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NOTE DE RECHERCHE

Intellectual Property Rights Business Management Practices:

A survey of literature

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Contents

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I. INTRODUCTION

Until recently, the non-legal literature dealing with protection of intellectual property (IP) was limited in scope and quantity. The situation has changed dramatically since the mid nineties. With the increasing importance of knowledge, private firms and public institutions such as universities, colleges and research institutes, discovered the importance of intellectual property rights (IPRs) and their protection.

The arcane subject of intellectual property protection ceased to be the exclusive domain of legal departments and became a daily preoccupation of CEOs in many industries. This sudden attention followed from the realization that the value of intellectual property of a typical firm rose in many industries substantially higher than the value of its assets. Even though the average difference between the market value and the value of assets declined in the aftermath of the stock market bubble, it remains important.

In the new economy knowledge is the principal economic asset and its management and protection became the cornerstones of corporate strategy. This has been reflected in the professional literature. For instance, the number of publications dealing with patents indexed in ECONLIT, the leading economic database, rose from 39 publications over the 1981-1984 period to 251 publications from 1999 to 2002. Perhaps even more importantly, there is also a growing popular management literature focusing on IP.

The present survey is necessarily selective. The subject of IPRs extends from purely legal aspects to formal economic models. Neither the exclusively legal literature, nor the formal economic theories were included in this survey. But of course, the IP protection and management are determined by the legal context and the conceptual framework underlying empirical studies is often based on insights from theoretical models.

The survey starts with an overview of changes in the US and international IPR regime leading to the so called “patent friendly era”. Surprisingly, as the third chapter shows, the notable increase in use of patents in the US can not be attributed mainly to favorable changes in the US IP regime. The rise of patenting and use of other IP instruments has often little to do with their effectiveness in protecting IP and much more with their usefulness in corporate strategies blocking competition and providing bargaining chips for cross-licensing. The fourth chapter overviews the IPRs use and strategies in the US, Canada, E.U., Japan and Australia. It is well known that the importance of various IP instruments varies significantly from one industrial sector to another. After a brief look at the IP in more traditional industries, the chapter five focuses on IP practices and strategies used in information technologies and communications, including computers, software, business methods and internet applications.

The empirical literature surveyed in the sixth chapter shows that small firms are less likely to use IP than the larger ones and multinational corporations more likely than firms owned by nationals. The reluctance of small firms to use IP is, to a certain degree, explained by the financial burden patenting and patent litigation represents for small firms.

With the increasing importance and use of IP, its management is becoming an integral part of firm’s competitive strategies. The cost of IP, its management and human resources involved are presented in chapter seven. In order to better derive value from IP firms use more and more sophisticated methods. The valuation of IP portfolios, its accounting and integration in corporate financial strategies is presented in the following chapter.

Finally, references to enforcement, infringement and negotiation of licensing agreements conclude the survey.

II. CHANGES THAT CONTRIBUTED TO CREATION OF A PATENT FRIENDLY ERA IN THE UNITED STATES

Introduction in the US of the Court of Appeals for the federal Circuit

The introduction in the US of the Court of Appeals for the federal Circuit (CAFC) in 1982 marked the beginning of important changes in the US legal environment regarding the protection of intellectual property. It began an era of strong IP rights. To document the importance of the change (Jaffe, 2000) reports that before 1980 a district court finding that a patent was valid and infringed was upheld on appeal 62% of time between 1980 and 1990 this percentage rose to 90%. Conversely, before 1980 appeals overturned only 12% of district court invalidity or non-infringement. That percentage rose to 28% in the later period. As a result the overall probability that a patent litigated patent will be held to be valid has risen to 54%. Patentees asserting infringement are also now more likely to be granted a preliminary injunction barring the sales of the alleged infringing product during the litigation ((Lanjouw and Lerner, 1998).

US policies regarding patenting of inventions arising from publicly funded research in federal R&D laboratories and universities

The rules regarding w*ho* can patent were changed. With introduction of the Bayh-Dole Act (1980) the policy has evolved from one in which patenting of inventions derived from public funding was the exception to one in which such patenting is widespread. Mowery et al. (2001a) examined the effects of Bayh-Dole at three leading universities: the University of California, Stanford University and Columbia University. Two of these universities (California and Stanford) were active in patenting and licensing before Bayh-Dole and one (Columbia) became active only after its passage. The evidence suggests however, that Bayh-Dole was only one of several important factors behind the rise of university patenting and licensing activity. A comparison of these three universities reveals remarkable similarities in their patent and licensing portfolios 10 years after the passage of the Bayh-Dole Act. In a subsequent article by Mowery and Ziedonis (2001b) extended their analysis to all US universities. According to their analysis of overall US university patenting, the patents granted to institutions that entered into patenting and licensing after the Bayh-Dole Act are less important and less general than the patents issued before and after 1980 to US universities with longer experience in patenting.[1] The most recent trends and practices in university licensing and intellectual capital management are discussed by Berneman and Denis in Goldscheider (2002, Ch. 11).

Expansion of the realm of patentability

The patentable subject matter, i.e. *what* can be patented, was expanded. The US patent office accepted patentability of genetically engineered bacteria and animals, genetic sequences (Eisenberg, 2000), surgical methods, computer software, financial products, methods for auctioning on the Worldwide Web etc. According to Kortum and Lerner, (1998) the share of biotechnology patents grew from about 3% of total patent in 1961 to about 6% and computer software from 4% to almost 7% of total patents in 1991. The increases were even stronger in the nineties. However, according to the authors, they do not explain the growth in total patenting.

Among the most important and controversial new patentable subject matter has been expansion of patentability of software (Graham and Mowery, 2001 and Mowery, 2001) and financial services products and processes Lerner, (2002), Hunt (2001). Software that was part of a manufacturing system or process became patentable in 1981 (Supreme Court: Diamond vs. Diehr). In 1998 the CAFC upheld a patent on a software system that performs real time accounting calculations and reporting for mutual fund companies (State Street Bank and Trust vs. Signature Financial Group); business methods became patentable. For

details see Merges (1997), the most complete and authoritative text on patent cases complemented with economic analysis and business history. Another controversial field is patenting of research tools and genetically engineered bacteria and animals and genetic sequences (Eisenberg, 2000). More about new patentable subject matter below.

Expansion of the Patent scope (breath)

According to theoretical studies (Kitch, 1977; Gilbert and Shapiro, 1990; Scotchmer, 1991; Green and Scotchmer, 1995; Scotchmer, 1996) reviewed by Jaffe (2000), granting broad patent rights to the pioneering inventor early in the development will ensure an orderly development of the technology by licensing the invention or other contractual arrangements enabling other inventors to contribute to subsequent development of the technology. However, empirical studies supporting this theory are few and inconclusive. Lerner (1994) found that firms with broader patents (measured by the number of International Patent classes (IPC) are valued more by venture capitalists. On the other hand, a survey by Harhoff et al. (1998) does not find that the number of IPCs is related to patent value. Sakakibara and Branstetter (1999) looked at the effects of the change in Japanese single claim patent system to a multiclaim system which awards presumably broader patent rights. They did not find any indication that the broader scope of patents increased incentives to R&D and led to higher research spending or higher Japanese patenting in the US. In contrast, Merges and Nelson (1990) examined several historical cases and found that the *ex ante* uncertainty about the future development of technology makes licensing and other contractual arrangements unlikely and/or ineffectual, thus contradicting the hypothesis on which the theoretical models are based. They show for example that the broad licensing of the original AT&T patent (result of antitrust decree, which prevented the AT&T to exploit the patent itself) benefited significantly further development of semiconductor industry.

Changes in the international trade and investment environment

On the insistence of industrialized countries led by the United States the protection of IP was integrated in the Uruguay round GATT negotiations that led to creation of the World Trade Organization. The trade related aspects of intellectual property protection, called the TRIP agreement, became one of the cornerstones of the new world trade order (Cockburn and Lanjouw, 1996). In contrast to other trade agreements which introduce common rules that national policies have to respect, TRIPs impose a common policy with respect to IPRs to all WTO members.

The TRIP Agreement introduced the following rules :

- Virtually all commercially important technological areas must be included within the realm of the patentable technology
- Patents must be granted for 20 years
- Patents must be tested for non-obviousness and utility as in the US patent system
- Patent holders must have the right to prohibit the importation of infringing products.
- Limitations are placed on the circumstances under which governments can order compulsory licensing of patents.
- There are transitional provisions for application of these measures by the Less Developed Countries (LDC).
- Overall, these provisions provide a major strengthening of patent protection around the world and shifted the global rules of the game in favor of industrialized countries (Lall and Albaladejo, 2002)1

- The most important change to the US patent policy is the extension of patent from 17 years from the date of grant to 20 years. The classic theory on economic effect of patent length is Nordhaus (1969) followed by a discussion on the subject (Nordhaus, 1972; Scherer, 1972).
- Patents started to be used aggressively in the standard-setting bodies, especially for telecommunications, computers and consumer electronics (Shapiro, 2000; Granstrand, 1999, p. 203-204). According to Granstrand the GSM system for mobile communications system involved more than 2000 patents, of which about 30 were standard blocking patents.
- Another important change is introduction of priority from the "first to invent" to "first to file" (Jaffe, 2000).
- Gallini (2002) reviews these and some more recent patent reforms introduced in the United States and discusses their economic implications. The Drug Price Competition and Patent Restauration Act (Hatch-Waxman Act) attempts to promote innovation in new drugs while facilitating generic entry. It restores up to five years of lost patent time spent on the Federal Drug Administration (FDA) approval process. The first firm to file an application for making a generic equivalent to a branded drug receives a 180 days exclusivity, while manufacturers of branded drugs are allowed to request a 30 months postponement of the FDA approval of generic drugs that arrive before their patent expires.
- Some developments aim at counterbalancing the policies that strengthened or extended the patent protection:
- The American Inventors Act passed by the Congress in 1999, requires all patent applications in the US and abroad be disclosed to the public 18 months from the earliest filing date.
- A reinterpretation of the "doctrine of equivalents" in favor of imitators.

Evolution of the interpretation of IP laws

In his insightful overview of the evolution and critique of the patent system, Kingston (2001) notes that the reinterpretation of the "inventive step" criterion of patentability[2] made the patent system suitable for protecting inventions which are the result of the purposeful, routine corporate R&D rather than the result of individual ingenuity. Routine R&D is invested in portfolio of risky projects. The investment in large R&D portfolios is close to certainty of success. It turns out patent portfolios that are used as a bargaining currency to prevent lock-out from state-of art components developed by competitors as much or even more as they are a stimulus to R&D.

The growing importance of products and processes represented by complex technologies[3] contributes, according to Kingston, to the growing importance of patent portfolios and patent pools. The have the advantage of giving all membe rs the freedom to use the technology of all other members without need for costly negotiation or litigation. If using patent pools is outlawed, firms tend to patent everything which can possibly to help them against being locked out by competitors patent from an incremental improvement they might want to use in the future. This leads to strategies of saturation patenting designed to slow down or prevent competition from exploiting alternative technological trajectories that are certainly anti-competitive.

III. THE TREND OF PATENTING IN THE US - WAS THERE A CHANGE, WHAT MIGHT HAVE CAUSED IT AND WAS IT BENEFICIAL FOR FURTHER TECHNICAL PROGRESS?

The first major empirical study that compared the evolution of patenting in the US before and after the beginning of the "patent friendly era" was (Kortum and Lerner, 1998) paper. Kortum and Lerner concluded that the data does not support the hypothesis of "friendly courts" (i.e. increased patenting in response to changes described above) , nor that of "fertile technology" (hypothesis that the overall increase in patenting was due to a sharp rise in patenting in a few new fields benefiting from extraordinary

progress in science and technology) or "regulatory capture" (i.e. increase in patenting by largest firms reacting to a perceived relaxation of antitrust vigilance by accumulating patent portfolios in order to increase their monopoly power). They concluded that the source of increased patenting is outside the patent system- they attributed it to more productive R&D.

The finding that patenting increased notably in the 80s and 90s is surprising in the light of the comparison of survey evidence that suggests that firms in most industries (surveyed Mansfield, 1984[4], Levin et al., 1987 and more recently by Cohen et al., 2000) have *not increased* their reliance on patents for appropriating the returns to R&D over the early 80s. Then, as Hall and Ham Zideonis (2001) ask, if firms in most industries do not rely heavily on patents to profit from innovation, then why are they patenting so aggressively?

Cohen et al. (2000) suggest that the reconciliation of increased patenting and the lack of perceived effectiveness may lie in the multiple ways that firms use patents. In addition to protecting the returns to specific inventions, firms use patents to block products of their competitors, as bargaining chips in cross licensing and to prevent or defend against infringement suits. These alternative uses of patents may be zero sum games not increasing the returns to innovations as suggested by Hall and Ham-Ziedonis (2001). They analyzed the patenting of semiconductor firms and suggest that the observed "patent portfolio races" are consistent with rising rates of patenting and rising patent/R&D ratios without there being any perceived improvement in the net value of patents in protecting the value of innovations. They also show that part of the increased rate of patenting coincided with the entry of "fables" firms specialized in design of chips and contracting their manufacturing to other firms. This practice would not be possible if the designing firms could not protect their creation from being appropriated by the contracting manufacturer.

Reviewing this empirical research Jaffe (2000) concludes that there is at best only limited evidence that the upsurge in patenting observed in the eighties resulted, at least directly, from the strengthening of patent protection in the eighties. He believes that it was the result of a combination of technological opportunities, the build up in government R&D spending and defense procuring, increased international competition and other factors that increased the returns to R&D.

According to Jaffe all these factors would have resulted in increased patenting even without strengthening the patent system but the strengthening of the patent system presumably reinforced these tendencies. There is however very little evidence that increased protection of IP had a significant impact on the innovation process. There is at least as much evidence that patent regime changes caused resources be diverted from innovation towards the acquisition, defense and assertion against others of property rights, as there is evidence of stimulating of research.

Reviewing the situation more recently, Gallini (2002) notes that recent extension of patenting to new fields (biotechnology, software and business methods) increased the number of patents in these areas (Graham and Mowery, 2001; Lerner, 2002). In comparison with the 1980s, new patent applications in the US to domestic inventors more than doubled by the late 1990s. Biotechnology and software patent grants doubled between 1990 and 2000. The largest 100 universities tripled their annual patent output from 1984 to 1994 (Cohen et al., 1998b) and R&D expenditures of small and medium size firms employing more than 5000 employees[5] more than doubled from 1987 to 1997. According to Gallini (2002), the most recent patent statistics not covered by the original Kortum and Lerner (1998) study and their review by Jaffe (2000) showing marked increased patenting in the US by foreign patentees lend more support to the "friendly court" hypothesis discarded in the initial paper Kortum and Lerner.
Whatever the causes of the recent upsurge in protection of IP and patenting, a more important question is what effects the observed trend is likely to have on innovation and the diffusion of technological change – the primary objectives of IP protection. Ordover (1991) argues that weak patent protection need not be inimical to economic growth and, conversely, that strong patent protection need not be enemy of

diffusion. An optimal configuration of patent law and antitrust rules may ensure incentives for R&D and also induce cooperation among firms in diffusing R&D results through licensing or other means. Merges[6] and Nelson (1994) looked at theoretical arguments, the legal doctrines and empirical evidence of the effects of broad patent scope decisions on the rivalry in technical progress. They came to the conclusion that the existing practice at the Patent Office[7] allowing overly broad interpretation of patent scope "…leaves too much of the job of reining in scope to litigation and courts".

In a more recent paper Mazzoleni and Nelson (1998) provide a useful overview of the arguments and empirical evidence in favor and against today's conventional wisdom that strong patent rights are conducive to economic progress. Mazzoleni and Nelson show that patents serve several functions:

- the prospect of patent protection provides a motivation for useful invention,
- patent protection may be needed to induce investments to develop and commercialize them,
- patents are awarded to induce inventors to declass their inventions,
- patents may be needed to permit orderly exploration of a broad prospect of inventions

The authors are arguing and present case evidence that strong patents were often not necessary to induce invention and entailed significant economic costs. They conclude that there is reason for concern that the present movement towards stronger patent protection may hinder rather than stimulate technological and economic progress. For a historical perspective on the evolving relationship between IP and antitrust in the US see Hart (2001).

As (Jaffe, 2000) earlier, Gallini (2002) is not sure whether the recent surge in patenting is beneficial for technological progress and economic growth. She structured her review of the recent literature on the economics of patents around three important questions:

- Do stronger patents stimulate more innovation?
- Do stronger patents encourage more disclosure?
- Do stronger patents facilitate technology transfer?

In response to the first question Gallini admits the possibility that the strengthening of patent rights may have already placed the United States at the peak of the "inverted U" relationship in which further strengthening of patents does not spawn more innovation. For details on the "inverted U" see the empirical study of 177 patent policy shifts in 60 countries over 150 years (Lerner, 2001).

