promote science, technology and engineering', stated

[14] A.J.P. Taylor, 'Is this £90 million being spent in the right way?', *Sunday Express* (7 October 1962).
[15] TNA CAB 124/2040. Zuckerman to Boothroyd, 25 October 1956.

his admiration for MIT and 'regretted that Britain had nothing comparable'.[16] According to this account, a network of influential scientists and industrialists, coordinated by Churchill's wartime secretary, John Colville, rapidly raised funds, but 'it soon became clear that it would be impossible to establish a university on the scale of MIT'. The outcome instead was Churchill College, Cambridge, approved by Senate in 1957 and, with New Hall the first new Cambridge colleges since the 1880s[17]; Snow was a founding Fellow. This was expansion of science higher education that began as a proposal for a radical break but fell back firmly in to the established pattern. Even then the idea did not die; it was quickly revived in public discussions following the surprise of Sputnik, for example.[18]

The language of experiment features prominently in the Robbins Report of 1963. 'The organisation of higher education must allow for free development of institutions', for example:

> Existing institutions must be free to experiment without predetermined limitations, except those necessary to safeguard their essential functions; and there must be freedom to experiment with new types of institution if experience shows the desirability of such experiments.[19]

Snow's arguments were influential behind-the-scenes on Robbins (Snow had been invited to sit on the Robbins committee, but declined the formal role; nevertheless he provided considerable 'informal guidance'[20].) One experiment proposed was the development of five Special Institutions of Scientific and Technological Education and Research (SISTERs).[21] 'In making this proposal', the authors noted, 'we have been much influenced by the fact that there is as yet in this country too little that compares for both scope and scale with the great institutions abroad that we visited, such as the Massachusetts Institute of

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[16] Ortalano, op. cit., p.110. In fact, the proposal of a new technological university, a British MIT, has a longer, more complex history, even in the 1950s, and is summarised in TNA CAB 124/2040. Quirk to Vintner, 1 October 1957. Shattock cites the Barlow Report (1946), see: Michael Shattock (ed.), *Making a University: a Celebration of Warwick's First 25 Years*, (Coventry: University of Warwick, 1991), p. 9. Churchill himself, speaking (and implicitly referring) to MIT at the Mid-Century Convocation held there in 1949, began: 'We have suffered in Great Britain by the lack of colleges of University rank in which engineering and the allied subjects are taught. Industrial production depends on technology and it is because the Americans, like the prewar Germans, have realized this and created institutions for the advanced training of large numbers of high-grade engineers to translate the advances of pure science into industrial technique, that their output per head and consequent standard of life are so high. It is surprising that England, which was the first country to be industrialized, has nothing of comparable stature.' http://libraries.mit.edu/archives/exhibits/midcentury/mid-cent-churchill.html. He then went on to praise MIT for nevertheless retaining a Dean of Humanities.

[17] James Jackson Walsh, 'Postgraduate technological education in Britain: events leading to the establishment of Churchill College, Cambridge, 1950-1958', *Minerva* 36 (2) (1998), pp. 147-177.

[18] Editorial, 'Need for scientists', *Financial Times*, 10 October 1957: 'One of the needs of the present situation is the establishment of a technological university. One naturally thinks of the Massachusetts Institute of Technology in the United States, and it is true that a single MIT type of institution would be of almost infinite value to British industry'.

[19] Committee on Higher Education, *Higher Education. Report of the Committee appointed by the Prime Minister under the Chairmanship of Lord Robbins 1961-63* (London: HMSO, 1963) , p. 9.

[20] Ortalano, op. cit., p. 107.

[21] Committee on Higher Education, op. cit., p. 128.

Technology'.[22] Robbins suggested three SISTER-style bodies were already being developed as existing institutions expanded in London (Imperial College of Science and Technology), Manchester College of Science and Technology, and the Royal College of Science and Technology at Glasgow. Two more were required, one from an existing CAT (in addition to all CATs being granted university status), and the other a new foundation:

> Such a new foundation could experiment boldly, unfettered by existing affiliations either with universities or with further education. It is important that the site provided should be large enough for large-scale experimental work and future development.[23]

Robbins' recommendations were largely accepted by the government. The new universities of this volume, however, were already underway. The point of dwelling on the wider debate about science, technology and higher education is that the parallel expansion of science at older universities, CATs and would-be SISTERS was an important context for the location and style of teaching and research at the new universities, not least because it removed any expectations that the new universities should be specifically science-focussed or tied to an agenda of modernising industrial centres.[24] The new universities were 'to be located not in the major centres and industrial conurbations, but in medium-sized, even smaller towns, preferably of the non-industrial, county-town type, and preferably those with national historical associations'.[25] Colchester, for example, not Chelmsford, where radio and electronics giant Marconi had its base.[26] (Warwick, in the car industry centre of Coventry, was an exception.[27]) Arguments, such as that of B.V. Bowden (physicist and computer scientist, Principal of Manchester College of Science and Technology, soon to be Minister of Education under Wilson), Nevil Mott (physicist, Master of Gonville and Caius College, Cambridge), and journalist (and son of a Labour minister) Thomas Pakenham, that Harwell was a better location for a new university, being at the centre of Britain's atomic energy

[22] Robbins and his team also visited ETH Zurich and Delft Institute of Technology (now Delft Technical University).
[23] Committee on Higher Education, op. cit., p. 129. The North-East of England was one possibility. 'Tees-side's claim to have a SISTER', *New Scientist* (19 December 1963) 370, p. 718.
[24] For the wider uncertainties about the need for more scientists and technologists (a need attacked, for example, by James Jewkes, see: Editorial, 'Expansion of university education in Britain', *Nature* (7 November 1959), pp. 1431-1434; also: W.G.V. Balchin, 'University expansion in Great Britain', *New Scientist* (12 March 1959), pp. 581-585.
[25] Muthesius, op. cit., pp. 96-97.
[26] Although Sanderson comments: 'Since biology was to be developed at the University of East Anglia, the chosen forte for Essex was the physical sciences to provide [quoting W. Boyd Alexander] "a firm base for the student in electronics and other branches of engineering which are the leading industries of Essex. Sanderson notes the early appointment of a professor of electrical engineering (a former chief scientist of Plessey-UK), investments (the GPO invested £100,000 in a chair of telecommunications), and links with firms (Plessey, Marconi, GEC and Bell Telephone Laboratories for electrical industries, Dunlop and Ilford for polymers). Sanderson, op. cit., p. 370.
[27] 'No other new university made such firm statements in its early days about "our determination to have a close relationship with industry and commerce"'. Sanderson, op. cit., pp. 370-371.

research programme, could be dismissed. But this alternative was significant. Pakenham summarised:

> Oddly enough, it is on grounds of economy that the case for a university at a cathedral town like York, or a seaside town like Brighton, is usually argued. Their attraction is the number of lodgings vacant during the winter. It certainly looks cheaper from the University Grants Committee's point of view to designate such delectable towns as the sites for universities. But, if there is to be much science at a university, the savings on halls of residence may be more than outweighed by the cost of duplicating scientific facilities. The waste of human resources seems even more disturbing that the waste of money. Scientists are attracted to the best equipment like wasps to jam …[28]

The post-war period marks the decisive rise of Big Science, the organisation of scientific research in managed teams working with large-scale and expensive, centralised instruments and facilities.[29] Paradigmatic examples include particle physics and radio astronomy. Choosing Brighton, York, Canterbury, Coventry, Lancaster, Norwich and Colchester meant choosing to be at a distance from Big Science.

