Seducing the Goose: Patenting by UK Universities

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Abstract

Universities are patenting more than ever before, much more. Why? If it is to make money, they are not doing at all well. Perhaps they seek to demonstrate their relevance to the needs of industry. Yet, there is evidence that the university's determination to patent may actually impede technology transfer to industry and poison relations. And there is a general danger that patenting will divert resources from the traditional activities of the university, benefiting the commercial at the expense of the intellectual. University managers seem blind to these possibilities. This paper examines their approach to patenting and suggests that their understanding of the patent system has been drawn from the technology with which they are most familiar, that of the pharmaceutical industry. An industry that is more dependent than any other on patents and that expends vast resources exploiting the system has become the exemplar for those who dabble in a system of which they know little.

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University patenting

Universities have taken to patenting as never before. In 1965, university patenting in the United States amounted to just 96 patents from 28 universities: by 1992, over 150 universities were patenting, producing more than 1500 patents that year (Henderson, Jaffe and Trajtenberg, 1998). By 1999, the annual university patent tally had grown to 3661. Perhaps more important, the number of licences US universities granted grew twelve-fold between 1991 and 2004, and their annual licensing revenue rose from just $1 million in 1980 to $259 million in 1991 (Argyris and Liebeskind, 1998) and then $862 million in 1999 (Siegel *et al.*, 2004). Table 1 gives some idea of the current situation in the UK, this paper's primary area of interest.

Table 1 . Patenting Activity in UK Universities, 2003-4

	UK	+ overseas
Disclosures	3209	
Patent applications	884	424
Patents granted	183	280
Total active patents	3216	2491

Source: HEFCE, 2006, Table 4

Because there is now so much university patenting, it is easy to assume that patenting is a normal activity for universities, as unexceptional as teaching. In fact, prolific university patenting is an aberration. After all, restricting the use of information through monopoly control is odd behaviour for a seat of learning. For this very reason, some of the most renowned institutions abjured patenting until quite recently (Sampat, 2006). Harvard did not file for medical patents until 1975, nor did Columbia (Mowery and Ziedonis, 2000). Johns Hopkins was hostile to patenting until about this time (Feldman and Desrochers, 2003, 2004), and Stanford, now reaping more than any other university from patent licences, once considered patents an obstacle to academic endeavour (Kenney and Goe, 2004). In the UK, Cambridge did not patent until 2006 (*Financial Times*, 2005).

Does it matter that the university sector is patenting more? Everyone is patenting more. Anyway, there are more universities than there used to be, and more expectations made of them. And universities have changed; they are now businesses within an international education industry, part of the global knowledge economy. Do they patent because that is what commercial organisations do? This paper considers the influence of the pharmaceutical industry on the patenting behaviour of UK universities. But first the behaviour itself must be explored.

Growth in patenting

The rapid growth in university patenting is usually seen from the perspective of changes in higher education. These have been many and profound, bringing pressures that push universities towards patenting. But the world beyond higher education, including the world of patents, has also changed. In the United States, the Bayh-Dole Act of 1980 transferred ownership of patents arising from federally-funded research from the government to individual universities, giving blanket permission to universities to collect royalties from licensees (Trajtenberg, Henderson and Jaffe, 1997). In the UK, there is a vague corollary to Bayh-Dole in the monopoly that the British Technology Group held on all university patents. This was ended in 1985 in order to free UK universities from the rapacious propensity to patent of the British Technology Group, allowing them to find more effective means of technology transfer than the patent (Advisory Council for Applied Research and Development, 1983). How times change – and arguments too. The increased patenting of US universities is almost always explained in terms of the opportunities offered by the Bayh-Dole Act (e.g., ProTon, 2007b). Only a brave few challenge the simplicity of this explanation (e.g., Mowery and Ziedonis, 2000; Mowery *et al.*, 2001). Colyvas *et al.* (2002), for example, argue that the expansion of patent scope together with university activity in areas of new interest to industry (particularly biotechnology and software) may be more important.

To be sure, 1980 was also the year in which the US Supreme Court determined in the Diamond v. Chakrabarty case that living organisms produced by human intervention

could be patented (Washburn, 2005). Six months later, the Cohen-Boyer patent enabled Stanford University to demand a licence from any company working on recombitant DNA (Hughes, 2001). University managers took note that an instrument once applied chiefly to mechanical invention was becoming applicable, at least in the United States, to almost anything. Business methods, for example, became patentable in the US, though not in Europe (Meyer and Tang, 2007), and by 1988 Harvard University had patented a mouse (Slaughter and Leslie, 1997).

1980 also had an impact on patent scale. It was the inaugural year of the Court of Appeals for the Federal Circuit (CAFC), a specialist patent court in the United States that proved receptive to maintaining the interests of patentees. Patents bestow property rights to information, but property rights are of little value if they cannot be defended. In making patents easier to defend, the CAFC made them more valuable and thus increased the attraction of patenting. Those with vested interests in the patent system protected their interests with new vigour. Those with a grasp of the intricacies of IPR achieved greater returns from their lobbying to shape the system to their own advantage. Gerald Mossinghoff, Commissioner of the US Patents and Trademarks Office in 1984, was President of the Pharmaceutical Manufacturers Association by 1985 (Sell, 2003). And 1980 was the year of President Reagan's inauguration, heralding an era of policy favourable towards the most powerful lobbyists, led by the big pharmaceutical companies (Angell, 2004b). In the UK, Margaret Thatcher had just begun to implement a programme that would transform many public goods, such as university research, into private goods.

The US government proved particularly receptive to this lobbying in the early 1980s. Concern about diminishing national competitiveness encouraged desperate resort to high technology. The prevailing philosophy was that the smokestack and the rustbelt were the detritus of yesterday's industry: the modern economy would be built on information, not manufacturing. In information, the US could be competitive. Commercial strength was reckoned every bit as important to national security as military strength, and both depended on the same technological information. To prevent the loss of this information

to competitors, export controls on information were introduced from the early 1980s (Macdonald, 1990). The rationale of patenting complemented the export control ideology perfectly: for both, information was valuable only if others could be prevented from using it. To lose control of information was to lose the value of information. So embedded in US strategy did patents become that, when the General Agreement on Tariffs and Trade (GATT) met in 1986 for the Uruguay Round, pressure was mounting to supplement the international patent administration of the quaint, esoteric and generally benign World Intellectual Property Organisation (WIPO) with the enforcement mechanisms of the powerful World Trade Organisation (WTO) (Drahos and Braithwaite, 2002). Predictably, the Pharmaceutical Manufacturers Association was among the first to apply this pressure (Sell, 2003), arguing that private industry should be allowed to bring complaints against foreign governments for violating trade agreements (Liu, 1994). The way was clear for the gradual introduction by 2006 of a harmonised - though uniformity is still a way off - international IPR system, with compliance the responsibility of national governments and deviance punished by trade sanctions under the Trade-related Aspects of Intellectual Property Rights agreement (TRIPS). Patenting had entered the major league.

