

Patents and Downstream Innovation Suppression – Facts or Fiction? - A Critique of the Use of Historical Sources in Support of the Thesis that Broad Patent Scope Enables the Suppression or Hindrance of Downstream Useful-Technology Development*

John Howells

Department of Management, Arhus School of Business, University of Arhus,
Haslegaardsvej, 10, 8210 Arhus, Denmark
(Email: Joh@asb.dk.)

Abstract Merges and Nelson have proposed that pioneer patents have enabled their owners to ‘block’ or ‘hold-up’ downstream innovation in cases as important as the car, radio, aircraft and electric lighting (Merges and Nelson 1990, ; Merges and Nelson 1994). Merges and Nelson use their work to question the value of Kitch’s prospect theory of patents, a theory that the social value of patents is that they enable the efficient coordination of technological development.

I re-examine history and legal sources bearing on Merges and Nelson’s illustrative cases and find no case to illustrate downstream innovation suppression as claimed. I argue instead that these cases illustrate problems in the coordination of development caused by various faults in the *administration* of patents by US Congress, the US Patent Office or the courts.

Key words downstream innovation, patent block, innovation suppression, broad scope

1 The Exclusive Right, Development Incentives and the Prospect Theory of Patents

This paper seeks to contribute to the debate about whether patents provide effective incentives to develop novel technical ideas. The rules that are intended to govern the grant of a patent and familiar to us from any Patent Office webpage tell us nothing about this issue: a patent may be granted for fully developed technology just before it becomes public and subject to trade, or it may be granted for what is no more than an experimental prototype that requires many years of further development work before there is any chance of commercialisation.

The debate over the function of patents should be understood as part of a larger debate over the function and nature of property rights in law. According to Merrill and Smith the development incentive function of rights *in rem* has lapsed from contemporary discussion amongst Anglo-Saxon lawyers and law and economics scholars (Merrill and Smith 2001).

‘Because core property rights attach to persons only through the intermediary of some thing, they have an impersonality and generality that is absent from rights and privileges that attach to persons directly... because property rights create duties that attach to “everyone else”, they provide a basis of security that permits people to develop resources and plan for the future’ (Merrill and Smith 2001, p359).

Merrill and Smith show that the *in rem* dimension of property rights was widely understood and written about in the eighteenth and nineteenth centuries by such as Adam Smith, Bentham and William Blackstone. Merrill and Smith cite Adam Smith using intellectual property rights as the ‘paradigmatic example of real rights, because they can be vindicated against anyone in the world who prints the book or copies the machine during the term of the copyright or patent’ (Merrill and Smith 2001, p362).

By this reasoning we should expect the exclusive right that is the patent to have the social function of securing development incentives for its particular class of intellectual property, unless shown otherwise. Indeed there does exist in the scholarly literature on patents Edmund Kitch’s ‘prospect theory’ of the patent institution, that in the light of Merrill and Smith’s scholarship could be understood as in effect a description of how rights *in rem* have been adapted to protect the incentive to develop novel technical ideas (Kitch 1977). It is significant that in his paper Kitch briefly acknowledged that the arguments in favour of a prospect function of the patent system ‘can also be offered in support of exclusive ownership of anything of value’, in other words, for other forms of property (Kitch 1977,

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p275). The insight is the same as that Merrill and Smith derived from their legal historical scholarship; one social objective of the grant of rights *in rem* is to aid development in some field.

Kitch's 'prospect theory' of the function of patents was written in 1977 and appeared then, in the words of one of its critics, as 'a radical new theory of the patent system' (Beck 1983, p193). It appeared radical because analysis of the patent system at this time was dominated by the assumption that patents were awarded to fully developed inventions. Kitch argued for the prospect function of patents on three previously neglected grounds related to the working of the patent institution and that he suggested only made sense in terms of this prospect function (Kitch 1977, p268). First, there exist various rules that encourage early registration, such as award of a patent to the 'first to file' an invention. Second, the scope of a patent is typically broader than that of the submitted invention and third, many of the important patents were issued years before it became possible to exploit them commercially. Together, these features of the patent institution encourage early, public registration of 'claims' on novel technological areas that require further development.

Kitch argued for the efficiency of the prospect function by comparing two institutional arrangements; a regime where there is the option of patenting or trade secrecy with a regime of secrecy alone (no patent system). It should be pointed out that this form of 'comparative institutional approach' was advocated by Demsetz as the basis for good public policy economics as part of his criticism of Arrow's analysis of the private incentives to conduct research and development (Demsetz 1969). The efficiency claims for the prospect function of the patent system are notably different to those that are made for patents awarded to inventions that are fully developed (when the principal justification is that the patent acts as an economic 'reward' for prior research and development). They include the following (Kitch 1977, p275-280): first, the patent database becomes a public registry of 'worked' prospects that allows developers to avoid repeating mistakes; second, the possession of an exclusive but time-limited property right creates a high incentive for the owner to coordinate development with others where necessary and the security and means to do so; third, the registration of patents in effect signals to third parties what prospects are being worked and so avoids development races, while encouraging developers to search out other prospects that might be distinct, or complementary (in which case cross-licensing provides an exchange of access) or substitutable (the attempt to 'invent around' the existing patents).

2 Merges and Nelson's Thesis on Broad Scope and Downstream Innovation Suppression is an Empirical Case Against Kitch's Prospect Theory

Since the prospect theory claims that patents aid the efficient development of the novel technical ideas for which patents are awarded, the most telling falsification would be if some fundamental feature of patents-as-prospects could be repeatedly linked to the generation of blocks to useful technology development.

This is precisely what is alleged to be the case in Merges and Nelson's paper;

Contrary to what Kitch suggests, we do not presume that granting broad scope to an initial inventor induces more effective development and future invention. We regard this as an open question' (Merges and Nelson 1990, p843)

They then go on to suggest that development block is more likely in specific scenarios of technology development they term 'systems' and 'cumulative' technologies. For example, '...in systems technologies, unlike those apparently envisaged by Kitch, prospects may be at odds. If a patent on one component that is key to a variety of systems is defined broadly, the holder of that patent may be able to block others from commercialising those systems without license, but on the other hand the holder of a broad patent on another essential component may be able to block the holder of the former patent from building a state of the art system' (Merges and Nelson 1994, p7).

They doubt that patent holders will cross-licence one another to support the development of state of the art technology. They express similar theoretically-derived doubts that broad patent holders in cumulative technologies (a sequence of dependent inventions in time) will assiduously pursue, or license to others, all secondary inventive opportunities falling within the primary patent's scope (Merges and Nelson 1990, p908) and conclude that, 'The chain of reasoning in our critique of the prospect theory, and our view of the patent system, is consistent with most of the historical evidence on cumulative technologies' (Merges and Nelson 1990, p885). In their theoretical article they draw a strong general policy conclusion from their review of their empirical examples, '...we come out with the belief that the granting and enforcing of broad pioneer patents is dangerous social policy. It can, and has, hurt in a

number of ways....And there are many cases where technical advance has been very rapid under a regime where intellectual property rights were weak or not stringently enforced. We think the latter regime is the better social bet (Merges and Nelson 1994, p16).

When this paper is cited in the legal literature, it is for having provided empirical evidence that contradicts the prospect theory*. When Nelson has later advocated a policy of weaker intellectual property rights in the innovation literature it is founded upon the empirical and theoretical analysis in these papers (Mazzoleni and Nelson 1998).

While Merges and Nelson's thesis has gone unchallenged† it does not appear possible for reviews of patent theory to describe Kitch's prospect theory as other than 'highly controversial' (Oddi 1996, p268; Duffy 2004, p441). Spence in his chapter in the current standard British patent law textbook 'The Modern Law of Patents' gives it credence and draws the conclusion that, 'It is by no means clear that patent protection is always either necessary, or sufficient, to ensure investment in innovation' (Spence 2005, p11). Yet the paper appears to be unique: I find with the economist Jaffe that Merges and Nelson's paper is the 'only paper that I know of that presents evidence on how patent scope affects innovation' (Jaffe 2000, p547).‡ This is an additional reason to re-examine the historical sources that bear on their thesis that patents of broad scope may hinder downstream innovation.

3 The Empirical Cases Reconsidered

3.1 An Exemplary Case? - Edison, General Electric (GE) and the Exploitation of the Carbon Filament Incandescent Bulb Patent

When Merges and Nelson make the claim that 'The chain of reasoning in our critique of the prospect theory, and our view of the patent system, is consistent with most of the historical evidence on cumulative technologies', it is immediately followed by a specific empirical claim, that, 'The early electrical illumination industry illustrates this most clearly' (Merges and Nelson 1990, p885). These claims and the two and a half pages including generous quotation from Bright's historical work on the carbon filament patent make this an especially important case for them. The following sections analyse both the use Merges and Nelson make of Bright and the reliability of Bright's analysis. The last sub-section considers an alternative interpretation of events in the Edison patent case.

