

## **University Courses for Tomorrow**

HEPI Lecture

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Royal Institution, Thursday 24 November 2005

When this Institution was founded in 1799 there were only seven universities in these islands, two in England, four in Scotland and one in Ireland, and none had been founded for over two centuries, since Edinburgh in 1583 and Trinity College, Dublin, in 1592. These were not the best of times. The long-running war against the influences of the French Revolution had been costly and had led to a loss of continental markets, and there were the consequences of what appeared to be waning international influence with the independence of the American colonies. The Royal Institution was founded to empower the nation to improve its own resources, and above all to facilitate wider access to scientific and technical knowledge so as decisively to improve agriculture and industry. These laudable intentions were expressed outside the tiny university world, which it would not be unjust to characterize as placid and self-satisfied and removed from the practicalities of life. Indeed it was to be another quarter of a century before a university was founded in London.

Historical parallels are risky but faint analogies can be drawn to our present situation although the growing forces in the world today are to our east rather than to our west. Before 1800 there had been some developments in university curricula, notably in medical education where the need for military doctors stimulated expansion, but very little in the way of recognizably modern teaching took place. My own university, Cambridge, was still governed under statutes adopted in the reign of Elizabeth I, with a curriculum largely of the same period. As David Starkey said recently, Newton was able to make his revolutionary advances because he had virtually no teaching commitments.

The lack of a university in London was remarkable as the capital had been the place where the money was made. Higher education, such as it was, took place a safe distance away, where it was conveniently fostered by the endowments of the metropolitan rich. Attempts to found a university 'closer to the action' had invariably failed: Gresham College came nearest but had sadly faded. It is interesting to surmise what the effect might have been had it succeeded.

But a huge enlargement of university education was about to take place in the nineteenth century, in other developed countries as well as in Great Britain, as new institutions emerged with new curricula more suited to the times. Their founding stimulated change in the older institutions too: Cambridge greatly enlarged both its curriculum and its student numbers in the later years of the nineteenth century. It is interesting to note that it was not until 1875 that Cambridge created its first professorship in engineering, the Professor of Mechanism and Applied Mechanics. Significantly, perhaps, the first holder of this professorship was James Stuart MP, already distinguished in the same field as this Royal Institution - he pioneered the

opening-up of University education through the extra-mural movement which he inaugurated in lectures delivered to workers at Crewe.

In other countries similar revolutions occurred: In most European countries, though, higher education remained the privilege of a tiny elite for a further century. It was not until fifty years ago that this decisively changed, with the onset of the unfortunately named 'massification' of higher education. In the whole of the 17th century it is said that fewer than 600 men attended Harvard. But in the 130 years between 1840 and 1970 - influenced by the vocationally -aligned 'Land Grant colleges and the great State Universities - when America's population grew twelve fold, college enrolments rose over four hundred times, setting a pattern which was to be repeated in Europe and elsewhere.

The expansion in numbers meant that governments nearly everywhere found themselves with an impossible circle to square. The funding which states had found possible for a small scale system proved impossible to sustain for a large scale one. In Great Britain successive governments increased the proportion of the age cohort going to university from 5% in 1960 to around 38% now, with a government objective of reaching 50%. The United Kingdom performs above the OECD average of 32%. But, in order to ensure that more students qualify at lower unit cost, governments have rigidly controlled the 'unit of resource', specifying student numbers, and the universities' income per student, and thus the quality of education the universities could provide. That dilemma is one which the present policy on student funding is designed to rectify, but with still-unknown effects on the participation rate, completion, and debt.

What I have termed elsewhere [in the Menzies Oration, 2000] the 'Faustian compact between universities and state' requires in exchange for state funding an elaborate process of scrutiny, evaluation, measurement and quality assurance, to persuade those who pay the piper that the tune is at least worth listening to even if not wholly understood. That process of evaluation I consider to be almost entirely arid, and indeed of questionable validity and value, and it is certainly not a source of inspiration and change. It would not be so unfortunate if circumstances had allowed strong private, and independent, institutions to emerge as they have in America, but the possibility for this disappeared following the first world war when, tragically the number of undergraduates fell dramatically and the government stepped in and, in effect, gained a financial controlling interest in every university in the land. Since then it has been impossible financially even for the richest and most successful of our universities to throw off the shackles of government control - but that is not what I want to talk about this evening. Our position is no worse than some of our European neighbours in this respect, and in comparison with some, Germany for example, it is better.

