Available online at www.sciencedirect.com
SCIENCE DIRECT®
Information Economics and Policy 16 (2004) 135–158
INFORMATION ECONOMICS AND POLICY
www.elsevier.com/locate/econbase

When means become ends: considering the impact of patent strategy on innovation

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Abstract

The patent is supposed to be a means to an end, that end being innovation. Whether the innovation comes from the protection the patent affords the inventor, or from the dissemination of the information of invention the patent allows, the patent is not meant to be an end in itself. This seems to be changing, the patent acquiring a strategic value increasingly independent of innovation. If this development has gone largely unnoticed, it may be because the patent system tends to be viewed from the entrenched perspectives of lawyers and economists, and of a number of interest groups that justify their reliance on the system in terms of the innovation it is supposed to encourage. These groups have never included small firms and developing countries in whose name they frequently defend the patent system. They may have some difficulty justifying a system whose strategic value is so divorced from its value for innovation.

JEL classification: O31; O32; O33; O38

Keywords: Patent; Innovation; Strategy; Policy

1. Introduction

Patents are meant to encourage innovation. They are to do this by encouraging invention, from which – so the argument goes – comes innovation, much more socially and economically valuable. This is not a realistic model of innovation, though it is a practical one in that it supports a working misunderstanding (every bit as

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0167-6245/$ - see front matter
doi:10.1016/j.infoecopol.2003.09.008

useful as an understanding) of how innovation comes about. The model is compatible with the bargain that underlies the patent system, which is that the inventor reveals to society the information of invention in return for society's grant of a temporary monopoly over the information. Though this bargain is often discussed as if it were a reality (Intellectual Property and Competition Review Committee, 2000, p. 134), it is actually much more significant in the breaking than in the observance. Both sides cheat, the inventor revealing the information required for a patent rather than the information required for an innovation, and society providing the inventor no more protection than the inventor can afford.

The patent system is not equally suited to all; it suits the pharmaceutical industry very well indeed, and most small firms (SMEs) very badly. Extraordinary, then, that the pharmaceutical industry supports the system not only for the benefits it yields pharmaceutical companies, but also for the benefits it insists that others gain. When a global enterprise whose business is entirely dependent on patents advances the merits of the patent system not just on its own behalf, but also on behalf of firms too small to speak up for themselves, alarm bells should ring. They are largely silent, muffled by a host of other interest groups that also reap benefits from the patent system. Without these shadowy allies, even the mighty pharmaceutical industry would have trouble defending its exploitation of the system.

The problem, if problem it be, is that a new factor has recently entered the equation: the patent has found a use in business strategy. This is not totally novel – the pharmaceutical industry has made strategic use of its patents for decades – but the implications of strategic use that can be quite separate from use in innovation should be appreciated. As long as debate is dominated by those who gain from a system seemingly tailored to their immediate requirements, and by those for whom the benefits of the system are not dependent on patent practice, this appreciation will not be easily acquired.

2. Thinking about patents

Discussion of the role of the patent in innovation tends to lay bare fundamental differences rather than resolve them. In one corner are those who point out that patents relate only to invention. As invention makes little contribution to innovation, then patents must make even less.

> Although most innovations can be traced to some conquest in the realm of either theoretical or practical knowledge that has occurred in the immediate or remote past, there are many which cannot. Innovation is possible without anything we should identify as invention, and invention does not necessarily induce innovation, but produces of itself.... no economically relevant effect at all. (Schumpeter, 1939, p. 84)

Patents, they concede, may be important to innovation in a few industries, but not in most, and the information they make available to society for its innovation is

insignificant when set alongside information from other sources. Taylor and Silberston, for example, calculate that patent information is worth about 0.75% of companies' research and development (R&D) expenditure, and thus an infinitesimal proportion of total innovation costs (Taylor and Silberston, 1973, p. 212). When the factors relevant to innovation are lined up, their ranks are filled by venture capital, entrepreneurial spirit, firm size, R&D expenditure, education of chief executives, and so on. Patents are not even in the front row.

In the opposite corner are those who see patents as essential to innovation, or at least to inventing, without which there would clearly be no innovation. For a variety of reasons, these people treasure a structure view of existence; they imagine a world in which change starts somewhere and proceeds in an orderly fashion to ultimate, though certainly not inevitable, innovation. A process is at work, and processes can be – should be – managed and controlled. Heavy users of the patent system are presented not just as proof of the system's importance and efficacy, but as examples of how others should behave, and would behave, if the world were a better, proper place.

> Patents are so central to the pharmaceutical industry that intellectual property specialists frequently cite it as a rationale for the entire patent system. (Shulman, 1999a, p. 132)

The pharmaceutical industry is the champion of this opposing corner. It is argued both that the industry deserves a special place within the patent system, and also that the patent system, buttressed by the pharmaceutical industry, deserves a special place within policy.

> Since, today, it takes an average ten years and over $100 million to develop a new drug, only seven or eight years are left for the product to recover its entire investment before manufacturers who made no R&D investment at all are free to copy and compete with it. In the United States, the 1984 Patent Restoration Act has added up to 5 years of life to a pharmaceutical patent to make up for some of the time lost in the government approval process.... If the United States is to avoid further erosion of its competitive position, a new framework for growth must be envisioned..., in which intellectual property rights are protected and in which investment and innovation are encouraged.
>
> (Miller, 1988, p. 88)

One reason why these opposing schools have not managed to resolve their differences may be that lawyers and economists frame the rules and referee the bouts. Both are clearly pleased that patents provide a platform on which they can display their expertise, and both would be displeased were the patent platform removed (Thurow, 1997). Both accept that the patent system is flawed and both proffer suggestions for improvement, though the lawyers are much more enthusiastic than the economists. The lawyers would amend the sub-clauses of patent legislation until the cows come home: the economists tend to feel that all the tinkering in the world cannot produce anything but an imperfect system.

> If the system accounts for a net increase in inventions having a value to society exceeding the costs society pays for them, the patent system is justifiable in economic terms. (Markham, 1962, p. 597)

> If we did not have a patent system, it would be irresponsible, on the basis of our present knowledge of its economic consequences, to recommend instituting one. But since we have had a patent system for a long time, it would be irresponsible, on the basis of our present knowledge, to recommend abolishing it. (Machlup, 1958, p. 80)

For the sake of decent debate, neither lawyers nor economists are averse to overlooking the odd practical problem. So, for example, lawyers explore the means by which the patent system affords redress to those whose patents have been infringed in the full knowledge that the system allows no redress at all to those without formidable means. Similarly, economists indulge themselves in patent race theory (Conner, 1988) and in determining optimal patent length and optimal patent breadth (Scotchmer, 1991). As long as they ignore the reasons for taking out patents, that the real world co-operates in its invention and innovation (Powell, 1996) and generally surrenders its patents well before full term, they can even regress patent breadth against patent length (O'Donoghue et al., 1998).

> The standard model involves perfect information and total patent coverage. Firms therefore optimally patent all innovations, and patents become an exact measure of innovative activity. (Horstmann et al., 1985, p. 838)

While expertise in the patent system resides so dominantly with economists and lawyers, it is often hard for others to be heard. It is becoming quite important that they be heard.

3. The patent within the innovation myth

In popular parlance, a myth is something neither real nor true. The technical definition is more subtle: a myth, like religion, is supported by faith and belief rather than by fact (Joseph, 1989). Consequently – and this is the important part – there is no point arguing for or against a myth. Logic is irrelevant. The power of myth is a product of the satisfaction it offers its adherents and the fervour of their belief. Most people are anxious to reduce uncertainty, but some activities – and certainly innovation – are inherently uncertain. Here, myth provides the illusion of certainty. The linear model that plods its way from basic and applied research to invention, and thence through various stages of development to an ultimate innovation, is a myth. Few would even attempt a reasoned defence of the model. In as much as the patent fits roughly within this linear model, it is part of a myth and can seize all the advantages this position offers.