- *Do stronger patents encourage more disclosure*? In addition to the conventional trade off between the presumed stronger incentives for innovation and disclosure of inventions, stronger patents may inspire strategic patenting for the purpose of cross licensing and hereby facilitate the exchange and diffusion of new technologies ((Hall and Ziedonis, 2001). Strategic patenting thus may be socially beneficial in encouraging the disclosure of information to other firms and in averting costly litigation. However, the strategic accumulation of patents in patent pools creates high barriers to entry (Barton, 1998). New semiconductor firms must spend $100 - $200 million in licensing fees for basic technologies that may not be that useful (Hall and Ziedonis, 2001).

- *Do stronger patents facilitate technology transfer*? Empirical research suggest that licensing is more prevalent in industries where effective patent protection is available as in biotechnology and chemical industries (see below: Arora and Fosfuri, 2001). It also encourages vertical specialization (Arora and Gambardella, 1990; Lerner and Merges, 1998). According to Gallini, a stronger legal right to exclude others from using an invention generally provides a stronger economic incentive to include them

through licensing. The discussion of various examples of strategies used in different industries shows, however, that while strong patents may facilitate the transfer of technology, they also may facilitate anticompetitive behavior (Anderson and Gallini, 1998). There is, however, strong evidence that licensing increased significantly in recent years (Goldscheider, 2002, Ch.1 by Manfroy).

IV. OVERVIEW OF THE IP RIGHTS USE AND STRATEGIES IN THE UNITED STATES, CANADA, JAPAN, EU AND ELSEWHERE

The use of IP rights in the US

Microeconomic empirical studies of patenting in the US by Scherer et al. 1959, (Patents and the Corporation, Boston, privately published) and (Mansfield E. et al., 1981), (Mansfield Edwin, 1985a) and Mansfield (1986) and in the UK Taylor and Silberston,1973) called in doubt the hypothesis that patents protect effectively innovations from innovation. The studies also showed that patent protection is important only in a few industries, most notably in pharmaceuticals. These disquieting findings were largely confirmed and documented in the path breaking study by (Levin et al., 1987). This study based on a large scale representative "Yale" survey of experts from US manufacturing industries found that firms typically trust and use alternative strategies such as lead time, secrecy, the use of complementary sales and services more than statutory IPRs to appropriate innovation related benefits. Given its capital importance for the subject of this review, it is resumed in greater detail below.

To examine what effects had the series of pro-patent measures adopted since the beginning of the 1980s in the US, a follow-up survey (sometimes called "Yale II") was launched by Carnegie Mellon in 1994 (Cohen et al., 2000a). Their paper reports IPR related findings from some 1165 cases included in a larger mail survey of R&D managers in a large sample of US manufacturing firms and business units complemented by interviews with R&D managers and intellectual property officers at nine firms. The principal objective of the study was to examine how firms appropriate (or not) results of their R&D activities and innovations, the effectiveness and the use (or not) of various IP rights and alternative methods and whether patents contribute to the advancement of technology. The second motivation was to provide a managerial perspective of firms' strategies to protect their inventions and the particular role of patents.

The study confirms that patents are considered as being significantly less effective means for appropriation of benefits from innovations than lead time, secrecy, complementary manufacturing and complementary services. Patents are however perceived as more effective than other legal IP mechanisms. Patents protect more effectively product innovations than process innovations. Secrecy is considered equally effective for appropriation of benefits from product and process innovations. Details are available for 3 digit manufacturing industries.

Although never reported as the most effective appropriability mechanism in any industry, patents are the central vehicle for protecting product innovations in pharmaceuticals and medical equipment (effective for more than 50% of product innovations). They are somewhat less central but still very important in special purpose machinery, computers, auto parts and miscellaneous chemicals (effective for about 40-50% of product innovations). In contrast, semiconductors and communication equipment and electronic components report patents effective for only 27%, 26% and 21% product innovations respectively. Patents are generally even less effective for protection of process innovations, which are best kept secret.

For the non-patented inventions the principal reason not to patent is the difficulty in demonstrating novelty. However, the most frequently cited reason for not patenting is the ease of legally inventing around a patent (65% of respondents) followed by the lack of novelty (55%) and information disclosure (47%). Small firms are deterred from patenting by the cost of litigation (see also Lerner, 1994). In

comparison with the earlier survey (Levin et al., 1987), patents appear to be somewhat more central in larger firms in a larger number of industries. Far more prominent however is the jump of secrecy from last place in the Yale survey to tie for the first in the present survey. The disclosure aspect of patents is, according to Duguet and Kabla (1998) the main reason why French firms do not patent all their inventions.

As demonstrated, the number of patented inventions has increased notably since the beginning of the 1980s. The survey asked respondents to check off, in a non-exclusive manner, which of the following reasons motivated their most recent decision to apply for product and process patents:

- prevention of copying, preventing other firms from patenting a related invention,
- the earning of license revenue,
- to strengthen firm's position in negotiations with other firms (as in cross-licensing), prevention of infringement suits,
- to measure the internal performance of the firm's technologists and
- to enhance the firm's reputation.

The prevention of copying is the first reason, which was reported by 99% and 89% of the respondents for the product and process patents respectively. The second most important reason was to prevent rivals from patenting a related invention (77% and 69% respectively) and close behind was the prevention of suits (74% and 63% respectively). Next, patents are filed to strengthen firm's position in negotiations (58% and 49% respectively) and less important, to enhance its reputation (38% and 32% respectively) and to earn licensing revenue (33% and 30%).

There are however significant differences across industries in the way that patents are used. They are closely related to differences between "complex" and "discrete" technologies (Levin et al. 1987; Merges and Nelson, 1990; Kusonaki, Nonaka and Nagata, 1998 and Kash and Kingston, 2000). Firms in "complex" technologies patent mainly for negotiations (81%) and cross-licensing (55%) while firms in "discrete" product industries use patents for these reasons much less (33% and 10% respectively). The paper shows that the taxonomy based on complex and discrete technologies explains also other differences in patent strategies.

One of the most recent and interesting accounts of patenting strategies comes from the Stanford Workshop on Intellectual Property and Industry Competitive Standards, 1998. As notes rapporteur's summary (Headley, 1998), the debates were based on the model of innovation that involves a set of incremental and often quite different contributions by different firms, each building upon the work of the others. By the time an idea becomes a commercial product, it has had many owners, each contributing special skills and, in the aggregate, hastening the rate of innovation (Scotschmer, 1991 and Scotschmer, 1995).

In addition to papers on different industries (reported below) we present here the main points from the synthesis of the workshop findings by Barton (1998) According to Baron, the use patents depends on the type of industry's competitive structure. They are used in three general patterns: to create a specific monopoly (the normal economic model), the use among competitors in an oligopolistic industry and the vertical use among suppliers and customers.

Use of patents to create a monopoly

This is the sole case that is conforming to the economic model. The IP creates a monopoly position for a product or process and exercise of the monopoly provides, *ex ante*, an incentive and *ex post*, a reward for the innovation or authorship. This monopoly pattern is possible when the IP effectively define rights over a specific product or category of products or process essential to the production of a category of products (the case of discreet technologies in (Cohen et al., 2000). These are situations typically found in the traditional pharmaceutical and chemical industries, where each product is likely to have a monopoly position for its specific use (or at least to have very strong market power as compared with alternatives that are technologically second-best). Such a monopoly position is what the leading agricultural biotechnology firms are currently seeking in their effort to use IP to drive competitors out of the business. Such a monopoly position is what the leading agricultural biotechnology firms are currently seeking in their effort to use IP to drive competitors out of the business. This is what Polaroid did, in its 1981 suit to exclude Kodak from the instant camera industry.

Use of IP in horizontal oligopolies

In many industries, however, the patent network is such that a number of competitors are routinely infringing other competitors' patents. Although it might be possible for one firm to acquire a dominant portfolio through license, acquisition, or successful litigation and thus to move into a monopoly position, the more typical pattern is that a number of oligopolistic competitors each hold substantial portfolios which they use to maintain freedom of action rather than to exclude competitors. Situation typical of semiconductors (cf. Hall and Ham-Ziedonis, 2001; Cohen et al., 2000) present evidence that, overall, blocking and the prevention of suits were the second and third most important motivations for patenting (after the prevention of copying).

The result of the cross infringements may be an armed truce, with each firm dissuaded from bringing suit against its competitors by the likelihood that suit would be met by a countersuit. In other situations, there may be formal cross-licenses. These may be royalty-free, or with a flow of royalties based on a very rough estimate of the comparative strength of the different firms' portfolios. Where one of the firms has a significantly more powerful position than the other, the cross-license may be still less symmetrical, providing for example that the weaker party obtains only the rights needed from the stronger party to pursue a specific line of innovation or market a specific product, while the stronger party obtains much broader rights to use the weaker party's IP.

Litigation will occur in a number of situations: it may be used against would-be entrants who have not purchased licenses from the existing oligopolists. Firms which have solid patent portfolios, but relatively weak market positions may face little concern about countersuits and therefore be more willing to seek royalties. If the patent portfolio balance among different firms diverges too radically from the cross-royalty payment pattern, litigation may be part of the renegotiation process, as perhaps in the case of IBM's desire to operate its patent department as a profit center or in the DEC-Intel litigation of 1997. Litigation may also be a method of signaling or communicating with a competitor; conceivably such a mechanism could be used to sanction a firm cutting the oligopolistic price. In these horizontal situations, there must be oligopolistic pricing, as distinguished from competitive pricing, in order to create the surplus needed to support research and development.

The effects on the research level are unclear. Plausibly, the same conscious parallelism mechanisms that establish prices may also establish innovation levels--a firm needs basically stay up with its competitors but does not have to push the technology frontier unless it hopes to gain market share. Nevertheless, it seems clear that the rate of technological change in semiconductors is essentially at the limits of human

research and organizational capability. Similarly, that in aircraft may be essentially at the limits of the ability of the market to amortize research and manufacturing expenditures.[8]

Patents are evaluated in this context very differently from the way they are in the previous contest. In this context, the most valuable patents are not those likely to be used by the patent holder but those likely to be infringed by competitors, because the main role of the patent is as a bargaining chip to buy freedom of action. The value of a patent is therefore a function of its engineering importance, of the ratio between the total sales of competitors using the technology and the patent holder's sales using competitors' technology and the propensity of the industry to litigate. A patent is worth more in the hands of a weak competitor than in the hands of a strong competitor.

Use of IP in vertical relations with suppliers and customers

The workshop defined a further category of *vertical uses of IP vis-à-vis suppliers and customers*. Two broad categories of examples were presented.

(i) In one, IP are used as part of an effort to allocate rents between different levels of production or development. In the other, they are used to extend power at one level of production or development to obtain a stronger position at a higher or lower level of production with respect to the next generations of technology.[9]

(ii) In the other vertical use of IP, firms are not merely using IP to negotiate about the allocation of rents; they are using it rather to obtain next-generation power in neighboring markets. Almost always this power is exercised through the provisions of a strategic alliance. A firm that is dominant at one level uses its control over its own IP to gain power and protect itself from competition from supplier or customer firms that need access to that IP to produce next generation products.[10]

As it should be clear from the discussion above, in both cases (horizontal and vertical correspond to "complex technologies" according to Cohen et al. 2000) patenting is driven by strategic reasons and not by the desire to protect ones invention against imitation.

Rivette and Klein (2000) and other authors of recent popular books on IP strategies urge managers to apply for patents and use them more aggressively. Cohen et al. (2000) caution managers of the possible risks and costs related to relying to heavily on patenting strategies when alternative methods such as being first in the market may be less costly and more effective. Another concern of economist is that relying overly on patents is likely to reduce the flow of R&D spillovers between firms, thus reducing one of the important sources of innovation-related increases in productivity.

Overview of the recent research regarding the use of IPRs in Canada

Firestone's 1971 book was the first comprehensive survey of the use of patents in Canada. Economic Council of Canada survey (De Melto, McMullen and Wills, 1980) examined major innovations introduced in five Canadian manufacturing industries. The study concluded that only about 32% of the major 283 innovations introduced in Canada in the proceeding twenty years were patented. According to that study:

(1) The propensity to patent innovations was increasing with the size of the innovating firm
(2) Foreign controlled firms (and even more so those under the US control) patented significantly more (39%) than their domestically controlled counterparts (23%)
(3) Innovations based on imported technology were more often patented in Canada than innovations based on technology developed in house

(4) There was a clear positive association between the cost of an innovation and patenting; the more costly innovations were more likely to be patented
(5) The rate of patenting declined over time, especially in the last half of the seventies. This tendency of firms to rely progressively less on the patent system to protect their major innovations was noted also in the US and later, motivated the influential study of by Levin et al. (1987).

A report commissioned by Industry, Science and Technology Canada, Consumer and corporate affairs Canada and the Science Council of Canada (Industry, 1989) looked at attitudes, practices and interests of Canadian industry with respect to IP rights (IPRs).[11] The authors found that: (1) Even though the majority of respondents were satisfied with Canadian IPRs, there was an important variance by industry sector and size of firm. Smaller firms[12] and firms in the "new economy" sectors such as software development and biotechnology expressed the most dissatisfaction with the Canadian IPRs.[13] (2) The second major finding of the study was the high reported degree of infringement and counterfeiting. Between 32% and 40% of firms in the four groups indicated that their IPRs had been violated in the four years preceding the study. A large proportion of firms complained that litigation was too expensive, especially for the smaller firms and the penalties insufficient to prevent infringement. (3) A significant number of firms stated that they had insufficient knowledge or expertise with respect to IPRs. (4) Finally, with the exception of copyright users, firms from all other sectors expressed that they had difficulties in terms of time and cost involved in registering and obtaining IPRs.

The study based on the Statistics Canada, Survey of Innovation and Advanced Technology, 1993, covering the period 1989-1991 found that there are substantial differences in the use of trademarks, patents, trade secrets, industrial designs and copyrights between those firms that had just innovated in the three preceding years and those who had not. Trade marks were the most popular form of protection, followed by patents and trade secrets, industrial designs and copyrights (Baldwin, 1997).[14]

Baldwin's study corroborated earlier findings by showing that: (1) the use of IPRs increases with the size of firm. (2) The use of intellectual protection varies significantly between industries. The inter industry differences in the use of IPRs are at least in part determined by the technology sector (Robson et al., 1988)[15], the nature of the products, their stage in the life cycle and competitive conditions. (3) Product innovations (with or without a change in production process) were more than twice as likely as pure process innovations to be patented. Process innovations lend themselves better to protection through secrecy. (4) Large firms are more likely than the small ones to introduce a world first innovation. (5) Some 15% of innovations of large firms are the world-firsts. The firms that introduced world-first innovations made in general much greater use of any IPRs than the less original ones. (6) Foreign owned firms irrespective of their size, industry or type of innovation had more often recourse to intellectual protection instruments than Canadian-owned firms. The results of the 1993 innovation survey also show that the US findings by Levin et al. (1987) suggesting that firms tend to value alternate strategies more highly than the statutory forms of intellectual property protection also apply for Canada. Moreover, the population of manufacturing firms as a whole ranks such strategies as patent protection as being less than "effective".[16] However, these rankings depend very much on the characteristics of a firm. If a firm is innovative, large, foreign-owned and operates in one of those industries that tend to produce more innovations, the score given to the statutory forms of protection like patents increases greatly. On average, users of patents find them effective; so too do large foreign-owned firms. Many firms use alternative strategies such as increasing the complexity of product design to fend off imitation or being first in the market to appropriate benefits from their innovations. They are judged to be more effective to appropriate benefits from innovation than relying on statutory IPRs.

Appraisal of the recent evolution of patenting in Canada

The 1989 reform of the Canadian Patent Act introduced a series of important modifications, followed by the repeal of the compulsory licensing in 1992. The first-to-invent patent system was replaced by the first-to-file system and the duration of the patent grant was extended from 17 to 20 years. These and other changes expanded the scope of patent protection in Canada. Whether the new patent policy impairs or encourages innovation is still disputed (Friedman et al., 1991). As in the US (Kortum and Lerner, 1998) the rate of growth of patent applications in Canada from foreign and domestic inventors alike has dramatically increased from mid eighties. Canadian inventors also increased their patenting in the US. According to Rafiquzzaman and Whewell (1999) the increase is due to a combination of effects of "fertile technology" and "patent favorable environment". However, according to the index of patent strength[17] reproduced in Rafiquzzaman and Ghosh (2001) in spite of the recent reforms, Canada's patent system is still weaker than that of all G7 countries. The effect of 1989 –1992 patent reforms in Canada on the propensity of foreign inventors to patent there has been examined by (Gallini et al., 2001). Their preliminary result suggest that using a single index of patent strength to explain a combination of various changes like those that were implemented in Canada is not entirely satisfactory.

The increased patenting is closely correlated with increased R&D spending (Trajtenberg, 2000). More specifically, there is convincing evidence that changes in the Patent Act also induced a significant increase in R&D and innovation activity in at least one particular sector -- the pharmaceutical industry (Pazderka, 1999).