What I want to consider this evening stems from the remarkable fact that through all of the changes we have seen over the last two hundred years, our universities have largely retained the old model of distinct faculties, homogenous courses, and lengthy residence that initially appeared over two hundred years ago. Many new subjects

have been introduced but the way they are arranged into silos and taught has remained largely unchanged for at least two centuries.

My argument tonight will be that we need to question whether this structure remains appropriate and contemplate as radical a review of the nature and purpose of our universities as that which took place two centuries ago.

What are Universities for? There are two opposed and extreme views, neither of which is wholly acceptable. On the one hand is the idealistic view of the self-motivated, self-regulated community of disinterested scholars, teaching and researching without external direction or control (but, it is usually assumed, with unlimited external financial support). The scholars' primary motivation is to further their subjects and to hold the intellectual high ground.

At the other extreme is the Gradgrindian, utilitarian view of justification by measurable results, or 'output' in terms of trained and compliant employees. In the modern version of Dickens' polemic the scholars are seen as researching and teaching for the material betterment of society as judged by their pay masters. The scholars' responsibility is to society, or worse to the national economy, rather than to their subjects.

Until about a century and a half ago, academics did not spend their time contemplating the purpose and ethos of their institutions. In ancient religious foundations the purpose was obvious and the ethos set elsewhere. Even in more liberal, secular societies, the task of the university was the education of governing elites and the professions. But influenced by growing democracy, growing participation in government through a widened franchise, and growing taxation, matters have changed.

In his seminal contributions a century and a half ago J.H. Newman crystallised the first view of the purpose of the University: it should be, he said, "the high protecting power of all knowledge and science, of fact and principle, of inquiry and discovery, of experiment and speculation". Teachers would 'teach universal knowledge', not engage primarily in academic research. Students were to learn the rudiments of intellectual enquiry, 'to think and to reason and to compare and to discriminate', free from consideration of the practical application of the results.

And remember the late Sir Kingsley Amis (thinking no doubt of his comic creation, the history lecturer Lucky Jim) in 1960: "The delusion that there are thousands of young people who are capable of benefiting from university training, but have somehow failed to find their way there, is a necessary component of the expansionist case. More will mean worse." That view is by no means dead.

For the severely utilitarian view, or the automatic denunciation of what have been shamefully termed 'Mickey Mouse Degrees', just turn to the record of any parliamentary debate on education policy, or to the periodical tabloid indignation at 'revelations' of unconventional university courses at which it is amusing to sneer.

My inclination, surprisingly perhaps, is closer to the first than the second view. I believe that what we need from our universities first and foremost is the provision for young people of an adequately broad knowledge base, together with modern analytical and communication skills - if you like, the modern day version of Newman's 'rudiments of intellectual enquiry.' Many of our undergraduate courses have become too narrow and over-specialized, and do not equip the young with flexible intellects that will be able to adapt to changing circumstances. An undergraduate degree should cover the fundamentals of a coherent range of subjects. Students need expert advice in choosing their subjects but the ultimate choice should be their own.

It is also important that these subjects be taught in a manner that starts by setting the context. The reasons why a subject is important and what it will enable a student to accomplish should be clear from the start. Too often, especially in science and engineering, students are fed indigestible quantities of pure mathematical background without its relevance being adequately explained. This merely leaves them in a state of confusion and disillusionment from which many never recover. It is falsely thought by some that students are in a position to appreciate the elegant generality of mathematical methods before they have applied any of these methods to the solution of a single practical problem. It is a rare student that has this ability, and even these brilliant students will benefit from an understanding of the practical importance of what they are doing early in their studies.

Progress is being made in my own field of engineering where examples of best practice include; in school teaching, the Technology and Engineering in Schools Strategy (TESS), which is being pulled together by the Royal Academy of Engineering, the Engineering and Technology Board, and fifteen of the Engineering Institutions; and in undergraduate teaching, the CDIO initiative being pursued at MIT, and fifteen other universities in eight countries that is based on the assumption that students will need to be able to Conceive - Design - Implement and Operate complex systems while working in teams. CDIO courses are designed to be both educationally effective *and* more interesting and exciting to students. Students are captured by the fact that they can see that what they are learning will be applicable in the real world, and they like it.

