

# Whither universities?

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## Emergence of the present system

One of the major contributions which universities make to a community is scientific research, teaching and development. Yet today's university is a far cry from that of Isaac Newton, whose discoveries contributed greatly to the rise of modern science. When he arrived at Cambridge in June 1661, he found it dominated by Aristotelianism, as it had been for four centuries. Of the books demanded by the curriculum, Newton never finished any of them, and almost all that he learned at Cambridge was the result of solitary reading and personal research. When Halley asked him "what he thought the curve would be that would be described by the planets supposing the force of attraction towards the Sun to be reciprocal to the square of the distance from it", he replied "an ellipse". With the time and freedom to think for a couple of months, he committed it to paper. This led to the concept of universal gravitation, an awesome synthesis born of academic freedom [1].

Natural philosophy, as it was called in the 17th Century, was often driven by the religious quest for a deeper understanding of God, particularly as depicted in the early chapters of Genesis. It became a search for the origins of the universe, for Nature's practical utilities, and for the exercise of human dominion over the planet with all the ambiguities that entailed. Later, Wilhelm von Humboldt (1767–1835) expressed the ideals of universities as the freedom and unity of teaching, learning and research which provided students with an all-round humanist education. These ideals were the founding spirit of many universities and, in particular, the University of Berlin. Later, as Darwin's theory of evolution by natural selection emerged, it appeared to substantiate David Hume's earlier claim that Nature was a moral vacuum with no theological conclusions of any consequence, and the move towards the secularization of science was truly underway [2].

Until recently, the Humboldtian tradition has been uppermost in many centres of learning. For example, students in Norway enjoyed the freedom of how and in what way they chose to study, and an absence of serious institutional pressure to complete their studies within an allotted amount of time. The primary goal of such centres of learning was to produce interested and independent students who matured into scholars. This utopian vision still retains its power today as a counterpart to the realities of mass education [3]. However, both commercialization and the Bologna Process are seen by some as a death knell to the Humboldt tradition and damaging to the old values [4].

This concern about commercialization in universities was expressed in a recent editorial in *Science* concerning Australia, where the current government is

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claimed to have dismantled research centres in order to leave programmes totally orientated towards commercial outcomes [5]. Also, in China, one of the goals of their current five-year plan is to bring pressure to bear on its universities to improve and apply their research. It is claimed that this has led to an apparent epidemic of fraud in universities run by administrators whose primary qualification is party loyalty [6]. So, has the process of moving away from the traditional view of universities as ivory towers of learning and creation of new knowledge gone too far?

## Modern forms of knowledge creation

The historical vision that portrayed science as autonomous, apolitical and ethically neutral has been transformed. No longer is the vision concerned solely with the pursuit of truth [7,8]. Instead, knowledge has become commodified and the boundaries have become increasingly blurred through the mechanisms of funding and the demands of funding bodies. Timescales from discovery to application may be greatly foreshortened, so that in biotechnology, for instance, industry-sponsored basic research into gene regulation can result in the incorporation of genetic engineering into medicine and agriculture within a single decade rather than in three decades [9].

Stephen Jackson, Professor of Biology at the University of Cambridge, a curiosity-driven biological scientist, discovered new ways to expose tumours to compounds that prevented the cells from repairing themselves and improved the efficacy of cancer treatments. He set up a spin-out company and, within 10 years, sold it to AstraZeneca for £121 million, giving an average internal rate of return for investors of 29% per annum, or 2.8 times [10]. Such examples have become more common and so it is unsurprising that U.K. universities have become market-orientated.

Boden et al. [9] describe 'curiosity-driven' (academic) science as a discrete and independent activity which should not be interfered with by management and funding controls. Ideally, it should be funded by organizations dedicated to the production of knowledge for its own sake and for public good. It is the seedbed of new ideas and paradigm shifts, so the idea of a European Research Centre that distributes EU (European Union) funding to fundamental research is welcomed, provided that it safeguards and increases the quality and visibility of fundamental European research globally.

'Useful science' is that which contributes to wealth creation and quality of life, and is supported by funds competitively acquired with outputs that are transferred to users. This model implies linearity, which is both misleading and an oversimplification; an interactive model more accurately describes what happens in reality between scientists, industry and end-users.

'Commodified science' goes further, because it refers to scientific knowledge produced in the context of its application, rather than with the potential for transfer to end-users. Hence in today's increasingly technologically driven world, the trend has accelerated in favour of work that will lead to increased competitiveness with a focus on what you do best, or at least better than your neighbours

or more distant countries. The outcome is that U.K. universities are now classified according to whether they are 'research-intensive' or 'business-facing', and although these terms do not depict exclusivity, they reflect how innovation has become a strong driving force that enables and benefits industrial and business exploitation.