Even though the increase of domestic and foreign patenting by Canadian inventors is good news, it does not necessarily follow that the increased number of patent applications signals an improvement in the composition of technological change in Canada and its "quality". In a provocative paper (Trajtenberg, 2000) argues that:

(i) the direction of technological change in Canada is sub-optimal
(ii) the quality of Canadian patents is lagging behind the US patents
(iii) the high proportion (35 percent) of Canadian unassigned patents, i.e. granted to individual inventors and another 19 percent owned by foreigners is another evidence of the weak Canadian innovation performance

Trajtenberg's analysis is based on a comparison of the industry composition of US patents granted to Canadian and US inventors. (i) According to his study Canada is lagging in several leading technologies such as Computers and Electrical and Electronic, while being unduly concentrated in traditional fields (Mechanical and others). (ii) Measured by their citation rate, the "quality" of patents granted in the US to Canadian inventors is lagging behind the US patents. (iii) The high proportion of patents granted in Canada to individual investors and their tendency to commercialize them less than patents granted to firms has been documented in detail by Amesse, (1991) and Séguin-Dulude (1988) and recently commented on by Trajtenberg (2000).

The latest study by Rafiquzzaman and Mahmud (2002) shows that overall Canada's innovation performance has improved since the work of Trajtenberg. Instead of "missing the technology boat" Canada has made impressive progress in innovating in the areas of strategically important technologies such as computers & communications, electrical & electronics and drugs & medicines. Canada's propensity to patent in terms of the ratio of US patents to R&D expenditures has also increased in recent years; Canada ranks third after the US and Japan in the production of patents per R&D dollar. In recent years, Canada experienced an explosive growth rate in filing patents in the US; during the period 1997-1999, Canada's patent applications growth rate in the US was exceeded only by those of the US and Japan.

In the area of the quality of innovations, according to Rafiquzzaman & Mahmud's study, Canadian innovations improved in quality, as measured by the rate of citation of patents, compared to other G-7 countries except the United States. Even though Canadian innovations are well above average quality, the "quality index" indicates that Canada still suffers a quality gap, as measured by the numerical difference in the average quality of patents between the United States and Canada. Nevertheless, this gap has been narrowing since 1998. Similar trends in the citation of patents are observed across all industries except drugs and medicines, where Canadian patents are on average cited more frequently than US patents.

In an attempt to measure the use of IPRs in various sectors of the Canadian economy, (Charles et al., 2001) computed indices of patent intensity (number of patent applications per $ billion PIB), for major groups of manufacturing industries and services in 1999. Similarly they relate the use of copyright and trademarks to the "economic importance" of sectors where these IPRs are used. These indices give an idea about the relative importance of intellectual property in various sectors.

An increase of the use or strength of IPRs does not necessarily lead to GDP or productivity increases. The effect is likely to be indirect, trough increased R&D investment (Park, 2001). However, the relationship between, IPRs, investment in R&D and innovation and the innovation's impact on productivity is complex. As recent microeconomic research shows (Baldwin and Hanel, 2003; Baldwin, Hanel and Sabourin, 2000), the effect of patenting as an incentive for innovation is far from being evident once the simultaneous nature of the underlying relationships is properly taken in consideration. A study of a large sample of Canadian pharmaceutical firms (Lazarus, 2001) failed to uncover a link between patent policy and innovation in Canadian biotechnology firms.[18]

The data from Statistics Canada Innovation Survey, 1999 analyzed by Hanel (2001), show that two thirds of all manufacturing firms in Canada use at least one of the several intellectual property rights. [19] The proportion of firms (innovating and non- innovating alike) that use IPRs is increasing with the size of firm. Firms operating in the core sector[20] that feeds innovations to the secondary and 'other' sector and to the rest of economy protect their intellectual property more frequently than firms in the secondary sector do. Firms operating in the low-tech 'other' sector use them least. The close association of the use of IPRs with the size of firm is also observed within each technology sector. It suggests that the cost of learning and using effectively protection of intellectual property discourage small and medium size firms from using it as frequently as larger firms.

Most original world-first innovators and firms that perform regularly R&D use all IP instruments most frequently. Firms using intellectual property, especially trade secrets, trademarks and patents are more likely to introduce innovations.[21] Using patents and also trademarks seems to be an integral part of a successful innovating strategy, which consists of performing regularly R&D financed in part by government subsidies and grants, introducing world first product innovations and exporting.

The majority of firms apply for patent in Canada, but many apply also in the US. Two thirds of firms which apply for patent do so in both countries. Less than 10% of firms that apply for a patent do so exclusively in the US. About 20% apply exclusively for a Canadian patent and some 5% apply elsewhere. The tendency to apply for patents in the US is increasing with the extent of patenting and the size of firm. Firms that apply for more than ten patents tend to patent more in the US than in Canada. Overall the evidence suggest that even tough intellectual property rights may not be perfect means of appropriating benefits from innovation, firms that protect their intellectual property are more likely to succeed in maintaining their profit margins or increasing their profitability than firms that do not.

Patenting and IP rights use in European countries[22]

One of the earliest empirical works on the practice and impact of patenting was Taylor and Silberston (1973) study "The Economic Impact of the Patent System in U.K". The survey covered chemical and engineering industries. Among information still interesting today is information on the size of patent departments related to economic characteristic of firms their activities (size, sales and number of patents). The study provides also information on the cost and budgeting of patenting and related activities. It overviews patenting and licensing practices, their duration, licensing payments, restrictive provisions, exclusivity and refusals. Also covered is the pure "know-how" licensing. Examples of calculation of royalty rates are also presented. The survey also inquired on the impact of patenting and licensing. The section on compulsory licensing and its impact includes also a description of a restrictive practice of 'tied' leasing: a procedure under which machines were leased to users on condition that the later should obtain all their auxiliary equipment and materials (including non patented ones) as well as new machines from the lessor. This practice was disallowed in the U.K. in 1907 but in reality used until 1951.

The decisive majority of respondents surveyed by Taylor and Silberston study indicated that the existence of patents had a negligible effect on their R&D; hence there was little indication that patents led to wasteful R&D for inventing around. Some of the industry specific points treated in the study are presented below. Some twenty years after the pioneering study by Taylor and Silberston, the European Patent Office surveyed thousand small and medium size European firms with less than 1000 employees that applied at least for one patent (EPO, 1994). These firms reported to have patented over 50% of their patentable inventions. However, no information is available on firms that did not patent. Neither does the report provide information on patenting by the size of firm or by sector. The survey-based information on patenting in Switzerland can be found in Harabi,1995 and for Sweden in Granstrand (1999).

A joint survey by MERIT in the Netherlands and SESSI in France surveyed patenting by Europe 604 largest firms in 1993 (Arundel and Kabla, 1998). Their results show that as in the US, patents are of greatest value in a few sectors such as pharmaceuticals, chemicals and machinery where the cost of copying an innovation is considerably less than the initial cost of invention. Like in the US, patents are relatively unimportant compared to alternative appropriation methods such as lead time advantage or technical complexity in sectors that produce complex products costly to copy or in sector with high barriers to entry (e.g. specific expertise and large investment), such as in aerospace industry. The patent propensity in the early 1990s in the EU was lower than the propensity to patent observed in the US by Cohen et al. (2000).[23] One possible explanation for the difference suggested is the lower cost of patenting in the US than in Europe, the other is the effect of pro-patent reforms in the US.

Arundel and Kabla report that the average propensity to patent[24] product innovations in EU was 36% (ranging from 8.1% in textiles to 79.2% in pharmaceuticals) and 24.8% for process innovations (ranging from 8.1% in textiles to 46.8% in precision instruments). Regression results that control for the effect of the industry sector show that the propensity to patent increases wit the size of the firm. Firms that find secrecy to be an important method for product innovations are less likely to patent, but secrecy has little effect on patenting process innovations. The R&D intensity of the firm has no effect on patent propensity rates for both product and process innovations. After controlling for the effect of other factors, the sector of activity has a strong influence on product patent propensities but very little effect on process patent propensities. Results of the French survey presented by (Duguet and Kabla, 1998) indicate that firms patent mainly to build a strong negotiating position and to avoid litigation. The propensity to patent is reduced by the reluctance of firms to disclose information; the cost of patenting and litigation does not have, according to their econometric study an effect on patenting.

Granstrand (1999) attributes the lower propensity to patent in Europe compared to Japan to a condescending attitude of West European engineers towards minor "junk" patents. He maintains that the correlation between the legal quality, the technical quality and the economic quality is not high.

Trends of protection of intellectual property by trademarks and patents in the UK, US and Europe of a sample of a panel of UK manufacturing and financial firms are discussed analyzed by Greenhalgh et al. (2001). They find that the decline of the rate of British patenting in UK and Europe during the 1990s was not compensated by a slight increase in US patents. In contrast, trademark applications increased both for firms in manufacturing and in financial services, especially during the mid 90s. Smaller firms are more than proportionally active in acquiring IP assets. An interesting British study estimated separately the effect of R&D and IPRs on the productivity of a firm. Somewhat surprisingly, firms in high technology industries register larger returns to R&D while those in low technology sectors show more significant returns to IPRs (Greenhalgh and Longland, 2002). See also (Pitkethly, 2001) comparing the British and Japanese intellectual property strategies.

The perception that Europe is lagging behind the US in IPR system led to establishment of the European Technology Assessment Network (ETAN, 1999) whose Working Group produced the report "Strategic dimensions of intellectual property rights in the context of science and technology policy. Too long to be overviewed here, some of the subjects of interest to the present survey include:

- It is recognized that the awareness of the importance of IPRs has to be improved by education both in universities and the business community.
- Acquiring European-wide patent is too costly, especially for the SME.
- The cost of IPR litigation, especially patents, is too costly and discourages the use of the system by SME and spin-off companies.
- Further harmonization is suggested.
- The present IPR system is not well adapted to new technologies.
- The report discusses and recommends tax regime changes that would reduce the effective cost of acquisition of IPRs.
- (In comparison to Bayh-Dole Act and its presumed effects on patenting by US universities and public research labs).The present regime is not well adapted to higher education incentives.
- The development of collaborative projects with industry- creation of spin-off companies.

The study by (Legler et al., 2000) analyzes indicators for technological performance including patent, R&D, innovation and investment activity in Germany, including separate account of the current level of innovation activity in Germany's new states. It outlines both actual developments and the development potential of Central and Eastern Europe and assesses its threat to Germany's competitive position in selected fields of technology.

Thumm (2000) presents results of a survey of patenting by European biotech firms. Almost two thirds of surveyed firms are satisfied with the protection the patents provide. The main reasons for patenting are safeguarding and commercialization of technology in view of negotiation for licensing. In addition to defend firm's own technology, patents are also means to attract the competition. They are crucial for production of genetic products and for the launch of R&D, not only by private firms but also by some universities. Only 18% firms use secrecy, small firms more than large and Italian firms most and British firms least. The author discusses the strategic reasons for patenting. He emphasizes two situations the first characterized by over-patenting that leads to the tragedy of the uncommons, i.e. the under-use of patents- versus the tragedy of the commons, i.e. too much use of unprotected IP. The author examines the situation in countries of Central and Eastern Europe (CEEC) that introduced in the early 90s new national patent

legislations oriented toward European Patent Convention. They are also committed to TRIPS. He notes that so far foreigners use the new patent systems more than nationals thus raising the question of the patent system's contribution to national innovation activity. The questions related to the relationship between the protection of the IPRs and their economic consequences for the CEECs remain, however, largely so far unanswered.

Among the other potentially interesting sources of information on IPR in Europe should be mentioned the proceedings of the conference "PATINNOVA '90, Strategies for the protection of innovation" Tager & von Witzleben (1991). It provides detailed accounts of IPR protection in several European countries, industries and major as well as small and medium size firms.

A descriptive account of basic S&T activities measured by Science Citation Index (SCI) publications and European Patent Office (EPO) patents at various levels (regions within EU, within countries, countries within EU) and their evolution during the period 1988-1995 is presented in (Zitt, 1999). Their analysis suggests an overall but slow tendency towards geographic homogenization in science and a more chaotic picture in technology.

The use of IP rights in Japan-comparison with the United States and other countries

Japan's fast technological and economic progress before the 1990s was a focus of many studies some of which concentrated at the differences in management of IPRs between Japan and the US and other countries. Even though I did not come across a comparative study of Japanese and Canadian IPRs and their use and management, the example of Japan is potentially very interesting because like in Canada, innovation is led by large firms there!

Before the patent reform in 1988 the Japanese patent system was conducive to licensing and cross licensing. In 1988 Japan's patent system switched from a single claim per patent to a multiclaim system similar to the one used in other industrial countries. The 1987 reform modified also the rules for registering the utility models (Japan Patent Association, 1988). Because of the adoption of a multi-claim regime[25], patent applications have gradually included part of technological improvements that would have been previously applied for as utility models (The Japan Patent Office, 1991) cited by Okada and Asaba (1997) in Goto and Ogadiri (1997). A clear and timely overview of differences between the patent systems in the US and Japan and their implications on innovation regimes in both countries is presented by Sakakibara and Branstetter (1999). As in the US, the number of patent applications and grants has increased dramatically since the 1980s. This seems surprising because the patent system reforms introduced in Japan in 1988 significantly expanded the extent to which multiple claims (dependent or independent of other claims) and related inventions can be included in a single patent. According to patent experts after the 1988 reforms, the scope of invention covered by a single application equaled or even exceeded that conferred by US and European patent systems (Industrial Research Institute, 1996). This is also conveyed in manuals for private sector patent experts which describe the impact of these reforms (Hiraoka et al. 1988; Japan Patent Association,1988).

Ordover (1991) presents the Japanese patent system as an example of patent law designed for cooperation and diffusion of innovation. "The Japanese patent system[26] is a complex web of policy choices more or less consciously structured to affect R&D diffusion while maintaining overall incentives for R&D investment". The 1988 reform strengthened the patent right making infringement easier to prove and prosecute. Firms are now allowed to use patents defensively. Rules of disclosure are different in the US and Japan. In Japan, patent applications are automatically published 18 months after filing. In the US, patent information is released only after the patent is granted (typically about two years but sometimes only after many years.[27] The short and previsible delay of disclosure in Japan is conducive to rapid

diffusion of information (spillovers). According to Aoki and Prusa (1996) that leads Japanese firms to make smaller improvements than they would under the US system.

The first-to-file rule in Japan versus the first-to-invent rule in the US pushe inventors and innovators to file patents sooner in Japan. Information is thus disseminated earlier (Ordover,1991) and more extensively than under an alternative system (Scotchmer and Green, 1990). In addition, in Japan, applicants can modify the application as long as the modification does not expand the scope of the original application. In Japan, examination of a patent does not start automatically with application but only upon request; it can be deferred for up to seven years. Hence the inventor has the opportunity to file a patent sooner. In Japan, there was a pre-grant opposition, in the US the third parties can oppose a patent only after it has been granted. Under the pre-grant opposition, regime, the applicant can react to opposition by quickly granting licenses to third parties (Ordover, 1991). Since potential opponents adopted the same strategy, the system was favoring cross licensing. However, in a move to strengthen patent protection, Japan adopted a post-grant system like in the US in 1996.

The penalty for patent infringement was much lower in Japan than in the US. (See details in the section on infringement). Japan favored fast technological development by awarding utility models for minor inventions (similar as the German system). Utility models were undergoing an examination system as patents and protected the model for 15 years. They were also favoring minor, incremental innovation. Econometric evidence suggests that patents 'caused' the number of applications for utility models which typically introduce incremental innovations (Maskus and McDaniel, 1999). Incremental innovations are believed to be of critical importance for capturing returns from original innovations (Rosenberg and Steinmueller, 1988). Since 1994 the utility models are not examined any more and protection period was shortened to 6 years after application date. These changes are perceived as to have nullified the protection provided by utility models, causing utility model applications to decline in favor of patents.

The second part of Ordover's 1991 article provides empirical evidence of the implications of the patents system differences between Japan and the US on innovation behavior in both countries:

(1) The Japanese patent system leads to a better and faster diffusion of information than the US system and new technology is imitated faster in Japan than in the US (see also Cohen et al. 1998 and Okamoto et al. 1996 on cost of patenting in Japan).

(2) In Japan as in Canada but in contrast to the US, R&D is increasing more than proportionally with the size of firm. Firms with fewer than 1000 employees account for 22% of corporate R&D in the US (National Science Foundation, 1998), while they account for only 16% in Japan. This suggests that consistent with the patent system, large firms contributed to innovation more in Japan than in the US.

(3) The modification to a multiclaim patent system in Japan in 1987 is believed to have shifted the innovation in Japan from incremental to a more US like product innovation. The proportion of process vs. product innovation that was about 2/3 to 1/3 in Japan and 1/3 vs. 2/3 in the US in the eighties (Mansfield, 1988) seems to have converged in the nineties. According to Cohen et al. (2001) about 81% of Japanese firms dedicated their R&D to product innovation compared to 66% US firms in 1990s. This would suggest that Japan became less incremental-innovation oriented.