The version of the linear model prevalent in the 1970s imagined the impetus for innovation to come from R&D, a perception that saw an obvious place not only for

the patent, but also for all those scientists and engineers practised in the technological arts, and for all those institutions, learned and otherwise, that offered shelter and succour to this technological priesthood. A Frascati Manual painstakingly catalogued what counted as R&D, thereby emphasising the importance of R&D in innovation and allowing R&D performance to be used as an input indicator of innovation. High technology rejuvenated the myth in the 1980s with a more mystical, more powerful technology that would bring instant prosperity to company, industry and region (Breheny and McQuaid, 1987). Faith in technology as the source of innovation was undermined less by the failure of high technology to fulfil its promise, than by the apparent success of the Japanese in innovating without heavy expenditure on R&D. While the West derided Japan for being incapable of inventing (they took neither R&D nor patents seriously (Spero, 1990)), the Japanese proved that innovation did not have to start with R&D and invention (Rothwell, 1992). Had the Japanese merely defied the prevailing myth, it would probably have survived and the Japanese would have been left to practice their heresy undisturbed. But Japanese innovation of the 1980s was itself to become mythic and – as the history of religion demonstrates – nothing threatens myth as much as conflict with other myth. The Japanese myth portrayed innovation as the culmination of process, and process required organisation and management. The fervour with which the West was converted to this myth at first took the Japanese aback, though they were not slow to capitalise on the situation. Most notoriously, MITI deliberately cultivated the impression that what became known as the Fifth Generation Computer Programme was a triumph of planning (Quintas and Guy, 1995; Forester, 1993). The new innovation myth is every bit as linear as the old myth, and every bit as uncompromising in its conviction that patents are necessary to turn invention into innovation. What is different is the justification it provides managers to exploit patents within corporate strategy.

> The most persuasive and relevant justifications of government-granted patent monopolies presume that the patent is only one step along a road to use, be it commercial or academic. Surely when the framers of the Constitution empowered Congress to grant monopolies to 'promote the progress of science and the useful arts', they did not envision the beneficiaries of this grant would use it to bury new technologies to protect market share or capital investments. (Turner, 1998, p. 209)

4. Patents and managers

A myth in which a technology-push model is dominant has no trouble accommodating the patent system. Whether the system is meant to work through affording protection or through disseminating information is less important than that the patent system is a milestone between invention and innovation. It is less clear, at least at first sight, where patents fit in the modified innovation myth. The modern manager has no particular interest in technology, beyond its public

relations role. He does, though, have an interest in process, for it is process that allows the application of rules and procedures to the managerial task. To be sure, the technology-push version of the linear model depicts innovation as the product of a process, but this is a process heavily influenced by scientists and engineers at its origin, a process taken over by proper managers only in its later stages. The modern innovation myth depicts a process that starts with the manager and works its way down to patenting, only nodding in the direction of science and engineering before returning to the manager. In other words, the manager initiates and consummates the innovation process.

> 'Market-led' does imply that Marketing knows what customers need and tells Research. Without that, Research would be directionless.
>
> (UK marketing manager, 1996)

> R&D people are naïve from a business point of view. They will tell you confidential stuff. I'm just amazed by the leakage that can occur.
>
> (UK marketing manager, 1996)

The patent is a corporate asset and corporate assets require managing. They have not always been well managed. GKN, for example, has long enjoyed a virtual world monopoly on the constant velocity joint, of which every motor vehicle requires several. Yet the original patents were acquired only incidentally and management did not appreciate their value for more than a decade (Macdonald, 1995a). As a technological resource, the patent tended to be neglected in the midst of more strategic corporate resources. Patenting was not a major concern of senior management. What has wrought the change? The obvious answer is that the patent became more valuable as corporate property with the inauguration in 1982 of the Court of Appeals for the Federal Circuit (CAFC) in the United States, a specialist patent court, in authority just below the Supreme Court. From a patent perspective, the CAFC has performed just splendidly (Nies, 1993). Between 1982 and 1987, the CAFC upheld 89% of district court decisions that patents were valid compared with under 40% previously (Silverman, 1990). It followed that the value of a US patent (and so of all patents providing priority in the US) increased substantially. Other developments increasing the propensity to patent were the Bayh-Dole Act of 1980 and related legislation, which permitted the patenting of publicly funded research, and the National Co-operative Research Act, which relaxed anti-trust laws (Hall and Ham, 1999). US patents granted between 1983 and 1995 increased by 78% (Cohen et al., 2000). US patenting both at home and abroad soared – and all without any increase in research investment (Kortum and Lerner, 1999).

Concern over declining US competitiveness became acute in the 1980s. Reduced economic strength was considered to imperil national security just as much as impaired military might (Macdonald, 1990). Foreigners had owned just 25% of US patents in 1947: by 1989, they owned 47% (Shapiro, 1990). Policy-makers looked to technology, and especially high technology, to save the day, and to patents both to keep American technology American, and for re-assurance that all was well. The pharmaceutical industry was not slow to seize the political

opportunity. As the President of the Pharmaceutical Research and Manufacturers of America (PhRMA), and sometime Commissioner of Patents and Trademarks, noted:

> As US comparative advantage has shifted away from basic industrial manufacturing to high-technology industries, such as pharmaceuticals or computer and information-processing industries, the protection of intellectual property has become a cornerstone of American economic foreign policy. (Mossinghoff and Bombelles, 1996, p. 43)

Interest was in just one side of the patent bargain: it was the monopoly, not the diffusion of information (which could easily go to foreigners), that would produce urgently and directly the innovation US competitiveness and security demanded (Merges, 1988).

> When intellectual property rights are protected, *innovators* are able to recover the costs incurred in research, product development and market development. This cost recovery... is essential for stimulating the future research and development that is necessary to maintain America's competitive edge. [emphasis added] (Silverman, 1990 , fn. 110)

The increase in the numbers of patents granted in recent years has been prodigious (Economist, 2001a). In those industries where patents have long been a fact of life, they are more entrenched than ever, but patents have now become common where they were once scarcely known. The Japanese, having shown the world how to innovate without resort to patents, now patent heavily, especially in the United States. In 1973, there were no Japanese companies among those taking out most patents in the US: by 1998, eight of the top ten companies were Japanese (National Science Foundation, 1998, p. 6.19). Firms in the West (Motorola and IBM, for example) are now following Japanese companies in paying bonuses to staff whose inventions are patented (Sosnin, 2000; Shapiro, 1990; Economist, 2001b). And the semiconductor industry, which once innovated far faster than the patent system could function, which generally eschewed patenting, and which left behind those firms that relied on patenting (Braun and Macdonald, 1982), now emulates the pharmaceutical industry in its dependence on patents (Hall and Ham, 1999; Grindley and Teece, 1997). Some 1655 US semiconductor patents were granted in 1981: by 1994, the figure was 5427 (Macher et al., 1998). Gone are the free-wheeling, Silicon Valley days of innovation based on interdependence and the network exchange of information (Shulman, 1999a, pp. 62–69). Residents of New York were granted fewer than 3000 patents during the first half on 1999, beaten only by residents of California with over 8000 (Hazelwood, 1999). Lucent Technologies, the owner of Bell Laboratories, an organisation once proud of its liberal approach to licensing, which gave free licences to the transistor patent to speed development, now has an intellectual property business group with 266 employees "to make a profit from licensing patents to companies that come to us for a licence or that we discover have in fact used our patents in their products and have not come to us for a license"

(Rubenstein, 1998). The patent system has come to shore up IBM, Intel and Microsoft as much as it ever reinforced Merck and Glaxo.