In research the need to collaborate across subject boundaries has been apparent for a long time and an increasing fraction of research at the world's leading universities is carried out in institutes that span the faculties and are independent of them. But this trend has not been so apparent in teaching, where many faculties have been reluctant to work with other faculties to provide linked education. Students want this and should be allowed, and even encouraged, to take a relatively broad range of subjects in their first two years. There are in fact many examples of good practice, I cite the emergence of degrees that combine science with law, business and the social sciences, and within science and engineering, a knowledge of biology, engineering and computer science is going to be essential to apply the knowledge that has emerged in the human genome project. The Natural Sciences Tripos in Cambridge, which was

first held in 1851 as a consequence of the great Victorian overhaul of the University, allows students to choose from the entire range of subjects in the physical and biological sciences and mathematics, and this course has long been praised by students and faculty members alike. A further advance would be realised if it was broadened to include engineering, computer science and management. I remain a cock-eyed-optimist on this issue.

Naturally those going on to be professionals in the sciences, medicine and engineering, or in law and the social sciences and management, or who are going on to be university teachers, need to be taught their specialities. There is no replacement for hard work and dedication in accomplishing this and it is very difficult or impossible to learn some of the more difficult fundamentals later in life. In my opinion, however, this is best done in post-graduate, masters courses. Much of this material can only be comprehended by the more talented students and even then time is required. For perhaps the majority of the students, who in any case will not go on to further their subjects, this material is unnecessary, even if they had the ability to understand it. For them a broader base prepares them better for what in future are likely to be far more diverse careers with periodical retraining and realignment during a working lifetime.

Our four year science and engineering 'master's courses', in part justified because of a perceived slippage in our school education standards, which leaves entrants less well-prepared for highly-specialised university courses, themselves fall between two stools. They are longer than is necessary for those who are not going to be specialists and too short for those who are. The '3 + 2' format, which was more widespread in the middle of the twentieth century in the UK, and which has now emerged in the Bologna agreement, is better suited to future needs.

As an aside, the '4+2" format that is common in the USA is probably too long and therefore expensive for us, although the first year, because it is relatively unstressed, provides valuable time for students to develop the self-discipline that they need in university life.

The '3 + 2' format will not necessarily be greatly more expensive than the four year format because a large proportion of students will only complete three years. However, there remains a large financial gap for universities which has certainly not been filled by the presently-authorized £3,000 fee. At present research funds are being used to subsidize teaching which is unsustainable and clearly detrimental to research performance. I am convinced that the funding regime must change so that the income from teaching balances expenditures. Universities should be freed from the constraints of government and allowed to test the market on the basis that those who can afford to pay should do so (for they are the individual beneficiaries), but that bursaries should be provided for those who cannot. An approach, which is being considered in Australia, is to charge a full cost fee to those taking the two year masters courses, because they will gain 'accredited' status thereby ensuring greater incomes. Freedom from central control would encourage the development of a

spectrum of differently priced, and differently structured courses, and different institutions.

No matter what the format, it is important to avoid asking young people to decide what they want to do before they have the knowledge, intelligently, to do so. For example, it is not necessary in my view to ask students to commit to the majority of professional careers until the second or third year of university, and it is certainly wrong to try to persuade young people to commit to given professions while they are still at school. While at school, they should be exposed to the different alternatives - visits to hospitals, industry, building sites, architectural practices, etcetera, to inform and inspire them - but their studies should be kept broad enough so that they are not constrained in what they subsequently do at university. By the end of their second undergraduate year they are in a much better position to form their own view of their future career, and to balance their own observations with what may have been parochial views imposed on them by school teachers and advisors, and even their parents.

This naturally will depend on what they are taught at school. At present those going to our top universities are essentially required to decide whether they are going to pursue arts and humanities, or science and technologies, half way through their secondary schooling. Many of our brightest young people study nothing but mathematics and physics, or alternatively study no mathematics or science, from the age of fifteen. The government's rejection of the Tomlinson proposals, which would have gone a long way to rectify this situation, was in my mind disastrous.