(4) The weaker protection provided by the patent system in Japan than in the US is believed to have led to more frequent alternative appropriability mechanisms such as technology alliances in high-tech industries in Japan than in the US. The Okada and Asaba (1997) chapter in Goto and Ogadiri, 1997 underlines the institutional particularities of the Japanese system (Utility models, single claim per patent, pre-grant disclosure and deferred examination, pre-grant opposition) and discusses their probable effect on the

increasing propensity to patent in Japan (no. of patents/ 1000 scientists and engineers). The main objective of the paper is an econometric analysis of determinants of patent propensity in Japan.

The differences of intellectual property regimes in Japan and in the US help to understand some of the important differences between the two countries with regard to collaboration between industry and universities. In Japan, it is recognized today that the collaboration between universities and industry should be improved. The promulgation of the Technology Transfer Law in 1998 favoring formation of technology transfer offices (TTO) in the universities was aimed at improvement of this unsatisfactory situation. Kneller (1999) describes the pre-1998 procedures used in Japan to transfer technology from universities to industry and compares them with the situation in the US. The IP rights to inventions belonged to the inventor or to the nation (the principle called "inventors retain rights") , according to the decision taken by the university invention committees. The practical effect of this procedure was not conducive to effective transfer of technology from universities to industry, nor to creation of spin-off companies by university researchers. The "inventors retain rights" principle has been upheld in the 1998 law that favors creation of TTO. The author believes that given the way the "inventors retain rights" principle worked in the past, it is unlikely that the new 1998 rules would lead to a substantial improvement of the collaboration between industry and universities in Japan.

The most comprehensive study examining the IP use, management and strategies in general and in Japan in particular is Granstrand's book *Economics and Management of Intellectual Property* (Granstrand, 1999). In addition to the detailed account and analysis of results of his own survey of large Japanese corporations, the author compares the Japanese situation and strategies of large corporations in Sweden and occasionally also in the US.

The historical overview of Japanese patenting provides an interesting introduction to the subject. It may be well known that the Meiji dynasty opened Japan to the world in 1868 and introduced a patent system inspired by the US and Europe three years later. Perhaps less well known is the introduction of the 'Ordinance Prohibiting Innovations' by the Tokugawa dynasty in 1718 in order to prohibit 'new things'. After the introductory chapter, follows an interesting overview of the philosophy and history of IP and then the general framework of IP with an extensive survey of the economic and management literature up to the mid 1990s. It also contains a useful summary of economic theory of IP and patents.
Granstrand reminds the reader that with regard to the monopoly power conferred by patents, an important distinction to be made is that a patent provides first of all a monopoly on an input: (1) many other costly complimentary inputs may be needed before monopoly profits are gained and (2) as many inputs, a patent may be substituted by other patented or non-protected solutions.[28]

The evolution of R&D spending and patenting in industrial countries is compared up to 1991, followed by the survey data on R&D and patenting in large Japanese firms (chemical, electrical and mechanical).[29] After the presentation of the Japanese patent system the rest of the book is dedicated to the discussion of patenting practices and strategies by Japanese corporations. It is based on author's survey and interviews. Follows an insightful description of Japanese technology and commercialization strategies and comparison of means for commercialization of new product technologies in Japan, Sweden and US. These strategies include patents, secrecy, lead time, switching costs and superior marketing.[30] The author discusses strategies related to IPRs use in standardization,[31] intellectual property policies and strategies and advantages and disadvantages of patenting in general and specifically in Japan.[32] His survey shows that 'the status of patent activities with in the firm' as well as the 'strategic role of patents', 'licenses' and 'top management's attention to patenting' all increased in Japan over 1987-1992. He stresses that unlike the European and US corporations, Japanese corporations considered patents as the most effective means of capturing the profits by restricting competition. One of specific features in Japanese strategy was the propensity to engage in technology-related product diversification in co evolution with product-related technology diversification, thereby benefiting from economies of scale, scope and speed (as exemplified

by the case of Canon). The chapter on patent strategies is particularly interesting and informative. The presentation of various strategies (patenting, trademark, secrecy, licensing and litigation strategies) is completed and illustrated with survey results detailed for the three industry sectors.[33] [34]
The discussion of the analysis of patent information as a source of technical information is complemented by warning regarding some caveats when using patent statistics.[35] The Appendix presents the methodology and research tools (the description of the survey, the sample and the questionnaire) used for corporate benchmarking[36] and the comparison of corporate patenting in Sweden and Japan that may be a valuable source of information for similar studies. I will return to some of these specific issues below in the relevant sections of the report.

In the synthesis of his richly documented book Granstrand argues that we are entering an era of intellectual capitalism, i.e. system dominated by private ownership of intellectual capital, an issue resumed and developed further in Grandstrand, (2000).[37]

Protection of IP rights in Australia

The Intellectual Property Australia contracted from (New Focus Research Pty Ltd., 2000) a report on Awareness of Intellectual Property among Australian firms. The report is based on survey by interviews and telephone interviews of awareness of various types of enterprises of IP and their use of IP. The report contains questionnaire and the tabulation of responses with brief observations for several groups of firms:

- SME who go through patent attorneys, those who go directly through IP Australia,
- firms from the tertiary sector,
- SME who do not use patents, trademarks or designs and also
- large scale enterprises, LSE.

Responses are provided by each group on a wide range of issues relative to the awareness of IP, how is IP valued and understood by users and non users, on perception of IP's importance, methods of protection and reasons for IP use and existing barriers to use of IP. Also treated is the use of patent office services, attorneys and various media. The last group of subjects covers training on IP issues, the opportunities for IP Australia in the lifecycle of developing, protecting and commercializing IP. The discussion of the future role of IP Australia and top priorities for readjustment to meet future needs concludes this interesting report.

V. PROTECTION OF IP IN SPECIFIC INDUSTRY GROUPS

In the following section is presented a brief account of principal studies of the use, effectiveness, strategies and obstacles of IPRs by principal industry groups. Industries are regrouped approximately according to similarities observed in empirical studies of IPRs.

Chemicals, pharmaceuticals, food, textiles, metals and metal products

Even though there are some important differences between IP effectiveness, use and strategies among industries included in this group the similarities are more important. Taylor and Silberston's finding (1973) that R&D first in pharmaceutical and second in chemical industries is more dependent on patent protection than in mechanical engineering still holds. An account of licensing by chemical industries is presented in Smith and Parr (1998).

More recent surveys by Levin et al. (1987) and Cohen et al. (2000)[38] established that patent protection is considered a more important effective means of appropriation of innovation benefits in pharmaceutical

industry than in chemical industry and in chemical industry more than in most other industries. Cohen et al. found that patents are considered effective for 50% of product and 36% process innovations in pharmaceutical industry, compared to about 38% and 25% respectively for chemical industry compared to the average of 35% of product and 23% of process innovations for all industries. Granstrand (1999) shows that in Japan taking patents to deter imitators is more important for large chemical firms than for firms from electrical or mechanical industries. The strategic role of patents increased from 1987 to 1992 in all Japanese industries, but most in large chemical firms. Not surprisingly then, the figures on corporate resources dedicated to patenting show that the Japanese chemical firms have higher percentage of employees dedicated to patent activities 0.32 than the manufacturing industry's average 0.18. The ratio of patent costs to R&D costs tells the same story (3.1% in chemical large firms versus 2.3% for aggregate manufacturing industries respectively).

Von Hippel (1988) comes to conclusion that the value of a patent depends to a great extent on how the patent offices of corporations (patentees) and the courts handle the potential and actual infringement of patent rights. These at turn depend on the type and complexity of patented technology hence the type of industry. Contrasting examples are patents for pharmaceuticals and chemical substances considered most effective and on the other extreme most patents protecting semiconductors and electronics that are considered to be worth very little. Chemical and pharmaceutical patents cover a well-defined chemical composition: they are unusually strong and difficult to invent around (Taylor and Silberston, 1973) cited by von Hippel (1988, pp. 48-53). Chemical and pharmaceutical patents are easily marketable (see patent medicines) generate royalties and are relatively highly valued.[39] In contrast, electronic and communication devices, semiconductors typically use many patents belonging to different firms. In these fields it is very likely that a new technology may infringe patents belonging to other firms. Except for relatively few patents that were upheld by the courts, the principal value of patents is to serve as bargaining chips for settlement and for cross licensing.

In chemical and pharmaceutical industry, IPRs effectively define rights over a specific product or category of products or process essential to the production of a category of products. Each product is likely to have very strong market power or a monopoly position for its specific use (Barton, 1998). This corresponds to the concept of 'discreet technologies' described in Cohen et al., 2000.[40] Chemical engineering built an objective vocabulary that allowed explicit and clear patent descriptions. Clear patent descriptions meant that patents' validity could be relied upon, resulting in relatively secure patents. Yet clear descriptions also helped, perhaps in conjunction with chemical engineering's historical affiliation with academia, prevent patents from becoming excessively broad in scope.[41] The 'discrete technology' that characterizes the chemical and pharmaceutical industries had, according to (Arora and Fosfuri, 2000), two interesting implications.

- First, patents provide an easy means for an innovator to license the technology to incumbents or new entrants. Unfortunately, patents can also lead to holdup problems where a patentee blocks entrants and impedes current competitors' innovation efforts.
- Second, certain industries have historically different licensing practices which can give rise to a market for specialized service providers (Specialized Engineering consultants and construction firms-SEF) who license process innovations rather than sell products. As service providers, their licensing practices are very liberal and especially conducive to facilitating new entrants, avoiding most if not all holdup problems.

The motivation of patenting strategies in 'discrete technologies', is to built patent fences around a core invention patent to foreclose patenting of substitutes by rivals. Typically, in these industries patents are rarely used for cross-licensing (Cohen et al., 2000).

In Canada, firms belonging to chemical, petroleum refining and pharmaceutical industries used all IP mechanisms more than firms from other industries (Hanel, 2001). [42] Surprisingly, in Canada firms from the chemical sector, patents are used less frequently than trademarks and, especially, less than commercial secrecy.

Pharmaceutical industry

The pharmaceutical industry is in some important ways different from other chemical industries. A detailed review of the literature on the use of IP in the pharmaceutical industry is outside the terms of reference of the present study.
Development of new drugs is considered by most analysts as the best example of the textbook case for patent protection. As noted by (Magun, p. 405) cited by Pazderka (1999) and (Pazderka and Stegeman, 2001):

- The initial cost of developing a pharmaceutical invention is very high. However, once the patented formula is known, copying is possible at very low cost (more so than in other high-tech industries) and as a result of free-rider behavior, the amount of investment in pharmaceutical R&D would be less than socially optimal.
- The character of pharmaceutical inventions enables the IP to effectively define rights over a specific product or category of products or process and each product is likely to have very strong market power or a monopoly position for its specific use (Barton, 1998).
- Chemical and drug industry produce highly codified technology, neatly codified and packaged ready for sale (Mandeville, 1996).

There is an extensive literature on patents in pharmaceutical industry. Some of it is reviewed in Pazderka (1999), Pazderka and Stegemann (2001), Weston (1998) and Barton (1998).

Effective protection of IP in pharmaceuticals is likely to increase its output, profit and employment as shown by Italy's example. Italy's introduction of patent protection for pharmaceuticals in 1978 was preceded by lengthy debates and worries about its impact on the domestic drug industry. A study by G. Jori ten years later reviewed the situation and concluded: The domestic industry has been strengthened; investment in R&D increased; there has been no reduction in employment; profits have increased and international companies have invested more in Italy (Tager & von Witzleben, 1991).

Information technologies and communications

This section includes overview of IPR use and management in several fields. On the one extreme are IPRs and their management by semiconductor, computer and communication equipment producers, on the other extreme IPRs management by firms producing softwares, databases and business methods.

Semiconductors, computer and communication equipment

While the patent propensity (measured as the number of patent approvals/R&D expenditures in the US) in all manufacturing industries, as well as in 'computing and electronics' and in 'pharmaceuticals' declined from the late seventies to early nineties, patent propensity of semiconductor firms increased notably. Except Texas Instruments who had a large patent portfolio before the 1980s, other semiconductor firms did not patent widely before the 1982s, i.e. before the introduction of the CAFC. For the evolution of patenting of semiconductor devices and manufacture in the US and the ranking of corporations with more than 15 patents over the 1969-1999 period, (see USPTO, 2000).

According to innovation surveys (Levin et al., 1987 and Cohen, Nelson and Walsh, 2000) R&D managers in semiconductors considered patents among the *least effective* mechanisms for appropriating results of R&D investments. They were considered less effective than alternative strategies such as being first in the market, secrecy, short product life cycles etc. Why then are semiconductor firms patenting so aggressively? Hall and Ham-Ziedonis (2001) explore this apparent paradox. They address also the other intriguing question of what effect the stronger patent rights have on patenting by firms engaged in rapidly advancing cumulative technologies (such as multimedia or computer and semiconductors) . Firms in these fields often require access to a 'thicket' of IP rights in order to advance technology or to legally sell or produce their product.

The authors present a summary of interviews with industry representatives of some 100 semiconductor producers (excluding unfortunately the large "systems" manufacturers such as IBM, Motorola or Siemens) and an econometric analysis of the patenting data.
The main findings from the interviews are resumed here. The authors start with the hypothesis that the surge in semiconductor patenting is a consequence of the pro-patenting shift in the US legal environment. They examine the following "operational" hypotheses:

- Do firms must vulnerable to "hold-up" in the new patent regime (i.e. firms with large sunk cost in complex manufacturing facilities) respond "strategically" to the institutional shift by expanding their patent portfolios with which to trade.
- Did the strengthening of US patent rights facilitated vertical integration and emergence of "technology specialists" i.e. more patent intensive design-firms as suggested by Merges (1998) and Arora (1995).

The findings of (Hall and Ham-Ziedonis, 2001) suggest that:

1. The large manufacturers have indeed invested more heavily in the "pro-patent" period and appear to be engaged in "patent portfolio races" aimed at reducing concerns about being held up by external patent owners and at negotiating access to external technologies on more favorable terms. Stronger patent rights are particularly important in attracting venture capital funds and securing proprietary rights in niche markets. Thus the paper confirms the validity of the "strategic patenting response" by capital-intensive firms. The authors find little support for the regulatory capture hypothesis (also rejected by Kortum and Lerner (1998) i.e. the view that the surge in semiconductor patenting is driven by the scale effects alone or by aggressive post 1982 patenting by the firm with largest patent portfolio the Texas Instruments. As regards the alternative hypothesis that the surge in patenting is driven by the unrelated improvements in management and productivity of R&D (hypothesis accepted by Kortum and Lerner as the explanation of the overall increase in US post 1982 patenting), the authors too find evidence of managerial improvements, primarily in how semiconductor firms manage their IPRs rather than their R&D.
2. As for the emergence of technology specialist design firms the "bargaining chip use of patents" appeared less prominent in the interviews with firms specializing in the design of semiconductor products. Unlike the manufacturers, the design firms seem to seek to secure strong "bullet proof" IPRs to technologies in their niche.

Thus patents appear to be an imperfect but quantifiable measure of technology that enabled technology-based trades to be made in external markets, both in financial markets for venture capital and with suppliers and owners of complementary technologies.

Stronger patent rights may have facilitated entry by specialized firms and contributed to vertical disintegration in the semiconductor industry (Merges, 1997; Arora and Fosfuri, 1998). But these positive effects coincide with a trend to accumulate large patent portfolios in order to use patents as bargaining chips leading to patent portfolio races. [43] This trend was greatly helped by the apparent lowering of standards of "non-obviousness" "usefulness" and "novelty" after 1982. For more details see (Grindley and

Teece, 1997) below. On patent pools, cross-licenses and standard setting and related business strategies in general and on semiconductors in particular see (Shapiro, 2001).

For more detailed observations on the semiconductor industry's IP management and strategies in consortia see : (Tilton, 1973; Ham, Linden and Appleyard, 1998; Grindley and Teece, 1997 and Headley, 1998).

Grindley and Teece (1997) provide a detailed account of the pro-active approach to IPR management in Semiconductors and Electronic and specifically of using IP to core business, developing patent portfolios and licensing practices of leading firms (RCA, ATT&T, IBM, Intel, Hitachi, Hewlett-Packard etc. The article shows examples of how leading companies managed IP, created patent portfolios and how these were generating royalty revenues from firms that had less to offer in exchange. The licensing strategies were shaped by public policies. This was notably the case for ATT's which was until 1984 a regulated monopoly and was obliged by the antitrust consent degree to license its IP to everyone for minimal fees. The competitive strategies and IP practices of telecommunication firms are also discussed by (Kefauver, 1993). IBM was also covered by the consent decree and practiced licensing "to ensure" the right to manufacture and market products protected by patents belonging to other firms.