It is not irrelevant to the issue of university patenting that the pharmaceutical industry played a major role in formulating the TRIPS model of universal compliance and enforcement within the WTO (Sell, 1995). It was also the patent lobby - not US universities at all - that engineered the Bayh-Dole Act (Washburn, 2005), and much of the argument for the Act drew on the experience of the pharmaceutical industry (Nelson, 2004). It is customary to see universities as the primary beneficiaries of Bayh-Dole; this may be naive. The association of patents with universities as well as with industry has been invaluable to the heaviest users of, and greatest beneficiaries from, the patent system (Angell, 2004b). The chief of these is the pharmaceutical industry.

The missing debate

While there is considerable debate in the United States about the advantages and disadvantages of university patenting, there is little consideration in the UK of anything but the benefits.

> "These 'benefits' are presented without any supporting statistical evidence and can only be regarded as a mixture of suppositions and expectations… It is remarkable that in most cases these putative advantages have been enumerated in an unqualified manner, with no spelling out of the possible costs or risks involved. To say the least, this conveys a rather one-sidedly favourable picture …" (Geuna and Nesta, 2006, p.795)

This is the more curious in that university patenting in the UK, and in Europe generally, tends to be measured against that in the US (e.g., Wallmark, 1997; European Commission, 2007). In this tradition, Table 2 compares the patenting of European universities with which members of the Association of European Science and Technology Professionals (ASTP) are associated with that of US universities with which members of the Association of University Technology Managers (AUTM) are linked. One interpretation of these figures is that European universities cling to a traditional start-up/spin-out route to commercialisation and are not as far down the patenting route as the Americans. A common conclusion is that because UK universities do not patent as much as US universities, they do not patent enough. Such comparative calculations, like many involving patents, may underestimate the complexity of the data they handle. For example, what might otherwise be university patents are often taken out by firms in Europe and so do not enter the tallies for European universities (Crespi, Geuna and Verspagen, 2007).

Table 2. University Patenting Activity per $1 Million Research Expenditure, 2004

	ASTP (Europe)	AUTM (United States)
invention disclosures	0.333	0.404
patent applications	0.095	0.255
patents granted	0.038	0.088
start-up firms established	0.028	0.011

Source: from Arundel and Bordoy, 2006, p.26

What, then, might stimulate debate about university patenting in the UK? Perhaps the argument that universities should really have better things to do. They should be contributing to the sum of human knowledge, not trying to make money. Lofty ideal has been replaced by lowly ambition. This was certainly a concern in the US in the early

1980s, when university research in biotechnology seemed to have outpaced that in industry. According to the President of Harvard, who hoped that industry would soon catch up,

> " … programs to exploit technological development are likely to confuse the university's central commitment to the pursuit of knowledge and learning by introducing into the very heart of academic enterprise a new and powerful motive – the search for utility and commercial gain." (Derek Bok quoted in Culliton, 1982, pp.961-2)

Years ago, when Stanford was rather less keen on patenting than it is now, its President feared that involvement in commercial activity would pull academics in too many directions, and that Stanford would lose out:

> "A large number of our faculty members, perhaps 2 dozen or more (at least), have recently concluded or are now contemplating individual arrangements with mostly young, new biotechnology firms ….We are not losing whole people. What we are concerned about is what the ultimate landscape will look like in terms of the loss of parts of people." (Donald Kennedy and quoted in Kenney, 1986, p.100).

Extraordinary though it seems now, the biotechnology goldrush of the 1980s produced a consensus among first-rank US universities that direct involvement in the biotechnology industry was more suited to universities of the second or third rank (Kenney, 1986).

Argyris and Liebeskind (1998) perceive an implicit contract between the university and society: the university is to make its research publicly available in exchange for funding. By patenting, they say, the university has broken this contract. Of course, it could be argued that society has not kept its side of the bargain for some time, forcing universities to seek funding elsewhere (Hughes, 2001). So, if universities also renege by restricting and selling information that should be given away (Brown, 2000), who is to blame them? Thomas Jefferson may have worried about the "embarrassment of an exclusive patent" (Washburn, 2005, pp.62-3), but not the modern university manager:

> "If universities want to encourage and stimulate more relationships to facilitate technology transfer with industry, then universities must be willing to tailor IP agreements in order to better meet industry's needs. Some of the more creative university research centers have attracted larger numbers of industrial firm partners by delaying the publication of research results in academic journals, allowing an industrial firm to equally share royalties, and providing first option

> exclusive licensing rights to a sponsoring industrial firm. Policies such as these have several key advantages." (Gopalakrishnan and Santoro, 2004, p.62)

Then there is the argument that the desire to patent may encourage the sort of research that yields readily-patentable information at the cost of other research, stimulating a general shift, perhaps, from basic to applied research (Florida, 1999), and even from scholarship to commercialization (Ramello, 2005). Open publication - once a fundamental purpose of the university - may be discouraged to facilitate patenting (Nelkin, 1984). If academics are to patent their inventions, it is fundamental that they have not previously published information about the invention. While not general, delays of more than six months are not uncommon in the life sciences (Blumenthal *et al.*, 1997). Nor are restrictions on what may be published (Florida, 1999). But there may be more subtle effects. University managers often seem to imagine that academics can produce patents at marginal cost. This is fanciful; the worlds of academic publishing and patenting are miles apart, and not simply because patenting precludes prior publication. Ways of thinking about research, of conducting it, of describing it, are all quite different, as are motivations and reward systems. Basically, the academic publishes to impress a peer group with his thinking: he patents to control the information he has created (Packer and Webster, 1996). Academic publishing makes information public property: patenting makes it private. The academics interviewed by Packer and Webster (1996) were very clear that patenting and academic publication are not at all the same thing.