If the scale of patenting has grown, so too has the scope. Software that was once developed under copyright protection is now patented, following creeping acceptance that if a computer is patentable, so too should be the algorithm that allows the machine to work, and if the algorithm, then surely the software that makes the algorithm functional (Merges, 1997).

> ...attorneys began to achieve software patents by expressing a software concept as hardware. By asking inventors to design hardware equivalents to their software inventions, the patent attorneys could patent these impractical electrical clones and, via embodiment equivalence, protect any software implementation utilizing the same concept. (Gibson, 1992, p. 36)

Software patents granted in the US have increased by 30% annually over the last decade (Shulman, 1999a, p. 71). Nearly one-third of the patents granted to IBM in 1997 were software-related (Puttre, 1998). And from the patentability of microbes nibbling their way through oil slicks (Kass, 1982), the argument that other life forms are patentable has been hard to resist. Plant genes are now patented, whether their sequence has been unravelled in the laboratory, or simply found in nature. Sounds, smells and colours can be patented in the US (Shulman, 1999b). Even mice can be patented (Kevles, 2002). And so with business methods, originally patentable in the US in that they were an extension of computing, and especially the programming function (Shulman, 1999a, p. 72). In Europe, business method patents are allowed if they make a technical contribution, not that the European Patent Directive defines 'technical' (Aharonian, 2001). But there are few business methods that are not, or cannot be, expressed in a manner that can be captured by a computer and therefore patented. There were 2700 applications for business method patents in the US in 1999 and 7900 in 2000 (Frieswick, 2001). US patenting applications using the word 'Internet' grew from 385 in 1997 to 1667 in 1998 and to 2598 in 1999 (Hazelwood, 1999). In short, patenting has never been so prolific, nor so promiscuous.

But of rather more importance in rendering patents the concern of managers has been the extension and expansion of management itself, a matter lawyers and economists do not seem to think relevant to the patent debate. In the early 1980s, the science of management was taught in a handful of business schools and practised only in the largest corporations. To be sure, lesser companies were managed, but more by art than by science, by experience rather than method. There are now few organisational activities that are not managed by methods taught in thousands of business schools. Even the public sector has been thoroughly permeated by the ways of private sector management. In such circumstances, it would have been extraordinary indeed had innovation, especially innovation as process, not been considered the legitimate concern of managers. Indeed, within a general agenda of change management, innovation was eagerly seized upon as the responsibility of the manager rather than the scientist or the engineer. In the very year the CAFC was established, Peters and Waterman

published *In Search of Excellence*, still the most renowned of management texts (Peters and Waterman, 1982). Chapter 6 is entitled 'Close to the customer' and set in train a succession of management methods in which the customer was pivotal (Macdonald, 1995b). These depicted the innovation process as impelled by market-pull rather than technology-push. Marketing and sales departments were not slow to seize the opportunities presented by the relegation of science and engineering.

> Why should anyone but Marketing have contact with the customer? The customers are our business. We keep other parts of [the company] informed on a need to know basis. (UK marketing manager, 1996)

> We couldn't have our customers meeting an engineer with a cup of coffee and a fag hanging out of his month. (UK marketing manager, 1996)

It followed that patenting was no longer the preserve of technological endeavour. It could be a strategic tool wielded by customer-oriented managers with little interest in technology. In the pharmaceutical industry, always the bell wether of patent change, 'customer-driven health care' strategy made innovation the responsibility of Marketing rather than Research (Angell and Relman, 2002). And as one management fad emphasising the importance of the customer was supplanted by yet another emphasising precisely the same thing (see, for example, Collins, 2000; Huczynski, 1993; Abrahamson, 1996), the patent became more and more entrenched in the strategy of the learning organisation, integral to knowledge management. Expressing concern in the late 1980s that the CAFC was giving too much weight to the commercial success of the patent owner's innovation, Merges noted that the Court had adopted "an implicit model of the innovation process that tends to underestimate the significance of market-side factors" (Merges, 1988, p. 876). Too true; these market-side factors were to become capable of supplanting innovation altogether.

5. Exploiting patents in strategy

While patents were primarily the responsibility of scientists and engineers, the expectation lingered that their purpose was technological innovation. In the hands of senior management, patents have come to have a broader strategic function in which innovation plays only a small part, and sometimes no part at all. It is worth remembering that the average patent never was of much value in terms of innovation. For example, of 1600 patented inventions submitted to the Wisconsin Alumni Research Foundation, only 65 were licensed to industry and only 36 generated sufficient revenue to cover the Foundation's costs (Udell, 1990). Another estimate is that just one in a hundred patents produce any income whatsoever (Glass, 1990). In terms of strategy, though, the patent can be much more valuable. One survey of the semiconductor industry finds that "the reasons that patents were important often had little to do with whether patents provide an incentive to conduct R&D or enable the firm to profit from the generation of products on which the invention was based" (Hall and Ham, 1999, p. 9).

The pharmaceutical companies and others who depend on the patent system for their innovation are understandably past masters in its strategic exploitation (Dunford, 1987; see also Arora, 1997).

> The danger is that loss of patents in HIV alone could destroy the global HIV market. The bigger danger is that the broader loss of patents in South Africa could be the thin end of the wedge which smashes patent protection for the industry [worldwide]. And if that happens, then frankly the entire economic base of the pharmaceutical industry is destroyed. (David Ebsworth, Head of Pharmaceuticals in Bayer, as quoted in Pilling, 2001)

But such crass devices as patent pooling have long since been replaced by the sophistication of patent stacking (Heller and Eisenberg, 1998), blocking (Afuah, 1999), clustering and bracketing (Rivette and Kline, 2000a), blitzkrieging, consolidation, blanketing and flooding, fencing and surrounding, by patent harvesting and ramping up (Hall and Ham, 1999), by portfolio and network arrangements (Kretschmer and Soetendorp, 2001), and other devices that tend to be directed less at facilitating innovation than with discouraging the innovation of others. It matters less that every patent is a potential contribution to innovation than that it may infringe or be infringed (Merges and Nelson, 1990). Among the patent strategies recommended by consultants are:

- patent in a thicket around key patents held by competitors
- patent discoveries that might block use of similar discoveries in competitors' products
- patent in order to have a portfolio with which to negotiate licensing agreements with other companies'' (Sullivan and Daniele, 1996, p. 37).

Given the importance of the strategic role of patents, at least part of the massive increase in patenting may well be explained by the increase itself. Defensive patenting strategy dictates that patents be taken out so that others do not use their patents to prevent working in an area. The greater the patenting of others, the greater the perceived need for defensive patents (Merges, 1997, p. 129).

> Accelerating technology is plunging the world of ideas into a runaway patent arms race. More ideas are being created, and more emphasis and wealth placed on ownership of ideas. At the same time courts are expanding what can be patented. This forces many companies and universities into a pure defensive maneuver to patent ideas they would not have otherwise. And that in turn forces others to do the same.
>
> (Anon., 2000)

Even governments exploit patents strategically, at least in the developed world. (The developing world, at least in its expectation and exploitation of TRIPS, still seems captivated by the innovation myth.) When the Canadian government sought enough of the anti-anthrax drug, Cipro, to supply the whole country in 2001, it discovered not only that Bayer, the patent owner, was unable to produce such a vast

quantity, but that Bayer was paying another pharmaceutical company $US30 million a year not to make the drug. Rather than force Bayer to license, both the US and Canadian governments settled for cheap supply (Foley, 2001; Economist, 2001c; Economist, 2001d; Godwin, 2002).