A second, contemporary sense of 'Big Science' was given by Derek de Solla Price: the phase entered when the exponential growth in knowledge created qualitatively new problems, not least ones of stemming from social and economic constraints on further expansion.[30] This analysis chimed with that of the first vice-chancellor of the University of York, Eric James, a chemist turned pedagogy maven. In speeches made from the 1950s through the 1970s, James argued that the most important factor – the 'dominant feature of the intellectual history of our time' - shaping education, especially higher education, was the growth in knowledge, especially scientific knowledge.[31] Profound questions were therefore raised, said James, for the teaching of scientists and non-scientists to live, work and continue to learn in such a world. James was alarmed by the cost of Big Science:

> Teaching and still more the pursuit of new knowledge have become increasingly expensive with alarming speed. In the universities of only 50 years ago [writing in 1975] even science teaching and research was inexpensive. If you go to [the

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[28] Thomas Pakenham, 'Universities. The case for a site at Harwell', *The Observer* (21 January 1961).
[29] Capshew, James H. and Karen A. Rader, 'Big Science: Price to the present', *Osiris* (1992), 2nd Series, 7, pp. 2-25. Peter Galison and Bruce Hevly (eds.) *Big Science: the Growth of Large-Scale Research* (Stanford: Stanford University Press, 1992).
[30] Derek de Solla Price, *Little Science, Big Science*, New York: Columbia University Press, 1963.
[31] Quotation from 'Democracy and authority in education', undated speech. Borthwick Institute for Archives (hereafter BIAUoY), University of York, JAM/2/1/1. Other speeches which reiterated this theme were 'The university and the idea of liberty', 'Science and education' (both manuscripts undated, same box reference), and 'Herbert Read Lecture', 1969, BIAUoY JAM/2/1/7. James' solution was i) for the scientist, that specialised, technical education with the focus essential to reaching the frontiers of current knowledge, needed to be complemented by humanistic teaching, and ii) for the non-scientist, again some measure complementary study. He was sceptical of much 'research' as needless, distracting novelty for its own sake.

> Canadian university] McGill today you can see the apparatus with which Rutherford made some of the fundamental discoveries in atomic physics. Compare that … with the cyclotron, or whatever its successor is called…[32]

If a university, argued James, was to pursue Big Science then it had to receive funds from, and open its account books to, the state. 'What will be the effect of this on that vague but precious concept, academic authority?', James asked,

> Does the prospect for man include the inevitable and complete control of the richest sources of knowledge and the highest peaks of education by an omni-present State? And if such massive financial dependence ever does not stifle any but conformist views, will it not lead to a distortion of curricula towards the manifestly "useful" as that great educator, Hutchins, feared in his University of Utopia?[33]

Therefore for the leader of at least one of the new universities, Lord James, Vice-Chancellor of York, science, through its over-specialisation and Big Science, through its inevitable ties to the state, were threats to the utopian project.

In 1965, the date by when all the new universities had opened their doors, and the post-war demographic 'bulge' of students was at its peak, concern mounted about the flow of candidates into science and technology. The Dainton report, commissioned in 1965 and published in 1968, identified a distinct 'swing from science to arts and to social sciences' as sixth-formers voted with their feet.[34] This 'relative decline' was not only 'potentially harmful' (ultimately because we live in a science-inflected world), but had occurred, surprisingly, at a time of

> remarkable progress in man's knowledge of the physical world. The exploration of the surface of Venus, deciphering the genetic code and the determination of the structure of complex molecules of vital importance, such as insulin, typify this excitement, and the sense of reaching ever further into the unknown, in science and technology today. In our view there is everything here to attract the imaginative mind and fire the curiosity of the young, and nothing justifies a movement away from these subjects in schools and higher education.[35]

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[32] James, 'The universities and the prospect for man', undated speech (c.1975). BIAUoY JAM/2/1/2.

[33] Robert Maynard Hutchins, the great and long-serving president of the University of Chicago, shared many of James' analysis of higher education, notably concerns over research specialisation that would be addressed by shared, inculcated knowledge of the Great Books of humanistic learning. Hutchins' *The University of Utopia* was published in 1953.

[34] Council for Scientific Policy, *Enquiry into the Flow of Candidates in Science and Technology into Higher Education, Presented to Parliament by the Secretary of State for Education and Science by Command of Her Majesty* (Dainton Report), Cmnd. 3541 (London: HMSO, 1968). See, also: Richard Layard, John King and Claus Moser, *The Impact of Robbins* (Harmondsworth: Penguin, 1969).

[35] Dainton report, op. cit., p. 35.

So, in this context of a two decades debate about the expansion of universities, of expansion of science and technology at existing universities (including the upgraded CATs), and evidence of a late swing away from science and technology, what was actually happening at the new universities ‘to attract the imaginative mind and fire the curiosity of the young’?

Drawing a New Map of Scientific Learning

If the ‘most central of the key words’ of the founders of the seven new universities was ‘community’[36], then it is also the case that the sciences were the most difficult to integrate into a community, given its need for special disciplinary technical training. So how did it fit? One trend in partial favour of integration was the movement towards interdisciplinary formations within the sciences in the twentieth century. Several combinations were prominent, not least in Britain, in the post-war period, notably molecular biology and radio astronomy. So there was a set of intra-communal linkages here. Arts-sciences or sciences-social sciences combinations were rarer, although important examples of both will be discussed below.

Many, but not all, of the new universities expressed the desire to reshape and reconnect disciplines by organising the subjects under broad ‘schools’. The approach was noted in the Robbins report, again using the language of ‘experiment’:

> There are long-established and natural groupings of subjects: chemistry, physics and mathematics, and, in the humanities, English with history and French, are obvious examples. We are arguing that there should also be experiments in new combinations of subjects which have recognisably organic connections: technology, for instance, with some social studies showing the more general implications of the technologist's profession; philosophy and mathematics with the history of science; and, for many students, some study of the past as well as the present state of the disciplines they study.

Although Robbins also wanted to ‘offer a word of caution’

> Undergraduates should not be made the guinea-pigs of experiments with totally new subjects without textbooks or a commonly accepted core of methods of thought. We have nothing to say against new subjects: it is part of the business of institutions of higher education to help to bring them to birth. But the place for thought when it is still inchoate and embryonic is chiefly at the postgraduate level, not in the instruction of first degree students. Few things can be more disturbing to most

[36] Muthesius, op. cit., p. 101.

> students than not to know where to turn, to have no books to which they can refer to confirm or deny the views they have heard expressed in lectures

At Sussex, students took multi-subject honours courses, designed with the intention of 'breaking free from "excessive specialization"'; within the sciences this meant a 'study of the social context and application of science' in addition to the traditional topics.[37] Sussex set up a School of European Studies, School of English and American Studies, School of European Studies, School of African and Asian Studies, and a School of Social Studies. These were planned early. 'The position in relation to the sciences was at first much less certain', wrote Asa Briggs, indeed 'it was not clearly envisaged in the early discussions, before the arrival of the first academics, that science departments would be abolished and replaced by Schools'.[38] Nevertheless in 1962 Sussex opened a School of Physical Sciences, in which an undergraduate could major in physics, chemistry, mathematics and even philosophy, was established. 'The basic idea', explained Roger Blin-Stoyle, the founding dean, was that 'physical sciences and mathematicians educated within the University' would be "complete", meaning they would study courses that gave them both a fundamental 'understanding' (an interdisciplinary grasp of the essentials of theory and method) and a 'spirit of inquiry' (a 'militantly questioning, doubting and inquiring frame of mind', felt to be largely erased by the grind of school study).[39] The pattern of compulsory majors and minors would continue for the undergraduate's three years. But the special demands of specialism made by the sciences could not be ignored completely. 'It is quite clear', wrote Blin-Stoyle, 'that in any university institution there must be provision for extreme specialist study … which has to be absorbed before any research can be embarked'; a fourth, optional year of such 'extreme' study was put in place.