The article discusses the types of cross licensing used and royalties paid in relation to firm's strategies and the life cycle of heir products. The practice of cross licensing has double positive effect on innovation. (1) It allows firms return on innovation thus helping to fund further R&D while (2) allowing firms to concentrate their innovation and patenting activities according to their comparative advantage. The authors conclude that licensing became recently an important activity in semiconductors, electronics and computers, in part at least owing to policy shifts in the US. See also Tilton (1971) and von Hippel (1988) for the description of the earlier evolution in these sectors. The footnotes contain useful references to other studies as well as to information on the cases discussed in the text. The current situation in semiconductor and computer industries was discussed at the Stanford Workshop in 1998 and is presented in rapporteur's report that includes also references to industry specific reports (Bresnahan on computer industry, Rostoker on semiconductors). Interesting points brought forward by industry experts are integrated in (Barton, 1998) synthesis.[44]

Protection of IP in the software industry

The US Patent Office was refusing patents on software and mathematical algorithms "per se", i.e. independently from a device using it until the early 1970s. The protection of software was initially ensured by copyrights rather than by patents. The arrival of personal computers was associated with the explosive growth of the software industry and beginning of software patenting in the US. More recently the development of e-trading led to introduction of patenting for business methods and multimedia.

In contrast, the law in relation to business method patents in the United Kingdom and European Patent Offices has not changed. A way of doing business "as such" cannot be protected; however, some protection for business methods may be obtained by claiming a new, inventive, technical method of implementing a business method. This is particularly relevant in the e-Commerce arena where there have been and continue to be technical innovations. The report by Likhovski et al. (2000) analyses the law in the United States and Europe and includes a survey of European Patent Office and United Kingdom patent filings for business methods. The survey indicates that United States companies are now filing significantly and proportionately more applications for business methods than their European counterparts. In the EPO over the sample period:

- 52% of all patent applications for business methods were filed by United States nationals. By contrast, over roughly the same period United States nationals filed only 28% of all applications.

- In the United Kingdom Patent Office, 31% of all business method applications were filed by United States nationals. By contrast, in 1997 and 1998 United States nationals filed only 10% of all patent applications.

The earlier history of the software industry and the use of IPRs to protect software and business methods (both by copyrights and patents) are documented in Graham and Mowery (2001) and in Merges[45] (1997). The essential source of information on the evolution of the software industry –including the closely related aspects of IPR's evolution in Japan and Europe- are the two recent collections of papers by invited specialists edited and co-edited by Mowery (1996) and by Mowery and Nelson (1999).

The latest addition of a new type of intellectual property subject matter are databases that received a "sui generis protection" i.e. specific right to protect them against copying from the EU in 1998. In Canada, as in the US, databases are protected by copyright and/or by business methods. The concept of database, their providers and users in Europe, US and Canada and their protection by IPRs are presented in (Scotchmer and Mauer, 2001) which cites Howell (1998) and (Knopf, 1999), as sources on Database IPRs protection regarding specifically Canada.

The problems and risks for the future development of open science posed by the EU's directive introducing 'sui generis' protection of databases and similar initiative in the US are emphasized by (David, 2000). David's list of references includes in addition of references to databases and their protection also several sources regarding electronic communications by Internet and related subjects.

IP and the Internet

Most material on IP related to Internet, e-commerce and digital enterprise are found on Internet. Wipo (2003) website for SME provides a useful reference source for the relationship between IP, Internet and electronic commerce. The "guide" provides information on how a firm should audit its IP assets relevant to e-commerce, how to protect its IP when designing a website, issues related to internet domain names and distribution of content on Internet. The patent issues in e-commerce, IP concerns related to e-commerce international transactions etc.

A particularly comprehensive volume on intellectual property in electronic commerce, its valuation and protection in global market is Simensky, Bryer, et al. (1999). It contains 62 chapters (too many to review here). The first part presents the role of IP in on-line commerce, the second treats accounting, finance and valuation. The third part deals with protection of intellectual property, followed by commercial exploitation of IP. The last 33 chapters cover the international aspects of securitization of IP in so many countries.

On protection of IP on the Internet see also the document published by the US. Copyright Office (2003) and a web "crash course" provided by the University of Texas (2003). The "digital professor" website created by Professor Michael Rappa provides a course material on managing the digital enterprise that includes several sections and references on related IP issues (digital professor, 2003).

These texts and sources are mostly of practical nature. They do not address the fundamental dilemma that the digital revolution created for the protection of intellectual property. The dilemma is created by the progress in digital technology that enables reproduction at very low costs and the existence of the World Wide Web that enables everyone to publish world wide on the one hand and the intellectual property law, on the other hand. The report by the Committee on Intellectual Property Rights and the Emerging Information Infrastructure of the National Research Council, *The Digital Dilemma- Intellectual Property in the Information Age* (2000) recognized that given the multitude of IP business models, legal

mechanisms and technical protection services possible, making one-size-fits-all solution to the dilemma would be too rigid. The Committee recommended that: "Legislators should not contemplate and overhaul of intellectual property laws and public policy at this time, to permit the evolutionary process (described above) to play out."

VI. THE USE OF IP RIGHTS BY SIZE AND OWNERSHIP OF FIRMS

Practically all empirical studies indicate that small and medium size firms do not use IP rights in the same way as large firms. Among the latter the multinational corporations stand out. I therefore survey first the findings related to small firms and then, those concerned with large multinational corporations.

Small and medium size firms

The contribution of small and medium size enterprises (SME) to innovation, technological progress and economic growth in the US has been well documented. Small firms also have higher patenting rate than the larger ones when measured on a per-employee basis (Audretsch, 2002; Himmelberg and Patersen, 1994). In contrast, larger firms produce a more patents per firm.

To assist SMEs to appreciate the importance of IP protection and learn to use it, WIPO has created a useful special website – "guide" on IP for SME (see WIPO, 2003).

Changes to the patent system may have undesirable effects on SME. The American Inventors Act passed by the Congress in 1999, requires all patent applications in the US and abroad be disclosed to the public 18 months from the earliest filing date. In a signed public letter, 26 Nobel Prize winners warned that smaller inventors may be disadvantaged in having to expose the details of their inventions before the patents have been granted (Gallini, 2002)

In Canada, Japan and Europe SME[46] are less inclined to patent than large corporation. However, results from a survey of British firms suggest that smaller firms were more than proportionally active in acquiring IPRs assets (Greenhalgh et al., 2001). The evidence for Canada also shows that the propensity to use any and all IPRs is increasing with the size of firm (Baldwin and Hanel, 2003). The most recent analysis of the use of IPRs in Canada confirms the earlier finding that the propensity to use any and all IPRs in Canada is increasing with the size of the firms. In contrast to SME who patent mostly in Canada only, the largest firms tend to patent both in Canada and the US (Hanel, 2001).

According to evidence regarding the small and medium size firms in Europe, the cost of obtaining a patent and the prospect of larger still litigation costs (Bouju, 1991) discourages small firms to patent, especially in other countries (Tager & von Witzleben, 1991). The same report contains also an interesting discussion of licensing strategies by a small firm supported by an example of an Irish firm producing plastic articles (Comerford, 1991; Kreikenbohm, 1991).

Regression results by (Arundel and Kabla, 1998) that control for the effect of industry sector show that patent propensity rates increase with firm size and are higher among firms that find patents to be an important method for preventing competitors from copying both product and process innovations. (Arundel, 2001) found that firms of all sizes find secrecy to be a more effective mean of appropriation than patents but small firms value secrecy more than large firms. The preference of small firms for secrecy is presumably due to their lack of financial resources needed to protect their patents from infringement.

Thus the evidence from Canada, Japan and Europe suggests that SME[47] are less inclined to patent than large corporation. However, results from a survey of British firms suggest that smaller firms were more than proportionally active in acquiring IPRs assets. It may be noteworthy that the UK patent office has in

the recent years reduced the application fees for patent and trademarks; it remains to be established if the reduced fees were behind the increased application rate in the UK (Greenhalgh et al., 2001).

A more recent, sector specific survey of European biotechnological firms shows that small firms use secrecy more than large ones and Italian firms most and British least frequently. Small firms tend to use more the national patent systems, the larger ones the European Patent Treaty (EPT) and even more the Patent Cooperation Treaty (PCT).

Small firms are less involved in litigation (19%) compared to (68%) of large firms. The typical cost per patent is including the cost of the attorney services and the fees is 2500 euro (attorney+ fees) as reported by Thumm (2000). The detailed analysis of the firm size distribution of R&D and patent applications at different patent offices by (Licht and Zoz, 1998) shows that the share of R&D performing firms is strictly increasing with firm size. The share of firms applying for patents shows an even steeper increase with firm size. Moreover, large firms are more likely to apply for patents in more than one country. The home patent office appears especially important for small firms. A similar finding for Canada also shows that SME patent mostly in Canada only. In contrast, the largest firms and those firms that patent massively tend to patent both in Canada and the US (Hanel, 2001).

Findings of a survey of 600 small and medium size enterprises from all EU states which obtained a European or US patent between 1994 and 1997 conducted by University of Dublin (199?) found that:

- Two thirds of the sample firms had experienced attempts to copy their patented inventions, but only one in five actually used courts to defend their patents
- For 49% of firms, fear of cost of patent defense litigation had a “very big” or a “significant” impact on their investment in invention,
- The current patent system works poorly for SMEs, especially in the US, large firms use resources which they have available to intimidate SMEs,
- For SMEs , patenting is currently not cost-effective as a means of protecting IP,
- Only in very rare cases are penalties for infringement awarded in practice,
- Compulsory expert arbitration should be investigated as a solution to the Excessive cost of patent litigation.

For information on the use of IP by Australian SME, see New Focus Research Pty Ltd. (2000) introduced above.

Use of IP rights by multinational firms

Owing to their proprietary advantages in research and development and innovation multinational corporations (MNC) are naturally very keen on the protecting effectively their intellectual property. The multinational lobby was behind the modification of drug patent legislation in Canada (Doern and Sharaput, 2000) and the inclusion of trade related intellectual property rules (TRIP) in the last round of GATT negotiations creating the World Trade Organization.

When the higher propensity to conduct R&D and the larger size of foreign-owned firms in Canada is taken into account, these firms are not very different from the domestic firms in terms of their use of IPRs. The only clear-cut difference is that foreign-owned firms use more frequently trademarks than their Canadian-owned counterparts (Baldwin and Hanel, 2003).[48]

There are many recent studies documenting that multinational corporations are disproportionably active in R&D intensive industries and are using IPRs intensively (Guellec and van Pottelsberghe de la Potterie,

2001; Cincera, 2001; Mayer and Pfister, 2001; Archibugi and Iammarino, 2002; Smith, Pamela, 2001; Cantwell and Santangelo, 2000).

The description of the corporate IP infrastructure and patenting strategies of the Belgian multinational Société Solvey & Cie Strategic shows how the MNC chooses among a defensive, a barrier, or bargaining strategies and the options to : (1) file first or to (2) study first and what are the deciding factors for the protection of innovations (Hermans, 1991). For the licensing strategies by multinational firms see Sandri (1991). The experience of licensing in and out by the Italian MNC Fiat —licensing agreements with US, German, French and especially licensing to Soviet bloc countries— is described by Sani (1991).

One of the strong arguments advanced for introduction of global standards for IPR's protection by TRIPS is based on the hypothesis that the transfer of technology by MNC towards less developed countries (LDC) is hampered by weak or non-existing protection of IPRs in LDC.[49] The survey of multinational corporations gives some empirical support to this hypothesis (Mansfield's, 1994 and Lee and Mansfield, 1996). Representatives of a sample of US. MNCs were asked to indicate how the strength of IPRs in a given foreign country and industry sector is likely to influence their decision to invest there. As hypothesized, MNCs were less likely willing to invest in countries with weak IPR record. The relationship reflected also inter industry differences in effectiveness of IPRs protection. A further research in this line by (Kumar, 1996) suggests that US multinational corporations prefer to locate their R&D activities in countries that are able to offer them, among other things, larger markets, technological resources and infrastructure. Host market-oriented affiliates are more likely to have R&D units than the export-oriented ones, especially in developing countries.

The relative strength of the patent regime appears to affect the direction rather than the magnitude of R&D investments made in a country. Seyoum (1996) uses empirical findings based on a study of 27 countries. They support the proposition that the level of intellectual property rights protection is a strong determinant of inward investment and that intellectual property rights have a greater impact on inward investment than many economic policy variables among certain country groups. According to Ostergard (2000) prior measures of IP strength lack a component that addresses the actual enforcement of these laws. His measure uses three types of IPR laws and enforcement components for them.

It should be noted however, that in several newly industrializing countries, Brazil, Turkey and Mexico to name only few, the absence of patent protection did not prevent multinational pharmaceutical firms from entering the local market and ensure them an important market share. Strong brand promotion and product differentiation of drugs played a stronger role for appropriating returns than IPRs (Zuniga and Combe, 2001).

Membership in intellectual property treaties increases the flows of payments and receipts for intellectual property as long as domestic patent protection is sufficiently strong. US parents export more to subsidiaries in countries that do not adhere to such treaties but their impact on arms' length exports and foreign investment is minimal (Ferrantino, 1993).

The Canadian experience points in the same direction. Canadian firms tend also to export more to those countries where their IPR are highly safeguarded (Rafiquzzaman and Ghosh, 2001).

VII. IP STRATEGIES, ORGANIZATION, HUMAN RESOURCES AND TRAINING OF IP PERSONNEL

IP strategies

The size, organization and human resources dedicated to protection of intellectual property are less frequently objects of inquiries than the use of IPRs and their effectiveness. The classical reference is Taylor and Silberston (1973) who surveyed the organization, size and cost of various functions of patent departments in UK firms.

Comerford (1991) shows that SME benefit from various forms of external assistance[50] in the pursuit of their licensing strategies. He illustrates the experience of a small Irish firm. Hermans (1991) presents the organization of the IP work in a large multinational European firm, the Solvay Group (Belgium). He discusses *inter alia*, the use of secrecy as part of patent strategy.

IFO's (Germany) research into cooperation between companies in the European internal market shows that each partner's patent portfolio and the accompanying exclusive rights are the critical factor in R&D cooperation. The use of patents by both partners free of charge appears only at a later stage and it is a sign that the cooperation is based on trust. The EU regulations on cooperation agreements provide companies with useful advice for drawing up contracts. The IFO survey has shown that in general patents are given much lower value than other competitive instruments in formulation of company's competitive strategy. Especially in consumer product firms the registered trademarks are considered to be a much better instrument than patents (Oppenlander, 1991).

However, when the research intensive firms have a systematic patenting strategy, patenting features prominently in their competitive outlook, especially if competitors are likewise 'arming' their products with patents. American and Japanese companies incorporate patents much more in their competitive strategies than European ones. There are large numbers of Japanese patent applications at the German and other European patent offices suggesting that patents are to put the competitive position of Japanese firms on a legal basis. Oppenlander (1991) recommends that firms should introduce training on patenting for their new engineers. It should be part of engineers' training so as to make them aware of the information available from patents.

Japanese corporations have integrated IP protection in their innovation strategies. The status and power of the patent and IP departments has risen. According to Granstrand (1999), Japanese corporations dedicate to IP protection more resources than most Western corporations do. The author presents the human resources in R&D and patenting divisions of several well-known Japanese firms and their growth over the 1987-1992 period. The chapter on IP organization and management includes a detailed account of organizational options for IP organization and management. The book also offers a detailed discussion of patenting strategies, complete with flow chart and operational details. The appendix includes the description of the survey design and questionnaire for corporate benchmarking of Swedish and Japanese firms regarding their IP protection attitudes, activities and resources.

Another study focusing the Japanese management of intellectual property in a comparative perspective, this time from the UK perspective is by Pitkethly (2001). Based on extensive surveys of Japanese and British patent departments, the paper shows the differences between the two countries in the size and staffing of patent departments, management attitudes to IP and licensing, patent information management, licensing revenues, etc.

Human resources and their training

The need to create IP culture at the level of higher education, create teaching materials and educate the broader business community and improve training in IPRs is emphasized in recommendations of the European ETAN expert working group (ETAN Expert Working Group, 1999).

The Australian survey (New Focus Research Pty Ltd., 2000) examined the awareness of firms of the importance of IP and of the services of the patent office and their use. The report contains the questionnaire and the tabulation of responses with brief observations for:

- a sample of SME who go through patent attorneys,
- those who go directly through IP Australia,
- tertiary,
- SME who do not use patents, trademarks or designs and also
- large scale enterprises LSE.

Responses are provided for each group on a wide range of issues:
Awareness of IP, how is IP valued and understood by users and non-users, IPs importance and methods of protection. Reasons for IP use. Use of patent office services, attorneys and various media. Training on IP issues. Opportunities for IP Australia in the lifecycle of developing, protecting and commercializing IP. Barriers to use of IP. Contacts with and delivery of services by IP Australia. The future role of IP Australia and top priorities for readjustment to meet future needs.

The services of national and international (European) patent offices are assessed from the point of view a patent attorney by Bardehle (1991). The increasing trend of patenting is stretching resources of patent offices. An interesting study by Adams et al. (1997) shows that the demand for services of the US Patent Office can be predicted rather well by an econometric model.

