MEETING NELSON'S CONCERNS ABOUT INTELLECTUAL PROPERTY

by

William Kingston

(School of Business Studies, Trinity College, Dublin.

e-mail: wkngston@tcd.ie)

Abstract

In his recent writings, Richard R. Nelson has expressed concern at the way intellectual property has been developing. It has never been so much used as it is to-day, and yet it has never been so widely criticised. To improve it, an EU Committee of Experts has recommended consideration of this author's proposal to add a financial dimension to the existing measurement of grants by time. Empirical work that provides a first evaluation of such a possible change is reported, and some lines are sketched out for more refined research on how it might be introduced.

Keywords: Invention; intellectual property; patents; trademarks; copyright; computer programs; biotechnology; accounting for intangibles; R&D expenditures; small business.

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1. Introduction: Nelson's concerns

Intellectual property is hardly mentioned in Nelson and Winter's famous book, except for some references to patents in Chapters 16 and 17. In recent years, however, it has become "a kind of unrelenting economic force" (Merges 1996 p. 1294) and Nelson has been paying correspondingly more attention to it in his writings.

Three examples will illustrate that he has serious doubts about the way in which intellectual property has been developing. In discussing how recent growth in interest in it is associated with a general view that "is heavily weighted toward the proposition that strong and broad patent rights are conducive to economic progress," he urges caution in respect of this proposition (Mazzolini and Nelson 1998 p. 274). Since he sees progress in any field of technology being made most rapidly when several firms are making incremental improvements to an invention along overlapping or competing trajectories (cf. 2000a p. 67) he believes that early freedom to use inventions should be an essential component of intellectual property (Merges and Nelson 1990 p. 908). Unfortunately, what has been happening is the opposite of this. Thirdly, Nelson has expressed particular concern about "the intrusion of intellectual property into what used to be the domain of public open science…I am calling, more broadly, for rewriting patent law, or at least revising patent practice, to keep intellectual property rights away from fundamental discoveries…" (2000b pp. 12, 15).

Intellectual property has indeed grown in importance with quite extraordinary rapidity during the last two decades. Amongst the contributory factors have been the explosion of software development and the use of copyright and patents to protect it; the growth of biotechnology and the patentability of its inventions; the development of electronic databases and arrangements for protecting investment in them; the multiplication of patents arising from University research; and the establishment in 1994 of the Trade-Related Intellectual Property Section (TRIPS) of the World Trade Organization with the objective of bringing about world-wide enforcement of intellectual property rights.

Yet, as the new professor of intellectual property law in the University of Oxford recently stressed in his inaugural lecture (which in fact is an independent endorsement of Nelson's concerns) all this formidable apparatus is "in crisis" (Vaver, 2000). Intellectual property protection has never been so much used, and at the same time its operation has never been so widely criticised. The present Paper argues that an important cause of this is the continued use of time as the measure of grants of protection. This is an inflexible means compared with the proper measure, which can only be money, and the achievements of accounting make it no longer necessary so suffer its disadvantages.

2. Details of the problems

There are two main roots of the present difficulties with intellectual property. The first of these is the shift from individual to corporate production of what is to be protected. In their origins, the two main types of modern intellectual property, patents and copyright, were directed towards protecting the results of *individual* creativity. This was typically expressed in Article I.8 of the United States Constitution which gives Congress power to legislate to confer exclusive rights on "inventors and authors for the protection of the creations of their minds." From the middle of the nineteenth century, however, invention progressively became the output of purposive, large-scale research in corporate laboratories, rather than originating from “flashes of genius” on the part of identifiable individuals. Similarly, with the arrival of recorded music, the cinema and broadcasting, much literary and artistic creation, which is the subject-matter of copyright, changed from being the output of independent individuals to “works produced for hire.”

The second root of intellectual property’s modern disfunctionality is that information and knowledge of quite new types have been emerging, and these have been shoehorned into the existing system to give them protection. There is no shortage of evidence that this process is becoming more and more difficult, and that the results are progressively less satisfactory. These new kinds of information are simply not receiving protection that is appropriate to their needs. Consequently, it is now being argued that

> The world’s one-dimensional intellectual property system must be overhauled to create a more differentiated one. Trying to squeeze to-day’s developments into yesterday’s system of intellectual property rights simply won’t work. One size does not fit all (Thurow, 1997, p. 103).

2.1 System breakdown

It was never going to be easy to adjust intellectual property to take account of both of these fundamental changes, and indeed this has been achieved only partially. Intellectual property, in fact, is “frozen” into a dual patent-copyright paradigm, and a typical expert statement of what has happened is the following:-

> [T]he nineteenth century vision that subdivided world intellectual property law into discrete and mutually exclusive compartments for industrial and artistic property has irretrievably broken down. The theory that the classical patent and copyright models coherently address the way intellectual creations behave has been discredited by its inability to deal adequately with the behavior of

> many commercially valuable, cutting-edge intellectual creations. These recent technological creations account for an ever-growing share of the gross domestic products of both developed and developing countries (Kronz, 1983, pp. 178, 180, quoted in Reichman, 1994, p. 2500).