> " … I had to be an inventor on this because I suggested they do it, but it is so obvious from the literature and it is so derivative that I am absolutely surprised it issued." (p.436)

> "Just because it's been printed and granted by the U.S. patent office doesn't mean to say that it contains anything that is scientifically sensible." (p.442)

> "You had to take it as a joke really, you had to say this will do this … and write it in the present tense, and just be over the top in the way you would never be in a publication." (p.442)

The demands of the patent system may alter how academics write and how they cite (Kenney, 1986). They may even determine what the academic says, and to whom. When even chatting on a bus can amount to disclosure (Williams, 1994), it is hardly surprising

that commercialisation makes academics less collegial and more secretive (Poyago-Theotoky, Beath and Siegel, 2002; Campbell *et al.*, 2002).

> "… if an academic were to discover or synthesise a new compound, publishing a paper saying that the compound might, even only conceivably, have biological uses, this can be sufficient to prevent others from patenting related compounds. Hence it can be very important that academics understand the highly important implications of a throwaway line." (Sheen, 1996, p.135)

Ironically, relations with industry also suffer:

> "In many ways university research departments are our competitors. … I talked to some guys yesterday who wanted to do a project on 'X' and I tried to say to them 'it would be interesting to look at the following area where there are some academic problems. It is of interest to me but I cannot do it, but it may be interesting to you because it is academic'. And they say, no we cannot because it is a Research Council driven project and it has to have a market and input substitutions, etc." (cited in Rappert, Webster and Charles, 1999, p.881)

While the UK government is convinced that university research should relate to the needs of industry, it is less certain just what these needs are. When the market is a philosophy rather than a practical reality, it is tempting to ignore the role of competition in facilitating innovation (Hamel, Doz and Prahalad, 1989). Firms may compete through innovation, but they are also dependent on each other for much of the information that makes their innovation possible. A good deal of this information is procured through exchange in the personal networks of key employees. The academics is likely to be a member of these same networks (Macdonald, 1992), accustomed to such exchange mechanisms, the invisible college being a classic example of an informal information network. The modern university manager is not. Nor is he likely to be particularly knowledgeable about the patent system. The patent is regard simply as a neat device to make clear that the results of academic research belong to the university, to confirm the value of this research, allow its transfer to industry, and make the university a profit in the process. Nowhere is this conviction more enthusiastically held than in the university's technology transfer office.

The technology transfer office

Accompanying the growth in university patenting has been an increase in the number of technology transfer offices (TTOs), university units with the responsibility of commercialising the university's technology. The responsibility includes patenting, though TTOs, and especially smaller offices, often leave the legal niceties to external lawyers (Charles and Conway, 2001). Table 3 gives an idea of the tasks carried out by TTOs in European universities. Patenting and associated activities are found in most, and are more likely to be encountered than other commercialisation activities.

Table 3. Services Provided by European University TTOs (%)

assessing patentability of inventions	91.9
negotiating or arranging licences	87.8
managing material transfer/confidentiality agreements	87.8
applying for patents	81.1
creating/supporting start-ups	79.7
negotiating government-sponsored research contracts/grants	68.9
providing incubator facilities to companies	41.9
managing seed funds	29.7

Source: from Arundel and Bordoy, 2006, p.9

In the US, the number of university TTOs grew from 25 in the early 1980s to over 200 by the end of the century (Jenson, Thursby and Thursby, 2003). Table 4 illustrates the rush to establish TTOs, in the US after 1980 and Bayh-Dole, and in the UK after the White Paper of 1993, *Realising our Potential*, in which the Department of Trade and Industry made very clear the role it expected UK universities to play in UK innovation and hence UK competitiveness (DTI, 1993). By 2005, what the DTI had taken to calling 'UK plc' had 126 universities with TTOs (BVCA, 2005).

Table 4. Date University Technology Transfer Operations Established (% of universities with TTOs in 2005)

Date founded	UK universities (%)	US universities (%)
pre 1980	4	14

1980-89	21	37
1990-95	22	29
after 1995	53	20

Source: from Williams (2005), based on UNICO and AUTM surveys

Running a TTO is not cheap. The ASTP survey reveals that European TTOs employ 7.3 staff on average (Arundel and Bordoy, 2006). In the United States, where Bayh-Dole required all universities in receipt of federal research funds to have a technology transfer function (Sampat, 2006), half of all TTOs have more than 5 staff (Bostrom and Tieckelmann, 2007). It seems likely that most university TTOs in the United States cost more to run than they earn (Trune and Goslin, 1998; Nelson, 2001; ProTon, 2007a). This also seems to be the case in the UK (Geuna and Nesta, 2006; Charles and Conway, 2001. See also Shepherd, 2006). Even a two-man technology transfer unit with clerical support goes through something like £150,000 annually, with another £100,000 to cover the year's patenting costs (Auril/Universities UK, 2002). The Lambert Review (2003) of university links with industry calculated that R&D expenditure of some £20 million was necessary for a university to cover the costs of running its own TTO. 25% of UK universities reach this threshold: 80% of UK universities run their own TTO.

The success of the university's TTO is commonly measured in terms of revenue from licensing, which has permitted the observation that university patenting grows in proportion to the struggle of each TTO to generate sufficient income at least to cover its expenses (Kenney, 1986). One sign of this pressure is perhaps apparent in Table 5: patent applications from US universities have been growing steadily as a proportion of inventions disclosed.

Table 5. Patent Filings by US Universities as % of Invention Disclosures

	Approximate number of invention disclosures	Patent applications as % of disclosures
1991	6200	26

1992	7100	27
1993	8300	29
1994	8400	28
1995	9500	30
1996	9800	32
1997	10900	38
1998	11400	42
1999	11800	46
2000	12600	51
2001	12800	51
2002	14600	51
2003	15700	51
2004	16900	62
2005	17500	59

Source: from Bostrom and Tieckelmann, 2007

In the UK, university IP revenue has fallen steadily this century, as steadily as the costs of selling university IP have risen (HEFCE, 2006). It may be mistaken to think of the Bayh-Dole Act having been directly responsible for more university patents in the US. It may be more accurate to think of Bayh-Dole producing more TTOs, which then had to maintain themselves by producing more patents (Chukumba and Jensen, 2004). But surely universities must have better reasons for patenting than supporting needy TTOs.

Why do universities patent?

According to Mansfield (1990), the temporary monopoly of the patent offers three basic advantages:

- it gives the inventor an incentive to invent
- in obviating secrecy, it allows early disclosure of invention, thereby accelerating innovation, and
- it protects the inventor's investment in the research and development required for invention and innovation.