VIII. THE IMPACT OF IP ON THE VALUE OF THE FIRM

Economists and business analysts working with stock market data endeavor to determine the effect of intellectual property instrument on the value of firm. There is a growing literature covering various methodologies for evaluation of the economic value IP rights and their impact on the value of the firm. These are mostly retrospective studies. There are reviewed in this section. In the next section devoted to management of IP are presented methods used to valuate new technologies available for sale, licensing or other means of extracting value from IP.

There is a long tradition of using patent statistics as economic indicators. Economists and students of technological change have used patent statistics and patent information for various purposes. The advantages and shortcomings of patent-based measures used as economic indicators have been frequently discussed in economic and business literature; the most authoritative survey of this literature well worth reading but too comprehensive to review here is by Griliches (1990). See also a series of empirical studies in Griliches (1984).

Economic value of patents

Only a subset of this literature[51] is concerned with the economic value of patents. According to Jaffe (2000), studies that estimated the value of the patent right show that it ranges from 5% to 10% of research spending in some industries to a high up to 35% in other ones (Lanjouw et al., 1998; Schankerman,1998). According to Gallini (2002) the value of patent protection, estimated from European patent renewal data

and averaged over technological fields, has been found to be 15%-25% of related R&D expenditures. These modest estimates are consistent with findings from surveys of innovating firms suggesting that innovators do not consider patent protection very effective in protecting the returns form innovations (Levin, Klevorick, Nelson and Witer, 1987; Cohen *et a.,.* 2000 present the evidence for the US; Baldwin & Hanel, 2003 corroborate it for Canada).

When research is sequential and builds upon previous discoveries, a stronger protection may discourage subsequent research on valuable but potentially infringing, follow-on inventions (Green and Scotchmer, 1996; Merges and Nelson, 1990; Scotchmer, 1991).

Lerner (1994) examined the impact of patent scope on firm value. Using a sample of privately held venture capital-backed biotechnology firms, he shows that the breadth of patent protection significantly affects valuations. A one standard deviation increase in average patent scope is associated with a 21 percent increase in the firm's value. Broad patents are more valuable when substitutes in the same product class are plentiful, a finding consistent with theoretical suggestions.

The use of patents in economic research has been seriously hindered by the fact that patents vary enormously in their importance or value and hence, simple patent counts may be misleading indicators of innovative output. As shown by Trajtenberg (1990), patent counts weighed by citations as indicators of the value of innovations overcome the limitations of simple counts. The market value of firms is closely related to its knowledge assets and according to (Hall, 1998); patent-based measures contain information about this value above and beyond that given by the R&D expenditures. In conclusion of her survey of recent findings in this field, Hall concludes that patent counts-weighted citations are overcoming the limitations of simple counts by improving the precision of the estimated relationship.

Accounting rules and value of IP

According to existing accounting rules, the book value of a firm does not include intangibles such as the value of intellectual property. The value of intangible assets (IA) of firms included in Dow Jones Industrial accounted for 43% versus 24% for the fixed assets in 1997 according to Bratic, Bersin and Benson (2002).[52] The phenomena of rising value of intangibles and the role of IP in the "New" economy was the subject of the Brookings Institution Study (2001) *Unseen Wealth: Report of the Brookings task Force on Intangibles*, Washington D.C., Brookings (2001).[53] The growing gap between the value of a firm and the value of its fixed assets led Razgaitis (2002) to define Old economy as a system where there is a direct measurable connection between the assets and income. The connection (correlation) between assets and value changed radically in the last twenty years. In the New Economy the Price-to-book ratio increased notably, suggesting that the conventionally accounted assets did not any more represent the market value of a company. The case study shows that Microsoft's market value follows much closer the number of US patents issued to Microsoft than the book value of its assets. Thus the value of technology seems to be the component missing in the value equation.

Even though the stock market value of most knowledge intensive firms has declined significantly since the 2000 peak, there still remains a significant gap between the market value of most firms and the value of their tangible assets. For example, the stock market value of Microsoft in Spring 2003 is far below its peak in but still well above the book value of its tangible assets.

However, the measure of intangible capital of semiconductor firms based on citation-weighted patents provides according to Shane and Klock (1997) a better measure than simple patent counts. The study by Blundell et al. (1999)**,** examines the empirical relationship between technological innovations, market

share and stock market value. The study finds a robust and positive effect of market share on observable headcount of innovations and patents. Another method for deriving the value of patents is based on patent renewal information (Lanjouw et al., 1998). For the earliest studies of this type see Pakes and Schankerman (1984) and Pakes (1985).

A significant proportion of patented inventions is likely to be used in other industries than the one to which the original inventor and/or owner of the patent belongs. For example, inventions patented by a chemical firm may be used in pharmaceutical, plastics or rubber industry. A study of a large sample of major manufacturing firms operating in the US has shown that the patent weighted R&D of upstream firms shows up in increased profitability of downstream (user) firms (Hanel and St-Pierre, 2002).[54]

The evidence on the growing gap between the value of a firm and its book value is not limited to the US Bosworth and Rogers (2001) investigate how R&D and intellectual property activity influences the market value of Australian firms, using *Tobin's q* approach. R&D data are available for the period 1994-96 and data on patent, trade mark and design applications for 1996. The findings suggest that R&D and patent activity are positively and significantly associated with market value. The results also suggest that private returns to R&D in Australia are low by international standards. Hoshi and Kashyap (1990) examined the effect of patenting on Tobin q in Japan.

Two recent studies explored the IP – economic performance nexus with German data. The empirical analysis of a sample of 49 manufacturers of machine tools shows a strong positive relationship between the market value of the firm and its patenting activities (Fleischer, 1999). Holger (2001) analyzed a panel of 50 German machine tool manufacturers and found that national patent applications lead to sales increases with a time-lag of 2 to 3 years after the priority year.

The mean value of patents may, however, not be a very informative statistics since the distribution of returns from patents is very skewed. According to Scherer and Harhoff (2000), the top 10% of their sample captured from 48 to 93% of total sample returns.

Patenting is a distinctive feature of the patterns of technological entry and exit across sectors and over time. Malerba and Orsenigo (1999) found that most of the entrants are occasional innovators, while persistent innovators are few in number but large in terms of patents.

Patents confer temporary monopoly power, which may be translated in higher prices. Jones et al. (2001) examine the impact of the 1987 changes in the Canadian Patent Act on the pricing of ethical drugs. From 1969 to 1987 Canada opted to control pharmaceutical prices by using the compulsory licensing provisions of the Act to promote competition between branded drugs and their generic equivalents. In 1987 however, the Act was amended to guarantee patent holders an extended period (7-10 years) of protection. The major conclusions are: despite evidence of significant first mover advantages which resulted in higher brand prices, competition from generics succeeded in reducing overall market prices prior to 1987; but, after 1987, the efficacy of generic competition was reduced and both brand and market prices increased. This conclusion is, however, contradicted by earlier empirical studies reviewed by Frank and Salkever (1992). Their article suggests that entry of generic competitors results in minimal decreases or even increases in brand-name drug prices as well as sharp declines in brand-name advertising.

IX. MANAGEMENT OF INTELLECTUAL PROPERTY

With the understanding that in the New economy the knowledge capital and not bricks or heavy machinery is the principal source of value, the protection of intellectual property acquired a new importance (see Granstrand, 1999) concept of intellectual capitalism). Possessing promising technology

well protected by appropriate IP instruments became a necessary condition for attracting venture capital, accomplishing a successful initial public offering (IPO) and increasing the value and profits in established firms.

The management literature added management of knowledge and intellectual capital to its popular subjects. There is an increasing number of reference materials providing guidance to practitioners of IP and technology transfer.[55] They typically cover the whole domain of IP management, including the financial aspects. In this section I review the most important recent contributions to this fast growing literature that deal with management and strategies for intellectual property protection. I overview those that take a broader view and leave aside those that deal only with legal issues.

Assessing, measuring and auditing IP portfolios

The growing interest in management of IP resulted in efforts to improve its measurement. The IP performance is measured in different ways than by the simple patent counts. The emerging measures combine quantitative and qualitative aspects and enable organizations to better evaluate and manage their patent portfolios Bratic, Bersin and Benson (2002).

Firms are performing IP "business" audits of their IP in order to assess the commercial value and competitive use of IP for their business. The audit classifies IP into several groups. It is the first step to creating an IP portfolio for strategic purposes. For example Dow chemical which has 29 000 patents required each business unit to classify its patents under three groups:

(1) most valuable patents related to high growth business,
(2) patents that had no present or planned use but are still of value to others and
(3) patents unlikely to be used.

The first group was left for business unit competitive purposes, the second offered for licensing and the third donated or abandoned (Nermien Al-Ali, 2003). For a case study of Dow Chemical see (Davis & Harrison 2001, Ch. 6), Swycher (in Simensky, Bryer, et al. 1999, Ch.7). For the Australian point of view see Ch'ang and Yastreboff (2002).
Identifying IP portfolio and mapping IP is of crucial importance for licensing (Smith & Parr 1998, Ch.2 and Ch 15), Fox and Kelley in Berman (2001, Ch. 9) present Hewlet-Packard's approach how to turn intellectual assets into business assets, how to manage innovation and IP based on a marketing-centric strategy.

Valuation of IP

One of the most important steps in managing intellectual property is to establish its value. Valuation is the process of ascribing value to technology. Valuation is particularly crucial for commercialization of early technologies, for licensing and for mergers and acquisitions.
Probably the best sources on valuation of IP in general are Razgaitis (2002), Smith & Parr (1998) and Lamb in Simensky, Bryer et al. (1999, Ch. 5) and Damodoran (1994). According to Razgaitis, the basis of valuation is recognition that there are two concepts involved: Technology and Right. When these change, the value changes as well. The principle valuations methods are:

1. Industry standards (key is finding an appropriate benchmark)
2. Rules of thumb (25% rule and many variants thereof
3. Rating-Ranking
4. Discounted cash flow
5. Advanced methods (Monte Carlo, Real options pricing (for details see author's book Early Stage Technologies: Valuation and Pricing)
6. Auctions

Razgaitis recommends using multiple methods of valuation. Multiple methods produce value or a coherent range of values that make sense from those multiple perspectives.

The valuation of early technologies presents specific challenges as evidenced by the dot.com and telecom bubble of the late nineties. This lends a special interest to the book on valuation of early technologies published at the peak of the stock market frenzy (Razgaitis ,1999 and Smith & Parr, 1998, Ch. 10). The valuation of IP is also particularly important in merges and acquisitions (M &A). On the valuation of brands in M & A see Forbes (2000). The role of IP in merges and acquisitions (M&A) is especially important in information technologies (Rivette and Kline, 2000). A comprehensive treatment of IP in M-A is presented by Bryer and Lebson on WIPO (2003) internet site.

Valuation of patents in case they are included in an industry standard should take into account the value confered by the patented invention and the value attributable to the standard (Patterson, 2002).

Intellectual property protection is also a significant factor in strategic alliances. Firms adopt more hierarchical governance modes when protection is weak (Oxley, 1999). Patent citation data are used to measure 'technological overlap' between firms before and after alliance formation. Partner selection can be predicted by measures of technological overlap and, once formed, alliances appear to affect firms' technological portfolios in ways predicted by the resource-based view (Mowery et al., 1998).

Under some circumstances the value of corporations' intellectual capital (protected or not) is maximized by the strategy of corporate "carves-out". A corporate carve-out occurs when a company itself desires to hold the intellectual assets of its business in two or more sister companies. In contrast to a corporate spin-out (or spin-off) whose shares are distributed to existing shareholders, a carve-out establishes a new set of shareholders. The chapter by Malackowski and Harrison in Goldscheider, (2002, Ch. 13) describes in detail the reasons for carve-outs, the criteria to be used in evaluating the intellectual capital for carve-outs, the selection of potential partners and how the carve-out should be structured. Se also Zack (2001) on how to restructure technology rich companies.

The joint venture IP strategies and special problems with Strategic Alliances are described by Smith & Parr (1998, Ch. 13 and 14).

Managing of IP assets

The evidence of corporations being increasingly capable of extracting value from intellectual assets is provided by the growing importance of licensing. This had, according to Manfroy (2002), the following consequences:

(1) Corporate vision changed and many corporations created a position of the Chief Technology Officer.
(2) Emergence of the Intellectual Capital Model. A model of a company from the intellectual assets perspective that explains how the different pieces of a corporation fall together, how they interrelate and their impact on intellectual assets and profitability.
(3) Attention is given to intellectual assets management.
(4) With increasing importance of intellectual assets the demand for a remuneration of licensing professionals is rising.

The various aspects of best licensing practices are presented in a collective volume edited by Goldscheider (2002) and in Goldscheider (1998). Even though the present survey is not over viewing legal aspects of IP management, I mention the chapter on the Do's and Dont's of licensing agreements. It is a very useful guide that should help managers and legal councils to better interact in their endeavor to write precise but comprehensive legal agreements (Ramsay, 2002).

Licensing increasingly involves a combination of patents and trade secrets and copyrights in the realm of software and internet (see respectively, Jager's Ch. 6 and Lechter's chapter 7 in Goldscheider, 2002). Trademarks protection and licensing from the US and Canadian perspective is treated in Small and McKay's chapter 8.

Positioning IP for share holder's value through "Patent Brands" is discussed by Berman and Woods in Berman (2001, Ch.10). One of the companies whose value is based on several world most valuable brands is Proctor &Gamble. Weedman in Berman (2001, Ch. 11) describes how the IP portfolio is managed and exploited by Proctor & Gamble.

Smith and Parr (1999) present Strategic IP plan and Gap analysis, illustrated by case studies of Merck and Dupont. The best intellectual capital management practices of a group of about 30 leading companies are the raw material from which Davis and Harrison (2001) distilled the patterns that characterize some of the activities leading-edge companies use to realize value from their intellectual capital and property. Rivette and Kline's (2000) book is full of examples of how the high tech firms from information technology industries extract value from their knowledge assets. They propose a three prong patent strategy for large R&D projects.

Accounting and IP

The American Institute of Certified Public Accountants (AICPA) has been requiring all companies - private and public - to disclose certain risks and uncertainties that could affect their financial performance, effective for fiscal years ending after December 15, 1995. The new requirement, known as Statement of Position (SOP) 94-6, "Disclosure of Certain Significant Risks and Uncertainties," challenges senior managers of businesses to find an appropriate balance between complying with new disclosure guidelines and guarding their own competitive positions and trade secrets (Kwestel and Nusbaum, 1996). However, this measure did not prevent the financial scandals that marked the end of the 1990s.

The Financial Accounting Standards Board of the United States introduced in June 2001 new Financial Accounting Standards (FAS # 142) Goodwill and Other Intangible assets that required significant changes in how companies record value of intellectual property. As stated by Baruch (2001) who was on the committee, *"*For the most successful companies patents, copyrights, brands and other intangible assets trump physical assets, such as factories, offices and even product inventory, hands down". In May 2001 the Securities and Exchange Commission Chairman recommended that SEC encourage supplemental reporting by corporations on such assets. Kossovsky and Brandegee (Goldscheider, 2002, Ch. 12) show how firms respond to theses new rules by integrating IP management strategies into corporate financial strategy.

The framework for auditing intellectual capital (see also above the section on IP portfolios), uses different methods. The comparison of their effectiveness is found in Abeysekera (2001). Many larger IP agent and attorny firms propose one model of IP audit or another e.g. see the website of Bereskin & Parr, Toronto, Ont. www.bereskinparr.com which offers a series of IP management related texts, articles and guides written by the firm's IP professionals (see also Aylen, 2001).

Financial accounting and reporting considerations are also covered by Carter and Lasinski in Simensky et al. (1999, Ch. 8).

One particularly sensitive issue in the era of precipitating technological change is the obsolescence of new technologies and their fiscal treatment. Amortization of intellectual property for US Federal income taxes is subject of Gehan's chapter in Simensky et al. (1999, Ch. 9).

Global exploitation of IP creates special accounting and fiscal issues, especially for joint ventures. The rules, constraints and methods of dealing with them are presented in Smith & Parr (1998, Ch.14). Baumgarten et al. (1995) look at fiscal aspects of software transactions.

IP as Financial Asset

The IP assets are increasingly integrated in corporate financial strategy. IP is leveraged in investment banking transactions (see Lamb in Simensky et al., 1999, Ch. 5). As IP assets became increasingly used by corporations as financial assets, their value is also assessed by rating agencies (see for details, Hoens in Simensky et al., 1999, Ch. 10.). Several other chapters in this book deal with other aspects of IPRs protection in the international market. One of them relevant for this country is "The acquisition and Disposition of Intellectual Property in Commercial transactions: The Canadian Perspective" by Jolliffe and Gill (Simensky et al., 1999, Ch. 23).