As one of the few output (rather than input) measures of innovative effort, patents have long played an important part in guiding science and industry policy (Johnston and Carmichael, 1981). But where patents were once counted to indicate technological performance (e.g., Pavitt, 1985; Patel and Pavitt, 1991, 1995), and were expected to bear some relation to R&D expenditure (Pakes and Griliches, 1980; Griliches, 1990), they are now more likely to be matched to financial performance for the convenience of investors (Narin, undated). With the financial world making such calculations, managers have no choice but to take patents very seriously indeed. The maxim in biotechnology is 'if you can't patent it, don't invest in it', a pragmatic extension of 'no patents – no cure' (Scullion, 2002), the attitude embued in the patent rationale offered by the pharmaceutical industry (Caulfield et al., 2000). But patent data can be used to measure more than mere performance: they can also play an important role in establishing the value of a company, a problem for investors when so much corporate value is intangible. Analysis of patent databases provides the market with much clearer signals than ever innovation did, signals that can easily be incorporated in buy and sell programmes, which, because they are run on a computer, are themselves patentable. What is called 'patent asset management', involving such techniques as patent mining and landscaping, has given a whole new purpose to patents.

> There are now automated systems that provide platforms for organizing, analyzing, and visualizing patents across an industry, for conducting patent audits, and for uncovering competitors' strategies. Patent-mapping efforts that used to take months can now be done in hours or days. Once unintelligible text documents can now be presented in 3-D reports that highlight patterns and relationships in technology development.
>
> (Rivette and Kline, 2000a, p. 66)

Companies are now ranked in terms of how many US patents they are granted annually (Anon., 2002a). A patent/employee ratio is applied, giving IBM an unimpressive .06 and small high technology firms something much greater (Anon., 1998). Stock markets, accustomed to valuing pharmaceutical companies by their success in patenting (Foley, 2002), have begun to apply the approach more widely. A decade ago, it was hard to find much connection between patenting activity and market valuation – except, of course, in the pharmaceutical industry (Griliches et al., 1991). Now calculations are much more sophisticated and much discussion considers whether a better estimation of corporate performance and value comes from totting up patent citations rather than just patents, a discussion that may miss the point. If patents are regarded as such important indicators, then there is an incentive to produce the indicator rather than what it is supposed to indicate (Macdonald, 2001). But the main point is surely that patents may not be indicators of wealth at all, but actually the wealth itself. Some

companies have no value beyond their patents (Shulman, 1999b). These methods may well be tracking not the innovation strategy of competitors, but their patent strategy. It is, then, hardly surprising that market valuations relate to patenting performance (Leadbeater, 1999).

With a value independent of the actual, or even potential, value of any innovation, the patent can be exploited in a variety of ways. One recent survey declares that "the limited explanatory power of patent effectiveness could reflect uses of patents that generate profits, but not directly from the commercialisation or sale of the patented inventions" (Cohen et al., 2000, p. 17). The theory of intellectual property rights may still struggle with the challenge of making property out of the intangible, but managers see only opportunity in exploiting property that is more valuable because it is intangible. Patent strategies sometimes seem strangely similar to the strategies of the dot.com companies. In both cases the corporate asset is an idea that may diminish in value with attempts to put it into practice. Managers responsible for the virtual instruments of modern finance and accounting have had little difficulty transferring their approach to the virtual world of intellectual property. It is therapeutic to think of the financial equivalent of the patent as splits, zeros, junk bonds, cross investments and derivatives. Patents are now an instrument of financing off the balance sheet in the US: so guaranteed are the future royalties of pharmaceutical companies that Global Asset Capital of San Francisco has been using them as security for loans since 1999 (Rivette and Kline, 2000b, p. 140).

The incentive to innovate is reduced and may disappear altogether as firms sell on the right to innovate much as futures traders sell the right to buy commodities without any expectation that commodities will ever be delivered. Equally negotiable is the right to prevent others innovating and some companies now have no activity beyond collecting patents in the hope of obstructing the innovation of other companies. As in the game of monopoly, payment is expected before the putative innovator is allowed to proceed. Sometimes the value of patents relates not to actual infringement by other companies, but merely the prospect of infringement. There are companies that rejuvenate patents nearing full term and sell the new patent back to the original owners. Sepracor did this for Eli Lilly when Prosac was nearing expiry in 1999. It made $US90 million (Rivette and Kline, 2000b, p. 132). The portfolio management of high technology projects typical of the 1980s has turned into portfolio management of patents. The hope that one or two projects out of a dozen or so will yield innovation has been replaced by efforts to position strategically a number of patents, much as City traders hedge their bets. The idea of a single patent relating to a single innovation, especially an innovation that simply improves the way things are done, is considered quaint.

> No company can build a formidable portfolio, having the ability to alter the marketplace factors it faces every day, on a foundation of productivity-enhancing technology. The sooner that reality is faced, the sooner the company can begin to craft a patent portfolio having market-influenceable value. (O'Shaughnessy, 1996, p. 150)

Xerox, which long valued its reputation for innovation more than its substantial patent collection (it earned just $US8.5 million in royalties from over 8000 patents in 1997) now analyses citations to its patents so that it can license these patents in strategic groups rather than individually (Rivette and Kline, 2000b, p. 59, 127). Strength lies in numbers, perhaps to leave options open or to close off whole areas to competitors. Both tactics have long been adopted in industries that patent extensively, the major constraints being the cost of patenting and the threat of action to enforce working of the patent. The increased value of the patent now dwarfs these costs and tempts many others into strategic patenting.

> What was missing before, and what we're now doing, is a systematic mining of our patent portfolio for opportunities.... This means, first and foremost, waging a proactive and aggressive effort to generate revenue from our patents. But it also means looking for other uses for our technology besides in products or just sitting on the shelf. If you only use your patents to protect your products, which is the old paradigm, you're missing all manner of revenue-generating and other opportunities.
>
> (Jan Jaferian, Vice President of Intellectual Property, Xerox, as quoted in Rivette and Kline, 2000b, pp. 127–128)

Portfolio management of patents also extends to old patents. The advice from those most nimble in these matters is that a triage should be effected to identify patents no longer being used by the company. Such patents may be irrelevant to the company's current and intended activities, but they may be very relevant indeed to the activities of other companies. Judicious searching of patent databases will identify possible intrusion, suggesting where remedy may be sought even though no damage has been done. It is recommended that totally useless patents be given away to educational institutions as this allows a tax deduction on the cost of R&D based on the charming notion that the patent emerges from the laboratory rather than the boardroom (Rivette and Kline, 2000b, p. 134).

With the increase in value of the patent, it has become important to ensure that correct patenting procedures are followed. To lose the opportunity to acquire such valuable property, or to fail to maintain its value, would be strategically incompetent. Consequently, the role of the patent attorney has expanded, legal expertise being judged much more relevant to patenting than scientific or engineering knowledge. Indeed, the direction of a company's research may well be decided not by a research director, but by a patent attorney, guided not by the prospects of discovery, but by the exigencies of the company's strategy.

> Corporate patent attorneys have started scrutinizing their companies' patent portfolios and have become more reluctant to give R&D managers the go-ahead on a new idea or business for fear of duplicating a patented product. (Perry, 1986, p. 80)

> Genetics Institute's patent counsel say the strength of the potential patent position is 'a leading factor' in deciding what research to pursue.
>
> (Rivette and Kline, 2000b, p. 58)

> A company's patent lawyers can protect the company's proprietary position without giving away too much in the application process.
>
> (Labich, 1988, p. 30)

Whereas 795 patent suits were brought in US federal courts in 1981, there were 2573 in contention in 2001. One estimation of the cost of patent litigation begun in 1991 is that it equalled 25% of expenditure on basic research for the firms concerned, and this was just the direct cost (Lerner, 2002).