Mansfield, of course, had firms in mind, perhaps specifically the pharmaceutical firms that funded some of his research, rather than universities, and while the modern university is very much a business, it is not clear that it will reap quite the same benefits

from the patent as the firm. Even in the managed university (see Willmott, 1995), academics retain some control over research, and academics have incentives to invent that are not at all dependent on the protection offered by a patent. And while the patent might enable disclosure in the commercial world, it would seem to restrict it in the academic world. Academics would probably publish sooner and more fully without the obstacle of a patent system. As for protecting the inventor's investment in R&D, the academic's name on his publications protects his investment.

Conventional wisdom is that a gap exists between university and industry, a gap that prevents the transfer of technology from university (where it is created) to industry (where it can be used), a gap the patent can help bridge by packaging information into a form that industry can recognise, appreciate and use. And yet, individual researchers in both camps often have long acquaintance and are well aware of what the other is doing (Colyvas *et al.*, 2002). Really, it would be rather strange if they did not. What is missing from these personal, informal links and networks is the stamp of organisation. Commenting with wholehearted approval on the recent decision by Cambridge University to claim ownership of academic inventions (*Financial Times*, 2005), the Director of MIT's Technology Licensing Office declared that economic development was "a tribute to policies which aggregate and professionalise technology transfer activities" (Nelsen, 2005, p.18).

The patent institutionalises technology transfer from the university; it makes information the university's property, not to be used without the university's permission, for which the university may demand payment. As the modern university is very interested in being paid, it is loathe to regard information produced within its walls as a public good; it prefers to see information as something which everyone should pay to produce, but which is available only to those who pay more. This vision is nicely compatible with the university's need to be seen as a source of technology for industry. Since the early 1990s, a whole range of UK government programmes has paid universities to strengthen links with industry and commercialise their research. This culminated in the launch of the first Higher Education Innovation Fund in 2001. The second of these two-year schemes

dispensed £186 million to universities, the third £238 million (HEFCE, 2007; Minshall and Wicksteed, 2005). Universities have had to bid for these funds, and patents can be used to demonstrate a corporate ability to transfer technology in order to be funded to transfer technology.

As government funding for UK universities has withered (at least relatively), government programmes encouraging universities to look to industrial support have sprouted (Geuna and Nesta, 2006). To be sure, universities, being education businesses, have taken to investing where profits are most promising. In the US between 1970 and 1997, industry's contribution to academic R&D rose from 2.6% to 7.1%, but the greatest increase in academic research funding actually came from universities themselves, investing their own money in centres considered likely to generate research income (Florida, 1999). The patent fits neatly within such an investment strategy, offering an approach to the commercialisation of research more enduring than the spin-out company, but less binding than the university company. The patent is flexible enough to allow universities whatever level of commercial involvement they deem appropriate.

Patents may well show the university's determination to serve industry, but they can be used to show other things too. The patent has long been valued as a performance indicator, a measure of real output from research rather than of mere input (Pavitt, 1998). It is also valued for the latitude it affords the manipulative (Meyer and Tang, 2007). Universities that could not otherwise claim to be first rank can use patents to make just that claim (Washburn, 2005). Once studies began to accept patents as a valid indicator of a university's technological output (e.g., Shane, 2001), the precedent was set for other studies (e.g., Powers and McDougall, 2005). The Lambert Review (2003, p.48) regarded UK university patenting in the US as "a reliable indication of world-class innovation output", and despaired that no UK university was among the top 25 UK organisations patenting in the US. Thursby and Kemp (2002) find that some universities are quite content to regard patents themselves as the output of research. To be sure, licensing by US universities has not kept pace with patenting, which has been interpreted as US universities tapping into weaker technology (Thursby and Thursby, 2002). Perhaps, but it

could also be that universities are finding increasing value in patents themselves and do not require their patents to make any contribution to innovation.

Skew

By far the dominant characteristic of university patenting is just how skewed is almost every aspect of the activity (Blake, 1993). Understandably, some universities take out many more patents than others, but just 20 institutions accounted for about 70% of US university patenting in 1991. MIT alone was responsible for 8% (Henderson, Jaffe and Trajtenberg, 1998). In Europe, 31% of university patent applications are made by just 3% of European universities (ProTon, 2007b), and over a third of universities have never patented anything at all.

And some universities license much more than others, though a licence need not be based on a patent. Arundel and Bordoy (2006) find that 40% of the licence income of the European public sector research organisations they surveyed comes from non-patented inventions. Just two institutions are responsible for half the licences issued by UK universities (HEFCE, 2006). The Open University would seem to be one of these; it has issued far more licences than any other UK university and has no patents at all (HEFCE, 2006). Just five universities are responsible for about a third of non-software licences granted by universities in the UK, and for about half of such licences issued overseas (Charles and Conway, 2001). Income from licensing is also highly skewed. TTOs responding to the AUTM survey in 2004 boasted an average income of $7 million, but 75% of universities earned less than $5 million, and 40% less than $1 million (reported in ProTon, 2007a). There is nothing new in this: the National Research Development Corporation, predecessor to the British Technology Group in patenting on behalf of universities, commonly derived most of its income from just one or two inventions, usually in medicine or biology (Grossfield, 1962).

Of course, patenting is hardly evenly distributed in the rest of the economy. Patenting is a practice of large organisations and the developed world, not of small firms and the developing world. It is particularly prevalent in the pharmaceutical industry (Nolan,

Oppenheim and Withers, 1980) and about 10% of all US patents are in the drugs/medical field (Henderson, Jaffe and Trajtenberg, 1998). But university patenting is even more skewed; about 35% of US university patenting (up from 15% in 1965) is in drugs/medical technologies, with a further 25% to 30% in chemicals. So, although the university sector is a minor player in patenting generally, taking out only 1.2% of US patents in 1990 (Trajtenberg, Henderson and Jaffe, 1997), it is very much more prominent in some areas (Rothaermel and Thursby, 2005), as Table 6 indicates. By 2006, US universities were responsible for 5% of all US patents (Clements, Holloway, Koh and Mutsuddi, 2006), but their influence was still marginal in all fields except health, where their share was 15% (Hicks *et al.*, 2001).

Table 6. Main Areas of US University Patenting, 1990

Class title	University patents	Total patents	University share (%)
Genetic engineering, recombinant DNA	58	321	18.1
Chemicals: natural resins; peptides or proteins	91	583	15.6
Chemistry: molecular biology and microbiology	171	1417	12.1
Surgery	12	105	11.4
Organic compounds	66	615	10.7
Superconductor technology	25	233	10.7
Drug, bio-affecting and body treating compounds	147	1490	9.9
Chemicals: analytical and immunological testing	67	688	9.7
Prosthesis (artificial body parts)	25	399	6.3

Source: from Rosenberg and Nelson (1994), Table 6.