3.1.1 Edison's Patent and His Company's 'Slowing Rate of Improvement'

Merges and Nelson are concerned with the use made of Edison's basic patent on his carbon

* Merges and Nelson say their 1990 Columbia Law Review paper best presents their empirical case and their 1994 paper their theoretical case (Merges and Nelson 1994, p2)

Three examples of the use of Merges and Nelson's paper follow: Oddi cites Beck ((Beck 1983)) and Merges and Nelson ((Merges and Nelson 1990)) for having 'urged that the empirical evidence does not support the theory' (Oddi 1996, p268) Oddi recognises the more thorough nature of the empirical claims in Merges and Nelson and the fact that they are at odds with the prospect theory by giving them credit for a new 'theory', a 'race to invent' theory of the patent system that stands as an alternative to the prospect theory (Oddi 1996, p282-284) However, the independent character of this 'theory' only exists if Merges and Nelson's empirical evidence really does contradict the prospect theory: if my re-examination of their evidence is accepted then it follows that Merges and Nelson have no independent 'theory' of the patent system and that Oddi's 'un-unified' economic theories of patents are a little more unified.

Duffy cites Merges and Nelson for their view that, in contradiction to Kitch, coordinated development is in practice worse in its development outcomes than rivalrous development, (Duffy 2004, p442)

Thomas cites Merges and Nelson ((Merges and Nelson 1990)) for their having provided evidence of 'technology suppression' (i.e. the deliberate block of the development of useful technology) through the use of patents, (Thomas 2005, p115)

† Of more than 280 citations of this article listed in the ISI citation index, I can find none that critically-reanalyse the historical case evidence. I examined the titles of all of the 280-odd citing works and selected abstracts and papers, when the title or abstract seemed to suggest the possibility of critical revision.

‡ Jaffe adds in his review of developments in the US patent system that 'Overall there is a noticeable gap between the highly-developed theoretical literature on patent scope and the limited empirical literature' (Jaffe 2000, p548)

filament light bulb. They point out that the manner in which such a patent is exploited may radically alter industry structure, but then claim, 'More importantly for our purposes, the validation of Edison's broad patent slowed the pace of improvements considerably' (Merges and Nelson 1990, p886).

What follows this strong statement is a quote from Bright on the Edison Company's understanding of its situation in 1891. This was the year when as a result of infringement proceedings the courts finally upheld the carbon filament bulb patent that had been granted in 1880, but left untested by Edison until 1885,

Even as the courts were passing on the Edison lamp patent in 1891, the Edison General Electric Company... [recognised that it] ...gradually had been slipping backward in its commercial position, particularly since 1886... Its technological contributions were becoming relatively smaller than they had been during the early [eighteen] eighties ((Bright 1949, p93) in (Merges and Nelson 1990, p886) The elisions are Merges and Nelson's).

This is a peculiar juxtaposition of claim and quote, for the quote refers to the period *before* the patent was held valid in court and so a period in which the company did not enjoy control of the carbon filament lamp field. If we must make a causal association between patent validation and the alleged period of slower innovation, it should be the reverse of Merges and Nelson's: it is conceivable that a contributory cause of the company 'slipping backward' was *because* the patent was not validated as a broad scope patent. However, the two elisions in Merges and Nelson's quote from Bright obscure that the passage is a description of the company's *general* position, not solely its position in carbon filament lighting, nor even solely its position in incandescent lighting (although that is included in the characterisation after 1886).^{*} Missing also from the passage is Bright's primary explanation for the Edison Company's perception of its relative decline in innovative accomplishment, 'With the withdrawal of Thomas Edison from active participation in the technical and commercial affairs of the company, especially after control had passed to a financial syndicate in 1889, the relative decline was hastened' (Bright 1949, p93-94). In this alternative explanation of 'decline' there are several contributory factors but one of them is a weak, not a strong patent position in the electrical lighting business.

3.1.2 Innovation and the Ediswan Company's Practical Economic Monopoly in Great Britain

Merges and Nelson develop their position by stating that Bright's description applied even more to the Edison Company's position in Great Britain, where the 'Ediswan' company held 'a practical monopoly of incandescent-lamp production' ((Bright 1949, p108) in (Merges and Nelson 1990, p886)). Their preferred interpretation follows, 'Given the lack of competition, it is perhaps not surprising that the pace of technical advance slowed' (Merges and Nelson 1990, p886).

This statement is not supported by their source, Bright: there is no evidence in Bright that relates the lack of competition in incandescent lighting in Great Britain to a retarded pace of technical advance. Such evidence might take the form of innovation that occurred elsewhere during the period of the Ediswan company's monopoly.

There is some evidence in Bright that the Ediswan company, as the technically most advanced British lighting company made good use of its patent position to maintain its industry leader position. Bright offers what appears to be a telling price comparison as evidence of the monopoly position of the Ediswan company: near the end of the patent's life the Ediswan company was able to charge 3 shillings and nine pence for a 16-candlepower lamp that sold for only a shilling on the continent (Bright 1949, p109). Within three years of the patent expiring in 1893,

close to fifty new brands were introduced in the British market... Despite the increased number of competitors and the reduction of prices to about a shilling for the standard 8-32 candlepower lamps, the Ediswan company had the advantage of a high-quality lamp and a well established commercial position and continued to lead the industry. It also still had important patents on lamp holders and lamp fittings. A great many of the newer firms soon failed... (Bright 1949, p109).

That the Ediswan Company still had important patents suggests that it had continued to innovate where it saw opportunities; this evidence in Bright supports the position that a degree of patent-enforced market control does not necessarily deter the continuation of innovative effort and achievement by the patent holder. Comparison with the situation in Germany is instructive, because the Swan and Edison basic patent conflict had not been resolved in favour of one company and entry to manufacture appears

^{*} In his book Bright is here preparing the logic for the Edison lighting company's merger with the second largest US electrical company, the Thomson-Houston company, to form the General Electric Company; first proposed in 1891, the companies merged in 1892, (Bright 1949, p94)

to have become effectively free in Germany. However, Bright does not provide evidence of German technical advance over the British and US leading companies in this period, but states that,

The European product suffered seriously in quality as a result of the violent price competition. Representatives of the German electrical-goods companies met in 1894 to study the problem, and they concluded that the complaints about low lamp quality were justified. Poor manufacturing techniques produced uneconomical lamps of short life, and imperfect sorting and false marking were common (Bright 1949, p113).

In response to this situation the German industry organised a lamp cartel and fixed prices of about a shilling retail for the standard incandescent lamp.

Given that Bright provides some evidence that the Ediswan company had exploited its monopoly position to continue to research and patent and no evidence that the 'free' market in Germany had generated technical advances greater than those of the Ediswan company, the claim that the Ediswan monopoly was causally connected to a slower rate of technical advance must be rejected for lack of evidence.

3.1.3 Bright uses 'Competition' Confusedly: to Mean Both neo-Classical and Schumpeterian Substituting Competition

Merges and Nelson make other claims that the basic Edison patent and its consequent lack of competition stifled innovation, but the real problem is that their preferred source is Bright and Bright has a habit of writing deterministically about competitive scenarios and innovation, albeit in contradictory ways. One illustrative quote follows, as Bright describes the tendency of companies to return to research into metal oxide and metal filaments to replace carbon, as carbon proved incapable of improvement after 1884,

In the United States this interest in large part represented attempts by competitors to get around the basic Edison patent. In England the stringent monopoly choked out almost all attempts at betterment, particularly after 1888. On the continent, where there was not a tight monopoly, interest in new materials was aroused more quickly and more keenly, although with no greater initial results (Bright 1949, p119-120).

In this one paragraph we first have the basic Edison patent encouraging research into radical substituting innovation in the US – acting as a spur to Schumpeterian, substituting competition. Then in England, the production monopoly (enforced by the patents on the carbon filament light bulb) is claimed to deter innovation, despite the equivalent situation in the US having just been cited as encouraging substituting innovation research by other agents. The last sentence suggests the reverse causal connection of competitive scenario to intensity of research activity to the first sentence; the total effect should be to shake the reader's confidence that simple competitive scenarios can be systematically related to propensity to innovate, without further analysis of context. And quite typically, Bright later supplies that context and shows that in the quote above, he over determines his account: the origin of the first breakthrough in the search for carbon filament substitutes was the Nernst lamp of 1897, which was invented and developed by a professor of electrochemistry at the University of Göttingen (Bright 1949, p170). Here, industry *structure* had no causal relation, was simply irrelevant to Nernst's university activity and eventual success.