Briggs, in his essay 'Drawing a new map of learning', argued that the 'map is seldom re-drawn', and cited the 'biological studies', which 'produce exciting new research which rests on cross-boundary thinking', yet have been 'controlled by independent potentates' of biology, botany and zoology, as a prime case in point.[40] (This line was not original with Briggs, and was an accusation made by an influential report on biology by the Royal Society in 1961.[41]) In 1965, BIOS, a School of Biological Sciences began with the appointment of a founding dean, the evolutionary biologist John Maynard Smith, an 'inspired choice', not

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[37] Asa Briggs, 'Drawing a new map of learning', in David Daiches (ed.), *The Idea of a New University: an Experiment in Sussex* (London: André Deutsch, 1964), pp. 60-80, p. 61.
[38] Briggs, op. cit., pp. 61-62.
[39] Roger Blin-Stoyle, 'The School of Physical Sciences', in Daiches, op. cit., pp. 120-134, p. 121, p. 122, p. 123.
[40] Briggs, op. cit., p. 72.
[41] Royal Society, *Report of the* Ad Hoc *Biological Research Committee. A Report Presented by the Council of the Royal Society to the Chairman of the Advisory Council on Scientific Policy in November 1961*. Including Appendix I. Memorandum on the organisation of biological subjects in universities in the United Kingdom. The committee was chaired by the able Royal Society President, Howard Florey. The ACSP had asked for the report, concerned that some vital interdisciplinary areas, notably microbiology and molecular biology, were 'falling between the gaps of the existing Research Council structure'. Peter Collins, *The Royal Society and the Promotion of Science since 1960*, Cambridge: Cambridge University Press, 2016, p. 46.

least because his interdisciplinary instincts: a ‘naturalist trained as a mathematician and engineer, “prepared to play away games with philosophers”.[42] The pattern of undergraduate biology teaching at university, dominated by the nineteenth-century divisions of zoology and botany, underpinned by comparative anatomy, ‘was broken by the establishment of the new universities’, states Maynard Smith, ‘and in particular by the Schools of Biological Sciences at York and at Sussex’.[43]

Another innovation was the Arts/Science scheme, ‘whereby arts students were exposed to some science, and vice versa’.[44] Neither arts nor sciences students could ‘escape the fact that they are living in a scientific and technological age’, wrote Blin-Stoyle:

> So, as a unifying influence between the Arts and the Sciences, every undergraduate in the University will follow a course of lectures, seminars and discussions contributed to by both the Science and Arts Faculties and dealing with such subjects as ‘Science and Industry’, ‘Science and Government’, ‘The Moral Responsibility of the Scientist’, ‘The Impact of Science on Contemporary Thought’ and so on.[45]

The notable science writer John Gribbin was one product of this scheme and remembered it distinctly:

> When I came to Sussex as an undergraduate in 1963, the Arts-Science scheme was a major feature of the university’s ambition to provide something new. As a physicist I can only recapture the flavour of how the scheme impacted on science students, which was generally (and specifically in my case) to create a sense of alarm at the prospect of being forced to think outside the box, and the rewards, with hindsight, far exceeded my expectations.[46]

The arts schools later opted out of the Arts/Science scheme in the late 1960s, a decision John Maynard Smith called a “bloody disgrace”.[47]

‘There were also difficulties in retaining interdisciplinarity in science’, noted one of the founding lecturers in science at Sussex, Brian Smith, a ‘multidisciplinary course, "Structure and properties of matter", the equivalent of an arts contextual course, was developed in time for the arrival of the first science students in October 1962 and served the early science schools well. But it was not popular with later arrivals and was eventually abandoned’ by

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[42] David Harper, ‘The JMS legacy’, in Gray, op. cit., p. 183.

[43] John Maynard Smith, ‘Integrating the biological sciences’, in Roger Blin-Stoyle, *The Sussex Opportunity: a New University and the Future* (Brighton: Harvester Press, 1986), pp. 125-134, p. 126.

[44] Brian Smith, op. cit..

[45] Blin-Stoyle, op. cit., p. 127.

[46] Gribbin, quoted in Jonathan Bacon and Benedict du Boulay, ‘Overview: doing science’, in Fred Gray (ed.), *Making the Future: a History of the University of Sussex* (Falmer: University of Sussex, 2011), pp. 163-168, p. 164.

[47] John Maynard Smith quoted in Bacon and du Boulay, op. cit.

the early 1980s.[48] Likewise the science school split, forming separate Biological Sciences, MAPS (Mathematics and Physical Sciences) and MOLS (School of Molecular Sciences).[49] MOLS has been described both as 'genuinely interdisciplinary' and also 'essentially a department of chemistry'.[50]

Sussex tutorial system of teaching was also a better fit for arts than for sciences. In arts pairs of students met the tutors for two-hour tutorials, discussing essays; the scientists 'have rather more tutorials a week, but attend them in groups of five, and because of the nature of their subject their sessions tend to be used to clear up difficulties and increase understanding rather than for the more discursive approach proper to an arts tutorial'.[51]

'The freedom to work along new lines and the power to plan new combinations of subjects' initially proved to be, as Briggs noted in 1964, 'great attractions in recruiting academics from universities where curricula can be changed only with the greatest difficulty'.[52] But, over time, the radical interdisciplinary ambitions, led by a vision of teaching and the unity of the student experience, would be undermined by the specific disciplinary requirements of advanced research. 'Research, fascinatingly largely absent from the 1950s and early 1960s national debate about the expansion of higher education, became an increasingly important and defining characteristic of the University', notes Fred Gray, introducing his history of Sussex, and as 'disciplinary knowledge expanded, so contextual study and the schools themselves were often threatened'.[53] Brian Smith concurs with this picture:

> as the university expanded, it became progressively harder to maintain consistent practices, and in one particular respect, Sussex became a victim of its own success. Once the university was established, applications for student places and staff jobs soared. But not all the staff who were appointed shared the founding fathers' enthusiasm for academic innovation. Many were committed to research, regarded the school contextual courses as unnecessary diversions and would have been more comfortable if Sussex had been a traditional departmental university. Some of the distinctive features of the redrawn map have been lost over the years, due in part to the influence of some of these later arrivals.[54]

The discussion and implementation of the Sussex 'schools' system influenced the other new universities. At Norwich, Noel Annan, Provost of King's College, Cambridge, and member of