The skew in university patenting has not gone unnoticed; in a world of performance indicators, it has been seized upon to highlight which universities are performing well, and which are not, which should be emulated and which castigated (DeVol and Bedroussian, 2006).

> "The survey shows that whilst some UK universities are not engaged in the commercialization of intellectual property in any substantial way, others are international benchmarks of excellence …" (UNICO press release, 2005)

> "In respect of patent quality, Wales clearly lags Scotland and there are signs that it is falling behind N. Ireland." (Beale, Blackaby and Mainwaring, nd, p.1)

Rather than looking to university characteristics to explain the skew, let us exploit the skew to help explain the patenting behaviour of universities. Some findings are predictable: most patenting is by the biggest, research-oriented universities in the developed world, just as most patenting in general is by the biggest, research-oriented firms in the developed world. In other cases, the skew is a little puzzling. For instance, universities that are most efficient in their patenting are those with the lowest research quality (Thursby and Kemp, 2002). And academics with the most extensive industry contacts are actually less likely to be involved in patenting than less connected academics (D'Este and Perkmann, 2007). As it happens, industrial interest in academic research is not often dependent on exclusive rights to technology (Nelson, 2001; Colyvas *et al.*, 2002). And technical universities do not transfer more technology than general universities (Audretsch and Lehmann, 2005). Nor do they often transfer technology to local firms (Roberts and Peters, 1981). Harvard does not contribute much to the technology of neighbouring firms, nor do Columbia, CalTech, Chicago and Berkeley (Rogers, 1986). And while pharmaceutical companies are interested in a location near the best university research, they are the exception (Jaffe, 1989); firms with interests in most other technologies tend to prefer location alongside weak university research (Abramovsky, Harrison and Simpson, 2007). All of this defies the technology transfer model traditionally attached to university research. Yet, the model not only survives; it prospers, bolstered by the role claimed for the patent.

The patent finds its place

Studies of technology transfer from universities have long focused on 'spin-out' companies; they hardly mention patents (e.g., Rothwell and Robertson, 1973; McQueen and Wallmark, 1982; Samsom and Gurdon, 1993; Rogers, 1986; Chappel *et al.*, 2005). Their model is of a university overflowing with valuable information that saturates the closest firms. This paradigm extended readily to the science/technology park, physical evidence of the diffusion of university information (Siegel, Westhead and Wright, 2003), but not to patenting. A contagion model explained nicely the spread of university information to local concentrations of high technology, and justified as nicely further

investment in the university (Miller and Cộté, 1985). While easy notions of the easy flow of information from the university were compatible with policy for regional development (Feldman and Desrochers, 2003), they sat less comfortably with the political doctrine that such aims were best accomplished through market mechanisms. Out went notions of spinning out: in came notions of selling information in a market (Lockett and Wright, 2005; Lambert, 2003).

So, while firms still think of technology transfer as a protracted, informal and often personal process, universities have come to see it as a transaction for which cash is received (Siegel *et al.*, 2004). Patenting fits this perception nicely. Universities much prefer up-front payment and regular royalties to less certain rewards, especially rewards dependent on equity holdings (Thursby, Jensen and Thursby, 2001). They are comfortable with a model in which they have done their bit and should be paid for what they have done. It matters not that the model is quite unrealistic (Rosenberg and Nelson, 1994).

The new-found enthusiasm of universities for patents is not shared by industry generally. Just as technology is transferred in other ways, technology is protected in other ways. Most firms look to trade secrets, marketing strategy and lead times to exploit technological advantage before they look to patents (Brouwer and Kleinknecht, 1999). Indeed, in the real world, technology is often much easier to protect than the patent taken out to protect it. In only a very few industries, most obviously the pharmaceutical, is patenting central to innovation (Levin, 1986; Harabi, 1995). The pharmaceutical industry is pre-eminent in its funding of university research, and the modern university manager has much exposure to its ways and its views of the world. But the industry's research is a peculiar sort, involving much testing of molecule combinations, followed by extensive clinical trials. It is the outstanding example of the classic linear model of R&D, the model beloved by managers everywhere for the control it permits over research, and found almost nowhere except in the pharmaceutical industry (*cf.* Hara, 2003). While only 19% of UK patent applications are granted, pharmaceutical applications progress regularly and routinely to an almost inevitable patent – 98% of applications are granted (Nolan,

Oppenheim and Withers, 1980). Research in the pharmaceutical industry is further controlled by regulation and legislation. It is routine rather than creative, the industry's strategy being to play the odds, on the grounds that one or two blockbuster drugs will make more than enough profit to cover the costs of all the others (Kingston, 2000). Blockbusters have been elusive of late and the industry has become increasingly desperate, seeking inspiration from skunkwork (Augsdorfer, 1996), from small biotechnology firms, and from academics (Angell, 2004b). The pharmaceutical industry's funding of university research is now huge - nearly 40% comes from the medical and biosciences industries (Holi, *et al.*, 2007) - as is the influence over university behaviour that such largess brings. Indeed, the modern university manager may see nothing untoward in the sort of arrangement universities sometimes have with pharmaceutical companies whereby academics put their names to papers the company writes on their behalf (Angell and Relman, 2002), or use results supplied by pharmaceutical companies that refuse to allow data to be checked (Baty, 2007). Not surprisingly, the resulting publications tend to be positive, and positive publications are positively associated with university patenting (Brown, 2000, Washburn, 2005).

Universities, then, are in the odd position of being marginal patentees that have adopted the model of the heaviest user of the patent system (see Arundel and Kabla, 1998). Not surprisingly, this model leads university managers to overvalue university patents (Rappert, Webster and Charles, 1999). The pharmaceutical industry lives and dies by the patent system; it is infrastructural to absolutely everything the industry does. University managers have come to share this reverence for a device that allows them to lay organisational claim to the information of individual academics (Sullivan and Edvisson, 1996) so that the university may make money from this information, either directly through licensing, or indirectly through the patent's use as an indicator of research endeavour and desire to transfer technology. In awe of patents, university managers can overlook the stark reality that in most technologies and for most firms patents are of little value. Very few universities make much money from their patents (Nelson, 1998, Charles and Conway, 2001; Bulut and Moschini, 2006). For half of UK universities, even the direct costs of IPR exceed the revenues gained from IPR (Charles and Conway, 2001).