Selective quotation from Bright could support many theoretic positions: a few pages after the quote above he appears to contradict the first line of the above quote by claiming that the expiry of the basic carbon filament patents 'resulted in a changed [more positive] attitude toward technological progress in the incandescent-lamp industry after 1894' (Bright 1949, p129).

Bright has value as a source, but he was published in 1949 and it is understandable that absent from his account is an understanding of the prospect function of patents and the difference between a neo-classical and what we today might call a Schumpeterian understanding of competition as a substitution process.

Merges and Nelson end their analysis of Bright by concluding that, 'Thus the broad Edison patent slowed down progress in the incandescent lighting field' (Merges and Nelson 1990, p887). Such a general statement about slowed 'progress', whether what is meant is economic or technological progress, is not justified by a thorough reading of Bright. When this patent was eventually used to exclude developers from the field covered by the patent, technological development of the basic idea was complete, diffusion of production technology was advanced and there is evidence of continued invention and development within the field covered by the basic patent by the Ediswan Company.

3.1.4 The Story Relevant to Broad Patent scope and Innovation is the Explanation for Why It Took 12 Years to Validate Edison's Patent

The informative story relevant to pioneer patents and broad patent scope is the explanation for why it took 12 years to validate Edison's patent. We must ask first, why Edison did not initiate infringement proceedings against the United States Electric Light Co. (USEL) until 1885, five years after the grant of his patent and then why it took seven years before the Supreme Court upheld the validity of Edison's patent. These were the delays that left Edison without effective control of the electric carbon filament lamp field.

Bright suggests Edison did not seek to enforce his patent between 1880 and 1885, because, * 'most inventors and companies seem to have been so busy taking out new patents and getting into production that they had neither the opportunity nor the inclination to defend their rights vigorously under the patents which they had already obtained... in general a live-and-let-live policy was practiced' (Bright 1949, p84).

This 'cultural' explanation is incomplete, for the validity of Edison's patent was in doubt while the true broad claims of the rival Sawyer-Man patent remained in interference proceedings with Edison's patent. The Sawyer-Man patent had been filed in January 1880, one month after Edison's patent was filed (40 F. 21 at 21). According to the 1889 judgment the Sawyer-Man patent did not issue until May 1885 because of 'various proceedings in the patent-office, including an interference with an application of Thomas A Edison' (40 F. 21 at 21). The owners of the Sawyer-Man patent then sued Edison for infringement of their patent in December 1887 only to lose their case in the District Court in 1889, confirmed by the Supreme Court in 1895 (159 U.S. 465, 16 S. Ct. 75).

The significance of the Sawyer-Man patent was that it was a true 'broad' claim, making claims that in the words of the 1889 judgment, 'amounted to the broad claim of the exclusive use, in incandescing lamps, of all carbons made of fibrous or textile materials' (40 F. 21 at 21). The Supreme Court held the very breadth of this claim against the patent in its judgment, commenting that, 'an examination of over 6,000 vegetable growths showed that none of them possessed the peculiar qualities that fitted them for that purpose. Was everybody, then, precluded by this broad claim from making further investigation? We think not' (159 U.S. 465, 16 S. Ct. 75, at 472). The Court also argued that if the Sawyer-Man patent were allowed, then the many prior uses made of fibrous carbon filaments would invalidate it as a broad patent.

The interference proceedings had the effect that, as Passer writes, Edison's company's directors lacked confidence in Edison's patents and so were very reluctant to launch an infringement case against the growing number of infringers of Edison's patent. Passer also writes that this lack of confidence was greatly mitigated by the British court decision to uphold Edison's patent against the Swan incandescent-lighting company, but Edison had to capture control of his board of directors in 1884 in order to initiate infringement proceedings against the United States Electric Lighting Company (USEL) in 1885 (Passer 1953, p 151). The suit would only come to a hearing in 1889, be decided in favour of Edison's company in 1891 and hold up upon appeal in 1892 (Bright 1949, p84). The patent then held valid would prove to have two years of remaining life and contrary to contemporary industry expectations, was used by the Edison Company not to license for royalties, but to close down competitors active within the patent's technology - a drastic form of usage.

Bright's comment on these two years, quoted by Merges and Nelson, was that 'for twelve years competition had been possible; it suddenly became impossible' (Bright 1949, p89). Yet once again, this is not a precise description and Bright undermines it by later describing how under the validated patent regime, a few companies redesigned their lamps to avoid infringing the patent, while other companies were created explicitly to make non-infringing lamps. 'From 1892 till the expiration of the patent, there were probably ten or more competing producers making lamps at all times, despite the vigorous efforts of the GEC to close them down' (Bright 1949, p90).

This is not a case of deterred or hindered or blocked technical innovation, but of attempted 'reversed diffusion', only possible because of the twelve years it took to validate Edison's patent and the entrants to manufacture that this delay allowed. If scope is involved it is not the broadest definition of scope, that claimed by the invalidated Sawyer-Man patent over the use of all fibrous carbon filaments. Edison's key insight was that high resistance filaments with small surface area could be the basis of an

* Passer suggests that Edison did not initiate any infringement suits until 1885 because he 'was too busy to give time to patent litigation, the Edison company had nearly the entire incandescent-lighting market, and the Edison directors were very cautious' (Passer 1953, p151)

electric lighting system (47 F. 454 at 461) and it was this insight that was imitated, despite variations in filament material used by the imitators. This case reads rather as an extraordinarily long delay in the validation of a patent, albeit for legal procedural reasons, that effectively compromised the prospect function of the patent.

3.2 Radio as an example of the development of a complex technology

Merges and Nelson comment that, 'Radio is thus a canonical instance where the presence of a number of broad patents, which were held by different parties and were difficult to invent around, interfered with the development of the technology' (Merges and Nelson 1990, p893).

3.2.1 Did radio patents hinder radio development?

The issue here is that a state of the art radio system would require access to the technology controlled by separately held patents – what is at issue here is how and whether companies will cross-license such technology, not the extent of the scope of the individually-held patents.

In the quote above Merges and Nelson describe patents as hindering development, but they also describe the solution that was found, 'The various pioneers formed RCA to break the deadlock; the new company promptly acquired the American rights to the Marconi patents. The companies that owned most major radio patents became RCA shareholders' (Merges and Nelson 1990, p893).

The question we should ask is what is meant by a 'deadlock', why it occurred and how long it lasted. What Merges and Nelson do not mention is the extraordinary circumstance that during the First World War, Congress suspended the enforceability of radio patents to encourage radio production for the military. As might be expected, radio producer companies moved into each other's 'radio-relevant' technological areas, and by the end of WW1, 'Each manufacturer, pushing its researches as far as possible, repeatedly encountered some device or circuit that was already patented by another' (Reich 1977, p216). The removal of the necessity to acquire patent licenses in a field where much technology was already developed probably did accelerate radio technology diffusion.

When patents were made enforceable again at the war's end, all these companies were technically in infringement of each other's patents. The period of 'deadlock' was in reality a period of search for a mutually acceptable resolution of this situation. There was an exceptional problem of how to manage the transition from a temporarily patent-free period of development to development under a restored patent regime. It only took 2 years, from 1918 until 1920, for AT&T, GE and Westinghouse to agree to the formation of RCA as a joint development vehicle for radio in exchange for individual RCA equity shares. In this period the sources do not suggest that radio production or development was halted. The example is not one of the hindering effect of patents. Rather, the 1920 agreement could reasonably be treated as another instance of businesses finding a means to collaborate to ensure profitable development paths are not foregone, despite exceptional institutional obstacles (the absence of continuity in the patent regime).

3.2.2 A case of blocking patents where no blocking occurred

Merges and Nelson base their strongest claim of technology suppression in radio on 'a classic instance of blocking patents' (Merges and Nelson 1990, p892) which resulted from the patent infringement proceedings when the US Marconi Company sued the De Forest interests. According to Merges and Nelson the result of the trial in 1916 was that, 'Marconi's diode patent was held to dominate De Forest's patented triode, yet neither party would license the other. As a consequence, no one used the admittedly revolutionary triode for a time' (Merges and Nelson 1990, p892). This last claim is odd since it does not make clear why the US Marconi Company should need to be licensed by De Forest. The same problem is apparent in Merges and Nelson's source for this statement, a few lines in a Federal Trade Commission report on the radio industry (Federal Trade Commission 1924, p26). That something is missing from the FTC account is evident when it states that as the results of the US Marconi Company's suit against De Forest; first, that the court granted an injunction to restrain de Forest's company 'from manufacturing tubes under its patents' and that, 'As a result of this decision the De Forest Co. ceased manufacturing vacuum tubes in their improved form and the Marconi Co. was limited to the manufacture of the two-element tube, which was incapable of performing all the functions of the

* AT&T would later renege on the agreement and attempt full scale, independent development of radio ((Reich 1977, p223)) AT&T tried to free itself from the 1920 agreement first by sponsoring independent arbitration, then by finding a legal opinion that the agreement it had once found so satisfactory was a violation of the Sherman antitrust act, because it blocked AT&T from selling the radio sets it was legally empowered to make under its own patents (Reich 1977, p229) AT&T's attempt to develop radio independently would later fail.

modern vacuum tube' (Federal Trade Commission 1924, p26). What it was about the court's decision that could have limited the US Marconi Company's rights to manufacture is not stated nor commented upon in the FTC report. It is necessary to refer to the court case and other historical sources to understand what happened.