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[48] Brian Smith, 'Life through a plate-glass window…', *Times Higher Education Supplement* (10 August 2001).
[49] Colin Eaborn and Ken Smith, 'The heart of the matter: physical sciences at Sussex', in Roger Blin-Stoyle, *The Sussex Opportunity: a New University and the Future* (Brighton: Harvester Press, 1986), pp. 108-124, p. 111.
[50] Bacon and du Boulay, op. cit., p. ?, and, in the same edited collection, John Murrell, 'Life in MOLS', in Gray, op. cit., p. 208.
[51] Walter James, 'Purposeful design: Britain's new universities', *Texas Graduate Journal* (Winter 1964), pp. 200-212, p. 208.
[52] Briggs, op. cit., p. 60.
[53] Fred Gray (ed.), *Making the Future: a History of the University of Sussex* (Falmer: University of Sussex, 2011), p. 12.
[54] Brian Smith, op. cit..

the Academic Planning Board (APB), praised 'the Brighton system' for the arts.[55] For the physical sciences, 'Sensibly conservative' and 'not inclined to flights of fancy', the eminent chemist Christopher Ingold proposed a single 'Faculty of Science', teaching a 'mix of interdisciplinary and single-subject' topics.[56] More broadly, Zuckerman, also a member of the APB, proposed what turned out to be a particularly distinctive feature of UEA. "If one had in mind to do something absolutely new and fresh in science", Zuckerman wrote to Ingold, "I am wondering whether Norwich could not embark in its Faculty of Science on a Division of Environmental Sciences – meteorology, oceanography, geology, conservation, etc. If it were, I am quite certain nobody could ever be able to say that scientists were trained in too narrow a way".[57] A School of Environmental Sciences ('ENV') was established, with Keith Clayton as Dean, as was a School of Biological Sciences ('BIO') and a School of Mathematics and Physics.[58] Lancaster University also established a School of Environmental Studies in 1963[59], and the two were the first of their name in the UK.[60] Lancaster aimed to teach arts students some science, and vice versa.[61] The UGC stifled attempts to teach agriculture (seen as a declining specialty, despite Norwich's location in the arable centre of England) or engineering (too expensive).[62] Unlike at Sussex, there was little sympathy for teaching arts to science students or vice versa.[63]

The senior professor in BIO, Thomas Bennet-Clark, was 'driven' to leave King's College London by the 'narrowness of the study of biology' there.[64] The proposal for a broad school

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[55] Michael Sanderson, *The History of the University of East Anglia*, London: Hambledon and London, 2002, p. 60.

[56] Sanderson, op. cit., p. 63.

[57] Solly Zuckerman Papers at UEA (SZ). Zuckerman to Ingold, 24 September 1960, quoted in Sanderson, op. cit., p. 64.

[58] Proposals for schools in medicine, Management and Technology and Molecular Technology, and Engineering failed.

[59] Gordon Manley had proposed a "Environmental Studies" (later Environmental Sciences) school after being invited to apply for a professorship. Manley's vision was ambitious: Lancaster's had the opportunity "beyond almost any of its rivals, of bringing to the mind of the students every aspect of environmental change over every time-scale; of training them in the art of measuring those changes; and in discussing their consequences, for industry, for human achievement and happiness for future planning … environmental studies combined with physics may well make a meteorologist". Marion McClintock, *University of Lancaster: Quest for Innovation. A History of the First Ten Years, 1964-1974*. Lancaster: University of Lancaster, 1974, p. 136.

[60] Sussex introduced a Major in Environmental Science in the mid-1970s 'in response to the increasing interest in environmental issues'. Eaborn and Smith, op. cit., p. 113.

[61] Marion McClintock shows that the APB in 1962 expressed its "desirability of every Arts student having to devote some time to the study of science and conversely of Science students having to acquaint themselves with the Arts. McClintock, op. cit., p. 131. A strong protagonist for the mix was the radio astronomer J.A. Ratcliffe, a member of the APB, supported by Dainton (p. 119). History of science, in the History department, was one of the bridges.

[62] Although Thomas Bennet-Clark did explain to local farmers at the Norfolk Agricultural Club that the BIO school would have its feet "firmly in the mud". Quoted in Sanderson, op. cit., p. 103.

[63] 'Noel Annan and Edgar Williams were keen on this idea in the wake of C.P. Snow's influential Two Cultures (1959). Ingold put a stop to it. He thought that humanists and scientists were fundamentally different in outlook and "he was not hopeful of any ultimate intellectual link between them". History for scientists had met "little sympathy" at UCL, while science for humanists was an "intolerable burden" for teachers and taught and had likewise been abandoned at UCL'. Sanderson, op. cit., p. 66.

[64] Sanderson, op. cit., p. 99.

was devised by Bennet-Clark and Zuckerman.[65] Bennet-Clark's letter written to the VC, Frank Thistlethwaite and the architect Denys Lasdun, is worth quoting at length, for it is one of the most powerful invocations of interdisciplinarity expressed in the context of the new universities:

> Frontiers between the various scientific disciplines are arbitrary. Two centuries ago they did not really exist and the different named sciences of the 19th and 20th centuries were all grouped as "Natural Philosophy".
>
> The immensity of the growing field of knowledge provoked a system of classification which like many such systems is artificial. This system has effectively broken down and the important advancing fields of knowledge lie in what are termed 'borderline fields'.
>
> …
>
> Advances really depend on breaking down the traditional specialised frontiers between mathematics, physics, chemistry, botany and zoology. This is being achieved in the School of Biological Sciences…[66]

Bennet-Clark conceded that such a bonfire of the disciplines was less welcome in the physical sciences. Nevertheless, while 'it would be less reasonable to compel mathematics, physics and chemistry to form "one school", as there is no notable decline in "classical" aspects of these sciences", it was, 'however

> Desirable and reasonable to try and return as closely as possible to the earlier situation of unified "Natural Philosophy". This implies location of all sectors as close to each other as possible. Mixing of Natural Philosophers (scientists) with others will be effected in Common Rooms and in the crescents of living accommodation … In fact, an architectural structure which impedes the full development of the sciences (Natural Philosophy: old sense) would be likely to hinder this desirable intercourse and bring about the cleavage into Scientists versus Arts…

In this way interdiscipinarity – or even a return to unified Natural Philosophy – would be written into the architecture of the new university.[67]

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[65] It also seems to 'have been a prototype of the ideal pattern as set out by the Royal Society', an ideal that needs to be identified in the Royal Society documents. TNA UGC 8/85, Biological sub-committee, 4th meeting, 22 March 1966.

[66] UEA Archives. FT/C3D1. Bennet-Clark to Thislethwaite and Lasdun, 6 January 1963. Bennet-Clark's text was reproduced in Lasdun's *UEA Development Plan*, copy also in UEA Archives.