Modern patent strategy demands that companies search the databases for patents that might have infringed their own. Consultants advise companies to turn out and dust down old patents in the hope that someone somewhere has infringed them. The traditional response to such approaches has always been counter-claim of infringement, the subsequent stalemate being resolved by cross-licensing. This old-fashioned compromise is a relict of the days when co-operation in competition was associated with rapid innovation in technology-intensive industries. Now, companies bent on pressing their infringement claims are advised to produce nothing at all so that they cannot be counter-sued (Rivette and Kline, 2000b, p. 135). Companies must realise that they are in the patent business, not the innovation business.

> We turn ideas into inventions, inventions into patents, and patents into profits.
>
> (Strategy manager, Lucent Technologies, as quoted in Rubenstein, 1998)

6. Implications

The mastery of the patent system by the pharmaceutical industry is no more than a modern example of the abuse that has occurred for centuries. In early 17th century England, patents were granted for such enterprises as running alehouses (Merges, 1997, p. 6). The benefits enjoyed by the pharmaceutical industry have imposed costs on society at large, costs of which society (generally content to bask in the benefits) might not approve were it more aware of bearing them (Macdonald, 2002). Significant among these is that, as a heavy user of the patent system, the pharmaceutical industry has been disproportionately influential in decisions about the development of the system (Vos, 2000).

> We are most interested in a strengthening rather than weakening of the Australian patent law, especially for pharmaceuticals. Substantial weakening might prompt us to drastically shortcut investments in Australia. (quoted in Mandeville and Bishop, 1982, p. 16)

The pharmaceutical industry has been instrumental in creating a patent system for the pharmaceutical industry, appropriate to the orderly innovation of that industry. Acceptance of the innovation myth has meant that this logic is rarely challenged. Thus, for instance, development may relate to many patents, not just one (Heller and Eisenberg, 1998). The costs of navigating through mazes of overlapping patent rights – through patent thickets – are likely to be considerable (Shapiro, 2001), and are likely to be an obstacle to innovation. In industries where the pace of change is rapid, where innovation is complex and dependent on information from a multitude of sources, patent problems once found pragmatic solutions.

> Mostly, your patents are used in horse trading. You come together and say, 'Here's our portfolio.' In [the communications equipment] industry, things all build on each other. We all overlap on each others' patents. Eventually we come to some agreement. 'You can use ours and we can use yours'. (quoted in Cohen et al., 2000, p. 19)

The strategic use of patents has no place for such solutions.

A system suited to large corporations and the developed world has never been especially appropriate to SMEs and the developing world (Drahos, 2000). The weak bear not only the costs of the patent system, but also the sanctimonious insistence of the strong that the system exists for the benefit of the weak. Thus, the chairman of Reed Elsevier and of the European Round Table, a grouping of business leaders in Europe, can declare that "Protecting intellectual property is crucial, not so much for large companies but for small and medium sized enterprises" (quoted in Betts and Groom, 2001). But how do the weak relate to the new reality of patent use (Lerner, 1995)? It is hard to believe that small firms and the developing world are proficient in patent blitzkrieg techniques.

> It is an expensive process, and large multinational companies will put a patent on everything that moves. Smaller companies, which may be more innovative, won't be able to afford to do this.
>
> (lawyer quoted in Anon., 2002b)

Even large institutions seem to be at sea in the new managerial world. Consider, for example, university patenting. Some 60% of US universities (Trune and Goslin, 1998), and half of UK universities (Charles and Conway, 2001, p. 56), do not earn enough royalty income to cover even the costs of their technology transfer offices. The profits from American university patents do not exceed even the direct costs of patenting (Feller, 1990). Why, then, do universities rush to patent? Presumably there is some sort of strategic purpose, perhaps supported by the innovation myth. In the UK, it is the new universities that are seeking to patent, and that most need to improve their research credibility (Charles and Conway, 2001, pp. 49–52). But, once again, the benefit is not without cost: the patent strategy of universities presumably results in the reallocation of resources to research likely to yield patents (Feller, 1990; Mowery and Sampat, 2001. See also Rosenberg and Nelson, 1994). The costs of constraining university research to meet the requirements of

the patent system may be greater still. From the perspective of the British Technology Group, which specialises in exploiting university patents, this is not a problem:

> Our biggest competitors are not other agencies like ours. They are researchers talking to industry or giving their ideas away at conferences and so on. (Ian Harvey as quoted in Harvey, 1989, p. 122)

If researchers are discouraged from talking to each other, the pace of innovation may well slow.

> More than half of the speakers that I approached said they couldn't speak this year because of patent-related restrictions placed upon them by their company's corporate counsel. It's going to be another two or three years to find out what they are doing, and so everyone working in that same field isn't going to be able to build on that research as quickly. (Russell Brand as quoted in Shulman, 1999a, p. 71)

Medical research, already familiar with the ethical problems posed by industry funding, now tries to cope with the pharmaceutical industry censoring publication through the strategic use of patents. Authors are not always allowed to see the data on which their papers are based (Angell and Relman, 2002. See also Wheelwright, 2002).

> ... in some arrangements with academic institutions, the [pharmaceutical] companies may design their own trials, retain and analyse the data, write the papers or at least review them before publication, and even decide whether to allow publication at all.
>
> (Angell and Relman, 2002, p. 105)

Ideas that not long ago would have remained in the public domain are now private property, and thereby part of the strategic armoury of corporations (Boyle, 2002). This would matter less if the patent system really did make public the information of invention. But the strong patent has rendered the patent system less satisfactory than ever as a source of information. Debate over whether public ownership of information is more conducive to innovation in the software and biotechnology industries than private ownership reflects a fundamental dichotomy. Conflicting convictions that innovation comes from either private ownership of information *or* from public access to information would seem to ignore the fact that the whole point of the patent system is to allow both (Sulston and Ferry, 2002). In practice, of course, the two do co-exist and inter-relate in complex, personal and institutional, network arrangements (Eisenberg and Nelson, 2002). It is not unlikely that such subtle and fragile relations, often seen as providing the foundation for innovation, are damaged by the new strategic use of patents.

The innovation myth, whether in technology-push or market-pull mode, accommodates the monopoly side of the patent bargain more comfortably than information diffusion. With the new strategic use of patents, interest in the patent providing society with the information of invention so that society might innovate

has almost disappeared. Patent information has come to mean one of two things, neither of which is a contribution to innovation. The first is the information required to satisfy the demands of the patent system itself. Small firms, for example, do not see the patent system as a supplying information, but as demanding it (Macdonald, 2003). The second sort of patent information is information about patents rather than from them. Patents are now less important than ever as a source of information for innovation: instead they provide information about patenting behaviour. It is only the innovation myth and the part that the patent is allowed to play in the myth that allows patent offices proudly to proclaim that they are providing the information of which innovation is made.