3. Money in the measure of intellectual property grants.

Part of the overhaul which Thurow calls for should be to add money to time in the measurement of intellectual property grants. This author's proposal for such a change was first mooted in 1987 and was then the subject of some empirical research in 1994. It has recently been recommended for official consideration by a European Union expert advisory group in the following terms:

> Invention and radical innovation can never be other than a cost from the point of view of industry accounting procedures. In to-day's complex technologies, money is only made by those firms that can develop them into commercial products through subsequent incremental changes. There is now persuasive evidence that progress in any field of technology is made most rapidly when several firms are competing to capture a share of a new market, and to widen the scope of application of an invention, through making such incremental improvements along different and competitive "trajectories."
>
> The recognised comparative failure of European firms to commercialise inventive and RTD efforts is partly explained by this. No firm can exploit more than a single trajectory of incremental change properly. Proprietary rights can prevent firms which could exploit other trajectories from doing so, thus also depriving the originator of competitive pressure to move along the learning curve as fast as possible. Eventually, products from foreign firms which incorporate more incremental improvements, gain an advantage in the market.

A useful contribution towards solving this problem would be the compulsory licensing of intellectual property, consistent with Articles 7, 8(1), and 8(2) (though Article 31 should also be noted) of the Agreement on Trade related Aspects of Intellectual Property Rights (TRIPS), subject to the condition of maintaining, and if possible improving incentives to invent and innovate.

It has been proposed with support from empirical research that this could be achieved by changing from time to money as the measure of any grant of intellectual property. The proper measure of any economic privilege, in fact, can only be money. No doubt at the time when intellectual property originated, any measure other than time was out of the question, since accounting techniques were undeveloped.

But to persist with such a poor measure as time to-day is simply to ignore all the achievements of accountancy since, which are now capable of providing the measurement required. Many of the problems of intellectual property rights, especially in new fields such as biotechnology and information processing, are actually caused by having to use time as the very crude measure of a patent, copyright or other grant.

The empirical research underlying this proposal shows how incentives to invent could be maintained or even enhanced by the use of capital payments for licences, instead of royalties. We think that if both objectives of this proposal could be achieved, there would be considerable benefits in terms of S&T policy. We therefore consider that although this is clearly a long-term project, it is worth investigating further (ETAN Report, 1999, Section 3.4).

4. The accounting calculations

The advantages of bringing money into the measurement of intellectual property which led the EU Committee to this conclusion will be discussed further below. Before this, it is necessary to examine the nature of the proposal in more detail, including its practicality.

As the ETAN Report observes, when intellectual property first came into existence, there was no alternative to time as its measure, although there is a neat conjunction between the first Venetian patent ordinance in 1474 and Paciola's treatise on formal double-entry bookkeeping, published in the same city twenty years later. Early copyrights, for example, were for a term of apprenticeship (7 years); patents for two terms. A modern patent gives its owner 20 years exclusivity in making, using and selling the invention. It is obvious that it can only be by chance that this term is just what is needed to attract the relevant investment, and that in most cases it will either be too long or too short. In at least one patented invention used in the Concord aircraft, for example, the protection had actually expired before the first aircraft flew.

In any event, time as a measure is no more than a surrogate for money. If all inputs and outputs could be measured accurately, then the logic of a grant of protection would have it last until an investor in R&D had received a multiple of the investment made which exactly corresponded to the risk which was taken in making itSuch a multiple would in fact be the reciprocal of that risk. With a lower multiple, the risk would be regarded as too high, and the investment would not be made, thus possibly depriving the public of something new and useful; with a higher one, the protection - and consequently the private benefit - would be more than it needs to be, and the public benefit (in terms of lower prices and/or improved products from competitors) correspondingly lower.

Such comprehensive measurement is out of the question, not least because so much risk is subjectively-assessed, and we aare unable to evaluate how much one investor may differ from another in terms of risk-aversion. It would therefore be necessary to fall back on some socially acceptable multiple. This could either be a single figure, applicable to all investments in R&D, or there could be different multiples for different technologies, according to evidence that risk in some is higher than in others, or even because a greater public need for invention in some areas is considered to justify a bigger incentive.

4.1 The profits "multiple"

The first approach towards introducing money into the time measure of intellectual property considered this way of measuring both investment and gains. According to it, a firm's protection of information it had generated would last until it had earned profits from an invention that were a prescribed multiple of its original risky investment in it (Kingston, 1987). Once the accounting practicalities came to be considered, however, it became obvious that this could not be done until costs and profits in multi-product firms could be allocated definitively with much more precision than is the norm at present. In particular, it would be necessary to devise and impose effective procedures to prevent managements from loading ongoing costs from non-protected products on to protected ones. This would improve profits on the former and ensure that protection on the latter would never run out, because profits on them could be prevented from ever reaching the multiple. The ability shown by Ferranti in the U.K. and Lockheed in the U.S. to manipulate their receipts under cost-plus Defence contracts in this way confirmed just how difficult it would be to develop a fraud-proof system.

4.2 Compulsory licencing instead of monopoly

This first approach had envisaged maintaining the monopoly element in the intellectual property grant, although the length of this monopoly was now intended to be varied according to the profits earned. Recent academic research, however (much of it by Nelson himself) has questioned the efficacy of monopoly for innovation, because it delays the start of *incremental* innovation along different trajectories by competing firms (cf. Merges and Nelson, 1990). The patenting of genes illustrates another facet of this, in that commercial applications need a number of gene fragments, so that the owner of a patent on a single one of these is in a "blocking" position that can hold development up to ransom (Heller and Eisenberg, 1998).