IP management as a financial asset draws its approaches from financial management. One of the more sophisticated approaches is the application of the options pricing theory to IP, presented in Berman's, (2002, Ch. 5) by Arrow. He presents the pros and cons of the options approach. The options approach is also exposed in Razgaitis (2002). The interplay of risk and reward involved in inventing is closely related to the similar interplay in investing. Jorasch (in Berman's 2002, Ch. 6) develops the concept of business driven inventing: a process which starts with identifying what the market wants and then finds a unique (perhaps patentable) solution to fill the need. The chapter is illustrated with examples from several industries (Pharmaceutical, a firm developing business solutions, casino slot machines). The relationship between IP and venture capital financing is the topic of Malackowski and Wakefield's chapter "Venture Investment Grounded in Intellectual Capital" in Bereman (2002).
Securitization of IP, i.e. using IP instruments to secure financing is one of the latest manifestations of "intellectual capitalism. Several subjects: Financing IP royalties, Credit analysis of Intellectual Property Securitization, Asset-based IP financing, Relevance of IP in mergers and acquisitions and Patents on Wall Street, are described in the last section of Berman (2002). Taking security interests in intangible assets must conform to international laws and comply with national Statutes. Simensky et al. (1999) presents the situation in 33 countries, including Canada (Chapter 33 by Wall).

X. ENFORCEMENT OF IP RIGHTS, INFRINGEMENT AND DISPUTE RESOLUTION

The increasing patenting in the United States led inevitably to an increasing trend in litigation. The number of patent cases filed before the US Federal courts was increasing regularly from 1178 in 1991, through 1723 in 1995 to 2484 in 2000. The number of terminated cases has been also increasing but less rapidly. Therefore the number of pending cases before courts has been steadily increasing from 1715 in 1991, 2104 in 1995 to 2888 (Prakash, 2001).

Does the cost of enforcing patent rights significantly reduce the value of patents as an innovation incentive? Does the risk of patent litigation from other parties reduce the incentive to engage in innovation even where the incentive is not to infringe? The early economic literature focused on the relationship of litigation on firm's behavior. It found that as the cost of litigation[56] increases the potential injurer exercises greater caution to avoid injuries and litigation (Ordover, 1978; Cooter, 1989; Lerner, 1995) found that firms with *high* litigation costs are less likely to patent in patent classes with many previous awards by rival firms and they tend to avoid those classes occupied by rivals that themselves have *low* litigation costs. Lanjouw and Schankerman (1997) show that patents that are litigated tend to have more claims and more citations per claim. They interpret this to mean that litigation is more likely when a patent is part of a stream of related development work, as evidenced by the number of citations received from the subsequent patents on related technologies owned by the same firm.

In the recent overview of the empirical literature on the enforcement of IPRs Lanjouw and Lerner (1998) examine several recent avenues of empirical research into the enforcement of intellectual property rights. Jaffe (2000) concludes that the evidence suggests that the perceived danger of patent litigation does affect firms' research decisions and affects those decisions depending on the firms' abilities to engage in litigation. For more on litigation see Lanjouw and Schankerman (1997 and 2001) ; Lanjouw and Lerner (2001); Granstrand (1999); Moore (2000); Kingston, (1995 and 2001) a handbook by Parr (1999). The legal and economic aspects of "gray market goods" i.e. goods infringing IP laws) are treated by Lipner (1990). The cost of trade secret theft is subject of Fry's (2001) article.

The value of patent rights is one of the important elements of litigation. Lanjouw et al. (1998) derived empirical estimates of the private value of patent protection for four technology areas--computers, textiles, combustion engines and pharmaceuticals--using new patent data for West Germany for the 1953-1988 period. Patentees must pay renewal fees to keep their patents in force as well as legal expenses in order to enforce them. Results indicate that the aggregate value of protection generated per year is on the order of 10 percent of related R&D expenditure.

Firm-specific wealth effects associated with US International Trade Commission Section 337 investigations of intellectual property right infringements are estimated by Harper (1994). A major finding is that the Section 337 protection is valuable to complainant firms, but the timing of wealth effects suggests differing motivations for firms which pursue this remedy. Other findings are that firms involved in concurrent District Court litigation and firms with greater number of respondents are less likely to settle their case prior to an ITC determination. Recent statutory changes in Section 337 also appear to have increased complainant firms' incentives to settle.

Litigation is costly. By reducing the residual value of a patent, the process of enforcing patent rights reduces and distorts R&D incentives. Lanjouw and Schankerman (1998) came to this conclusion after analyzing a large sample of patent filings from the US district court linked with the detailed patent data from the USPTO. There are about 11 suits per 1000 patents. There is a positive association between the value of patent rights and the expected legal cost of enforcing them. Patentees are more likely to sue when they have subsequent inventions in the same technology area. The highest incidence of litigation is in biotechnology, followed by pharmaceuticals that have twice as high rate of litigation as the overall industry average.

Since litigation is very costly, it is advisable to avoid it. Foster (2002) describes the steps to take when a firm suspects that its IPRs are being infringed. The IP guides also offer advice on what to do in case of infringement how to avoid costly litigation in patent licensing (Goldscheider, 2002, Ch. 14 and 15) and in trademarks (Shilling, 2002). Patents for new business models that use Internet and their infringement is subject of a chapter in Rivette and Kline (2000). For enforcement of patented business methods see Kang and Snyder (2000)

Insurance

The use of insurance as a protection of legal costs involved in IPRs litigation has been in use in UK since 1974. At the beginning of the 1990s there were indications that the practice may be extended to EEC and elsewhere (Raincock, 1991). Websites of private patent attorneys and technology and IP licensing service firms sometimes list infringement insurance among services offered, e.g. Patent cafe (www. 2xfr.com/resources.asp). See also a brief mention of the patent insurance in Breesé (2002) and a chapter in Goldscheider (2002, Ch. 12).

An optimal management of IP has to take in consideration fiscal constraints and opportunities as well as the legal risks and opportunities. Chestek (2001) shows that in some situations it may be advantageous

from a fiscal and legal point of view for a corporation to insulate from lawsuits and prosecution regarding IP by creating an Intellectual Property holding company. The management of IP risk and insurance coverage of IP transactions are dealt with by Simensky and Osterberg in Simensky et al. (1999, Ch 22) and earlier by Stanzler (1993). Intellectual Property Wales (2003) published a very interesting study Intellectual Property and Legal Expense Insurance based on a vast survey of SME in UK.

When the worst comes and a firm goes bankrupt, what if anything can be done with intellectual property? Treatment of IP in Bankrupcy is the subject of Goldman and Klink's chapter in Simensky et al. (1999, Ch. 22).

Examples of infringement of IP on Internet and computers

With globalization and in spite of efforts such as TRIPS to standardize IP protection internationally, the effectiveness of IP protection varies from country to country. Lamb and Rosen (in Simensky et al., 1999, Ch.11) look at the global piracy and its effect on valuation of intellectual property. Industrial espionage, or the covert theft of confidential information, has increased more than 300% since 1992. Losses exceeded $1.5 billion in 1995. The dangers of industrial espionage that often aims the main items of firm's intellectual property and the means of protection are discussed by Greenlee (1996).

Although software piracy is often described as a threat to innovation, only a minority of publishers has chosen to adopt hardware keys, the most secure technology protecting intellectual property in software. A survey of German software publishers reveals that they demand different levels of costly security, depending on product characteristics and markets served. Since public protection incurs costs of its own, initiatives to strengthen intellectual property rights in software and their official enforcement should take into account empirical evidence about private willingness to pay for protection (Stolpe, 2000).

Internet marketing has also brought new risks, such as "cybersquatting," in which an individual registers the domain name of a company and attempts to sell the domain name to the company. However, a federal trademark registration based on an application filed before the application to register a domain name is a basis for unseating cybersquatters.

Recently signed legislation provides a remedy for "cyberpiracy." It creates an action against anyone who, with a bad faith intent to profit, registers, traffics in, or uses a domain name that is: 1) identical or confusingly similar to a mark that was distinctive when the domain name was registered; or 2) identical or confusingly similar to, or dilutive of, a mark that was famous when the domain name was registered. (Foudree and Trzyna, 1999).

A brief description of R&D and IP strategies pursued by Gillette to fend off imitators by Galarza (1996) shows that the company is protective of its product line to the point of litigation where appropriate.

See also the article, written by Reback (2002).[57] The article criticizes the recent "pro-patent changes" introduced by the US Patent and Trademark Office.

Within the past 5 or 6 years, economists in particular have started to question the USPTO practices, finding little correlation, if any, between patent proliferation and invention. If the system is to be fixed, the USPTO needs to focus on the economic costs of its policies and correct its own balance sheet. The internet domain is increasingly misused and abused. The World Intellectual Property Organization (WIPO) stripping cybersquatter Kenneth Harvey of the domain walmartcanada.com is an example of the difficult relationship between internet domain and fair trademark protection (Libin, Oct 16, 2000). The Internet is opening new opportunities for legal attacks. Goldsborough offers some commonsense advice to avoid getting hauled into court, particularly in regards to libel, copyright and trademarks (Goldsborough, 2001).

Many agencies, including the Federal Trade Commission and the US Department of Transportation, have been regulating Internet advertising. For example, FTC has filed actions against Web site owners for violations of the Mail and Telephone Order Merchandise Rules. Actions also have been filed by the Securities and Exchange Commission when Web site owners failed to comply with laws requiring companies to have prospectuses (Lans-Retsky, 1997).

As the sheer volume of Web addresses grows, so does the likelihood of confusion between similar domain names - and of legal disputes. The procedures for resolving such differences are through the dispute resolution process available from the Internet Corp. for Assigned Names and Numbers (ICANN) or in the courts. The critical difference between ICANN's dispute service providers and the US court system is the ability to seek financial restitution. A company could lose substantial revenues if its trademark has been seriously diluted and while ICANN can make the offender give up the domain name in question, it is not empowered to force defendants to pay any compensation. On the other hand, unless monetary damages are substantial and provable, ICANN's speed and efficiency often make it the venue of choice (Jarvis, 2000).

Description of the litigation and patent enforcement regarding computerized phone services based in part on Katz's patents on forms of interactive technology ranging from phone-sex lines to telephone database retrieval. The case illustrates the possibility of an independent inventor wining over the large and powerful firms. Katz's detractors say he is not an inventor as much as an exploiter of the US Patent & Trademark Office (Lubove, 1997).

Innovation related to Internet has been characterized by two opposite attitudes to IP. On the one hand some innovating firms realized the potential patents offer to secure and defend profitable position in the e-commerce economy and patent intensively.[58] On the other hand, Internet is also the medium which saw the emergence of the Open Source Initiative— a loose group of volunteer programmers who collaborate to develop free software for Internet. The clash between those two attitudes and the patent wars related to Internet are well described in Rivette and Kline (2000). As many other texts in this section, theirs has been written before the stock market fall, which makes it more interesting if less informative reading today.

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APPENDIX 1

A selection of recent books on IP management
An overview of a selection of most recent reference books on management of IP, often including a summary description of their content or brief reading notes.

Berman, B., ed. *From Ideas to Assets: Investing Wisely in Intellectual Property*, N.Y.: John Wiley & Sons John, 2001.

A collection of invited papers is a multidisciplinary guide for practitioners, investors and managers designed to help them tom stay at the top of their own business as well as others'.
It is organized in four sections:

> Identifying and organizing IP, Exploiting IP, Measuring IP performance and Transactions and finance. The author summarizes the motto of the volume as attempting to answer the question: "What information do I need to know about IP to compete?"

After an introduction of fundamentals on IP and IP strategies, Blair et al. discuss the IPRs for the "new" economy. The authors show that the ratio of intangible to tangible assets' value has been sharply increasing (market to book value) over the nineties. The phenomena of rising value of intangibles and the role of IP in the "New" economy was the subject of the Brookings Institution Study (2001) *Unseen Wealth: Report of the Brookings task Force on Intangibles*, Washington, D.C. Brookings, 2001 co-authored by the first author of this book. The chapter summarizes the principal findings of the Brookings report and its recommendations to improve IP protection.

The chapter by Arrow "Managing IP Financial Assets" presents the application of the options pricing theory to IP and discusses the pros and cons of the options approach.

The interplay of risk and reward involved in inventing is closely related to the similar interplay in investing. Jorasch develops the concept of business driven inventing: a process which starts with identifying what the market wants and then finds a unique (perhaps patentable) solution to fill the need. The chapter is illustrated with examples from several industries (Pharmaceutical, a firm developing business solutions, casino slot machines).

Malackowski and Wakefield "Venture Investment Grounded in Intellectual Capital: taking patents to the bank". They discuss different strategies used by venture capital firms, illustrated by several case studies.

The IP practices of leading research universities seem to shift from patent licensing to equity participation in joint ventures. The interview with J. Granowitz of Columbia University presents the IP practices of one of the leading academic institutions.

Fox and Kelley "Making Innovation Pay" argue that firms have to develop a prospective perspective (based on what the market needs and will need) in creating and evaluating IP portfolios. They present Hewlett-Packard's approach how to turn intellectual assets into business assets, how to manage innovation and IP based on a marketing-centric strategy.

Positioning IP for Sharholder's value through "Patent Brands" is discussed by Berman and Woods. One of the companies whose value is based on several world most valuable brands is Proctor & Gamble. Weedman describes how the IP portfolio is managed and exploited by Proctor & Gamble.

The growing interest in management of IP is linked with an intensive interest in measuring the IP. There are three ways to manage and evaluate patent portfolios; through IP holding companies (Boeing, Xerox, Ford), internal benchmarking and other non-financial metrics (citation impact, science linkage, technology cycle time).

Positioning IP for Sharholder's value through "Patent Brands" is discussed by Berman and Woods. One of the companies whose value is based on several world most valuable brands is Proctor & Gamble. Weedman describes how the IP portfolio is managed and exploited by Proctor & Gamble. Patents provide brand and shareholder value not only for high-tech products but also for the mass-produced products. The relationship between patents and brands is explored by Berman and Woods 'Patent "Brands" Positioning IP for Shareholder Value'. One of the best examples of a "old" economy using IP to redefine its competitive advantage is Proctor & Gamble (Weedman, 2001, New Economy Innovations from an Old Economy Giant).

The IP performance is measured in different ways than by the simple patent counts. The emerging measures combine quantitative and qualitative aspects and enable organizations to better evaluate and manage their patent portfolios Bratic, Bersin and Benson (Measuring Intellectual Property Portfolio Performance). As IP and intangible assets grow ever more important, their evaluation is of outmost importance. The value of intangible assets (IA) of firms included in Dow Jones Industrial accounted for 43% versus 24% for the fixed assets in 1997. The operating profit is found to be positively correlated with the relative importance of IP and IA. There are several ways companies can leverage their IP to increase the value. These range in terms of increasing complexity and value creation from purely defensive, followed by various forms of income generation through licensing up to securitization of IP (accepting IP as a loan collateral for borrowing) to using IP as an "entry fee" to strategic Alliances (Parr, IP leverage). Patents contain a wealth of qualitative information. Narin, Thomas and Breitzman present a technology score indicator that combines the number of patents possessed by a firm, their quality in terms of citations, the proximity to science and importance of R&D. They show that the stock market valuation (market value to book ratio) is correlated positively with their technology score. They show that the technology score is a good indicator of the stock market performance.

The last section of the book deals with intellectual property transactions and finance. Agiato (The Basics of Financing Intellectual Property Royalties) describes intellectual property royalties financing as a "put" option that "creates a floor on what an IP owner will receive on their asset". A licensor of IP can take the future cash flow expected from a license agreement and receive an "up front" cash payment representing the present value of the future cash flows. This allows the owner of the IP to leverage income today that they expect to receive in the future. The rest of the chapters in this section of the book present related aspects such as a rating agency's perspective of the credit analysis).

Goldscheider, R. *Licensing Best Practices*. N.Y.: John Wiley & Sons, 2002.

This is a collection of up-to-date contributions of many licensing specialists, mostly members of the Licensing Executives Society (LES) on the licensing and technology management.

Part I. The Changing landscape of licensing

Chapter 1. The subject of the book is introduced by W. Manfrey who overviews the recent (after mid eighties) surge in licensing due to corporations being increasingly capable of extracting value from intellectual assets. Emergence of a new form of *Invention on demand.* The volume of licensing is believed to have increased form about $15 billion in 1990 to $100 billion in 1998.

This recent trend is due to a combination of reasons:

(1) Legal (a more patent friendly court system in the US after establishment of the Court of Appeal of the Federal Circuit),
(2) Business strategy marked by emerging of information technology as a separate industry segment (a) It allowed grater ease of access to and transparency of information (b) created its own set of intellectual assets that were licensed, enforced and traded (c) electronic marketing, data manipulation and retrieval tools (patents, citation trees, IP databases),
(3) Internationalization led to more intensive patenting abroad,
(4) With corporate restructuring and labor shedding, corporations realized the growing importance of translating their intellectual capital that is inherently mobile into a more tangible form. Knowledge management became one of the top priorities in companies.