[67] Maths and Physics were located between Biology and Chemistry, although the 'original intention was to locate it between Chemistry and the Arts Building so that mathematics using arts subjects, notably economics, would have access to it'. When the costs of the physics building became apparent (it included 'rooms reinforced with two inch steel plate to withstand explosions; rooms for compressors creating vibrations which must not affect other rooms, especially the balance room; a room with a floor capable of accepting a five ton

Researchers in interdisciplinary areas (biophysics, biochemistry, genetics, marine biology) were soon at work in well-provisioned laboratories (including a £156,000 Philips EM200 electron microscope), part of Lasdun's Teaching Wall edifice. The Agricultural Research Council's Food Research Institute relocated nearby, as did the John Innes Institute at a slightly further distance. Finally, the Lowestoft Fisheries Laboratory was incorporated. Altogether this made for a distinct and 'powerful network of biological research all of whose components were particularly appropriate for the East Anglian region'.[68]

But interdisciplinarity at UEA could be, and was, challenged. Again we see the influence, this time negative, of the experience at Sussex. Alan Katritzky, a "breathtakingly young [31], abrasively dynamic" chemist "with the firmest ideas", was dead set against subsuming chemistry under a broader school of physical sciences.[69] As the first professor, he lobbied against Ingold's influence, mobilising support from powerful outsiders, including John Cockcroft, Robert Robinson and Alexander Todd. At the critical meeting held at Senate House, London, on 25 August 1962, Katritzky won the argument, not least because he could cite the experience of the professor of chemistry at Sussex, Colin Eaborn, that "mistakes made at Sussex [must not be] repeated at East Anglia … an independent School of Chemistry was of primary importance".[70] At an even later foundation, Warwick, too, the interdiscipinarity expressed in the schools structure of Sussex was rejected.[71]

Such tensions were largely disciplinary ones, expressed internally within the university. External competition could also shape the new map of scientific and technological learning. A UEA the presence of local technical colleges was a factor in early discussions[72], while at Warwick there were concerns that there might be conflicts with the local technical college if the university also chose a 'similar technological bias'.[73] Warwick's novelty was to be found in such entities as a graduate school in business administration, something Essex also attempted.[74] Another external force was the UGC. When an oversupply of biologists was forecast in 1966, the UGC's Biological Sciences sub-committee took a hard look at existing plans for expansion and foundation, including the new universities.[75] This was despite a

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electromagnet' and so on), Thistlethwaite began privately to have doubts about having physics at all. Cockcroft told him that 'not to have physics as a subject in the new university was unthinkable'. Sanderson, op. cit., pp. 160-161.

[68] Sanderson, op. cit. p. 103.

[69] Sanderson, op. cit., p. 105.

[70] Draft letter, Katritzky to Thistlethwaite, undated (September 1962). Quoted in Sanderson, op. cit., p. 107.

[71] Burgess quotes the founding professor of philosophy, saying that the 'views were shared by other founding professors': that "I didn't like anything about Sussex… I wouldn't have wanted to go to Sussex because I wouldn't be starting my own department. I would have been fitting into an academic and intellectual strait-jacket". Robert G. Burgess, 'Working and researching at the limits of knowledge', in Shattock, op. cit., p. 95.

[72] Such as the large Norwich Technical College, which had aspirations in the first half of the century of university status, and Kings Lynn Technical College.

[73] TNA ED 188/74. Minutes, E(61)2nd, 8 May 1961. See also: Shattock, op. cit., p. 21. For Norwich and Norfolk. Sanderson, op. cit., p. 18.

[74] James, op. cit., p. 207.

[75] TNA UGC 8/85. Minutes, UGC Biological sub-committee, 2nd meeting, 16 November 1966. The evidence for the mismatch came from two sources: the Willis Jackson committee on scientific manpower forecast a 50%

recognition that biology 'provided … as good a general education as the arts subjects which traditionally served this purpose', not least because the 'recent revolutionary change in emphasis away from "Natural History" [towards lab-based yet interdisciplinary study] … had greatly enhanced biology students' adaptability and usefulness'. So now, in review, the UGC's biological sub-committee found UEA biology to be 'disappointing' and advised that it 'should be encouraged to add to existing staff but not start any new developments'; at Lancaster (where interdiciplinarity was also encouraged[76]) buildings were 'already too advanced to be halted'; at Sussex the problem was 'overreach' and going 'too fast'; at Warwick the study of life sciences 'should be discouraged'; likewise at York, while an interdisciplinary school in biochemistry and microbial genetics was noted, animal physiology 'should be discouraged'; furthermore at Kent, even though the natural sciences building was scheduled for occupation in 1970-71

> an immediate enquiry should be made into the need for a School of Biological Sciences. The proposals that were known to members of the sub-committee were disquieting, quite apart from the general question of whether this or any large new schools should be founded.[77]

Some CATs (Bath, Chelsea, Salford, Surrey, with Brunel as an exception) also received similar criticism, whereas the older institutions (such as Imperial, Kings, UCL) were marked as actual or potential 'centres of excellence'. The UGC's sub-committee's view was forthright, and carried a clear sense that its top-down encouragement and discouragement would have effect.

Sometimes the interdisciplinarity of science at the new universities was present, if not vaunted. The case of biology at York, for example, illustrates how interdisciplinarity could hide behind apparent disciplinary singularity, while also showing how founding professors could have considerable leeway within the broad frame set by the academic planning board. In 1961, two years before the university opened, the UGC wrote to say that 'biology was a suitable subject'; the Academic Planning Board (chaired by Robbins) then discussed what 'biology' might mean, but main decision was to confirm Eric James' view that 'you appoint a man whose interests are wide'.[78] In 1963, James wrote to Lady Ogilvie, member of the APB,

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increase in the stock of biologists between 1961 and 1968, while the Manpower Survey suggested that demand would be less than supply.

[76] The Lancaster APB in March 1963 'was at pains to explain that "in the science group of subjects the intention is to have, quickly established, a really effective senior staff in at least one major area of study, and to recognise from the outset the importance of developing cross-connections between scientific subjects"'. McClintock, op. cit., p. 134, quoting the Interim Report of the APB to the UGC. The science grpups were: biology (including biochemistry and biophysics), chemistry, maths (pure, applied, statistics), operational research and physics.

[77] TNA UGC 8/85. Biological sub-committee, 4th meeting, 22 March 1966.

[78] 'Record of meeting of the Academic Planning Board of the University of York held at the offices of the UGC at 10.30 on 23 March 1961'. BIAUoY UOY/F/APB/1/2. They also noted with puzzlement the fact that the UGC seemed to be insisting on 'Biology' whereas the Royal Society ad hoc committee (see above) had said traditional departmental divisions should not be followed, despite shared members, such as Peter Medawar.

seeking approval for the appointment of Mark Williamson as Professor of Biology. He stressed the 'absolutely first-class work in various fields', or, in other words, his wide interests.[79] Once in post, Williamson built up a Department of Biology that might have had a singular, disciplinary title but in fact was an expression of modern, interdisciplinary biological sciences (including, for example, biochemistry, as well as a wide, non-traditional curriculum).[80] He also secured top of the range, expensive equipment, such as an electron microscope and a Spinco-E ultra-centrifuge.[81] It is also clear that the sciences at York, which could not be housed in the colleges, strained the desired ideal of 'community' as envisaged by the vice-chancellor.[82]

The organisation of the sciences at the new universities therefore did indeed reveal 'freedom to work along new lines and the power to plan new combinations of subjects', and did so with imagination. But the early starters had more freedom to do so, later developments were constrained, and existing traditional disciplinary forces could still overcome interdisciplinary best intentions. Academic Planning Boards, moreover, provided a broad framework for development, but individual professors still had agency to develop their subjects, albeit in often interdisciplinary ways. I will now turn to examine three specific case studies in more detail.

Sussex: COGS and SPRU

At Sussex the case of cognitive sciences shows how interdisciplinarity could overspill from the already interdisciplinary schools, while a second new development, the Science Policy Research Unit (SPRU) is another example of a distinctive and novel combination of approaches. Maynard Smith's plan for undergraduate biology teaching integrated study in molecular biology ('that hybrid between genetics and biochemistry that dominates so much biology today'), development, brain and behaviour.[83] Within this plan were soon seven Majors. Six were, in order of increasing interdisciplinarity: Biology, Biochemistry,

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[79] James to Ogilvie, 8 August 1963. BIAUoY OUY/F/APB/2/1.