In fact, it is ironic that if the existing patent system actually worked in practice as it is supposed to do in theory, there would be even less innovation than there is. Empirical research has shown that in contrast to a U.S. patent's former nominal 17-year term, the average period of effective protection was no more than three years (Mansfield et al. 1981; Levin et al. 1987). Worse still, the cost to the imitator of producing a competitive product within that period, has been shown to be less than what the invention had cost the originating firm. Instead of relying for innovation diffusion on the failure of the patent system to deliver the protection it promises, therefore, it would clearly be better to use compulsory licencing to get the process of diffusion started as early as possible.

This would not eliminate the monopoly element in grants, but would change it from the exclusive right of "making, using and selling," to that of granting licences to others to "make, use and sell." It would put into practice the dictum of Chief Justice Ellenborough that whosoever "will take the benefit of the monopoly, he must as an equivalent perform the duty attached to it on reasonable terms" (Quoted in Epstein 1998 p. 283: 104 English Reports 210-211).

Innovatory managements have never shown any enthusiasm for compulsory licencing, because they think that any form of copying must mean loss to whoever originates information. This is not necessarily the case. Scherer's study of such licencing in more than 100 U.S. Antitrust settlements showed “little if any adverse impact on the target companies’ R&D investments” (2001).

A classic example of this is the transistor, which in fact we know about through Richard Nelson’s own early research. Because of an Antitrust Consent Decree, Western Electric, the owners of Bell Laboratories where it was invented, was prevented from manufacturing transistors itself. Consequently, it licenced the patent widely (Nelson, 1962). According to conventional wisdom, it should have lost out through not having a patent monopoly to exploit exclusively. In fact, it is far more likely that so many firms took a licence from Bell Labs. that the number of fields of *application* of transistors grew much more rapidly than it would have done if transistor development had remained exclusively in Western Electric’s hands. The resulting new markets provided opportunities for Western Electric which developed quicker and were eventually larger than if the firm had been the sole exploiter of transistors through a patent monopoly. The wealth of the world was undoubtedly much greater, and Western Electric shared in this additional growth. Because of the compulsory licencing which led to this growth, it probably made more money out of its path-breaking invention in the end. It is also significant that the most profitable of all University-originating patents, for the Cohen-Boyer gene-splicing invention, is also the most widely licenced.

4.3 A multiple of R&D costs

Given compulsory licencing, how could investors in R&D still be enabled to hope for high returns to match the risks they run? The idea of a multiple of R&D costs was again invoked, but this time it would define the amount of a *capital* payment for a licence. The objective would be to ensure that a second or later comer could be allowed to use an originator’s information by sharing retrospectively in the investment *and in the risk* which had brought the information into being. A model for establishing the price for a compulsory licence could therefore be seen as a sort of inverted version of Capital Asset Pricing. The price of a compulsory licence cannot be computed in the same manner as the values of other financial assets - namely as the present value of the expected future cash flow stream discounted at an appropriate risk-adjusted rate of return. Licencees may be able to estimate their expected cash flows as a function of the profits derived from the exploitation of a licence, but no-one can calculate the risk the originator took to produce information which others, once they grasped its commercial significance, would want to use. This is all the more so, since the very first money that is put behind an idea involves uncertainty rather than risk, and is to that extent irrational. For these reasons, some socially-acceptable multiple of the money the originator risked must be used to set the price of a licence which is to be compulsory. Moreover, such a multiple must be attractive enough to encourage very high-risk investments.

The logic of payment for such a licence through a once-off capital amount, rather than by royalties, is that this investment is now a sunk cost for the originator. If the objective is to have a second or later comer share retrospectively in both the amount and the risk of the investment which the originator had made, there is no reason why that sharing should be dependent on a licencee's future success in using the information, which would be the case with royalty payments.

It should be stressed that the multiple would only set the price at which the originator of information would *have* to grant a licence for its use by another. The proposed arrangements would not prevent any type or number of licence agreements between willing buyers and willing sellers. No licence which would be granted under the present system, therefore, could be prevented by what is now proposed.

4.4 Initial empirical research

The records of the Small Business Innovation Research Programs (SBIR) in the United States provided a source of empirical data on how such compulsory licencing arrangements might work out in practice. These programs were established by Statute in 1982, according to which all the public Agencies with the biggest research contract budgets are bound to divert a small percentage of their funds to firms with no more than 500 employees, according to a prescribed formula. This involves at least one open competition annually for first stage awards of up to $75,000 and second stage awards of up to $750,000, the intention being that venture capitalists will take over in the third stage to bring the best ideas to market. These programs have been extremely successful, and now put more than $1 billion annually into smaller-firm R&D (State of Small Business: a Report of the President (1997).

The results of these awards in terms of commercial products are carefully monitored and published by the U.S. Small Business Administration. Thus, it was possible to track the full history of 23,000 cases, involving about 200,000 applications. Each of these applications presumably was for an idea which the owners or managers of a firm considered to have the potential of eventually being a new product on the market. What makes these histories so valuable is that an SBIR award covers all research costs, including the firm's normal overhead. It is even recognised that the conduct of research has an opportunity cost for a firm in terms of management distraction from more immediately paying activities, and consequently 7% of an award can be taken as a contribution to this.

4.5 First estimates of "multiples"

In all these 23,000 cases, where the full cost of the R&D is known, the records show that 1 in 9 applications won a first-stage award, that 1 in 2 of these won a second-stage award, and that 1 in 6 of these in turn became a product on the market within 7 years. The results make it clear just how risky the innovation process is. Since the probability of a series of discrete events is the product of their individual probabilities, the odds against an idea going through all stages and becoming a product on the market are worse than one hundred to one. Many products fail after reaching the market, so that the odds against having a real "winner" must be very much worse.