First, by the time of this patent suit, De Forest had sold the rights to use the triode as a 'repeater' (as an amplifier) in 1913 and in radio in 1914 to AT&T, so that he manufactured triodes only for the residual and relatively unimportant market for 'amateur and experimental use' (Maclaurin 1971, p85). In control of the important commercial rights of the triode, AT&T had 'launched a massive attack on its theory, its mathematics, its construction, and its behaviour' (Reich 1977, p213). The triode enabled AT&T to build the first transcontinental telephone lines by 1915, a year before the De Forest and US Marconi Company infringement judgement. And later, rather than De Forest, it would be AT&T, RCA and other developers who would exploit the full commercial potential of De Forest's invention – but their exclusive right to do so, however cross-licensed, depended on the legal status of De Forest's patent. De Forest's biographer writes that AT&T's legal department had understood the risk that De Forest's patent would be sued for infringement by the US Marconi Company when it purchased rights to De Forest's patent, but proceeded anyway (Hijiya 1992, p91). So although the court cases between De Forest and US Marconi Company in the first instance only affected De Forest's ability to manufacture for a relatively minor market for amateur use, should the US Marconi Company win, it would threaten AT&T's control of radio.

The text of the judgment of September 1916 makes clear what was only implicit in the FTC report; that upon being sued, De Forest had immediately countersued the US Marconi company for unlicensed use of the third element of the triode (236 F. 942). However, the court found in favour of the Marconi Co. and dismissed De Forest's counterclaim (236 F. 955, affirmed 243, F 560, 567).

When referring to these same cases, Maclaurin also writes as if the counterclaim had succeeded; 'the court decided that de Forest had infringed the two-element Fleming valve, while Marconi had infringed the three-element de Forest patent. Neither company could manufacture the triode' (Maclaurin 1971, p85). Yet reference to the court judgments that Maclaurin cites show that, in fact, these court judgments awarded the Marconi Company with the legal right to exclude De Forest from the manufacture of his triode - should it so choose (it did not, see below).

It is tempting to enter into the detail of the reasoning of the District Court, for its judgment (in 236 F. 955) in essence treats the triode as a variation of the diode and therefore within the scope of the diode patent. From the vantage point of today this appears at first sight absurd – the diode would remain the limited but useful rectifier that it was then understood to be, but the triode was the forerunner of the transistor and the essential component of the electronic age. The reason is given by Hijiya, De Forest's biographer. De Forest does not appear to have understood the full significance of what he had invented; so although he invented the three element 'audion' in 1906 (Maclaurin 1971, p81) he only conducted an experiment illustrating feedback (or 'regeneration') in 1912, and then, 'De Forest understood so little of the potential of regeneration that he failed to copy the notes of his supposedly crucial August 1912 experiment, failed to explain regeneration technically, failed to make use of its oscillating feature' (Hijiya 1992, p90). So when sued for infringement by the Marconi Company, he was in such a poor position to substantiate his (late understood) novelty claims with documents that he failed to convince the court.

But first, it matters that the September 1916 and 1917 judgments against De Forest were just before and then during the period when the enforceability of radio patents was suspended by Congress to aid radio production for military purposes. Archer writes that it was in July 1919 that President Wilson signed the Congressional resolution to return telephones, telegraphs and cables' to private ownership {Archer, 1938 #1115, p172}. The US Marconi Company sued De Forest for infringement in the District Court again and won again in July 1919 (262 F. 393). So it was from July 1919 the US Marconi Company had a patent enforceable over De Forest's 'triode' patent and in principle therefore over De Forest's licensees such as AT&T. But as Maclaurin states,

During the war however, De Forest manufactured triodes under government immunity; but at the conclusion of hostilities some sort of working compromise with the Marconi Company was essential. For a brief period the two companies tried to work together. A lamp manufacturer named Moorhead assembled triodes for de Forest, who passed them on to the Marconi Company for exclusive distribution in the United States' (Maclaurin 1971, p85).

Yet given the 1916 finding of the courts in favour of the US Marconi Company it is not clear why the US Marconi Co. needed to compromise with De Forest. Indeed, the description in the above quote

should probably be read as the US Marconi Company exploiting De Forest's technical expertise in three-filament tubes by leaving manufacture in his and his supplier's control, but retaining control over the profits by remaining sole US distributor – but all this it should be remembered, only concerned production and sales for the amateur market for the triode.

The great economic potential of the US Marconi Company's legal victory over De Forest rather lay in the prospect of control over AT&T's successful development of the triode. It was not used in a straightforward bilateral deal, but became involved as one of the bargaining chips in the complex series of deals that led to the formation of Radio Corporation of America (RCA). Two months after the return of radio patent enforceability, the British Marconi Company would agree to have its shares in the American Marconi Company bought by General Electric in September 1919 {Archer, 1938 #1115, p178}. In October 1919 the American Marconi Company and General Electric signed an agreement that began the process of transferring their radio assets to RCA; in July 1920 RCA finished negotiating a mutual cross-licensing arrangement with AT&T which gave RCA the rights to manufacture the state of the art triode for radio purposes (Maclaurin 1971, p85; Hijiya 1992, p95). This agreement was 'really a cross-licensing contract by which each party acquired rights with certain limitations to utilise patents held by any of the four' {Archer, 1938 #1115, p195}. Another result of the absorption of the US Marconi company's interests into RCA was the end of any 'working compromise' between the two companies, so that De Forest's firm would become excluded from triode manufacture until the patent on the diode expired in 1922.

What is clear in the above events is that manufacture and development of the radical attributes of the triode continued throughout the process of patent litigation and corporate merger. So despite single sentences in Maclaurin, Merges and Nelson and the FTC report which read as clear statements that manufacture of the triode was stopped by the outcome of the patent suits, manufacture and development never stopped. First, because the locus of development had shifted to AT&T as De Forest's licensee before 1916, second, because of the wartime suspension of the enforceability of radio patents and third, because the American Marconi Company and De Forest worked together for a time to manufacture and distribute the triode. Lastly, two months after the American Marconi Company won its last infringement suit against De Forest in July 1919 it began to be acquired by General Electric and its patent rights to be absorbed into RCA. The later cross-licensing arrangement with AT&T gave RCA access to state of the art triode technology developed by AT&T and removed any threat that RCA would use its inherited patent position against AT&T.

3.2.3 Conclusions - technology suppression is absent from the history of radio development

The role of patents in the development of radio was complicated, but it is not a story of technology suppression. The diode-triode litigation ended in favour of the diode patent holder, but in Maclaurin's account it is clear that in practice this did not hinder development of the triode technology; the significant development was occurring within AT&T and two months after the US Marconi Company obtained an enforceable patent in July 1919 it was acquired by General Electric as part of the process of the creation of RCA and then a bargain struck with AT&T to share AT&T's state of the art triode technology.

The apparent 'deadlock' in radio patents was no more than a period of negotiation between the radio developer companies to find a mutually acceptable means of continued development under the restored patent regime. The war time suspension of the enforceability of radio patents makes this a highly atypical case. Yet there is no evidence in these sources that development of radio technology was impeded in any way during this period of negotiation.

Rather than downstream innovation suppression these two exceptional cases instead demonstrate the determination and ability of companies to continue manufacture and development despite unusual legal circumstances.

3.3 The alleged downstream innovation 'blocking effect' of pioneer patents with broad scope: the Selden automobile patent and the Wright Brothers warped wing patent

Although 'broad' scope has featured in the Edison carbon filament case (in the litigation with the Sawyer-Mann patent with its broad scope claim) and in the US Marconi Company and De Forest litigation, it was not apparently significant in the negotiations that resulted in the formation of RCA and none of these cases illustrated downstream innovation suppression.