[80] Mark Williamson and David White (eds.), *A History of the First Fifty Years of Biology at York*, York: Department of Biology, 2013, especially pp. 9-13. The curriculum for 1963 included: genetics, the diversity of living organisms and ancillary chemistry (part I), and biochemistry, microbiology, biochemical genetics, plant and animal physiology, embryology, ecology, population genetics, evolution, behaviour, statistics, taxonomy, comparative anatomy, palaeontology, histology and electron microscopy (part II). Individual elements of this curriculum were traditional, but others were not, and nor was the interdisciplinary whole.

[81] Rachel Leech, who arrived in 1966, wrote: 'The decision to buy appropriate and top of the range equipment was critical. If we hadn't been able to do this I'm sure our research credibility (& departmental reputation) would have suffered badly'. Williamson and White, op. cit., p. 17.

[82] 'York aims at being a collegiate university', wrote Eric James, summarising his, and the APB's vision of community, but science didn't fit: 'Every teacher in *other than laboratory-based subjects* has a room in one or other of the colleges to which he is attached, and it is here that he gives his tutorial teaching. Other teaching in *non-science* subjects … are also associated with the colleges' (my emphasis). James, 'The University of York', undated manuscript. BIAUoY JAM/2/1/2.

[83] Maynard Smith, 'Integrating the biological sciences', op. cit., pp. 128-129.

Neurobiology, Geography (a combination of biology courses with mostly physical geography), Human Sciences and Biology with European Studies.

The seventh, though, shows how new interdisciplinary research could be generated from the school system. In 1965, Stuart Sutherland was appointed as Professor of Psychology and began a ‘unique’ Major in Experimental Psychology. (Neurobiology also overlapped with this development.) But the mid-1960s was when the provision of electronic stored-program computers to UK universities reached full throttle. The Flowers report of 1966 confirmed that computers would be essential to research (and even teaching[84]) and must be provisioned generously, while, also from the mid-1960s, the technology available diversified from the giant mainframes of the 1950s to smaller, cheaper, more networked machines.[85] There was therefore space for imaginative exploration of new possibilities. Sutherland brought from a couple of spells as a visiting professor at MIT a strong and influential ‘belief that artificial intelligence and computational modelling provided new and powerful ways to tackle the problems of cognitive psychology’.[86] In the same year Margaret Boden was appointed as a Lecturer in Philosophy, and swiftly became a leading interpreter of AI. Sutherland first planned a ‘Brain Institute’ and then a new ‘School of Cognitive Studies’, encompassing ‘Artificial Intelligence and Computer Science, Psychology, Linguistics, Logic and possibly, on an experimental basis, English Language and Literature’.[87] This plan became, not a ‘School’ but a ‘Programme’, in ‘Cognitive Studies’ in 1972. Based fundamentally on the computer-as-mind and mind-as-computer models, this project survived the mid-1970s dip in funding support for artificial intelligence and flourished in the 1980s.

Discussions about another interdisciplinary endeavour, this time at the intersection of the sciences, social sciences and humanities, took place between 1961 and 1964 between, amongst others, Stephen Toulmin (a professor of philosophy at Leeds) and Asa Briggs.[88] When Toulmin decided that levels of funding were inadequate, Briggs appointed

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[84] Sometimes the integration of computing into teaching was progressive. For example, ‘It was agreed…that all students in the School of Social Studies would be expected to do at least one term’s work on statistics and to become acquainted with the mathematical techniques which in some universities are beginning to command the whole field of social studies. Operational research, including data processing, would find its place at Sussex not so much as a contextual element in undergraduate education as the equipment of the undergraduate with a set of useful techniques.’ Briggs, op. cit., p. 71. But, note, too that despite Maynard Smith being a biologist who used computing, it was only in the mid-1980s that computing became a course for undergraduates in the Sussex biology school. Maynard Smith, op. cit., p. 131.

[85] F. Verdon and M. Wells, ‘Computing in British universities: the Computer Board 1966-1991’, *The Computer Journal* (1996) 38, pp. 822-830. Jon Agar, ‘The provision of digital computers to British universities up to the Flowers Report (1966)’, *The Computer Journal* (1996) 39, pp. 630-642.

[86] Nicholas Mackintosh, ‘Obituary: Professor Stuart Sutherland’, *The Independent* (18 November 1998). Sutherland suffered a traumatic depression in the early 1970s and subsequently wrote *Breakdown: a Personal Crisis and a Medical Dilemma*, (London: Weidenfeld and Nicolson, 1976).

[87] Alistair Chalmers, ‘Thinking about thought: the cognitive sciences at Sussex’, in Roger Blin-Stoyle, *The Sussex Opportunity: a New University and the Future* (Brighton: Harvester Press, 1986), pp. 175-189, p. 178.

[88] Christopher Freeman, ‘Policy research for science and technology’, in Roger Blin-Stoyle, *The Sussex Opportunity: a New University and the Future* (Brighton: Harvester Press, 1986), pp. 190-205, p. 191.

Christopher Freeman to lead a new outfit. The Science Policy Research Unit (SPRU) was entrepreneurial as well as interdisciplinary: nearly all of the staff and projects were supported by contracts, with funds coming from governments (UK and foreign), research councils, foundations, and business; the 'balance between longer-term, more fundamental research and shorter-term contract research', noted Freeman, was 'one of most difficult issues'.[89] Indeed, SPRU here was wrestling with relationships with sponsors that would become more widespread, as the encouragement of user-relevant, applicable interdisciplinary research became a common concern for UK universities.

East Anglia: Environmental Interdisciplinarity

UEA's Climatic Research Unit is a good example of how the institution created space for influential interdisciplinary research even as organising and funding teaching was the main concern in the early years. Its origins were quite contingent. In 1966, Hubert Lamb, who had been employed for 30 years at the Meteorological Office at Bracknell, was browsing the brochure that came with his daughter's UCCA application when he noticed a proposal to start a School of Environmental Sciences.[90] Emboldened, Lamb wrote wondering if there might be space for his work on climatic forecasting (as distinguished from short-term weather forecasting). 'My research on what affects climatic development and trend has started to lay the foundations for climatic forecasting…

> But much more work, with many fields of learning contributing, is possible and should be undertaken to improve the position. Moreover, it is vital that this be done and done soberly and scientifically, lest irresponsible persons make premature recommendation of schemes for large scale modification and control of climate or seek to make money by unsoundly based climatic forecasting.
>
> …
>
> There are now enormous economic stakes in all this for the community as well as new light to be thrown on human history (including British and European history), palaeobotany, palaeozoology and the history of health and disease... The endeavour must involve coordinating research in different disciplines rangimg from history, archaeology and botany to satellite meteorology and solar physics.