From the point of view of what is now proposed for reform of intellectual property, it is the figures for risk at each stage that are most useful. The reciprocal of these estimates of risk is the corresponding "multiple" which would put an investor who comes in at a later stage on level terms with the originator. That is, by paying the originator the appropriate multiple of what the originator had invested in generating the information, for the right to use it, a newcomer would share fairly, retrospectively, in both that investment *and its risk.*

From the SBIR figures, therefore, assuming that the amount of a first stage award enables enough information to be produced to obtain a patent or to make a prototype, and another firm now wishes to take advantage of this, it appears that this second firm ought to pay eight times the originating firm's investment in R&D to date for a compulsory licence. If the second firm was more cautious, so that it waited to compete until the first firm had actually reached the stage of putting a product on the market, then the payment should be four times the first firm's R&D expenditure to that time, which would of course be very considerably larger than it had been to the patent/prototype stage (Kingston, 1994).

5. Research for general application

It was possible to obtain these first insights into "multiples" because in the cases studied, all the R&D costs were paid by the State through SBIR awards, for which comprehensive data are published. General application of the arrangements proposed would depend in the first instance upon how far modern accounting techniques are capable of establishing an acceptable base figure for the cost of R&D on particular informational outputs, when firms are funding it themselves. This is the figure to which the multiple would eventually apply to set the price for a compulsory licence to use the information. On this point, it has been expertly observed that

> proving such costs will not be difficult or burdensome. Patent applicants and patentees collect this information anyway for a variety of reasons, including 1) tax benefits, 2) internal cost accounting, 3) use in project evaluation, 4) use in licensing negotiations and the like. Patentees appear to have no trouble showing research expenditures at the damages stage of a patent infringement suit, and...such information has been introduced in some cases to show the nonobviousness of the invention involved. Simply adding one more reason to collect data on the cost of a research project does not appear to pose a major problem (Merges, 1992, p. 55).

It is also the case that analysts of high-tech stocks on the Nasdaq market are increasingly paying attention to price/R&D ratios, which in itself must be forcing innovatory firms towards more precise recording of their investments in research.

5.1 R&D portfolio or individual project?

Should the cost to which the multiple applies be that of a firm's entire portfolio of R&D projects, or only the cost of the single project to which the licence relates? A convincing reason for choosing the portfolio is the extent to which a single success may reflect many failures, so that the costs of these also deserve to be taken into account. A second reason for using the portfolio is that if the R&D costs of every individual product had to be measured precisely, the cost of record-keeping might become excessive.

Nevertheless, even with use of the R&D portfolio, there would still be an essential role for more precise accounting, because by no means all of what firms designate as R&D expenditure is high-risk. Particularly in engineering firms, much of the work of R&D departments is routine, dealing with eliminating design faults which have been discovered through actual use of products, or with incremental improvements. Often, too, because instrumentation is involved, testing of components or raw materials is assigned to the same department. The accounting practice in any firm seeking protection would therefore have to be precise enough to extract the costs of low or non-risk activities from any figure on which a claim for R&D investment is to be based.

It consequently seems that the protocols which would apply to the “R&D cost” aspect of the protection arrangements proposed would only require increased precision in accounting measurements, using techniques that are in common use already. Some fairly conventional empirical research would be needed to establish how far firms’ existing procedures are capable of providing the detail required, and what additional recording they would need to introduce so to enable the proposed arrangements to work. If new measurement costs imposed on firms are not excessive, it can be assumed that managements would be willing to bear the addition to their accounting budget, since protection of the results of their R&D is so important to them.

6. Establishing the “multiple”

Establishing an acceptable “multiple” or “multiples” would be much more demanding of research. It would probably be politically impossible to bring about the introduction of money into the time measure of intellectual property if it did not give at least as much incentive to invest at high risk in research and development as present arrangements do. This in turn would depend upon what multiple is applied to the cost of R&D to give the price of a compulsory licence. The obvious point at which to begin this research is to establish what sort of returns to investment in research and development the present intellectual property system actually delivers.

It is immediately clear that accounting’s current ways of valuing intangibles for balance sheet purposes would be of little help in this. The primary objective of these appears to be to ensure that intangible assets are not over-valued, and this is at its clearest in relation to brands, which are the most valuable of all types of such assets. A justifiable fear of all those who sign off accounts involving brands is that their values can change instantly and catastrophically, Perrier being a prime example. One day, it was the most valuable brand of bottled water in the world; the next, it was virtually worthless because its source had become contaminated. When the same thing happened to the Farley brand of infant food, a takeover which valued the business at £40 m. was aborted and liquidation of the business followed.

Periodical publishers are allowed to attribute a value to their titles, but intellectual property such as patents or copyrights is valued very conservatively indeed. Since balance sheet data will not do, other sources of information on the value of intellectual property must be sought, if a reasonable basis for calculating multiples is to be established. Several such sources appear to be quite promising.

6.1 Pharmaceutical risks and rewards

The pharmaceutical and related industries depend upon intellectual property protection more than any other, and are consequently the biggest single user of patents. The risks and rewards of pharmaceutical innovation have been well documented for many years, e.g. by Grabowski and Vernon (1990, 2000). Returns in this industry were very high in the 1950s, as the potential of the antibiotics revolution was harvested, then dropped because of more stringent health and safety regulations, and rebounded since the 1970s, due to factors such as extending the period of patent protection to take account of time lost in obtaining regulatory clearance.