Merges and Nelson specifically identify enforced pioneer patents as hindrances to innovation in their category of cumulative technologies, i.e. technologies where later innovation depends on the earlier innovation. They cite as empirical examples; General Electric's development of the incandescent light bulb, the Selden automobile patent and the Wright brothers' warped-wing lateral control aircraft body

patent (Merges and Nelson 1994, p15).

In what follows, first Merges and Nelson's allegations of development block are re-examined in the Selden and Wright brothers' patent cases. In the detail of the cases it will become clear that neither of these patents acted as a pioneer patent should in theory; the Wright brothers were never free of litigation long enough to exercise control of the technological field; the grant of the Selden patent was deliberately delayed by 16 years so that the patent would control a developed, not a developing field. Neither case could illustrate the general thesis that pioneer patents of broad scope encourage downstream innovation suppression. For reasons of space I will not treat either the General Electric case or the Townes-Schawlow patents for accounts exist which show these to be exemplary pioneer patents that did serve the purpose of coordinating a field of development and without evidence of technological block.*

3.3.1 The Selden patent as a submarine patent - a subverted pioneer patent

The problem with treating the Selden patent as a typical example of a pioneering patent with broad scope is that it is the classic example of a 'submarine patent' (Welsh 1948).

Selden was a patent attorney who applied for a patent on the automobile ('any vehicle with a gasoline engine and a steering gear' (Welsh 1948, p264)[†]) in 1879, but succeeded in delaying its grant for 16 years, by which time there was a sizeable US automotive industry. The method of ensuring delay was to exploit the Patent Office rule that a patent applicant had 2 years within which to reply to a Patent Commissioner's queries. Selden's claims 'were withdrawn, modified, and reworded time after time in the years following 1879' (Welsh 1948, p264). This generated a string of queries from the Patent Office, none of which were answered until just before the 2-year deadline.

The threat of injunctions was used to extract royalties from many of the automobile companies present in the technical field: Welsh, writing in 1948, cites contemporary estimates of the total Selden patent royalties collected from the industry as between \$5.8m and \$10m, a significant sum (Welsh 1948, p267). Although legal it was widely perceived as 'unfair' and this is why Henry Ford would contest the patent's validity until in 1911 the Court of Appeals for the Second Circuit, while sustaining its validity, restricted the scope to motor vehicles using a two-cycle engine: since most manufacturers were by then using a four-cycle engine the decision 'in effect, made the Selden patent worthless'.[‡] Whether or not one agrees with Merges and Nelson when they judge that the protracted law suits between the later owners of the Selden patent and Ford 'slowed Ford down' (Merges and Nelson 1994, p14) (the suits were certainly a nuisance) this does not bear on the prospect theory as the outstanding feature of the Selden patent is that the prospect function was deliberately subverted by Selden's exploitation of a loophole in USPTO rules.[§]

Although Merges and Nelson use Flink's history of the introduction of the automobile in America as a source on the Selden patent (Flink 1970), they do not cite the description of Selden's manipulation of Patent Office rules to delay the grant of his patent by 16 years (Flink 1970, p17).^{**} It is likely this absence from their analysis that leads them to use the case to query the prospect function of patents;

* The General Electric incandescent light bulb patent case provides a particularly good illustration of the incentives to conduct secondary invention during the lifetime of a pioneer-type patent and of how the period of secondary control is a more litigious and weaker form of control compared to the period of pioneer patent control (Reich 1992). Kitch uses the Townes-Schawlow patents as an exemplar of the use of the prospect function to coordinate development and the history by Bromberg and autobiographical account by Townes support such a view (Bromberg 1991, ; Townes 1999).

[†] Quotation from the testimony of Willis Rice in Hearings before the Committee on Patents on HR 4523, 74th Cong. 1st Sess. 545 (1935) in (Welsh 1948, p264)

[‡] See 184 F. 893 at 915 'Granting the patent as broad a range of equivalents as its interpretation will permit, and giving due consideration to the degree of invention involved, still we are not able to hold that the Otto improved engine is the equivalent of the Selden engine or that the defendants infringe by employing it as an element of their motor vehicle combination.' The court thereby restricted the scope of the Selden patent to exclude the Otto engine. See also (Flink 1970, p325)

[§] Not discussed here is the controversy over the way the early challenges to the validity of the patent were resolved; see (Welsh 1948, p265-267) See also circuit court decision 104 F. 814.

^{**} Flink writes that 'Selden filed his original patent application in 1879 and then used evasive legal tactics to delay the patent's acceptance until conditions seemed favourable for the commercial exploitation of his patent rights. In this manner he was able to maintain adequate security for his claims while he deferred the outset of the seventeen-year period of exclusive rights to his invention provided by law' (Flink 1970, p17)

‘thus while it was available, Kitch’s proposed strategy of orderly development of the ‘prospect’ was not even tried’ (Merges and Nelson 1994, p14). One may rather say that the failure of Patent Office rules to enforce the prospect function in this case is not evidence of how pioneering patents of broad scope in general hinder downstream development: it is evidence that the rules for patent filing ought to be designed to support the prospect function of patents. Had this patent issued close to the time of the invention it would have operated as a true pioneer patent, forcing the holder to encourage early development in the hope of later royalties – the object of the ‘submarine patent’ strategy is to avoid exactly this.

Submarine patents represent a challenge to the implementation of the principles that govern the patent institution, not a challenge to the principles themselves; the US Congress acted effectively 1995 to prevent future submarine patents* by changing the term of a patent to 20 years from the date of the priority filing, instead of the 17 years from the date of grant; and since 2000, most US patent applications are published 18 months after filing rather than remaining secret until granted.

3.3.2 The Wright Brothers ‘warped wing’ patent

Merges and Nelson’s case against the Wright brother’s patent is that the litigation costs ‘significantly held back the pace of aircraft development in the United States by absorbing the energies and diverting the efforts of people like Curtiss’ (Merges and Nelson 1994, p15). Litigation activity and costs must have absorbed some of Curtiss’ time and energy, but at the crucial moment, when the Wright brothers’ patent was held enforceable by the Court of Appeal in 1914, Curtiss and his backers received powerful material aid from Henry Ford and especially Ford’s lawyer, Benton Crisp, the latter being the lawyer who had resolved the problem of the Selden patent for Ford. This aid was crucial, for Crisp ensured that the Wright brothers’ broad patent was never used to enforce injunctions against Curtiss: it was cleverly kept in litigation by the Curtiss-Crisp interest until it became part of a patent pool that included both the Wright and the Curtiss patents.

The historical evidence presented in Roseberry’s account and Bittlingmayer’s analysis of events contains no evidence that the genuine technical advance was delayed or blocked by the litigation (Roseberry 1972, ; Bittlingmayer 1988). Yet this litigation was a true battle over appropriate patent scope. Although the Wright brothers patent, granted in 1906 ((Roseberry 1972, p62) and 177 F. 257) only described their ‘wing-warping’ mechanism it contained a clause that claimed broad scope such that, ‘any construction whereby the angular relations of the lateral margins of the aeroplane may be varied in opposite directions with respect to the normal planes of said aeroplanes comes within the scope of our invention ((Roseberry 1972, p62), 204 F. 597 at 600-601)). When the Wright brothers’ patent was judged enforceable, in principle it could have been used to block the use of any other method of obtaining lateral stability in flight. And in this case at the time of the judgement there was a technically superior downstream innovation in widespread use – the aileron. How and why the Wrights’ power over the field of flight was never effectively used is a story that sheds light on the significance of broad patent scope.

a) Analysis of Key Events in the case of the Wright Brothers ‘warped wing’ patent

Soon after Curtiss flew successfully in 1908 using ailerons (wing flaps) to provide lateral control of the aircraft, the superior method now in universal use, the Wrights sued Curtiss for infringement of their patent.† Judge JR Hazel of the US District Court of New York would hold that the Wright brothers’ patent was enforceable in late 1913 and this decision was subsequently upheld in January 1914 by the US Circuit Court of Appeals (Roseberry 1972, p346, 349). At this point the remaining Wright brother, Orville Wright, had acquired the legal power to control the field of aircraft manufacture.