> Patent specifications are a source of valuable technical information, readily available and much of it *free* for the taking. It is a pity that *so few* manufacturers, engineers and scientists seem to be aware of this. So next time you have a technical problem, check to ensure that it has not been solved already. Even if you don't find a ready solution, you may pick up some good ideas for use in your current or future design. [original emphasis] (Australian Patent Office, 1981, p. 2)

> Each patent specification is a detailed disclosure of the invention and it is this aspect of course which is particularly valuable as a rich source of technical information. (Blackman, 1994, p. 47)

To be sure, there is still some searching of the databases to measure concentration of effort and performance in particular technologies (National Science Foundation, 1998, pp. 6.21–6.30), but this use of patent information must decline as technological focus is blurred by greater strategic purpose. Companies are much more anxious to search the databases to avoid infringing the patents of others, or to find others who have infringed their own patents. With treble damages and cessation of production enforced immediately, conviction for infringement has become an expensive business in the United States, and companies do all they can to reduce the risks.

> Companies should not work on a new process or concept without reference to existing patent literature. Relevant patents may still be in force which, if ignored, could prevent the manufacture and marketing of the new concept under consideration. (Moss and Evans, 1987)

> Defendants that have been judged guilty of 'wilful and wanton' infringement can be assessed treble damages, interest that accrues while they appeal, and the plaintiff's legal fees. Worse judges are ordering companies found guilty of infringing to stop selling copycat products immediately, rather than allowing them to continue business as usual until completion of the appeal. (Perry, 1986)

The Kodak case, settled in 1990, is notorious. For infringing Polaroid patents, Kodak paid Polaroid $US925 million, its lawyers $US100 million, its customers $US500 million, it closed a manufacturing plant at a cost of $US1.5 billion, and dismissed 700 employees (Rivette and Kline, 2000b, pp. 93–96).

> A district court put Kodak out of the instant camera business in one day. That's something chief executives understand. (Glass, 1992)

So punishing is conviction for infringement that firms take desperate precautions. These may include ordering staff not to read patent specifications, and avoiding innovation that abuts on the patents of others, two responses that, between them, nicely nullify the patent bargain. So, too, does not citing previous knowledge in applications for software patents, a tactic designed to frustrate those searching the databases for potential infringement, but which does not seem to prevent such patents being granted. It is said that half of all new software patents mention no prior knowledge at all (see Rivette and Kline, 2000b, p. 20).

It is not at all unusual these days for firms to regard patents, rather than innovation, as the means by which revenue is realised. In some large corporations, royalties yield much more profit than any product line, especially as nearly all revenue derived from royalties is profit. IBM now makes $US1 billion annually from patent royalties, over 10% of its total profits. The figure was just $US30 million in 1990 (Rivette and Kline, 2000b, p. 58). In 1992, TI made $US391 from patent royalties, and only $US274 from all other activities combined (Rivette and Kline, 2000b, p. 125). Time and effort put into the strategic exploitation of patents are not available for other activities, including innovation.

> Resources that could have been used to further innovation have been diverted to the patent problem. Engineers and scientists such as myself who could have been creating new software, instead are focusing on analysing patents, applying for patents, and preparing defenses. Revenues are being sunk into legal costs instead of into research and development.
>
> (Evidence of Douglas Brotz, Principal Scientist, Adobe Software, 1994)

> With cases lasting four years plus and running anywhere from $2 million to $10 million, computer companies are spending as much time in the courts as they are in the laboratories. (Howes, 1993, p. 7A)

Indeed, innovation may sometimes be thoroughly inimical to the effective exploitation of patents. Rather than incur the risks and costs of litigation, firms may choose to avoid innovation altogether (Lanjouw and Lerner, 1997).

> In the context of patents, one way of avoiding disputes with other patentees is to avoid innovating and producing in areas where others are present. (Lanjouw and Lerner, 1997, p. 21)

> That's the key: no exposure.... While we can sue for infringement, we can't be countersued because we're not making or selling any products, so there's no way we could possibly be infringing anyone else's patents. Our only 'product', if you will, is intellectual property.
>
> (Mark Lieberman as quoted in Rivette and Kline, 2000b, p. 135)

Even the pharmaceutical industry, which now has the strong patent regime it insists is essential for its investment in innovation, may be less innovative than ever (Economist, 2002). Because each 'blockbuster' competes against very similar 'blockbusters' from other companies, marketing rather than innovation is the industry's main challenge. While R&D costs amount to 12% of revenues, marketing and administration costs are roughly 30% (Angell and Relman, 2002).

7. Concluding thoughts

Some 20 years ago, the Advisory Council for Applied Research and Development in the UK observed that if society really wanted to treat intellectual property like tangible property, society would prosecute alleged offenders at public expense. If tangible property is stolen, the police prosecute: if intellectual property is stolen, the owner must prosecute (ACARD, 1980). In consequence, only rich owners have protection, but also in consequence, society absolves itself of much responsibility for intellectual property rights. Society delegates its powers to rich patent owners, who act as feudal barons or privateers armed with the monarch's writ to pillage where they will. Indeed, outraged at the usurpation of its property, the pharmaceutical industry accuses others of piracy. Consider this from the president of one large pharmaceutical group:

> Les produits génériques sont des actes de piraterie qui seront éradiqués comme l'avait été la piraterie au XVII siècle.
>
> (Quoted in Cohen, 2001)

It matters not whether the accusation is justified; what does matter is that the model is misleading, a distraction. The real pirates are not those who steal innovation from patent owners, but those who steal the system of encouraging innovation from the public.

There are now many who avoid innovation and seek wealth from the patent itself. The drivers of a modern economy are public relations, advertising, and the media; presentation and spin are crucial. The surreal is a more valuable asset than the real, and the intangibility of information activities offers positive advantages in terms of flexibility in representation. The harder it is to define the product of information activities, the more necessary it is to employ indicators. The more these information activities are to be managed, the more the impact of management must be measured and translated into bonuses and share prices, a process overseen by the accounting profession. In this virtual world, the patent can represent – can be – almost anything – an entitlement, an encapsulation of information, an insurance, a currency, an advertisement, a weapon, a status symbol (Mann and Canary, 1993), a reward, a signal. In this world, there is no pressure from patent owners to have their property treated more like tangible property; the less tangible the better. With the expanding scale and scope of patents, the relationship between patenting and innovating becomes more and more distant, and the value of the patent's intangibility the greater.

The way out of this surreal mess is plain. Society must assert its rights and ensure that the patent bargain delivers the public value it is supposed to deliver. It is no longer satisfactory to delegate enforcement of the bargain to the barons and privateers, or to rely on their assessment of the public benefits the system is meant to bring. Actually, it never was satisfactory, but the situation is now a little more critical. The patent system is in some danger of becoming just another management method, the equivalent of business process re-engineering or total quality, though in technical disguise and with rather more strategic potential. There is no public outrage, nor will there be until faith in the innovation myth is shattered. An illusion that has long sheltered the pharmaceutical industry now hides an even greater public menace. Of course, management fads come and go, as do dot.com companies, and accounting standards. It may be that the strategic use of patents will soon become a casualty of fashion and there will be no need to lose the reassurance of the innovation myth. After all, without the innovation myth to give us faith in the patent system, what would we think of it?