Grabowski and Vernon report that new product introductions from the 1970s earned an average annual after-tax return of about 9%. However, the distribution of returns by individual product was skew, with the majority of their sample of 100 new drug introductions actually failing to meet average R&D costs. They comment:

> While many of these lower decile products will be contributors to firm profits (in the sense that incremental expected cash flows exceed incremental development and capital investment cost), a firm's fully allocated R&D costs must also be covered over the long run. In this regard, the results indicate that a firm must have an occasional "blockbuster" compound from the top deciles of a sales distribution, if it is to cover the large fixed costs which characterizes the drug development business (1990, p. 816).

These observations relate to established pharmaceutical firms. For the higher risks involved in start-up firms, Grabowski and Vernon quote evidence to U.S. House of Representatives Hearings to the effect that in order to obtain venture capital a new project must be projected to have the ability to generate a 25%-35% annual rate of return (2000, p. 207).

Clearly, all the Grabowski/Vernon and similar pharmaceutical industry data could be mined with great advantage for the task of establishing the multiple.

6.2 Empirical research on patent renewal fees

The skewness in the distribution of returns to R&D investment which Grabowski and Vernon noted in respect of pharmaceutical innovation is to be found to an even greater extent in other industries. This emerges from research in those countries which charge renewal fees for keeping patents in force, in which a group of scholars from Yale and the London School of Economics have specialised. The assumption of this research is that if such a fee is *not* paid, the patent's owner considers its value to have become effectively zero. It is then possible to restrict the focus of the research work to valuable inventions by examining only the patents which have their renewal fees paid for the maximum possible number of years. By doing this for German patents, Pakes put a maximum value on a patent of about $420,000 in 1980 dollars (1986, p. 777). Schankerman and Pakes reported that for patents in Britain, France and Germany, "the returns appear to be only a small fraction of the domestic R&D expenditure of the business enterprises." The means of the discounted sum of rewards from patent age 5 were about $7,000 in Britain and France and $19,000 in Germany. The value of patents as a proportion of total national R&D expenditure was 0.057 in France, 0.068 in Britain and 0.056 in Germany (1986, pp. 1068, 1074). Schankerman subsequently estimated that a subsidy to R&D of 15%-35% would be enough to provide an equivalent incentive to patents (1988, p. 95).

In extraordinarily sharp contrast, later work by Harhoff and Scherer (e.g. 1997, 1998) has produced estimates that are at least two orders of magnitude higher. They estimated the value of 772 German-owned patents renewed for the maximum possible term of 18 years by obtaining answers to the following question from their owners:

> If in 1980 you knew what you now know about the profit history of the invention abstracted here, what is the *smallest* amount for which you would have been willing to sell this patent to an independent third party, assuming

> that you had a *bona fide* offer to purchase, and that the buyer would subsequently exercise its full patent rights? (2000, p. 560).

The values were found to be so skewly distributed that a log normal curve gave the best fit. No less than 84% of the aggregate value was accounted for by the top 10% of the inventions studied. Bearing in mind that the latter are only the small minority (18% of all patents) whose patents were maintained for the maximum possible period, and making some allowance for the value of the patents which were not so maintained, it appears safe to assume that about four-fifths of the aggregate value of all patents is gained by only two or three per cent of them. The skewness of the distribution is further emphasised by the 69 highest-value patents, where it was found that

> Altogether, the best-estimate values ranged from less than DM 1 million (in 5 cases) to well over DM 1 billion. The mean value was DM 38.8 million if all 69 observations are averaged, and DM 15.1 million if the most lucrative invention, with a point estimate roughly 15 times that of the second most valuable invention, is excluded (1997, p. 11).

6.3 Relationship to R&D expenditure

Using the same technique, Scherer and Harhoff also investigated patents issued in Germany for inventions originating in the United States. These had the additional benefit that many of them could be matched to reported R&D expenditures:

> For the 48 companies with complete data, company-financed research and development outlays in 1976 totalled $4.8 billion, 27.6% of the reported $17.44 billion aggregate for all of U.S. industry in that year. Assuming an average value of $250 million for inventions valued at over $100 million, the total value of those companies' inventions was $5.16 billion. That the estimated value of linked full-term renewed inventions, which comprised only

> a small fraction of all the inventions patented by responding companies, exceeded (or at least approximated) total company-financed R&D outlays, suggests that on average the profit rewards to industrial R&D were appreciable (ibid.).

Similarly skewed patterns to these were later found in about 2000 observations from six other studies in the U.S., reflecting University as well as private firm research (Scherer and Harhoff, 2000, p. 560).

In terms of the research necessary before such estimates could be relied upon for establishing the multiple, the huge discrepancy between the results from the different studies, depending on the investigatory technique used, would first have to be resolved. The Scherer/Harhoff figures seem to paint a more realistic picture than those of Schankerman and Pakes, since it hardly seems likely that managements would continue to invest in R&D if the returns (only 5.5% of total R&D expenditure) were really as poor as they estimate.

On the other hand, any multiple derived from the Scherer/Harhoff data would be too high. With compulsory licencing, presumably the originator would continue to exploit the invention, which would be prevented if the buyer "would subsequently exercise its full patent rights," as their research question put it.