I am not optimistic that we will adopt the '3 + 2' alternative for possibly overwhelming political reasons, but we should. Another one of its advantages is that it would allow those who will be probing the frontiers of knowledge, who need to complete a PhD, to do so in three years, and certainly in no more than four. At present, at least in science and technology, the four year masters courses do not provide sufficient background and require many PhD students to spend their first year studying rather than starting their research project. With two additional years for the masters following completion of the bachelor's degree, background study can be completed fully before the PhD is started, and the student's potential as a researcher assessed in a major project before they are accepted for the PhD.

The purpose of the PhD is to teach people how to conduct research, not to produce volumes of research output and enhance their supervisor's reputation. It should be possible, with a two year masters, to complete this in three years. In some countries the time has been extended way beyond three years, which I believe is unfortunate as it captures the students through what may be the most productive period in their lives when they would be better practising their research skills for the betterment of their professions.

Before leaving the discussion of the duration of courses, I would like to recognise the importance of the one year masters courses to the arts and humanities and social sciences. These have proved valuable in attracting overseas graduates to our

universities and a significant fraction of these students go on to complete PhDs. The one year courses are almost certain to survive, despite their conflict with the Bologna agreement.

I would like now to talk about students and how they are selected. I believe that a University, of whatever character, is only as good as its students. By this I mean that it is the input of the students, refreshing and stimulating the entire character of the institution, which maintains and enhances its quality. I myself came late to University teaching, having worked in industry for twenty years, but I soon came to realise, as career academics know only too well, that this annual renewal was the magic ingredient of universities that affects all that they do. What better than to be questioned every year, and have one's competence challenged once again by those that will replace you? Wearing perhaps, and many fall by the way side, but it is an infinitely better challenge than a government run assessment exercise, or even the changing competitive scene that challenges industrial research units.

It follows that the way students are selected is of paramount importance. Much effort and energy has been expended - or wasted - on attacking (and refuting) supposed social bias in University admissions, and I do not believe from my own experience that any responsible University teacher chooses other than those he or she considers to be the best applicants. But in many universities the basis for that choice is the flawed system of A-level results, which are neither an efficient indicator of attainment nor a reliable predictor of future achievement.

I have already talked about the limited breadth in our school system, which is also largely a product of the A-level system. I criticise A-levels because they are largely a 'memory' test and I believe that this is not sufficient in selecting students. They also favour the better off and privileged, because they depend heavily on the standard of teaching, which is demonstrably better in our expensive private schools. Is there not a need also to use an 'IQ-type' test? There is no need to think that the two types of test are mutually exclusive. They can complement each other, and allow us to capture a wider range of talent. The introduction of SATs in the United States - inspired, I think, by James Conant, the legendary president of Harvard from 1933 to 1953 - began a profound process of change in the nature of US universities, although the availability of financial aid for those without personal means was equally important. His object was to devise a system of assessment which would identify real ability rather than acquired presentational skills. Poorer children entered great universities. And some richer children had to accept demotion. The Economist observed unkindly in 1997 that "George Bush sailed into Yale in 1964, thanks to his family connections; but seven years later, when Yale had belatedly embraced the SAT revolution, his brother Jeb went to the University of Texas instead".

Clever selection of students is without benefit if the pool of students from which the selection is made is not sustained in number and quality. That some structural action may be required in redefining the nature and purpose of undergraduate education in Great Britain is indicated by the most recent (September 2005) OECD statistics. While growth in United Kingdom university participation has been strong over the

last decade, the new data show that this trend has now levelled off, with tertiary enrolment growing at lower rates than the OECD average and the UK's entry rates falling below the OECD average. Also, while the United Kingdom remains one of the most popular destinations for foreign students, its international market share of foreign students has declined faster than in any other country, even if foreign enrolment has grown in absolute terms. This is a serious consideration bearing in mind the financial underpinning which full-cost overseas students bring to many HE institutions. At the tertiary level, a below-average increase in spending in the UK - 18% - just matched the below-average increase in student enrolment (18%), such that spending per student remained steady between 1995 and 2002, when comparing these figures in constant prices. [Figures from OECD, 13 September 2005, see <http://www.oecd.org/dataoecd/20/54/35344362.pdf>] We cannot afford to fall behind in international recruitment.