As Ford had refused to recognise the legitimacy of the Selden patent, Curtiss always refused to recognise the legitimacy of the consequences of the scope extension clause of the Wright brothers’ patent (Roseberry 1972, p62). Ford put his legal staff at Curtiss’ disposal and Benton Crisp advised that, rather than go directly to the Supreme Court, a ‘diversionary tactic’ might be tried: a different method of using ailerons was employed to encourage Orville Wright to launch a fresh infringement suit and, ‘obligingly, the Wright Company took the bait. With Curtiss once more a beleaguered defendant, Crisp was enabled to obtain a stay of the permanent injunction ordered by the prior decision’ (Roseberry 1972,

* Lemelson was an inventor who filed many IT submarine patents from the 1950s onwards, some of which have been activated recently to extract royalties. In *Symbol Techs. Inc. v. Lemelson Med.*, 277 F.3d 1361, 1363 (Fed. Cir. 2002), the validity of Lemelson’s bar code reading patents were successfully challenged (*see* www.baldwins.com/elibrary/bscarticlearchive/submarinepatents.htm)

† An injunction was granted in January 1910, 177 F. 257, reversed June 1910, 180 F. 110.

p357). In 1915 Orville Wright sold his interests and patents to a syndicate and went into retirement. Litigation continued until the US entered WW1 when a large appropriation was made by Congress for aircraft. The continuing litigation prompted political moves involving the National Advisory Committee on Aeronautics to compel the litigating parties to join a cross-licensing agreement; this was achieved by the President and Congress threatening to compulsorily purchase the patents for a low fee of \$1 million (Bittlingmayer 1988, p232). The owners of the Wright patent and the Curtiss interests and other manufacturers then joined a patent pool entitled the Manufacturers' Aircraft Association and all litigation ceased (Roseberry 1972, p361).

b) What Can the Wright Brothers' Case Tell Us About Broad Scope and Downstream Innovation Suppression?

This is our only case of a patent with clear 'broad' scope granted and then made enforceable through a Court of Appeal hearing and having at least the potential to hinder a real and technically superior downstream innovation – in this case, the aileron. The events of the case show that the Wright patent owners never freed themselves from legal cases long enough to use the injunctions necessary to enforce their will on the field of development. It was therefore never possible for the Wright brothers' patent to block technical advance, not even to slow diffusion to the extent that their preferred royalty demands might have. The Curtiss aileron was in use in Curtiss' machines and we have evidence that it diffused widely and unhindered; for example Bittlingmayer writes that 'By 1915 all airplanes used wing flaps instead of the Wright method. Curtiss was officially granted the patent in 1916' (Bittlingmayer 1988, p231).

Yet because the Wright brothers won in the Court of Appeal their patent might be viewed by some as a case typical of how the operation of the law for patents of broad scope creates a 'blocking patent' (Merges and Nelson do not specifically assert this in their discussion of the case). Two types of evidence bear on this issue and they are necessarily of the 'what if' kind.

First, Roseberry refers to an interview given by Orville immediately after the Court of Appeal judgment in which he declared how he intended to use his new powers,

'He would demand a royalty of 20% on every airplane... plus retroactive settlements. He would permit no plane to be manufactured or flown without a license from the Wright Company. He was prepared, however, to adopt "a policy of leniency" for all manufacturers, with the sole exception of Curtiss. Those who had built planes without deliberately knowing they were infringing would be "dealt with lightly"' (Roseberry 1972, p351).

This was not a declaration of intent to block development, but to require a royalty to be paid to the inventor. It acknowledges that development had continued without waiting upon the outcome of the patent litigation and that such development would be dealt with 'fairly'. Curtiss is singled out for exceptional treatment, but the relationship between Curtiss and the Wrights had become personal rather than economic by this time.

Second, it is possible to follow contemporary debate and to doubt the quality of judicial reasoning of Judge Hazel in his judgment that the broad scope claim of the Wright brothers' patent should be enforceable. This is an appropriate point to discuss the broad scope issue in the Selden patent case as the one other controversial legal decision on broad scope in our set of cases,

c) What do the Wright brothers and Selden patents cases tell us about judicial reasoning on broad scope?

It is clear from Roseberry's contemporary evidence and especially in his chapter 'Feud with the Wrights' (Roseberry 1972, p121), that the Wright brothers' patent was publicly and legally controversial at the time because of its claim for broad scope and even more so when Judge Hazel upheld the claim for broad scope. It becomes of interest to know why Judge Hazel judged the broad scope claim enforceable.

The initial, 1910 injunction obtained by the Wrights against Curtiss' company was subsequently reversed because the reversing Court of Appeal acknowledged that sufficient new evidence had been presented by Curtiss to make it questionable whether the Wright brothers' patented inventive principle encompassed the Curtiss invention (180 F. 110). This makes clear that the general question regarding scope was whether the Curtiss aileron was an application of the Wright's principle or a distinct invention: if it were understood as an application it fell within the scope of the Wright's patent. This Court of Appeal also clearly stated the matter of fact upon which a case for infringement of the Wright

brothers' patent would rest,* and Judge Hazel accepted its reasoning in his 1913 judgment.†

'Defendants firmly deny that there is any turning tendency or swerving which requires turning the rudder away from its central position; and, giving effect to the language of the Circuit Court of Appeals in its opinion on the appeal to be relieved from the preliminary injunction, upon this point really hangs the question of infringement' (204 F. 597. at 611).

Judge Hazel's decision to find for the Wright brothers by his own account pivoted around a sub-decision to overrule much 'testimony of witnesses who have flown the defendants' aeroplane and swear that the rear rudder is not in fact used for recovering lateral balance, but that such function is performed solely by the ailerons' (204 F. 597). His grounds for doing so were that *sometimes* the rudder could be used to aid the attainment of lateral stability: So for the Curtiss rudder, 'That it is capable of action separately from the ailerons, or that it is turned to the high side only on extraordinary occasions, or that it is primarily for use in steering, and only incidentally to assist in restoring balance when abnormally tilted, does not avoid infringement' (204 F. 597 at 613).

Whether one agrees with this decision or not, the above quotes should make it clear why many contemporaries did not accept the reasoning and why figures such as Henry Ford were willing to lend their resources to support Curtiss in his fight against this decision's possible consequences for aircraft developers. Judge Hazel held the aileron to infringe the Wright's broad scope claim by ignoring expert evidence that in normal operation it did not need the rudder to attain lateral stability and by holding as decisive the evidence that it was *possible* to attain lateral stability by use of the rudder. One may imagine another judge concluding that the aileron had sufficiently novel manner of operation that it was outside the scope of the Wrights' patent. This reasoning reminds us that whether to uphold a broad scope claim is a matter of judgement and not the product of a general calculus.

The issue in the Selden judgment on broad scope also pivoted around the issue of *whether* the subsequent improvements to the car were sufficiently distinct that they were not covered by the scope of the pioneer patent. The 1911 Court of Appeals decision on the Selden patent was to exempt the Otto improved engine from the scope of the Selden patent,

'Granting the patent as broad a range of equivalents as its interpretation will permit, and giving due consideration to the degree of invention involved, still we are not able to hold that the Otto improved engine is the equivalent of the Selden engine or that the defendants infringe by employing it as an element of their motor vehicle combination' (184 F. 893 at 915).

This reversed the decrees of the 1909 Circuit Court, which had decided that such an improved engine invention *did* fall within the scope of the Selden patent.‡ It was this restriction of scope of the Selden patent that left it valid, but unenforceable on the developed field. It is evident that this decision shares with Judge Hazel's decision a dependence on a judgement of the degree of novelty of the downstream innovation.

3.4 Exemplars of 'technology that developed without patent blockages'? (Merges and Nelson 1990, p893)

If none of the pioneer patents considered above illustrate technology block, it is also clear that none of them are exemplary cases of the prospect function of pioneer patents being used to coordinate development as the prospect theory would suggest they should be. The pattern which is emerging is

*'There is no dispute as to the proposition that the question whether or not there has been infringement of this patent, however broadly it may be construed, depends upon the question whether or not in defendant's machine a tendency to spin or swerve is checked or counteracted by the operation of the vertical rudder. That of course - on its theoretical and on its practical side - is a question of fact.' 180 F. 110.

† Judge Hazel specifies the condition for Curtiss machine to be sufficiently novel to be outside the scope to the Wright brothers' patent at 204 F. 597 at 611.

‡ See 172 F. 923 at 932-933, 'If I have correctly apprehended it, there was clearly room for a pioneer patent; and it must now be held that on its face, and in view of the art, Selden's is such a patent. This means that Selden is entitled to a broad range of equivalents, and this rule as applied here results in this crucial inquiry: Was Selden (or any one else) entitled in 1879 to appropriate as one of the elements of any patentable combination a 'liquid hydrocarbon gas engine of the compression type'?

I think he was... If this be true, then the use or disuse of any then well-known mechanical appliance, which will increase the efficiency, usefulness, or commercial success of such combination, without changing what defendants call its co-operative law, is on the one hand open to Selden, and on the other will not free defendants from infringement.'

that Merges and Nelson have collected a set of cases where the *administration* of the patent did not allow development to follow the predictions of the prospect theory. Where this is so, the cases cannot be used to falsify theory, but informs us instead of the difficulty of administering the patent institution to maintain the prospect function of patents.