6.4 Use of patent citations

Yet another promising line of accounting research to help establish appropriate multiples relates to patent "citations." When one patent is cited in a later one, either by the inventor or by a patent examiner, it testifies to the fact that the later patent is building on the information in the earlier one, and hence to the quality of the latter. Work by Trajtenberg (1990) showed that citation levels are indeed an indication of value. Harhoff then expanded his work on German patents renewed for their full term by examining the extent to which they were cited, and found that citation frequency does indeed rise with economic value. For the most valuable patents, each of their citations in a later patent is associated with a value of more than $1 million (Harhoff et al., 1999). If it were found possible to extrapolate such results to patents which are not renewed for their full term, they might provide useful qualifications to the German data discussed above.

6.5 Dispute awards and settlements

Another valuable source of relevant data is the record of awards and settlements arising from litigation. These will not necessarily indicate the full value of a patent or copyright, but should at least give an approximate measure of the value of the information "stolen" from its owner by a single infringer. Appropriately discounted, and after stripping out litigation costs, this should be the *minimum* price that an infringer should have paid instead for a compulsory licence under the proposed arrangements.

The website www.bustpatents.com/awards.htm includes a list of 137 such awards or settlements in the United States. Half of these were for less than $100 million; 19 were from $100 million to $300 million; and there were 3 very large cases of $0.7 billion (Digital) $0.9 billion (Polaroid) and $1.2 billion (Litton Industries). It seems likely that study of the accounting calculations and estimates argued for by the parties or made by the Courts in these cases could be useful in establishing what multiples would need to be, so as to offer comparable incentives to invest in R&D to those of existing intellectual property.

7. Some implications of skewed value distributions

It is clear that one of the most difficult questions which accounting research would face arises from the skewness of rewards to investment in R&D. This has to be accepted as endemic, given the amount and quality of research already done. From the Grabowski/Vernon pharmaceutical data, it is evident that the multiple must be generous enough to enable firms to make more from their very few successes than from their many failures.The Scherer/Harhoff studies are a further reminder that investment in invention and innovation has many of the elements of a lottery. It is well-established that the motivation for buying lottery tickets is much less calculation of the chances of winning, than simply *the magnitude of the top prize.* People invariably look optimistically at their chances of winning. Whilst decision-making about large-scale R&D investments is presumably more rational than that of the general public in buying lottery tickets, the first money placed behind a new idea can never be completely rational. Consequently, it may not be possible to discount some effect on investors of hopes of "riches beyond the dreams of avarice."[1]

If this was the only factor, patent-owners might hope that each R&D project in which they invest would lead to a patent or patents amongst the 10% that are extremely valuable, rather than being in the 80% that either barely earn their keep or fail to provide any return at all. Expressed in terms of the German data quoted earlier, this could mean that at the limit, the multiple would have to hold out the possibility of being one of the five patents, each of which was worth DM 50 million or more, rather than being geared to the 552 patents renewed to full term (72% of the total) whose average earnings were less than a single million deutschmarks. But at such high multiples, no licences would be taken, so that all the potential benefits of bringing money into the time measurement of intellectual property would be lost. Consequently, the proposed arrangements should keep the multiple low enough to make taking a compulsory licence attractive, and provide for the possibility of very large returns to the originator *through multiple licences.*

[1] "When the sale of Thrale's brewery was going forward, Dr. Johnson appeared bustling about, with an ink-horn and pen in his button-hole, like an excise-man, and on being asked what he really considered to be the value of the property which was to be disposed of, answered, 'We are not here to sell a parcel of boilers and vats, but the potentiality of growing rich beyond the dreams of avarice" (Boswell, *Life of Johnson*,, 1791, Penguin edition 1979, p. 274).

7.1 Multiple licences

The socially-acceptable multiple of R&D cost would relate to a single licence. The more valuable an invention, the more licencees it could be expected to attract, and each of these would pay the same amount. The originator could also expect to benefit from expansion of the total market, through the competitive activities of each of these licencees in marketing and in incremental innovation.

Thus, in the pharmaceutical industry as measured by Grabowski and Vernon, if a single licence was bought at a multiple of no more than 2, it would put the product' value into the second decile from the top of returns. (Products in decile 8 slightly more than cover average R&D costs, which products in deciles 7 through 1 progressively fail to do). If three such licences were taken, the payments would put the product into the most profitable decile (the home of the "blockbuster" drugs).

7.2 Matching present incentives

These figures suggest that there should be different multiples for different industries, according to the risks prevailing. Since pharmaceutical firms depend overwhelmingly on the market power they possess from their intellectual property, their managements' decisions on investing in R&D to capture this, are likely to be the most rational and risk-averse. In contrast, risk-aversion does not enter at all into research under SBIR awards, because the State is funding 100% of the cost. No owners of a small firm - indeed no managers of a firm of *any* size - could rationally invest in R&D when the chances against even getting a product on the market are worse than 100 to 1, as the SBIR figures show them to be. Also, the SBIR calculations take no account of tax on returns, whereas the Grabowski/Vernon ones do.

Clearly, much accounting research would be needed before specific recommmendations could be made. Apart from explorations of the sources already discussed, there would be need to obtain data of the Grabowski/Vernon type for other industries, through study of firms' pricing calculations in proposals for investment in R&D, the actual outcomes in terms of decisions to endorse or reject a proposal, and in the case of endorsements, the eventual financial outcomes.