What emerges from this brief review of different types of knowledge creation in universities is the impact on the public good: take-up of research findings and the exploitation of intellectual property, development of human capital through the acquisition of skills and knowledge, and improvements in quality of life, including the environment, social welfare and health. Some impacts may have been unintended and some were not necessarily part of the original rationale for the specific investment and, in this respect, the full range of impacts may be easily under-represented [11].

## How valuable is the university–market relationship?

### Returns

The economic case for investment in science and research has been frequently advanced based on evidence that a strong public science base supports improvements in human welfare. One study found that 1% growth in public R&D (research and development) led to a 0.17 % increase in the total factor productivity in the long run; a 1% increase in business R&D raised it by 0.13%. Moreover, this effect was increased with the share of public science conducted in universities [12], and there was a positive, but non-linear, relationship between citation intensity and GDP (gross domestic product) per head for 31 countries [13]. However, the gross expenditure on R&D in OECD (Organisation for Economic Co-operation and Development) countries falls short of the Barcelona target of 3% of GDP; except for Finland, Sweden and Japan, indicating that greater public and private investment is needed in many countries [14,15].

The returns of commercialization to one of the world's most progressive and successful centres, MIT (Massachusetts Institute of Technology), are substantial, although they may not reach the size of golden eggs that solve all of the financial problems of a modern university. The revenue from MIT's intellectual property amounted to approx. 5% of its research budget (MIT-sponsored research budget for the fiscal year 2007, \$1306 million; number of inventions disclosed, 487; royalties, \$61 million; expenditure on patents, \$13 million; number of staff in office, 30) [16,17]. So while intellectual property may have great potential value, universities and governments should not overestimate the returns since they will hardly protect against impending shortfalls.

Cambridge University, its colleges, press and assessment centre employ 11 700 people, support 77 000 jobs and have a direct expenditure of nearly £1 billion. Outward transfer and exploitation of research ('technology-push') has occurred in the Greater Cambridge Technopole (Silicon Fen), which consists of 900 innovation-based companies; 250 of which have been started on knowledge transfer from the university and survive today. The substantial venture capital scene has facilitated a steady growth in the flow of knowledge into industry not only locally, but also nationally and internationally (152 invention disclosures,

58 patents filed, 61 licences granted, 28 new start-up companies, 82 consultancy contracts and four spin-out companies created annually). If the university did not exist, the realistic economic impact of the loss on the U.K. over the next 10 years has been estimated at a NPV (net present value) of £53.1 billion in GDP and 143 000 jobs [11,18].

Evidence from the U.K. suggests that high-technology clusters of R&D-based and venture-backed companies grow out of the research excellence of the local university and around large research universities, regardless of the size of the city in which the university exists. A cluster also grows out of universities with a high score in the Research Assessment Exercise; they have a disproportionately larger effect on cluster formation than those with a lower score [13].

A different example emerges from the city of Enschede in the region of Twente, The Netherlands, where ‘technology-pull’ has been the dominant factor [19]. Although there was a serious decline in its long-standing history of textile manufacturing during the second half of the last century, its science-based Technical University created in 1964 now has a population of approx. 8000 students and academics. University starter schemes encouraged the formation of spin-out companies and the emphasis has been on a mix of engineering projects that include environmental, chemical and medical engineering. This activity has created a new entrepreneurial climate replacing classical academic attitudes, with the significant impact of R&D companies on the local economy boosted by government incentives for the establishment of start-up companies.

### **Opportunities**

The concept of excellence is not only about surpassing others in terms of originality and creativity, but also fundamental to the type of innovation that translates discovery and invention into application. Pavitt [20] has argued that high-quality academic papers arising from publicly funded work in prestigious universities and institutions have been the major source of patents in the U.S.A. in recent years. Businesses also gave great attention not only to immediately useful knowledge, but also to the benefits of trained researchers familiar with the latest research techniques and results, background expertise and membership of leading-edge international networks. For these and many other reasons, Pavitt [21] has argued that there are strong reasons for supporting policies at the heart of governance in Europe to ensure high-quality academic research that is mainly publicly funded and frequently interdisciplinary in nature.

The U.K. is a country with 1% of the world’s population, produces 8.5% of the world’s papers, receives 11% of the world’s citations of scientific papers, and has steadily claimed approx. 10% of all internationally recognized scientific prizes and awards throughout the last century. It occupies a leading position if the data were scaled for population size. Yet it has rarely admitted science to the centre of its policies. During a brief period in the 1960s, Harold Wilson’s Labour government experimented with the white heat of technology as a charter for modernizing Britain. Tony Blair, when he was Prime Minister, stated that “science is vital to our country’s continued future prosperity” [22] and Lord Sainsbury, then Science Minister and now Chair of the Review of Science and Innovation in the U.K. averred that “science and scientific research should be at the heart of government

policy-making” [12]. More recently, Sainsbury [13] stated “the challenge is not to hide behind trade barriers or engage in a ‘race to the bottom’, but to invest in the future in areas such as knowledge generation, innovation, education, retraining and technological infrastructure”.