Nothing daunted, university managers, much like their counterparts in the pharmaceutical industry, look to the blockbuster patent that will earn a fortune (Bosworth and Mahdian, 1999). They present the rare success as typical (see Howard, 2003), forgetting that the Lycos that made Carnegie Mellon $25 million (Florida, 1999) or the Google that made Stanford $190 million can as easily be the Seragen that lost Boston University almost $150 million (Washburn, 2005).

University patent strategy

University managers might ape the style of pharmaceutical industry patent strategy, but its substance is quite beyond them. Universities are really very restricted in what they can do with their patents: they cannot work them, and they lack the resources to use patents strategically. University managers are naïve users of the patent system, unaware that reaping its benefits requires working that system. TTOs rarely engage in patent citation analysis or patent mapping to reveal technological trajectories or the patent strategies of others. There is no interest in defensive patenting or in amassing patent portfolios to cover specific areas of technology. Universities may be international education businesses, but TRIPS is a mystery to the university manager, happily oblivious of the need to support patents with other forms of IPR. Logic suggests that universities should be patent trolls, lurking and then leaping on the unwary infringer (Johnson *et al.*, 2007). This may not be a role in which universities should be comfortable, but university managers should worry that others may be less squeamish. To be unaware is to tempt trouble. The history of extensive university patenting may be short, but it is littered with examples of the inability of universities to master the finer points (Kenney, 1986). The University of Utah, for example, spent between $1 million and $2 million defending a notorious cold-fusion patent that no one wanted to license and that badly damaged the university's research reputation (Nadis, 1998). Or again, it is decidedly unwise these days for academics to look to colleagues elsewhere to supply biological material for research if the university may want to patent the end result. Formal agreements, approved by the TTO, are required, and license fees must be paid (Kimpel, 1999).

Patenting is no longer an area for faint hearts. Before the goldrush of the 1980s, universities might have been well advised either to put real resources into patenting effectively, or to opt out of patenting. Opting out may no longer be an option; the prolific patenting of others has made the university's inadvertent infringement more likely than ever. In genetic testing, for example, navigation around patents has become so hazardous that some tests are simply not carried out (Cho *et al.*, 2003). And while patent licensing has not kept pace with the increase in patenting in the US, patent litigation certainly has (Cook, 2007), as has the number of patent attorneys (Barton, 2000). The prolific patenting of universities has made them a target – an easy target – for those who would challenge the validity of patents. The usual strategic response of veteran patentees to what is a common ploy is to pay the challenger off, or to cross license, for which a stock of patents is required. TTOs are not culturally attuned to checking whether the university's patents and research activities infringe the IPR of others (BVCA, 2005), and much less to retaining strategic patent stocks. Their thinking and experience go little further than patenting whatever likely discoveries happen to come along, and getting licence income from the result (DeVol and Bedroussian, 2006). One wonders how a university TTO would have handled the human genome project, where the challenge for the UK research team was not to patent, but rather to prevent American companies patenting the entire human DNA sequence (Sulston and Ferry, 2002).

> "… the best way to prevent the sequence being carved up by private interests was to put it into the public domain so that, in patent office jargon, as much as possible became 'prior art' and therefore unpatentable by others. (Sulston and Ferry, 2002, p.269).

Presumably the TTO would have limbered up for a patent race, or entered into cosy collaboration with the American companies, and thereby rendered the world a much poorer place.

Once US patent statistics became available online, they were soon enough processed for input to business strategy (Griliches, 1990). Patent citation analysis is now commonplace, though not in universities. One wonders how many university managers know, or care, that patent citation analysis is employed to judge the quality of university patents.

Ironically, it can be used to show that all patents, not just university patents, are dependent on academic publication: 73% of papers cited in US patents are published by academics rather than by industrial scientists (Narin, Hamilton and Olivastro, 1997). If universities are determined to patent, their managers really should be aware, for example, that US patents cite academic literature much more than UK patents (Meyer, 2000), that university patents are more likely to be cited than other patents (Feldman, 1999; Jaffe, Trajtenberg and Henderson, 1993), and cite more academic papers than other patents (Hicks *et al.*, 2001). Is this because academic papers have a general relevance, or because academics are inclined to cite academic papers whenever possible, or perhaps because university patenting is concentrated in fields – pharmaceuticals in particular - that traditionally cite scientific papers rather than other patents (see Table 8) (Noyons, van Raan, Grupp and Schmoch, 1994)? It is unlikely that such issues disturb the sleep of many university managers. Analysis of citations to US university patents produces the conclusion that the quality of university patents has declined in the rush to patent of inexperienced universities post Bayh-Dole (Hicks *et al.*, 2001). Whether there really has been an overall decline in the quality of university patents (see Sampat, Mowery and Ziedonis, 2003) is not actually the point. The point is that this is not an indicator universities can afford to ignore.

Table 8. Citations in US Patents, 1994

	Number of patents	Average citations per patent	% citations to journals
Chemicals (excluding drugs)	10592	13.5	29.1
Drugs	2568	16.9	20.6
Instruments	14950	13.5	16.3
Electronic equipment	16108	10.1	12.2
Electrical equipment	6631	11.2	4.4
Office and computing	5501	11.7	4.3
Non-electrical machinery	15001	12.9	3.3
Rubber and miscellaneous plastic	4344	13.4	1.9

Source: from Pavitt, 1998, p.109

Nor do universities seem able to deal with the wider implications of their patenting. University managers have no time for the argument that academic freedom might suffer, and is even more likely to suffer if universities ever do become competent in their patenting (Argyres and Henderson, 2000). The managerialist approach to technology transfer prevailing in universities does not seem to consider that the academic might not always share the manager's enthusiasm for patenting (Henkel, 1997). University managers seem to think of the academic's incentive to patent in terms of the proportion of royalties to which he will be entitled (e.g., Lack and Schankerman, 2003). Wider benefits are likely to be more influential (Colyvas *et al.*, 2002). Were academics driven primarily by commercial considerations, they would probably not be academics, and those who have spent part of their careers in industry are much more likely to patent than those who have not (Dietz and Bozeman, 2005). Much of the responsibility for patenting that is accepted by the technology manager in the firm, must be shouldered by the academic in the university. The university TTO lacks the resources to identify patentable technology and leaves this to individual academics (Packer and Webster, 1996). Whether they have sufficient skill and incentive for this task is rarely questioned. Moreover, the interests of university managers and academics are not identical: university managers view links with industry in terms of the commercialisation of university technology, but academics have other objectives, most usually associated with the furtherance of their research (Jensen, Thursby and Thursby, 2003; D'Este and Perkmann, 2007).