With opportunities at the Meteorological Office restricted (it had a service focus on short-term weather forecasting), Lamb saw expansion of such highly interdisciplinary research as

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[89] C.H. Geoffrey Oldham, 'Twenty-five years of science and technology policy research at the Science Policy Research Unit', in Hiroshi Inose, Masahiro Kawasaki and Funio Kodama, *Science and Technology Policy Research "What Should Be Done?" "What Can Be Done?"*, (Tokyo: Mita Press, 1991), pp. 31-41. Freeman, op. cit., p. 200.
[90] UEA/Jones/40. Lamb to Secretary to the University of East Anglia, 5 October 1966.

only likely in an academic context. The university responded by saying that his proposal would be put to the Dean of the new school, once one was appointed.[91] Lamb in turn suggested his name as a possible candidate.[92]

After Keith Clayton was appointed, Lamb eventually returned with his first proposal renewed. With the Met Office 'basically unwilling to divert staff to these ultra-long-range problems (as they appear to most meteorologists)', and hinting that other universities were interested, Lamb told Clayton that there was 'now a new element in the situation in that I now have a firm offer of financial backing from Shell to contribute towards the setting up the proposed Centre'.[93] Clayton this time responded with interest: 'I would certainly agree with you about the timeliness of the development, and it could certainly fit in very well with some of the inter-disciplinary studies that we are trying to foster here'.[94]

Much of UEA's financial resources were being devoted to developing teaching, but since the 'inter-disciplinary scope of Mr Lamb's research would fit particularly well into our range of interests' there was a determination to move forward.[95] There was nevertheless a protracted period during which Lamb and his UEA supporters sought promises of funding, largely from industry.[96] Shell offered £10,000, less than expected (£80,000 was needed) but partly so because it thought that such was the 'usefulness' of the Centre other stakeholders would be willing to contribute.[97] Behind the scenes, Zuckerman worked his contacts in academia and government.[98] Eventually, with funds primarily from Shell, but supplemented by BP, CEGB, the Electricity Council and potentially from the Nuffield Foundation, Lamb's Climatic Research Unit opened in 1971. Lamb retired in 1977, but before then his Unit's work had established precisely the broad-ranging, statistical understanding of past climate variability that enabled it to be a counter-weight to the Met Office's scepticism towards climate change.[99] In particular, Lamb's arguments were part of the mix of climatological theories and evidence that informed central government in the mid-1970s that climate

[91] UEA/Jones/40. Osborne to Lamb, 24 October 1966.
[92] UEA/Jones/40. Lamb to Osborne, 29 December 1966.
[93] UEA/Jones/40. Lamb to Clayton, 26 March 1969. NERC (in close contact with Shell) also offered funds. Shell was a key site for the development of long-range planning. The company's interest in Lamb was sparked by seeing Lamb's article 'Why Britian's weather seems to be getting worse' (*The Times*, 30 August 1966). R.G. Chalkey of Shell explained that he himself was 'directing a planning study for the Shell Group aimed at finding the most effective way of coping with the effects of seasonal variations on demand for oil'. Few mild winters meant a demand for more oil storage, which would require considerable Shell expenditure. Chalkey to Lamb, 8 September 1968.
[94] UEA/Jones/40. Clayton to Lamb, 2 April 1969. Indeed Clayton followed up saying that he should have responded 'more warmly' – he hadn't because of the understandable distraction of his wife suddenly suffering a virus-related paralysis.
[95] UEA/Jones/40. Clayton to Chalkey (Shell), 22 May 1969.
[96] The file at UEA has many of the refusals, from companies such as Burmah Oil, Esso, BOAC, Unilever, and Birds Eye, and organisations such as NATO. A list can be found in UEA/Jones/40. 'Industrial sources of research funds', undated (1970).
[97] UEA/Jones/40. Chalkey to Lamb, 31 October 1969.
[98] UEA/Jones/40. Zuckerman to Clayton, 31 May 1970.
[99] Jon Agar, '"Future forecast – changeable and probably getting worse': the UK government's early response to anthropogenic climate change', *Twentieth Century British History* (2015), 26, pp. 602-628.

change was a genuine phenomenon of political significance. (Interestingly, John Ashworth the Chief Scientist, Central Policy Review Staff, who reviewed this evidence, had been recruited to the government's think tank from another of the new universities, Essex.) In the 1990s and 2000s, UEA continued to be a centre of the world-wide expert investigation of climate change, and weathered the so-called "Climategate" incident of 2009, when over a 1,000 email messages held by the Climatic Research Unit were hacked and published.

Warwick: Catastrophe and Sudden Change

Like almost all his fellow founding professors, Erik Christopher Zeeman, known as Chris Zeeman, who arrived in 1964, wanted to establish a research-oriented, largely single-disciplinary subject department.[100] Zeeman contributed to the course 'Enquiry and change', which all Warwick undergraduates took. But this was not a display of interdisciplinarity; rather it was a beauty contest of disciplinary competition ("it was about each professor trying to convince a general audience that his subject was an exciting thing to do", recalled one seminar leader).[101] Zeeman built up critical masses (this deliberate, focussed growth of nuclei of scholars approach was influential) of staff in the pure mathematics specialties of topology, algebra and analysis. He also established in 1965 a Mathematical Research Centre to house symposia held by world-leading specialists, not least René Thom in catastrophe theory, a subject Zeeman would significantly further develop at Warwick. Thom had applied catastrophe theory (which in its essence is a specialty in pure mathematics) to embryology. But Zeeman's extension of the subject was distinctively an interdisciplinary conversation. A flavour of this can be seen in his reminiscence:

> I suppose I am particularly fond of having unknotted spheres in 5-dimensions, of spinning lovely examples of knots in 4-dimensions, of proving Poincaré's Conjecture in 5-dimensions, of showing that special relativity can be based solely on the notion of causality, and of classifying dynamical systems by using the Focke-Plank equation. And amongst my applications of catastrophe theory I particularly liked buckling,

[100] Burgess, op. cit., pp. 102-103. Although note in practice there was interdisciplinarity. Chemistry for example exposed students to much molecular biology, biochemistry and x-ray crystallography. Burgess, op. cit., p. 107. Moreover, the primary sources from the founding years illustrate a desire to avoid disciplinary silos that is similar that expressed at Sussex or UEA. For example: 'At the present time, both at school and at the university, the student is subjected to "compartmentalised science" with the attendant disadvantage of failing to realise that knowledge derived from, say, Physics, can be applied to a problem encountered in Biochemistry. By uniting separate disciplines at the molecular level such barriers as at present exist should be minimised and might possibly disappear'. UWA/M/BFS/1/1. 'School of Molecular Sciences', authors probably V.M. Clark and T.C. Waddington, 25 March 1965.

[101] Rolph Schwarzenberger, quoted in Burgess, op. cit., p. 98. Burgess adds: 'In many universities this course might have been presented as an interdisciplinary offering with links being made between different branches of knowledge. But at Warwick, the strength of subjects showed through…'.

capsizing, embryology, evolution, psychology, anorexia, animal behaviour, ideologies, committee behaviour, economics and drama.[102]

In language strikingly similar to Bennet-Clark's language of a rebirth of older, more connected scholarship, Zeeman also spoke of 'natural philosophy':

> Ever since the disappearance of natural philosophy from our universities and the fragmentation of mathematicians into pure and applied, our canvases have steadily been growing smaller and smaller. At least catastrophe theory marks a revival of natural philosophy, to be enjoyed once again for a while at any rate.[103]

Indeed this extraordinary range can be found in Zeeman's *Catastrophe Theory: Selected Papers 1972-77*.[104] What is striking is how this research at one of the new universities drew on and rationally analysed the sudden, seemingly irrational problems of the 1960s and 1970s, from prison riots and stock exchange instabilities to anorexia. All this analysis took place in a university which went through its own abrupt spasm of protest, as E.P. Thompson described in *Warwick University Ltd* (1971). The resonances between seemingly arcane mathematics and the era of radical change partly explain why catastrophe theory reached a surprisingly popular audience (in many ways it was a precursor of late 1980s popular interest in 'chaos' theory). Zeeman himself not only became a public scientist (he presented for example the Royal Institution's Christmas Lectures in 1978), but also encouraged people to 'make and play with' their own 'catastrophe machine', a device of '2 elastic bands, 2 drawing pins, half a matchstick, a piece of cardboard and a piece of wood' thereby showing 'how continuous forces can cause catastrophic jumps'.[105] This toy is the materialisation of 1970s hopes and fears: the fears of abrupt change, the hope for rational explanation, and that they might be achievable through self-experimentation.