8. Beneficial results

On the assumption that accounting research can provide workable answers to the questions just discussed, the benefits of the proposal appear to include at least the following:-

8.1 Flexibility

Merges (1996) argues against compulsory licencing on the ground of its inflexibility, but this would not apply if it is associated with bringing money into the measurement of intellectual property grants in the way proposed. The combination would then operate in sharp contrast to the "one size fits all" characteristic of the present system. Varying the multiple according to industry could also reflect differentials in the importance of intellectual property in each, as compared with other kinds of market power. Complex technologies such as electronics, for example, have much less need for patent protection than pharmaceuticals or biotechnology. Changes to the multiple could be made as experience shows they are needed, for example to accelerate investment in a new technology which promised special public benefit.

8.2 More incremental innovation

Next, the public would obtain the benefits of competition in every field through the development of new ideas along as many different trajectories as the technology warranted, as in the transistor example. No firm would be prevented from developing any new market as long as it was ready to share retrospectively in both the investment and the risk which had brought that market into being.

8.3 Freeing up information use in complex technologies

Of all the types of industry and business which use intellectual property, the proposed change would be most beneficial in complex technologies, which are rapidly increasing in importance. Firms in these use patents in quite different ways to those in simple technologies, such as chemicals. They seek to protect "every blade of grass" by patents, so as to be able to use these as trading currency to prevent being locked out from use of competitors' incremental innovations. The need for this is due to banning of patent "pools" (which were an efficient way of achieving these transfers) by Competition Authorities, and it involves much wasted effort. Compulsory licencing with capital payments as proposed would have all the advantages of a patent pool, with no anti-competitive drawbacks (cf. Kash and Kingston, 2001).

8.4 Restoring the value of intellectual property to small firms

In any reform of intellectual property, special consideration needs to be given to the position of smaller firms. These are productive of inventions to a degree that is quite disproportionate to their resources. In the U.S., for example, they receive less than 4% of Federal support for research, yet they produce more than half of the innovations and get close to two-fifths of all patents (State of Small Business Report, 1997). Smaller firms are prolific users of intellectual property because they lack other types of market power to protect the information they produce. Larger firms can do this through their investments in productive assets, and in marketing (being early into a market has been shown to be of the highest value (Levin et al., 1987; Arundel et al., 1995; Cohen et al., 2000)).

There have been so many cases of large and dynamic new businesses which were built on a single radical invention (Xerox and Hewlett-Packard being outstanding examples) that it would be particularly desirable that bringing money into the measure of a grant was not harmful to smaller firms. One of the reasons why the SBIR Programs have been so successful is that (contrary to earlier U.S.

Government practice) awardees own the intellectual property arising from their research. It is this - and indeed only this - which enables them to obtain were easily able to get follow-on venture capital funding to bring their inventions to market. If large firms compulsory licences on new technology which smaller ones had originated, the small firms would be prevented from growing and industrial concentration would be intensified. Small firms with ideas would be vulnerable to large ones with money. In particular, new firms (which, as noted earlier, have to be able to offer the prospect of high returns to venture capitalists to enable them to take high early-stage risks) should not have their prospects clouded by arrangements which would bring competition into their market before they have found their feet.

Clearly, therefore, if the proposed change in the way intellectual property is measured is to reinforce smaller high-tech firms rather than to undermine them, this type of predation would have to be prevented. There are several ways in which this objective might be achieved. The most obvious is only to apply the proposed changes to larger businesses. Large firms might then object that small firms could obtain a compulsory licence from them, but the system would not work in reverse. (Such an imbalance might in fact be socially beneficial in terms of innovation, given the proven dynamism of small firms and the inertia of large ones). If it was necessary to meet this point, only firms whose own measurable R&D investment is above a prescribed threshold might be entitled to buy compulsory licences. Or the multiple could be weighted according to the relative size (or indeed, age) of the parties.

Still another possibility would be to set up facilities to assist small firms in buying licences to avoid the large-firm concentration which up-front capital charges caused when they were applied to oil and gas exploration licences in the U.S. (Scherer, 2001). There should of course be no question of applying the proposed changes to individual inventors, since their investment in R&D would be so small that a compulsory licence on any good invention they produced – which in fact is a very rare occurrence in spite of how skilfully the inventors' lobby articulates its case – could be obtained for very little. The classical monopoly- and time-based patent system was set up to protect them, and should revert to serving their needs. The changes now proposed are designed to deal with inventions which result from significant investment, not the "flashes of genius" of individual inventors.

8.5 Giving appropriate protection to software development

If the proposal were to be put into effect, the beneficial effects of intensified competition would be felt immediately by the public in relation to computer programs. As a new way of generating information, these needed a new kind of protection. Forcing software instead into copyright has resulted in programs receiving absurdly inappropriate terms of protection which can be up to 120 years. Among other outcomes, this has made conflict between Competition authorities and Microsoft inevitable in the U.S. and elsewhere.