It does not seem to occur to university managers that academics might not volunteer to disclose their inventions in readiness for patenting (see Thornton, 2004).

> "… we find a negative career experience effect: the longer the time that had elapsed since graduate training, the less likely the faculty member was to actively embrace the new commercialization norm." (Bercovitz and Feldman, 2004, p.19)

It is often forgotten that academics have it in their power to prevent university patenting in that they can always publish the information of their inventions (Argyris and Liebeskind, 1998). The rewards from publishing may be more attractive than the rewards

from patenting. Apparently, fewer than half of US university inventions estimated to have commercial potential are disclosed to TTOs (O'Shea, Allen, O'Gorman and Roche, 2004). And it looks like this is the worse half: there is some evidence that the best academics with the best ideas may not be the ones who approach the TTO (Jensen, Thursby and Thursby, 2003). Indeed, Jensen, Thursby and Thursby (2003) encapsulate the TTO's opinion of academic invention in their splendid title: 'The best we can do with the s**t we get to work with'. Part of the explanation may be that academics are reluctant to bear the transactions costs of dealing with the university TTO (Owen-Smith and Powell, 2001). Industry is certainly reluctant. Only 7% of TTO directors and university administrators see university bureaucracy and inflexibility as barriers to technology transfer in the US, compared with 70% of academics and 80% of businessmen (Siegel *et al.*, 2004). Evidently, the technology transfer gap is not between universities and industry, but – once again – between university managers on the one hand and industry managers and academics on the other. As one managing director put it, dealing with the new commercial university was "a bit like walking into a lawyer's office" (cited in Rappert, Webster and Charles, 1999, p.882). Academics agree:

> "It's the technology transfer office that is giving us trouble, so we are trying to go around them."
>
> industry manager (quoted in Siegel *et al.*, 2004, p.131)

> "[I would probably develop software] as a personal consulting job rather than going through the university. Although it is probably easier for me to do it through the university, and it would probably also benefit the students more effectively, it is a hassle to do it … it is such a pain in the neck."
>
> academic (quoted in Siegel *et al.*, 2004, p.131)

TTOs, it would seem, play little part in establishing the links with industry that technology transfer requires (Colyvas *et al.*, 2002). TTOs are staffed by a breed new to universities, less skilled in holding hands with the outside world than in aggressive marketing (Florida, 1999; Cockburn and Henderson, 2000; Siegel *et al.*, 2004). US firms have certainly complained that the hard-nosed attitude of university TTOs has soured their relationships with universities (Washburn, 2005; Hertzfeld, Link and Vonortas, 2006). The TTO's forceful marketing may actually discourage the transfer of technology:

> "… [a] nonexclusive licensing program, at its heart, is really a tax … [b]ut it's always nice to say 'technology transfer'."
>
> former director of Stanford's technology transfer programme (quoted in Colyvas *et al.*, 2002, p.67)

Table 9. Source of Leads for Licensing Agreements in Six US Universities

	Licensing agreements	% of total
Inventor	641	56
TTO	219	19
Licensee	119	10
Research sponsor	81	7
Unknown	80	7
Total	1140	100

Source: from Jansen and Dillon, 2000, p.152

Table 9 presents data from a sample of university licensing agreements and reveals that most arise from the contacts of academics, not the efforts of the TTO. Chappel *et al.* (2005) find TTOs to be grossly inefficient in their licensing of technology. They suggest more specialised managers might help. But, then, the higher wages of the private sector are always likely to attract the best technology managers (Kenney, 1986; Lockett and Wright, 2005; Proton, 2007b). University TTOs in the US seem to specialize in IPR, while European TTOs are also expected to look after relations with industry generally (ProTon, 2007b). Problems with the sophistication of modern patenting may be why some universities are taking on specialist companies to look after their IP. While such companies may be competent in their handling of IPR, they have even less interest than the TTO in the university's traditional functions.

> "York University has become the latest partner of private intellectual property company IP2IPO in a deal worth more than £2 million to the institution. … Spike Willcocks of IP2IPO said: 'We felt universities in this country, apart from a few growing successes, were not that strong in commercial IP. Lots of them were allowing their academics to publish rather than patenting.'" (Davis, 2003, p.8)

Concluding thoughts

In the effort to commercialise university research, it is often forgotten that the resources of universities and of academics are not infinite: if resources are spent on commercialising, they are not available for teaching and research. There is much to be gained from links with industry, but the benefits are not free of costs. In the rush to swim in the third stream, these costs can be overlooked, even when they become so great that they exceed benefits. Who would notice if teaching standards dropped a bit because industry contact increased? Who would complain if basic research were pared just a little so that resources could be diverted to research of more direct use to industry? And yet, educated employees are the university product industry values most, and without basic research the economy slows and falters (David, Mowery and Steinmueller, 1992).

One wonders who gains from the current obsession with university patenting. Just occasionally, a patent licence may bring financial return to both university and academic. The patent may show the world just how useful and street-wise the university really is. It may even mean a bonus for the TTO manager. But these are rare and small benefits beside the costs of universities abandoning their traditional role. The conclusion of one important study in this area (Henderson, Jaffe and Trajtenberg, 1998; see also Pavitt, 1998) is that universities should concentrate on their indirect economic contribution rather than attempting to reap direct returns through the commercialisation of their inventions.

> "This whole desire to make a university researcher apply for patents does not make sense. We are trained to do research. We are trained to explain what we do in our research, so that experiments can be done elsewhere, on the basis of what is written, and if possible without direct instructions. Thus the whole exercise in publication is to narrow down the range of phenomena for which the experiment holds, and to foster its duplication in any other place in the world. Instead, we are asked to write patent applications, but the exercise is absolutely opposite. University researchers must think of the whole range of possible applications so as to be able to claim for as many situations as possible. University researchers are not trained for that at all."
>
> Spanish academic (quoted in Geuna and Nesta, 2006, p.802)

Amidst the clamour to commercialise university technology may still be heard the occasional reminder that the world was not always so enthusiastic about patenting in particular (Sampat, 2006), and third-stream activities in general. The Compton rule,

imposing a 50% tax to discourage academic consulting at MIT during the 1930s, did much to maintain the university's reputation and thus to enhance demand for the consultancy services of its academics. The proceeds went to fund research leave for non-consulting academics (Beath *et al*., 2003). Similarly, Johns Hopkins, no slouch in its commercialisation efforts these days, discouraged its academics from patenting for many years lest its scholarly standing be compromised (Feldman and Desrochers, 2004). At MIT, patenting has its place, but below the salt: patents account for only 7% of technology transfer to industry from even MIT's patenting academics (Agrawal and Henderson, 2002).