Long 1960s

[102] J.J. O'Connor and E.F. Robertson, 'Erik Christopher Zeeman', http://www-history.mcs.st-and.ac.uk/Biographies/Zeeman.html. 'Focke-Plank' was mistranscribed. 'Fokker-Planck' is correct.

[103] E.C. Zeeman, 'Catastrophe theory: a reply to Thom', in Zeeman, *Catastrophe Theory: Selected Papers 1972-77*, (Reading, MA: Addison-Wesley, 1977), pp. 622-632, p. 622. First published in A.K. Manning, *Dynamical Systems, Warwick 1974*, (Berlin: Springer Verlag, 1975).

[104] See for example: the discussion of anorexia in 'Catastrophe theory: draft for a Scientific American article', 'Differential equations for the heartbeat and nerve impulses', 'Brain modelling', 'Some models in the social sciences' (with C.A. Isnard), 'On the unstable behaviour of stock exchanges', 'Prison disturbances', 'Stability of ships', all in Zeeman, *Catastrophe Theory: Selected Papers 1972-77*, op. cit.. He also, in a cross-new university exchange, commented on and extended Maynard Smith's use of game theory as applied to animal behaviour'. See: E.C. Zeeman, 'Dynamics of the evolution of animal conflicts', Journal of Theoretical Biology (1981) 89, pp. 249-270.

[105] E.C. Zeeman, 'Catastrophe theory: draft for a Scientific American article', in Zeeman, *Catastrophe Theory: Selected Papers 1972-77*, op. cit., pp. 1-64, p. 8. A version was published in *Scientific American* (April 1976) 234(4), pp. 65-83.

Elsewhere I have asked whether the category of the 'long 1960s', the period of social and cultural change from roughly the mid-1950s to the mid-1970s, has any use for the historian of science.[106] My answer was that amongst the continuities and noise, a common pattern, formed of the interference of three waves, could sometimes be usefully discerned: the proliferation of experts produced by the expanded post-war educational systems, powerful social movements that could stage conflicts, not least between experts, and, thirdly, an orientation towards the self, in diverse ways. Since the new universities of the UK were created during the long 1960s, it is worth asking whether these waves marked the sciences found within them.

In the United States, student-led social movements led to protests on campuses in which the Cold War military research and development was part of the focus for dissent. At Princeton military R&D was fiercely debated in 1967; at Stanford the much more extensive secret contracts and classified research at the Applied Electronics Laboratory and the nearby Stanford Research Institute were protested against by students and faculty in 1966; while at MIT, which received more defence research and development grants than any other university, the Lincoln and Instrumentation laboratories, specialising in electronics and missile guidance technologies respectively, were the target of a strike intended to 'provoke "a public discussion of problems and dangers related to the present role of science and technology in the life of our nation"'.[107] In the UK, while defence research contracts were placed with university departments, they were at a much lower level, and, despite fraught public debate about the implications of Sputnik for education (mostly school rather than higher education), postwar British universities are not best described as 'Cold War campuses', except as part of the broader context.

Nevertheless, at the new UK universities – a "laboratory in staff student relations" – unrest was also evident.[108] The rapid expansion, for example at UEA, was reflected in woeful external examiners' assessments of academic quality at the end of the 1960s.[109] The disruption at Warwick has already been noted. At Essex, the most affected by the '68 events, it was indeed a *science* event that sparked the major incident (see also the paper in this volume by Caroline Hoefferle). Dr Thomas Inch, a scientist from Porton Down, the UK

[106] Jon Agar, 'What happened in the Sixties?', *British Journal of the History of Science* (2008) 41(4)4, pp. 567-600. There is increasing interest in this question among historians of science and technology, for example: W. Patrick McCray and David Kaiser (eds.), *Groovy Science: Science, Technology, and American Counterculture* (Chicago, University of Chicago Press, 2016).
[107] Stuart W. Leslie, *The Military-Industrial-Academic Complex at MIT and Stanford*, (New York: Columbia University Press, 1993), p. 233.
[108] As discussed more generally elsewhere in this collection. For "laboratory": Perkin, quoted in Muthesius, op. cit., p. 179.
[109] Sanderson, op. cit., p.213. Soon after we find Solly Zuckerman reflecting that the fact that he was launching a series of seminars on 'The Challenge of Environmental Change' was 'not a case of jumping on the bandwagon. The University set itself up originally in a series of Schools and long before the subject of pollution, environmental pollution etc became the popular subject, which replaces [sic] student unrest, this University had set up a School of Environmental Sciences'. SZ/UEA/9/23. Transcript, 'Tape 1. First session;, undated (1971).

government's chemical and biological warfare laboratory, arrived at to give a talk at the Chemistry department on 4 May 1968. A witness recalled:

> The planned demonstration was organised in secret. Communication was by word of mouth and only to those people whose discretion could be relied upon.
>
> The Chemistry Department had expected a handful of third year science undergraduates to attend the meeting. What they got was hundreds of protesters armed with an indictment.
>
> Before Dr Inch could start speaking, a young woman with long black hair, stood up and started reading the indictment in a strong, loud voice. She described in some detail the activities of Porton Down; in particular, the development of CS gas which was being used in Vietnam and on the streets of Paris.[110]

It is not known who this student was, or whether she was a scientist or arts student. At Essex, all arts students were taught some science in the first year, as well as a 'paper in social arithmetic or elementary statistics'.[111] Inch received for his pains a tin of Colman mustard powder emptied on his head, accompanied with the cry of 'Ban mustard gas. Ban mustard gas'.

Conclusion

This paper has reviewed some of the features of the sciences in the new universities of the 1950s and 1960s. The upgrading of the Colleges of Advanced Technology, as well as earlier expansion at older universities and new establishments such as Churchill College, meant that there were lower expectations, or demands, that the new universities must focus on science and technology than might have been expected. The 1950s and 1960s, after all, were the highpoint of technocratic modernism. Nevertheless, the largely free hand given to the designers of curricula, research programmes and laboratories – especially the first of the new foundations (Sussex and East Anglia), where all was fresh – meant that interesting experiments in the provision of university science could be and were conducted. In particular, I have argued that interdisciplinarity, while not without problems for the consciously disciplined sciences, was a hallmark. Partly interdisciplinarity was a reflection of longer, deeper trends (evident throughout the 20th century), but also it could be specifically trialled in new forms at the new universities. While interdisciplinarity in the sciences was

[110] Chris Ratcliffe, 'May days at Essex'. http://www.essex68.org.uk/may68-e.html. See also a short radio program presented by Ellie Cawthorne, with contributions from Esmee Hanna, 'A very Essex protest', *Scenes from Student Life*, BBC Radio 4, broadcast 28 April 2016. http://www.bbc.co.uk/programmes/b07881l1
[111] James, op. cit., p. 207.

not uniform, and partially retracted over time, it stands as the most significant characteristic of science at the new universities.