Here, if we needed it, is further evidence that the relationship between higher education, scientific research and social change is an important one, given the considerable sums of public (government) money spent on research. Moreover, competition for the creation of new knowledge has increased globally [23], as revealed by recent figures showing that China has overtaken Japan and the U.K. to become the world’s second largest producer of scientific research papers in 2006, second only to the U.S.A. [24].

### **Weaknesses**

In the U.K., all centres of excellence have been in the vanguard of profound changes in respect of institutional cohesion, employment structures, resources and their management, research priorities and their evaluation, the evolution of global networks, and the emphasis on university–industry collaboration [25]. Tenure has virtually disappeared, career paths and career choices have diversified, while small research groups have learned to flourish through networking. Activities have shifted towards research projects so that many of today’s research workers can boast a portfolio of short-term projects that provide a mix of basic science, and others that are funded directly by users and stakeholders who demand quick returns to specific questions of an applied nature [9].

However, during this period of turmoil, the credibility of scientists has been put at risk. The association between academia and industry has been heavily criticized in the case of genetically modified crops, where the validity of publicized claims has been questioned. Over the last 12 months, more than 3000 news stories were critically analysed and posted on the website of GM Watch, indicative of the intensity of scrutiny by one of several activist groups. Furthermore, analysis of the responses from 1100 people questioned in the U.K. by the opinion pollsters MORI about who they trusted showed that doctors registered 92% of votes, professors 80%, clergymen and priests 75%, scientists 72%, police 61%, ordinary people 56%, business leaders 31%, politicians 20% and journalists 19%.

### **Threats**

There is an interesting codicil. Not only do you need demonstrably good scientists to create new knowledge, but you also need demonstrably impartial scientists. Historically, these came from academia and independent people, such as those with private incomes who owed no allegiance to anyone. The supply of overtly independent bench scientists is threatened by policies energetically pursued in many countries to drive academia and industry together.

This is not a minor matter. Academic biologists and corporate researchers have often become indistinguishable, with special awards being given by governments for collaborations between the two sectors for behaviour that used to be cited as a conflict of interest. Efforts are now made either to avoid or to document potential conflicts of interest so that the nature of the advice is transparent and not called into question [26].

## Conclusions

Universities have undergone a remarkable evolution, particularly since the onset of the modern scientific revolution. They are now seen not only as creators of knowledge and sources of learning and education, but also as drivers of innovation. They are international by nature, and the scale of their activities, aspirations and investments are increasing rather than declining in terms of public good as exemplified by work on the human genome, climate change, infectious diseases, particle colliders, large data sets and many other fields. National networks and facilities have been crucial to this process, and the development of the international reach has been unprecedented [24]. This trend seems set to continue in relation to things that we value such as wealth, health, food, environment and security [13].

‘Curiosity-driven’ research needs to be protected because it is the lifeblood of new initiatives and business opportunities, and it fosters a rich source of the skills required to translate new knowledge into practice. It provides an enhanced ability to solve complex technological problems, and it can be used as an ‘entry ticket’ into the world’s stock of knowledge because it provides the ability to participate effectively in networks and to absorb and exploit the resulting knowledge and skills [20,26]. Basic research also improves our ability to reach informed decisions and to formulate policies [27] and should not be compromised by the temptations of commercialization. It should be rigorously evaluated because this will show where investments for the future should be focused. Outputs are not easily measured, as the U.K.’s Research Assessment Exercise has demonstrated, but the aim should be to enhance ‘curiosity-driven’ research as a public good [13].

The greatest challenge is how to balance the pursuit of creative science and the ever-growing demands of economic benefit [13,28,29] because without it lies opportunism and exploitation of knowledge, rather than the discovery of its conceptual utility and trustworthiness for the greatest good as distinct from its instrumental use. As Pope John Paul II has argued, “the pre-eminence of the profit motive in conducting scientific research ultimately means that science is deprived of its epistemological character, according to which its primary goal is discovery of the truth. The risk is that when research takes a utilitarian turn, its speculative dimension, which is the inner dynamic of man’s intellectual journey, will be diminished or stifled” [30].

*I am greatly indebted to many colleagues for stimulating discussions and insights and in particular to Dr Peter Collins and Dr Keith Root at The Royal Society and Dr Richard Jennings of the Research Services Division, University of Cambridge. Part of this chapter consists of an update of an earlier version [26].*

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