8.6 Rescuing biotechnology from the patent trap

Similarly, if ever there was a new kind of information, it is DNA, the "operating system" which programs biological cells. Genetic inventions therefore clearly called for a new and appropriate type of protection of their own. But just as software had been forced into copyright, genomics was forced into patents. The results of this have caused much concern, firstly because the science is still too young to permit sound decisions to be made as to what should be legally protected and how this could best be done. Secondly, a large amount of the research in this area is publicly funded and freely available, so that it is impossible to be precise about the balance between the public and private contributions in any disclosure in support of an application for a patent. Patent monopolies lasting twenty years may consequently be granted to private firms in respect of advances to which their own contribution may be small compared to the scale of the investment (and its related risk) which has been provided by taxpayers. But with money as the measure of patent grants, firms could not “free-ride” on the results of research carried out with public funds, since the “multiple” which they could charge for a licence would only apply to the amount of their own related R&D investment.

As noted earlier, the classical “blocking” position of the holder of a patent on a single gene fragment may frustrate commercialisation of the results of genomic research, thus making the patent system an impediment to innovation rather than a stimulus to it (Heller and Eisenberg, 1998). Concern with issues such as this caused the U.S. President and the British Prime Minister to issue an unprecedented joint statement on March 14, 2000, urging private sector scientists to “release raw fundamental information about the human DNA sequence and its variants rapidly into the public domain.” To judge by subsequent comments of those who direct the publicly funded project, they are not hopeful that this will happen. Simultaneous measurement by money as well as time would deal with all such problems by making blocking of development impossible whilst maintaining or indeed improving incentives to invest in R&D.

8.7 Balancing producer and user needs in Databases

The most extreme example of the inability of traditional arrangements to provide protection that is enough to give the incentive for high-risk investment in the generation of information, but no more than this, is in relation to electronic databases. These represent yet another new way of producing information, brought about by nothing but investment, in which creativity is replaced by “sweat of the brow.” Using the traditional paradigm, an EU Directive effectively offers producers of these the possibility of perpetual monopolies (European Commission, 1996). This has been described by two eminent American legal academics as “a monstrous caricature of intellectual property laws” (Reichman and Samuelson, 1997, p.164).

In contrast, the new arrangements proposed for measurement would give compilers of electronic databases all the incentive they need, whilst making their data available as freely as possible.

8.8 Reducing wasteful litigation

The “winner takes all” element in so many types of intellectual property inevitably fosters litigation, and the volume of this has been expanding even more rapidly than the use of intellectual property. Just how serious this problem is, has been officially recognized in a recent Report of the United States Advisory Commission on Patent Law Reform, when it stated that

> patent litigation has become an increasingly inefficient, ineffective and undesirable means of resolving patent related disputes...The Commission fears that, unless the problems of cost and delay in patent litigation are addressed now, the central purpose of the patent system to provide an effective incentive for development and commercialization of new technology will be seriously eroded. Such an erosion could well prove a threat to the very existence of the patent system . . . (1992, pp. 78, 76).

In addition to the measurable costs of litigation, there are many others that are very substantial and that certainly have important social implications. These are the burdens in terms of distraction, diversion of energy, and misdirection of creativity that any intellectual property dispute imposes on innovatory firms. Worst of all, litigation costs are destructive of the exceptionally valuable contributions to innovation that smaller firms have proved they can make. It is obvious that the measurable costs of prosecuting or defending an action for infringement of intellectual property are far beyond the resources of all but the largest firms, apart from the fact that the burden of the costs that cannot be measured (such as distraction from more immediately paying tasks) falls most heavily on smaller ones.

With compulsory licencing in the form proposed, there is likely to be much less infringement and waste of time, energy, talent and money in litigation. Because lead time is recognised by business men as one of the best ways of protecting innovation, competitors would be likely to calculate that it is in their interest to pay the capital sum required for a licence and get into production quickly, rather than take the risk of losing "early mover advantage" in the market as well as an infringement action. Also, it would be reasonable to expect the Courts to treat infringers more severely than they do now, because infringers would have had an option to purchase a licence which they had not exercised.

8.9 Contributing to a humane international free trade regime

The World Trade Organization was brought into being in 1994 as a new and extended version of the General Agreement on Tariffs and Trade. However, TRIPS (the Trade-Related Intellectual Property Section of this) has met with enormous opposition from poorer countries, which regard it as a vehicle for Western technological imperialism. Not unreasonably, they ask why they should give monopolies for numbers of years in their countries to Western brands, inventions and media productions, when they themselves produce nothing similar which could benefit from reciprocal protection in Western countries.

Adding money to time in the measurement of intellectual property could do much to resolve these tensions. The survival of TRIPS may even depend upon it. The violent demonstrations at Seattle, Davos and elsewhere which have prevented WTO meetings, show the depth and breadth of feeling against it. Since the multiple in a money measure of intellectual property would only apply to investment in R&D in each individual country, it would instantly remove what is seen as the "imperialistic" aspect of the monopolies granted under the present system and defuse this world-wide anger.

9. Conclusion

Richard Nelson has rightly identified some important aspects of the present crisis in intellectual property, but the change discussed above could meet many of his concerns.

It was a principle of the great nineteenth-century scientist, Lord Kelvin, that “we advance according to the precision of our measures,” and this must surely be just as true of the social as well as the natural sciences. There is consequently every reason to hope that intellectual property could benefit greatly from the much more precise measurement that modern accounting techniques could bring to bear on it through adding money to time.

The Agenda which has been sketched out above would only be the beginning of the accounting and other research which would be needed to underwrite such a radical change of measurement means. No doubt once it had been undertaken more and better sources of data would be found. Achieving precision about the costs of doing R&D should not be difficult: the main challenge would be to develop multiples of these costs which would offer incentives for risky investment in R&D that are at least as good as those from the present system of intellectual property.

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