Society may not benefit from university patenting, but do even universities benefit? It may be no coincidence that royalty income from university inventions is meager, often too little to cover the costs of getting it (Geuna and Nesta, 2006). Even the royalties of the biggest earner of them all, Stanford, amount to only 11% of the research budget and only 4% of total budget (Argyris and Liebeskind, 1998). In 2002, the various parts of the University of California spent $3.4 billion on research, and reaped just $100 million from licensing agreements (Howard, 2003). One survey estimates that university licensing revenue amounts to a mere 0.17% of university R&D (ProTon, 2007b).

The real problem stems not from a lack of logic - university managers are not fools - but from a distorted perception of patenting. About half of all university patents are in the fields of chemistry and drugs (Herskovic, 1989). University managers have embraced the view of the patent espoused by the pharmaceutical industry. For the pharmaceutical industry, the patent actually does transform the value of vast, long-term investment in R&D into assured income, all the while generating benefits for society. But the pharmaceutical industry is not a typical user of the patent system; it is highly atypical. If even managers in the pharmaceutical industry struggle for the next blockbuster, university managers have almost no hope.

This is not to argue that universities should eschew patenting. They have little choice but to patent. However, they have much discretion in what they patent, how their patents are

managed, and in how they allow their patenting to affect their academic function. University managers might, for example, consider whether a separate TTO for each university is really the best way to cope with the complexities of the modern patent system. It may be worth looking at a return to the days when university patenting was handled by a national agency, the Research Corporation in the US (Mowery and Sampat, 2001), and the British Technology Group in the UK. Similarly, it may be that collaboration among universities would permit the portfolio strategy deemed essential to the modern management of patents (Lambert, 2003; Nicol and Hope,2006), even by the UK Patent Office:

> "The returns to IP exploitation are typically uncertain and realized over the medium to long term. In addition the majority of revenue is usually derived from a few highly successful cases rather than being evenly spread over the IP portfolio … universities need to:
> - articulate clear strategies as to their objectives in relation to managing IP
> - decide how success in meeting these objectives will be assessed
> - take decisions based on the performance of the portfolio as a whole rather than individual items of IP." (Auril/UUK/Patent Office, nd., p.8)

The commercial success of universities seems to be a function of their intellectual eminence much more than their patenting practice (Washburn, 2005). Ironically, the latter may be undermining the former (Nelson, 2001), and may even be an obstacle to the very technology transfer it is supposed to facilitate (Rappert, Webster and Charles, 1999). Technology transfer from universities is not a simple, single-factor process (Perkmann and Walsh, 2007). Nor is it a one-way process: universities have as much to gain from industry as industry has from universities (Cockburn and Henderson, 2000; Siegel *et al.*, 2004). Academic inventors generally have to be involved in the development of their inventions, transferring tacit information. Jensen, Thursby and Thursby (2003) and Thursby, Jensen and Thursby (2001) find them involved in 71% of university inventions licensed. It seems that the personal contacts of academics are also fundamental in finding potential licensees (Thursby, Jensen and Thursby, 2001). Similarly, personal links between leading academics and firm scientists are critical to commercialisation (Harmon *et al.*, 1997); they must share the same workbench (Zucher and Darby, 1996; Siegel *et al.*, 2004). Industry acquires university information through publications, conferences, and consulting (and often a combination of these), but not patents (Cohen, Florida,

Randazzese, and Walsh, 1998; Agrawal and Henderson, 2002). Informal links between the two lead to much more communication than formal. Patents may actually divert attention from non-patent means of technology transfer (such as sponsored research, consultancy and collaboration) that make much more contribution to the commercialisation of university technology (Hughes, 2006). There is far more technology transfer from universities to industry through academic publishing than through academic patenting (Agrawal, 2001).

On those rare occasions when a university does make large sums from a patent, it often adopts tactics borrowed from the pharmaceutical industry (Washburn, 2005) - rigorous enforcement of exclusive licences and constant litigation. One major casualty of this approach may be not just technology transfer, but innovation itself (Feller, 1990; Sulston and Ferry, 2002; Royal Society, 2003). The observation has already been made that industry may eschew patents for open publication in order to promote rapid innovation (see Hope, 2005). University managers, on the other hand, intent on squeezing what they can from university patents, seem oblivious to the effect on innovation (David and Hall, 2006).

> "… as some firms act more like universities, in developing an interest in sharing knowledge, universities have become more like firms in asserting a financial and proprietary interest in the potentially commercializable knowledge that they produce in the course of research and teaching activities." (Etzkowitz *et al.*, 2000, p.327)

University managers seem to expect only benefits from patenting. This paper has suggested one explanation for the prevalence of such naïve optimism. University managers have adopted a model from the pharmaceutical industry, that part of the commercial world with which university managers are most familiar. But while the pharmaceutical industry expects very real benefits from the patent system, it works very hard indeed to ensure that the patent system delivers these benefits. In some contrast, university managers seem to assume that the benefits from patents arrive automatically. They disregard not only the costs naïve patenting imposes on the university's traditional activities, but also the damage such patenting can inflict on technology transfer and on relations with industry generally.

University managers are playing with patents; they have little idea what they are doing, and are guided by no more than a general feeling that patenting is a marginal cost activity from which universities can only benefit, perhaps royally. For all the interest in totting up university income from patent royalties, there is precious little appreciation that universities must also pay royalties, sometimes to each other (Malakoff, 2003). Universities cannot have it both ways (Eisenberg and Nelson, 2002).

> "Universities seem to think that they can continue to get public funding in a field, and at the same time make a lot of money off of patenting and licensing. I doubt that they can, over the long run." (Nelson, 2001, p.19)

For the commercial university, there is no 'research exemption', allowing its research to infringe the patents of others (Geuna and Nesta, 2006; Washburn, 2005). Nor is there a research exemption in the general sense of permitting universities to dabble with patents without getting hurt. For the silly goose seduced into playing with the foxes there is only one likely fate.

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