And is there perhaps a growing realisation amongst potential students that the lifetime income benefits of what may be their second- or third-choice degree course are not always obvious, especially when their attainment requires substantial personal financial commitment?

Let me now turn to the need for diversity in our tertiary institutions. It is a mistake to delude ourselves that all HE institutions are the same and even worse to go on to rank them according to performance criteria designed for a single ideal model for the comprehensive research university. One of the potential benefits of the huge growth in the number of institutions, the six in Great Britain in 1799 [six because Dublin no longer in UK] had become well over a hundred by 2005, is the opportunity for wider diversity in the scope, aims, and methods of different institutions. But this will bring benefit only if we accept and encourage them to respond flexibly to their students' varying needs and abilities, and their different relationships with other local institutions and partners.

Sneer at this model at your peril, those with exclusive academic pretensions: I would commend the community colleges of the United States, in many respects the uniquely valuable aspect of their educational system. They provide, flexibly, and at an affordable cost, a range of courses from the preparation of students for four-year degrees, to continuing and remedial education, whilst keeping closely in touch with specific local needs. They offer a model we might well aspire to, and indeed are doing.

It may be argued that Great Britain has already tried to cater for less academic school-leavers in the former polytechnics, which aimed to provide qualifications equal in quality to those offered by the universities, but with a more practical and vocational bias. It was intended that these would maintain closer links with local industries, and they were controlled by elected local authorities instead of being given the legal (if not the financial) independence of the universities.

But it was the universities which continued to attract the most highly-qualified students, and because of this the polytechnics sought themselves to become "real"



universities, and they eventually succeeded. What was lacking was parity of esteem. There was a persistent feeling, reinforced by invidious differences in funding, that people thought that the students, and just as important, the staff, were second rate. In fact this had more to do with endemic British snobbery than with the actual state of affairs, but there were those who asked at the time of the Major government's final translation of them into universities whether high esteem as a polytechnic wasn't preferable to the same sneers directed at them as 'new' universities. Beside for many the polytechnic provided a much more appropriate training both from the point of view of the graduate and of their employers.

It is my observation that perhaps the major enabling factor in the remarkable success of the Singapore economy was the quality of the technical graduates produced by their polytechnics. The significance of the polytechnics was at least equal to that of their fine universities. Many of the graduates from the polytechnics have gone on later to complete full university degrees, but they were all trained to be immediately effective in the high technology companies that were thinking about locating in Singapore. Sir Andrew Foster's recent report on Further Education Colleges emphasizes the importance and potential of another perhaps-neglected resource in Great Britain. See <http://www.dfes.gov.uk/furthereducation/fereview/index.shtml> }

There is need also to be conscious of the changes that have taken place in the workplace especially in industry, and it is difficult here to discriminate between cause and effect. Statistics show that the reason we have fallen behind our competitor nations in our private sector R&D spend, is that we no longer have the industries that traditionally spend a lot on R&D. Is this because our skill base was inappropriate, or is our skill base as it is because of the fall off in the innovative industries? Has this fall-off occurred because we have too few senior executives who have spent their early careers as creative engineers and scientists - I do not include those that graduated in these subjects but never used their expertise - or because the City does not believe that these forms of industry are good for themselves, or the national economy? No matter what the answers to these questions are, we need in future to make sure that we take the broad view in structuring our university courses, and do what we can to close the gap between what we are delivering and what is required.

I conclude by again looking back two hundred years to the founding of this Institution. Sir Joseph Banks PRS, companion of James Cook that indefatigable explorer, hosted the meeting at which he and his colleagues decided that their task was to empower the nation to improve its own resources on which it had increasingly to rely, and above all, as I said at the start, to facilitate wider access to scientific and technical knowledge so as decisively to improve agriculture and industry. Their meeting and this their foundation anticipated, not wholly coincidentally, the most sustained wave of invention and discovery there has ever been, and in little more than the lifetime of the youngest amongst them the world had changed to something beginning to be recognizable as our own. Those pioneers stated their objectives as being "...teaching, by courses of philosophical lectures and experiments, the application of science to the common purposes of life."

Set in less ornate tones, this prospectus defines the main character of the university today, instruction, experiment, application, and relevance.

I hope that some of the ideas I have outlined this evening will help towards redefining that mission.

November 2005

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