This judgement will prove to hold for those cases that Merges and Nelson present as exemplars of how patents should be modified to mitigate the alleged problem of broad scope.

3.4.1 The Transistor and Integrated Circuit/Planar production process cases

Merges and Nelson complement their suggested examples of downstream innovation suppression in cumulative technologies with,

important post-World-War II technologies that have advanced rapidly *because* no one held a pioneer patent that was used to restrict access' (Merges and Nelson 1990, p893) (my italics).

They present three examples in the 1990 paper, and in their 1994 paper an additional three, of pioneer patents that were modified or overturned by government agency, such as the Department of Defense, or antitrust action.

There are several general problems for the claim that such modified property rights regimes are preferable to the unmodified ones. First, we are not in a position to know for certain what use would have been made of the unmodified patent rights. So Merges and Nelson write about the AT&T antitrust consent decree that,

'Many companies ultimately contributed to the advance of transistor technology because the pioneer patents were freely licensed instead of being used to block access' (Merges and Nelson 1990, p894).

Given that Merges and Nelson have not provided any examples of technology development block in downstream innovation (cumulative technologies) or in systems technologies (such as radio) it remains a reasonable belief that *had* AT&T remained free to exercise its exclusive rights, AT&T might have chosen to licence where it could not develop itself. Since it was already a powerful developer, it might have been able to move more quickly and effectively than the weaker developer firms who suddenly gained access to transistor technology. The argument may be strengthened by reference to the increase in research activity that occurred in cases such as the Townes-Schawlow broad scope patent,* not a case considered by Merges and Nelson. The same reasoning applies to the other cases where patent rights were modified by outside agency – we cannot know for certain how the owners would have developed the technology had there been no outside intervention, but given the lack of examples of technology block we may doubt that development would have been retarded.

Second, in none of these cases has there been consideration of the point that if would-be inventors come to expect that their future patents will be weakened by some government agency's intervention then the incentives to invent will have been effectively weakened and the time of introduction of inventions will be plausibly delayed. Indeed, in a review of US anti trust policy towards corporate patent positions, Weston (and see Langenfeld and Scheffman's review) drew this very conclusion: that such was the vigour with which patent positions were attacked by anti trust suits in the US until the 1980s, that social welfare had probably been lowered because the incentive to invent had been weakened (Kitch 1977, ; Weston 1984, ; Langenfeld and Scheffman 1989).

This is a reason to doubt that examples of a (plausibly) more rapid diffusion of novel technology under a regime of weakened intellectual property rights indicates that weakened property rights are *in general* in the public interest. The 'rapid diffusion' is plausible because the exclusive right has been weakened; but if inventor expectations are that patents will be weakened then any incentive they provide to inventive and development effort will also be weakened.

An interesting variant case of this type is the parallel invention of the Integrated Circuit and the Planar process for its production. Merges and Nelson write that the Department of Defense 'had a strong interest in seeing these important technologies become broadly available through the industry' and their conclusion follows, 'Again, the absence of a single, broad patent assisted the rapid development of an industry' (Merges and Nelson 1990, , p894). This is plausible, but irrelevant to our empirical investigation into the prospect function of patents, because the problem with this example is that the Department of Defense is a non-market, government agency and its intervention and its payments in pursuit of its perception of national security interests mean the case can tell us nothing about theories of the *private* exploitation of the prospect function of patents.

* See (Bromberg 1991, ; Townes 1999).

3.4.2 Two more examples of how the prospect function of patents may become compromised - the polyethylene and polypropylene patents

The most significant feature of Merges and Nelson's chemical industry examples is that none are alleged to illustrate the blocking of useful technology development. Rather than interpret this fact as counter-evidence to their 'broad scope' thesis, Merges and Nelson prefer to suggest that 'special circumstances' apply to the chemical industry; no development blocks occurred in chemical innovation because of the 'very well established practice of licensing in these industries' (Merges and Nelson 1990, p911)* and cite in support the extensive licensing for development that certainly took place in the examples of innovation in the Leblanc and Solvay processes, rayon, nylon, polyethylene and polypropylene.

Merges and Nelson have an equivocal view of chemical industry licensing: on the one hand they see licensing as 'good' because it mitigates what they continue to assume is the potential of broad patents to block development, '...licensing by no means renders broad patents harmless. But it may indicate an attitude within these industries that reduces the potential blocking effect of a broad patent (Merges and Nelson 1990, p912). On the other hand, they express what might be considered the more conventional view, compatible with the prospect theory, that licensing is the means by which a patent holder with no, or limited development capability coordinates development by others in exchange for royalties so ensuring full exploitation of their prospect (Merges and Nelson 1990, p912).† The significance of this second view is that if it is true in the chemical industry examples, it is difficult to understand why it should not be true for other technologies, as the licensing behaviour of the patent holder derives especially from the expected value of the prospect and their own ability and desire to develop the prospect themselves, not principally from the type of technology.

Yet two of the chemical industry innovations provide further examples of how the administration of the patent institution may undermine the prospect function of patents. These examples will be briefly reviewed here because they strengthen this alternative view that is beginning to emerge from this review: that where we have encountered problems in development under the control of pioneer patents it has often been because the prospect function has been compromised by its administration.

a) The Polyethylene Patents

Whereas Merges and Nelson see Ziegler's widespread licensing of his patents on high-density polyethylene as an unalloyed good, a contrary view is expressed in the history of Du Pont, a rival developer whom Ziegler (a researcher in the academic Max Planck institute) had beaten to the patent office by only a few months for essentially the same invention. Du Pont's reservations about Ziegler's licensing strategy allow us to contrast the licensing strategies of developers, one of whom intends to participate in development, the other not.

In 1954 Du Pont learned that Ziegler was 'offering to discuss his linear polyethylene process for 50 000 dollars in advance. Several US companies had already accepted his offer' (Hounshell and Smith 1988, p493). Even in this year of discovery, the problem from Du Pont's point of view was that Ziegler 'continued to license his technology to all comers' (Hounshell and Smith 1988, p494). As an academic scientist with no development ability he was primarily interested in maximising royalties rather than in coordinating the development of technology and market. Du Pont's experience of the polyethylene market does suggest that the licensing of the technology was not being managed for 'orderly development'; Du Pont began manufacture in 1960 to eventually attain a 10% share of the market (Hounshell and Smith 1988, p493) and 'by 1970 the product was still 20 million dollars in the red' (Hounshell and Smith 1988, p495).

The problem was the continual stream of rivals that entered the market for 'strategic' reasons and

* The first statement refers back to a series of studies on technology licensing that show that licenses cost the licensor money and sometimes an appreciable percentage of royalties earned (Merges and Nelson 1990, p911, notes 146-148) It is therefore implied that transaction costs may deter licensing of development opportunities and therefore allow non-development of economic opportunities of equal or less value to the transaction costs. This remains a plausible scenario but it is not plausible that significant economic innovation is deterred in this way, above all if it is allowed that firms have some ability to control licensing transaction costs with respect to the expected economic value of the technology being licensed; yet Merges and Nelson use general language, as in this first quoted statement, that extends the idea to a generalisation applying to all patents, especially the 'broad' patents of greatest technological and economic significance.

† Expressed when they approve of Karl Ziegler's extensive licensing of his polyethylene patents.

not for profit (Hounshell and Smith 1988, p495),

Numerous manufacturers kept bringing new capacity on stream well ahead of anticipated demand. From its beginning the industry suffered from over capacity and cost cutting. Other companies had joined in the plastics gold rush only to find many others working the same veins. A major concern of Du Pont from the beginning was that competitors would not be primarily motivated by profit considerations but would be moving into the business for strategic reasons (Hounshell and Smith 1988, p495).

This is essentially a description of a field where a patent has not been exploited to control development for the sake of maintaining a profit. Even the metaphorical use of gold rush and veins is reminiscent of Kitch's mining metaphor for the prospect function of the patent system – albeit to emphasise the lack of coordination of development.

Because other methods of producing high-density polyethylene were discovered, this situation probably cannot be ascribed solely to Ziegler's licensing strategy. Ziegler's 'excessive' licensing strategy also depended on a stream of licensees that lacked an understanding of the business. The case nevertheless illustrates what a more restrictive patent licensing policy (should there have been a single agent in control of an effective patent prospect) seeks to avoid and contrasts with Merges and Nelson's position that licensing is good because it mitigates the potential of broad patents to block development. Licensing has to be adjusted to the economic and technological context of the prospect. This case is better seen as one where the potential of the prospect function of the patent to regulate development was ignored by the patent holder in favour of excessive licensing for royalty income, so that the economic outcome for developers (of no profits) began to resemble the outcome had there been a free for all without a controlling patent.

b) The Polypropylene Patents

Merges and Nelson find no fault with the development of that other important plastics polymer, polypropylene, only expressing approval that rather than a single company gaining control of the patents, there were 'a series of cross-licensing agreements which kept the technology open to a number of firms' (Merges and Nelson 1990, p902).