References

Abrahamson, E., 1996. Management fashion. Academy of Management Review 21 (1), 254–285.
ACARD, 1980. Exploiting Invention. Report to the Prime Minister, London, December.
Afuah, A., 1999. Strategies to turn adversity into profits. Sloan Management Review Winter, 99–110.
Aharonian, G., 2001. Why all business methods achieve a technical effect, October. Available from http://www.bustpatents.com/aharonian/technical.htm (accessed 20 July 2002).
Angell, M., Relman, A., 2002. Patents, profits and American medicine: conflicts of interest in the testing and marketing of new drugs. Daedalus, Spring.
Anon., 1998. ATMI's intellectual property portfolio reaches 100 patents. Business Wire, 6 October.
Anon., 2000. Review of Kevin G. Rivette and David Kline, Rembrandts in the Attic. Whole Earth, Winter.
Anon., 2002. AMD ranks fifth among US companies in US patents awarded. Business Wire, 22 January.
Anon., 2002. German government opposes software patents. Available from http://news.zdnet.co.uk/story (accessed 16 July 2002).
Arora, A., 1997. Patents, licensing, and market structure in the chemical industry. Research Policy 26, 391–403.
Australian Patent Office, 1981. Patent Literature – A Source of Technical Information. AGPS, Canberra.
Betts, P., Groom, B., 2001. Industry urges faster EU reform. Financial Times, 20 March, p. 1.
Blackman, M., 1994. Taking patent information services to small and medium enterprises. Intellectual Property in Asia and the Pacific 40, 44–67.
Boyle, J., 2002. Fencing off ideas: enclosure and the disappearance of the public domain. Daedalus (Spring), 13–25.
Braun, E., Macdonald, S., 1982. Revolution in Miniature. The History and Impact of Semiconductor Electronics. Cambridge University Press, Cambridge.
Breheny, M., McQuaid, R. (Eds.), 1987. The Development of High Technology Industries: An International Survey. Croom Helm, London.
Brotz, D., 1994. Public Hearing on the Use of the Patent System to Protect Software Related Inventions. San Jose CA, 26 January.
Caulfield, T., Gold, E., Cho, M., 2000. Patenting human genetic material: refocusing the debate. Perspectives 1, 228–231.
Charles, D., Conway, C., 2001. Higher Education-Business Interaction Survey. CURDS, University of Newcastle upon Tyne, December.

Cohen, D., 2001. La propriété intellectuelle, c'est le vol. Le Monde, 8–9 April, 1, 13.
Cohen, W., Nelson, R., Walsh, J., 2000. Protecting their Intellectual Assets: Appropriability Conditions and Why US Manufacturing Firms Patent (or Not). National Bureau of Economic Research Working Paper 7552.
Collins, D., 2000. Management Fads and Buzzwords. Routledge, London.
Conner, K., 1988. Strategies for product cannibalism. Strategic Management Journal 9, 9–26.
Drahos, P., 2000. Trade-offs and Trade Linkages: TRIPS in a Negotiating Context. Quaker United Nations Office Occasional Paper 1, September.
Dunford, R., 1987. The suppression of technology as a strategy for controlling resource dependence. Administrative Science Quarterly 32, 512–525.
Economist, 2001. The right to good ideas. 23 June, pp. 27–28.
Economist, 2001. An end to slavery. 24 November, p. 76, 81.
Economist, 2001. Patent problems pending. 27 October, p. 14.
Economist, 2001. Patent remedies. 27 October, p. 100.
Economist, 2002. Mercky prospects. 13 July, pp. 59–60.
Eisenberg, R., Nelson, R., 2002. Public vs. proprietary science: a fruitful tension? Daedalus (Spring), 89–101.
Feller, I., 1990. Universities as engines of R&D-based economic growth: they think they can. Research Policy 19, 335–348.
Foley, S., 2001. Drugs company refuses to relax crucial patent. Independent, 24 October.
Foley, S., 2002. Glaxo dives on patents setback in US court. Independent 25 May, 21.
Forester, T., 1993. Silicon Samurai. How Japan Conquered the World's IT Industry. Blackwell, Oxford.
Frieswick, K., 2001. License to steal? CFO Magazine for Senior Finance Executives, September.
Gibson, S., 1992. US Patent Office's softening opens floodgates for lawsuits. Infoworld 14 (35), 36.
Glass, B., 1990. Patently unfair? Infoworld 12 (44), 56–62.
Glass, B., 1992. Modem users, fear not; it's just the sound of patent attorneys. Infoworld 14 (31), 81.
Godwin, M., 2002. Prescription panic: how the anthrax scare challenged drug patents. Reason, February.
Griliches, Z., 1990. Patent statistics as economic indicators. Journal of Economic Literature 28, 1661–1707.
Griliches, Z., Hall, B., Pakes, A., 1991. R&D, patents, and market value revisited: Is there a second (technological opportunity) factor? Economics of Innovation and New Technology 1, 183–201.
Grindley, P., Teece, D., 1997. Managing intellectual capital: licensing and cross-licensing in semiconductors and electronics. California Management Review 39 (2), 8–41.
Hall, B., Ham, R., 1999. The Patent Paradox Revisited: Determinants of Patenting in the US Semiconductor Industry. National Bureau of Economic Research Working Paper 7062.
Harvey, D., 1989. BTG: the mother of invention. Director (September), 121–122.
Hazelwood, S., 1999. Pending cases will set tone for new patent field. Business Journal, 24 December.
Heller, M., Eisenberg, R., 1998. Can patents deter innovation? The anticommons in biomedical research. Science 280, 698–701.
Horstmann, I., MacDonald, G., Slivinski, A., 1985. Patents as information transfer mechanisms: to patent or (maybe) not to patent. Journal of Political Economy 93 (5), 837–858.
Howes, K., 1993. The shield and the sword. Satellite Communications 17 (1), 6A–9A.
Huczynski, A., 1993. Explaining the succession of management fads. International Journal of Human Resource Management 4 (2), 443–463.
Intellectual Property and Competition Review Committee, 2000. Review of Intellectual Property Legislation under the Competition Principles Agreement. IP Australia, Canberra, September.
Johnston, R., Carmichael, S., 1981. Australian Science and Technology Indicators Feasibility Study – Private Enterprise, Department of Science and Technology Occasional Paper 4/81, Canberra.
Joseph, R., 1989. Silicon Valley myth and the origins of technology parks in Australia. Science and Public Policy 16 (6), 353–366.
Kass, L., 1982. The right to patent. Dialogue 58 (4), 42–45.
Kevles, D., 2002. Of mice and money: the story of the world's first animal patent. Daedalus (Spring), 78–88.

Kortum, S., Lerner, J., 1999. What is behind the recent surge in patenting? Research Policy 28, 1–22.
Kretschmer, M., Soetendorp, R., 2001. The strategic use of business method patents: a pilot study of out of court settlements. Journal of e-Business 2 (1), 9–38.
Labich, K., 1988. The innovators. Fortune 6 (June), 27–32.
Lanjouw, J., Lerner, J., 1997. The Enforcement of Intellectual Property Rights: A Survey of the Empirical Literature. National Bureau of Economic Research Working Paper 6296. Cambridge, MA.
Leadbeater, C., 1999. New measures for the new economy. Paper presented to the symposium on Measuring and Reporting Intellectual Capital: Experience, Issues and Prospects, Amsterdam, June.
Lerner, J., 1995. Patenting in the shadow of competitors. Journal of Law and Economics 38, 463–495.
Lerner, J., 2002. The patent system and competition statement to the Federal Trade Commission/ Department of Justice hearings on competition and intellectual property law and policy in the knowledge-based economy. Available from www.ftc.gov/opp/intellect/lernerjosh.pdf (accessed 22 June 2002).
Macdonald, S., 1990. Technology and the Tyranny of Export Controls. Whisper Who Dares. Macmillan, London.
Macdonald, S., 1995a. Culture and image in international strategy: engineering and metal-bashing. Technology Analysis and Strategic Management 7 (4), 355–369.
Macdonald, S., 1995b. Too close for comfort. Implications for strategy and change arising from getting close to the customer. California Management Review 37 (4), 8–27.
Macdonald, S., 2001. Managing with method: information for innovation. In: Lamberton, D. (Ed.), Managing the Global: Globalisation, Employment and Quality of Life. Tauris, London, pp. 209–221.
Macdonald, S., 2002. Exploring the hidden costs of patents. In: Drahos, P., Mayne, R. (Eds), Global Intellectual Property Rights: Knowledge, Access and Development. Macmillan, Basingstoke.
Macdonald, S., 2003. Worlds apart: Patent information and innovation in SMEs. In: Blackburn, R. (Ed.), Intellectual Property and Innovation Management in Small Firms: Results from a Research Programme. Routledge, London 123–143.
Macher, J., Mowery, D., Hodges, D., 1998. Reversal of fortune. The recovery of the US semiconductor industry. California Management Review 41 (1), 107–136.
Machlup, F., 1958. An Economic Review of the Patent System. Studies of the US Patent System No. 15, US Senate Sub-committee on Patents, Trademarks and Copyrights, USGPO, Washington DC.
Mandeville, T., Bishop, J., 1982. Economic effects of the patent system: results of a survey of patent attorneys. In: Mandeville, T., Lamberton, D., Bishop, J. (Eds.), Supporting Papers for Economic Effects of the Patent System. AGPS, Canberra, p. 16.
Mann, M., Canary, P., 1993. Protecting innovation through patents. Business and Economic Review 39 (2), 25–27.
Markham, J., 1962. Inventive activity: Government controls and the legal environment. In: National Bureau of Economic Research, The Rate and Direction of Economic Activity. Princeton University Press, Princeton NJ.
Merges, R., Nelson, R., 1990. On the complex economics of patent scope. Columbia Law Review 90 (4), 839–916.
Merges, R., 1988. Commercial success and patent standards: economic perspectives on innovation. California Law Review 76, 805–876.
Merges, R., 1997. Patent Law and Policy. Michie, Charlottesville VA.
Miller, W., 1988. Productivity and competition: a look at the pharmaceutical industry. Columbia Journal of World Business, Fall, 85–88.
Moss, C., Evans, A., 1987. Protecting ideas and new products. Industrial Management and Data Systems (September/October), 21–24.
Mossinghoff, G., Bombelles, T., 1996. The importance of intellectual property protection to the American research-intensive pharmaceutical industry. Columbia Journal of World Business 31 (1), 38–48.
Mowery, D., Sampat, B., 2001. Patenting and licensing university inventions: lessons from the history of the Research Corporation. Industrial and Corporate Change 10 (2), 317–355.
Narin, F., undated. Patent indicators, international technology comparisons and company stock performance. Available from http://www.interdependenc.org/pages/Narin.htm (accessed May 2002).

National Science Foundation, 1998. Science and Engineering Indicators 1998. National Science Board, Washington, DC.
Nies, H., 1993. Ten years of patent law development under the US Court of Appeals for the Federal Circuit. IIC: International Review of Industrial Property and Copyright Law 24 (6), 797–802.
O'Donoghue, T., Scotchmer, S., Thisse, J.-F., 1998. Patent breadth, patent life, and the pace of technological progress. Journal of Economics and Management Strategy 7 (1), 1–32.
O'Shaughnessy, J., 1996. Strategy for the times: intellectual property can drive corporate responsibility. In: Parr, Russell L., Sullivan, Patrick H. (Eds.), Technology Licensing, Corporate Strategies for Maximizing Value. Wiley, New York, 147–173.
Pakes, A., Griliches, Z., 1980. Patents and R&D at the firm level. Economics Letters 5, 377–381.
Patel, P., Pavitt, K., 1995. Patterns of technological activity: their measurement and interpretation. In: Stoneman, P. (Ed.), Handbook of the Economics of Innovation and Technological Change. Blackwell, Oxford, pp. 14–51.
Patel, P., Pavitt, K., 1991. Large firms in the production of the world's technology: an important case of 'non-globalisation'. Journal of International Business Studies 22, 1–21.
Pavitt, K., 1985. Patent statistics as indicators of innovative activities: possibilities and problems. Scientometrics 7 (1–2), 77–99.
Perry, N., 1986. The surprising new power of patents. Fortune 23 (June), 73–83.
Peters, T., Waterman, R., 1982. In Search of Excellence. Lessons from America's Best-Run Companies. Harper & Row, New York.
Pilling, D., 2001. Patent case holds key for drug groups. Financial Times 18 (April), 12.
Powell, W., 1996. Inter-organizational collaboration in the biotechnology industry. Journal of Institutional and Theoretical Economics 152, 197–215.
Puttre, M., 1998. A banner year for Big Blue patents, Design News, 16 February.
Quintas, P., Guy, K., 1995. Collaborative, pre-competitive R&D and the firm. Research Policy 24, 325–348.
Rivette, K., Kline, D., 2000a. Discovering new value in intellectual property. Harvard Business Review January/February, 54–66.
Rivette, K., Kline, D., 2000b. Rembrandts in the Attic. Unlocking the Hidden Value of Patents. Harvard Business School Press, Boston MA.
Rosenberg, N., Nelson, R., 1994. American universities and technical advance in industry. Research Policy 23, 323–348.
Rothwell, R., 1992. Successful industrial innovation: critical factors for the 1990s. R&D Management 22 (3), 221–239.
Rubenstein, D., 1998. Patent profits. Industry Week, 2 November.
Schumpeter, J.A., 1939. Business Cycles. McGraw-Hill, New York.
Scotchmer, S., 1991. Standing on the shoulders of giants: cumulative research and the patent law. Journal of Economic Perspectives 5 (1), 29–41.
Scullion, J., 2002. Patenting Genes: An Analysis of the Interaction between Law and Industry in Policy Formulation, CIPPM Working Paper 3, Bournmouth University.
Shapiro, C., 1990. Responding to the changing patent system. Research Technology Management 33 (5), 38–43.
Shapiro, C., 2001. Navigating the patent thicket: cross licences, patent pools, and standard-setting. In: Jaffe, A., Lerner, J., Stern, S. (Eds.), Innovation Policy and the Economy, vol. 1. MIT Press, Cambridge, MA, 119–150.
Shulman, S., 1999a. Owning the Future. Houghton Mifflin, Boston.
Shulman, S., 1999, Patent absurdities. Sciences, January.
Silverman, A., 1990. Intellectual property law and the venture capital process. High Technology Law Journal 5 (1), 157–192.
Sosnin, B., 2000. A pat(ent) on the back. HR Magazine, March.
Spero, D., 1990. Patent protection or piracy – a CEO's view. Harvard Business Review (September/October), 58–67.
Sullivan, P., Daniele, J., 1996. Intellectual property folios in business strategy. In: Parr, R., Sullivan, P. (Eds.), Technology Licensing, Corporate Strategies for Maximizing Value. Wiley, New York, 27–48.

Sulston, J., Ferry, G., 2002. The Common Thread. A Story of Science, Politics, Ethics and the Human Genome. Bantam, London.
Taylor, C., Silberston, Z., 1973. The Economic Impact of the Patent System. Cambridge University Press, Cambridge.
Thurow, L., 1997. Needed: a new system of intellectual property rights. Harvard Business Review (September/October), 95–103.
Trune, D., Goslin, L., 1998. University technology transfer programs: a profit/loss analysis. Technology Forecasting and Social Change 57, 197–204.
Turner, J., 1998. The nonmanufacturing patent owner: toward a theory of efficient infringement. California Law Review 86, 179–210.
Udell, G., 1990. It's still caveat, inventor. Journal of Product Innovation Management 7, 230–243.
Vos, E., 2000. Views of the pharmaceutical companies on the new EU licensing procedures. ESRA Rapporteur (March–April), 22–27.
Wheelwright, J., 2002. Review of Healy, D. The Creation of Psychopharmacology. Independent, 7 May, p. 12.