The polypropylene patent problem was the complexity of the task of deciding to whom to award the patent under the US patent rule that this award should be to the first to invent (Hounshell and Smith 1988, p496) and given the near simultaneous registration of polypropylene patents by five different companies between 1953 and 1955. It took the US Patent Office four years, until 1958, simply to fix a precise description of the invention (Hounshell and Smith 1988, p496). The costs of deciding who was 'first to invent' in this case are suggested by the following, 'Throughout the 1960s, the parties involved amassed evidence in the form of more than one hundred witnesses, 18000 pages of evidence and 1000 exhibits to support their claims' (Hounshell and Smith 1988, p496). It took until 1971 for the US Patent Office to decide that Montecatini was the 'senior party' in the interference proceedings, which placed the other parties under the burden of having to show why Montecatini should not be granted the patent (Hounshell and Smith 1988, p496). In this they succeeded and Phillips Petroleum would be granted the patent in 1981 when Montecatini was judged to have committed fraud during the proceedings (Hounshell and Smith 1988, p497; Merges and Nelson 1990, pn292).

In other words, it had taken some 25 years from the date(s) of the invention before the exclusive right was awarded. By the time it was awarded this patent could not perform its prospect function. In these years there was presumably a deterrent effect on any would be developers from the fear that the patent would soon be awarded to some rival, who would then gain control over their investments. As in many of the other cases discussed in this article, this probable deterrent effect did not stop firms from entering the market, with the first commercial manufacture of polypropylene occurring in 1958 (Hounshell and Smith 1988, p497), but it is difficult not to conclude that development would have benefited if the patent interference had been resolved decades earlier.

The complete failure of the prospect function of the polypropylene patent is significant in the present discussion because it is another example of Patent Office rules being designed for other purposes than the maintenance of the prospect function. Had the US Patent Office operated a first-to-file rule it would not have had the burden of having to process the mass of evidence described in the quote above and the patent would have had a good chance of being awarded at a time when it could have had a prospect function.

Polyethylene and polypropylene are two more examples that support the alternative thesis to the downstream innovation suppression thesis: that the general social and economic problem with patents is not a problem of hypothetically excessive broad scope, but that there are many ways in which the prospect function of pioneer patents may be undermined in practice.

4 An Alternative Interpretation of the Historical Case Evidence Is That the Prospect Function of Pioneer Patents Has often Been Compromised

Merges and Nelson emphasise examples of complex and cumulative technologies as particularly good illustrations of their thesis* and so their interpretations of every one of their cited historical examples in these development classes have been discussed in the sections above. If the reinterpretation offered here is accepted then it can be said that their thesis that pioneer patents of broad scope-facilitated downstream technology development block is unwarranted by their selection of evidence.

What a subset of these cases does illustrate is how the prospect function of pioneer patents may become compromised for very different reasons. To emphasise that this is a pattern in their examples the table below summarises the examples and the nature of the compromise.

Table 1 Pioneer Patents with Compromised Prospect Function

1 Edison's US carbon filament light bulb patent – Interference proceedings at the USPTO with the Sawyer-Man patent (5 years) then the infringement suit against the USEL company (7 years) meant that it was 12 years between date of application and the date at which the patent became enforceable. Lengthy procedure in the USPTO and the courts removed this patent's ability to act as a prospect.

2 Selden patent – Selden deliberately and legally subverted the prospect function of his patent by exploiting a flaw in the rules of the Patent Office patent assessment process to delay the date of award of his pioneer patent on the automobile for 16 years. The object was to obtain a patent which when granted would govern a developed field.

3 Radio patents 1: RCA – The suspension and reintroduction of radio patent enforceability was a drastic and exceptional intervention in the prospect function of radio patents that permanently altered the pattern of organising for radio development (the creation of RCA as a development vehicle was the result); the Congressional intervention makes this an exceptional case.

4 Radio patents 2: the Diode/Triode case – The US Marconi Company sued De Forest and De Forest counter-sued the US Marconi company for infringement of the third element of the triode. The court found De Forest to have infringed the patent on the diode but dismissed De Forest's counter-claim. Once radio patents were made enforceable after the war, and after another successful suit for infringement against De Forest in 1919, the US Marconi Company was finally in a position to threaten the development of radio – but two months after this last court case, General Electric acquired the US Marconi Company as part of the creation of RCA. No suppression of development.

5 Wright brothers' warped wing patent – The 'broad' patent was held valid in infringement proceedings against the Curtiss interests by the District Court in 1914, but the lawyer Benton Crisp managed to engage Orville Wright in a further round of infringement proceedings which enabled him to apply for and receive relief from Wright's injunctions. Litigation continued until the Curtiss and Wright patent owners joined a patent pool in 1917. Almost continuous litigation through the entire term of their patent ensured that the Wrights were never able to enforce their rights over the technological field. There was therefore no prospect function possible.

6 AT&T and the transistor – An anti trust suit ended with AT&T signing a consent decree and agreeing to keep out of the transistor business and to license the technology widely. Successful antitrust action compromised the prospect function of the AT&T transistor patents.

7 Integrated Circuit/Planar Process - the Department of Defense intervened to accelerate the diffusion of the technology and so compromised any prospect function.

8 Polyethylene – As an academic scientist Ziegler did not participate in development of his patents and instead licensed so extensively that the stream of new entrants to production depressed prices below the level at which other developers such as Du Pont could make a profit on their investment. The patent owner chose not to exploit the prospect function for a profitable market but for the maximisation of royalties.

9 Polypropylene – The near simultaneous registration of polypropylene patents by five companies in 1953-1955 forced the US Patent Office into a 25 years investigation into which company should be awarded priority. When the patent finally issued it could not have a prospect function.

In the Edison, Selden and polypropylene patents the delays in procedure at the Patent Office and in court cases were each longer than a decade and so damaged the prospect function. The exceptional suspension and reintroduction of radio patent enforceability by the US Congress ruined the chance that the theoretic prospect function of radio patents would be exploited to coordinate the development of radio: RCA was created as a means of resolving the scenario of mutual infringement that existed on the reintroduction of enforceability post-war. Although found enforceable by the Court of Appeal the Wright brothers' warped wing patent was kept in litigation through almost its entire term; the Wright

* In their section 'Differences in Industrial Patterns of Technical Advance' (Merges and Nelson 1990, p880-884)

brothers were never able to exploit their patents' prospect function. In the diode-triode infringement case the theoretical ability for each company to take out injunctions against the other resulted in the companies pooling their interests in a third party producer to maintain production. Finally, the transistor and IC/Planar process patent cases are examples of outside agencies intervening to alter (in AT&T's case, to weaken) the patent owners' exploitation of the prospect function.

With this view of the cases no general policy prescription on patents necessarily follows; judgement is on a case by case basis. The Selden case of the 'submarine' patent strategy is the one that most clearly suggests a need to adjust the rules governing patent application to close off similar efforts – but decades later this has been done. The Congressional intervention in radio patents in wartime may have damaged the prospect function of the patents, but who would judge that the serious harm given the superseding social objective of conducting a war?

These cases do illustrate the diverse scenarios of development that occur when the prospect function is weakened or lost. One might suggest that collectively they illustrate some of problems of establishing and exploiting the prospect function in practice as opposed to the elegant theoretical description contained in Kitch's theory.

5 Conclusion: These Cases Illustrate Not Technology Block But Practical Difficulties in the Administration of the Prospect Function of Patents

This paper has re-examined the legal and historical sources that Merges and Nelson claim illustrate their thesis that the 'broad scope' of pioneer patents often results in the blocking of technology development either 'downstream' in the case of cumulative technologies or in systems technologies such as radio.

On the basis of the re-examination of legal and historical evidence in this paper, this thesis must be rejected for lack of empirical evidence of technology block.

Had their interpretation been confirmed, it would have made plausible that there was an important general problem with Kitch's prospect theory of patents. Since it is rejected, Kitch's prospect theory of patents survives this particular test against the historical record.

The Selden and Wright brothers' patent cases, the two cases where scope decisions were controversial and important, did not support the idea that there was a general problem with 'broad' patent scope, but it was evident that the decision whether a downstream innovation is encompassed by the broad scope claim is one with a degree of judicial discretion.

An alternative interpretation of the cases reviewed was that they illustrated diverse problems in the practical administration of the patent prospect function. As a group these cases do not support any general novel policy towards patents. It was suggested only that the administration of the prospect function in practice is difficult in ways the theory does not anticipate.

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