Increased licensing had the following consequences:

(1) Corporate vision changed (a brief survey of recent management theories) and led to the development of the *core technology competency (*a set of skills and behaviours that consistently provide a competitive advantage according to Prahalad and Hansel *(The Core Competence of Corporation, Harvard Business Review, May 6, 1990)*) and many corporations created a position of the Chief Technology Officer.
(2) Emergence of the Intellectual Capital Model- Model of a company from the intellectual assets perspective that explains how the different pieces of a corporation fall together, how they interrelate and their impact on intellectual assets and profitability.
(3) Attention is given to intellectual assets management.

With increasing importance of intellectual assets the demand for an remuneration of licensing professionals is rising.

Chapter 2. Technology valuation by R. Razgaitis, Valuation is the process of ascribing value to technology being licensed. The author defines Old economy as a system where there is a direct measurable connection between the assets and income. The connection (correlation) between assets and value change radically in the last twenty years. In the New Economy the Price-to-book ratio increased notably, suggesting that the conventionally accounted assets did not any more represent the market value of a company. The case study shows that Microsoft's market value follows much closer the number of US patents issued to Microsoft than the book value of its assets. Thus the value of technology seems to be the component missing in the equation.

The brief chapter presents the principles of technology valuation. The basis of valuation is recognition that there are two concepts involved: Technology and Right. When these change the value changes as well.

The chapter presents various elements of a license deal and forms of payment. The discussion of valuation starts with a reminder that most licensing deals are *specific* and involve various *risks*. The principle valuations methods are:

1. Industry standards (key is finding an appropriate benchmark)
2. Rules of thumb (25% rule and many variants thereof)
3. Rating-Ranking
4. Discounted cash flow
5. Advanced methods (Monte Carlo, Real options pricing (in reference to author's book Early Stage Technologies: Valuation and Pricing)
6. Auctions

The author recommends using of multiple methods that produces a deeper understanding of the impact of risk and ways to increase value. Multiple methods produce value or a coherent range of values that make sense from thoses multiple perspectives.

Part II. New Outlooks on Patents, Trademarks, Copyrights and Trade Secrets

Chapter 3. The Expanding Role of Technology Management Consultants - The International Licensing Network, by R. Goldscheider:

Chapter 4. Dreadful Drafting : The Do's and Don'ts of Licensing Agreements, by J. Ramsay. A very useful guide through licensing contracts, how to draft them and what to avoid.

Part II

Chapter 5. Recent Changes in Patenting Procedures and Protection: Developments in the European and US Patent systems, by H. Goddar.

Chapter 6. The Critical Role of Trade Secret Law in Protecting Intellectual Property Assets, by M. Jager. This chapter presents a useful overview of the scope of trade secret protection in various countries. It discusses the differences between patents and trade secrets and their licensing and valuation.

Chapter 7. Copyright, Software and Web Site Issues in the Internet World, by M. Lechter, deals with e-commerce, presents web-based revenue models for software and intellectual property laws and the internet.

Chapter 8. Tradmarks, Trade Names and Trade Dress, by T.M. Small and K.D. McKay. Presents both the US and Canadian practice of trademark licensing.

Part III. Advances in Industry-Specific Licensing

Chapter 9. Licensing in the Biotechnology Industry, by C. Campbell.

Chapter 10. Pharmaceutical Licensing during the Revolution, by T. Picone.

Chapter 11. University Licensing Trends and Intellectual Capital, by L.P. Berneman and K.A. Denis. This chapter presents an up to date overview of the quantitative importance of university licensing and technology transfer.

Part IV. Financial Issues, Legal Protection and Litigation Developments

Chapter 12. What to Do with Technology Rights that Are Financial Assets and Instruments, by N. Kossovsky and B. Brandegee.

This is an overview of the state of the art on how firms integrate IP management into corporate financial strategy.

Chapter 13. IC-Based Corporate Carve-Outs: Strategy, Structure and Funding, by J.E. Malackowski and S. Harrison.

Under some circumstances the value of corporations' intellectual capital (protected or not) is maximized by the strategy of corporate "carves-out". A corporate carve-out occurs when a company itself desires to hold the intellectual assets of its business in two or more sister companies. In contrast to a corporate spin-out (or spin-off) whose shares are distributed to existing shareholders, a carve-out establishes a new set of shareholders . The chapter by Malackowski and Harrison describes in detail the reasons for carve-outs, the criteria to be used in evaluating the intellectual capital for carve-outs, the selection of potential partners and how the carve-out should be structured.

Chapter 14. Licensing and Litigation, by R.L. Grudziedcki and A. Michel.

Chapter 15. Alternative Dispute Resolution: Fighting Smarter, Spending Less, by T. Arnold.

Part V. Licensing in Global Economy

Chapter 16. Ingnore Europe at your Peril!, by P. Chrocziel.

Chapter 17. Challenges of Licensing to and From China and Hong Kong, by L.W. Ewans.

Chapter 18. Is there a Future for Japan, by D. Unkovic.

Chapter 19. Licensing in Russia: Opportunities and Pitfalls, by N. Karpova

Chapter 20. Australia: Licensing Opportunities in the Medical and Biotechnology Industry, by R. De Boos.
Chapter 21. Challenges to Arab Industries in Acquiring and Selling Appropriate Technologies, by T. Abu-Ghazaleh.
Chapter 22. The South African Experience in Economic Development, by A. Lewis and D. MacRobert.
Chapter 23. Prospects for Increased Licesning in Latin America, by F. Noetinger and G.F. Leonardos.
Further Reading List

Smith, G.V. and R.L. Parr. *Intellectual Property Licensing and Joint Venture Profit Strategies*. 2nd ed. N.Y. John Wiley & Sons, 1998.

The 2nd edition of Smith and Parr(1998) responds to the growing interest in intellectual capital and intellectual property.[59] It contains a wealth of information on the theoretical framework and practical applications of intellectual property identification, exploitation strategies and valuation. Even a brief overview of individual chapters would be too long. An enumeration of the principal issues by chapter includes:

Ch2-IP exploitation strategies, including a section on how companies manage their portfolios of IP. Ch3- History of licensing; Ch4- Creating Industry Standards; Chapter 5 provides the economic analysis of exploitation of IP. The Ch6 reviews the economic contribution of IP to profits and corporate value. It provides the foundation for royalty rates and joint ventures profit splits, which are treated in Ch7 and Ch9.

The *risk of exploitation of IP* is dealt with in Ch8. The particulary difficult issue of how to deal with IP related to *early stage technologies* that are not yet commercialized is presented in Ch10. *Licensing of trademarks Ch11 and licensing negotiations and agreements are treated in Ch12.* The analytical model presented in Ch13 identifies the *contribution of technology and trademarks to joint ventures and the corresponding split of profits.* The rest of the book concentrates *on the exploitaiton of IP on the global scene*. All chapters are well illustrated with practical examples.

United Nations Industrial Development Organization (UNIDO). *Manual on Technology Transfer Negotiation*. Vienna: UNIDO, 1996.

The United Nations Industrial Development Organization (UNIDO, 1996) manual on technology transfer is a useful reference text providing answers to technology transfer practitioners, both on the recipient side or on supplier side. Even though it is mainly aimed at technology transfers between industrial and developing countries, most of the conceptual and practical material presented in the manual may be very useful also for management of IP and technology transfers between firms belonging to industrial countries e.g. the chapters on valuation and pricing, on warranties in technology transfer transactions and on technology transfer by strategic partnering. Since it was published in 1996, there is little about the specifics of IPRs in the context of the New Economy.

Burge, David A. *Patent and Trademark Tactics and Practice*, 3rd Ed. New York, John Wiley and Sons, 1999

A new edition of a "primer" on how to use patents and other IP instruments by a patent attorney. Focused on the generalities and specifics of what IP to use, how to apply for it and when and how to keep it in force. A potentially useful source of first information for business managers and entrepreneurs and others engaged in the development, protection and management of intellectual property management. It is focused on the legal and administrative aspects of IP. This clear guide presents critical coverage of cutting-edge issues related to international law, electronic data, the Internet and more. It covers the

definition and understanding of patents and trademarks, legal rights and obligations and the correct procedures necessary for legal protection in each case. It answers dozens of legal and procedural questions, from how to find a good patent attorney and apply for a patent to how to select and use a trademark and protect trade secrets. The third edition has brought updates that reflect important changes in the law and additions that treat areas of practice that are of increasing interest and importance.

H. Jackson Knight. *Patent Strategy: For Researchers and Research Managers*, 2nd Ed. New York, John Wiley and Sons, 2001

As individuals and companies realize the importance and value of their inventions, issues surrounding patent laws and practices are taking center stage around the world. Thus, all inventors require a basic understanding of the patenting system if they are to successfully protect their inventions. The continuing increase in patent activity has spawned a number of new laws and undoubtedly is affecting the interpretation of existing ones. To reflect these changes, the *Second Edition of Patent Strategy: For Researchers and Research Managers* has been reorganized and completely updated.
This book bridges the gap between the legal system and scientific research and avoids legal jargon; details the reasons behind patents, their importance and relevance to all researchers and the strategy needed for filing for a patent; and focuses on strategy and reasons rather than merely presenting patent law. The style is readable and the subject matter passes from basics right up to strategy development.

Davis & Harrison. *Edison in the Boardroom : How Leading Companies Realize Value from Their Intellectual Assets*. New York: John Wiley and Sons, 2001.

The completely revised fifth edition of Fishman's (2002) *The Copyright Handbook* for writers, editors, publishers, literary agents and anyone else concerned with protecting creative expression under US and international copyright law The book offers new information on the Digital Millenium Copyright Act; the 20 year extension of all copyright terms; it demonstrates how to register a work; how to determine what works can be protected; how and when to use a copyright notice; the rights and duration of ownership; what constitutes infringement; electronic publishing rights; how to protect creative works on the Internet; and much more. Includes 23 legal forms in print form and on the accompanying CD-ROM, with step-by-step instructions on how to fill them out.

Razgaitis, Richard. *Early-Stage Technologies*. N.Y.: John Wiley & Sons, 1999.

This is a business - oriented book. It is concerned with analyzing valuation, pricing and negotiating technology agreements, i.e. transactions for pre-commercial designs and data , normally without large - scale manufacturability or even a single legitimate customer.

The author makes a distinction between valuation, i.e. forecasting the future value of operating profits, and cash flows. It produces range values. Pricing is using valuation findings to reach an agreement. Valuation is an opinion ; pricing is a commitment. The book analyses in detail the type of technology rights offered by sellers and the related payment forms, the risk and even the psychology involved and their effect on the price. The first part, Ch. 4 to 9 of the book, presents an overview of valuation methods with examples drawn from many industries. The second part of the book presents the payment methods, the first by equity investment in the start-up operation. Follows a chapter on the structure of licensing payments. The last chapter deals with pricing, negotiation, readiness and conclusion. The appendix contains list of key institutional resources for technology licensing.

Breesé, P. *Stratégies de propriété industrielle*. Paris: Dunod, 2002.

Notes: This is "a textbook" approach to IP strategies written for the use of enterprises. After the review of instruments of IP it presents briefly different patent strategies, their advantages and inconveniences and some practical examples. Follows an industry by industry look at the effectiveness of various IP instruments (with reference to European IP system). The remaining part of the book treats the management of IP by firms, the human resources devoted to IP management and their tasks including fiswcal aspects. Separate chapters deal with the relationship of trade secret and IP, management of patent portfolio (including sections on auditing of patent portfolios, patent insurance and the relationship between patents and standards and normalisation). Another chapter deals with financial evaluation of intangible assets (patents, trademarks, etc.). It concludes by rather thin chapter on the management of a knowledge based enterprise and groups of firms.- The appendixes include examples of contracts (for licensing of patents and secrets and an overview of an IP audit).

Granstrand, Ove. *The economics and management of intellectual property: Towards intellectual capitalism*. 99. Cheltenham, U.K. and Northampton, Mass.: Elgar; **distributed by American International Distribution Corporation, Williston, Vt., 1999; xv, 464.**

The example of Japan is potentially very interesting for Canada because like in Canada, innovation is led by large firms there! Differences in establishing property rights to physical and intellectual objects (p.24-6); History of protection of intellectual property (p.26-40) and role of IPR in economic history and history of technology. History Tokugawa dynasty decreed in 1718 that innovations (new things) are forbidden; The Meiji dynasty open Japan to the world in 1868, a year after establishing the patent system inspired by the to-the IPR system was in general neither a necessary nor a sufficient for technological progress at country or company level historically Probable reasons for the emergence of the Pro-patent era in the US (p.38). Regarding the monopoly power conferred by patent, an important distinction to be made is that patent is first of all a monopoly on an input: (1) many costly complimentary inputs may be needed before monopoly profits are gained (2) as many inputs, a patent may be substituted by other patented or non protected solutions (p.48);
Economics and management of patents: The product life cycle and patents; who, what, where and when to patent ; valuation of patents and pricing of licensing (p.80-82) the secrecy alternative to patenting; Survey of the literature on IPRs (p.86-93); economic theory , pricing determination of royalties (p.93-106); Knowledge properties in general, special properties of technology (p.121).
Japanese patent system, history, IPR systems comparison with the US Europe and international comparison of patenting trends in the US Table 5.6 ; survey data on R&D and patenting in large Japanese firms (chemical, electrical mechanical) (p.137-175).
Technology and commercialization strategies in Japan; comparison of means for commercialization of new product technologies Japan; Sweden, US (patents, secrecy, lead time, switching costs, superior marketing T6.5 - T6.6. (p.180-191),
Standardization and IPR (p.202-208); Intellectual property policies and strategies advantages and disadvantages of patenting in general and in Japan(p.210-226); Litigation strategies, secrecy strategies, trademark strategies (p.234-255);
Analysis of patent information- sources of technical info. application of patent information, some caveats when using patent statistics (p.290-299); intellectual capitalism (p.318-325), the future of IC (p.345-356); Appendix-Comparison of patenting in Sweden and Jan-research questions for corporate benchmarking (p.357-365), the design of the survey and the questionnaire.

Correa, Carlos M. *Intellectual property rights, the WTO and developing countries: The TRIPS Agreement and policy options.* 2000. Penang, Malaysia: Third World Network; London: Zed Books; distributed by St. Martin's Press, New York, 2000; xii, 254.

The book is a useful approach to understanding of most TRIP and IPP related concepts.

Merges, R.P. *Patent Law and Policy, Cases and Materials*. Charlottesville, Virginia: Michie Law Publishers, 1997.

A unique rich source of reading on Legal and economic aspects of IP too extensive to e reviewed here.

Towse & Holtzhauer. *The Economics of Intellectual Property*. A four-volume collection of 89 previously published papers. New York: John Wiley and Sons, 2002.

Nermien, Al-Ali. *Comprehensive Intellectual Capital Management*. New York: John Wiley and Sons, February 2003.

Parr, Russel L. *Intellectual Property Infringement Damage*, New York: John Wiley and Sons, 1999.

ETAN Expert Working Group. Strategic Dimensions of Intellectual Property Rights in the Context of Science and Technology Policy. 99. -Final report for the European Commission Directorate General XII- Science, Research and Development Directorate AP- Policy Co-ordination and Strategy.

Glick & Reymann. Intellectual Property Damages : Guideline and Analysis, 2002.

Berman. *From Ideas to Assets : Investing Wisely in Intellectual Property*, New York, John Wiley and Sons, 2001.

Simensky, Bryer et al. *Intellectual Property in the Global Market Place*, New York: John Wiley and Sons, 1999.

Smith & Parr. *Intellectual Property Licensing and Joint Venture Profit Strategies*, New York: John Wiley and Sons, 1998.

NOTES

[1] Since patenting by universities is outside of the scope of the present project, the large and rapidly increasing literature covering patenting by universities is not covered here.
[2] This change (US patent Act of 1952) was brought about by patent attorneys in the US after discovery of streptomycin (1947-result of long laborious search), in contrast to penicillin (example of the flash of the genius), invented earlier but not patented, since it was considered wrong that something as useful to mankind could be given a monopoly.
[3] Complex technology is a product or process that can not be understood in full detail be an individual expert sufficiently to communicate all the details of the product or process over time and distance to other experts (Roycroft and Kash, 1999, p.262).
[4] Mansfield's survey of research firms found that the effective lives of most patents were shorter than the stipulated 17 years (this was before the reform that extended patents in the U.S. to 20 years).
[5] Note that the definition of what constitutes a SME in the U.S. does not necessarily correspond to the concept of SME in Canada.
[6] Merges is a leading legal authority on IPRs (cf. Merges, 1997) and Nelson one of the most influential economists in the field of technological change.
[7] The exemplary case being patents claiming rights to "whatever useful may come from" identification and purification of particular DNA fragments which is basically a scientific discovery.
[8] The patenting level follows the research level--and is effectively defined by the most active patenter in an industry. Where patent disputes have not been the tradition, e.g. the semiconductor industry before Texas Instruments lawsuits, there is generally no need to obtain patents except as an insurance against the possibility of such lawsuits (or as rewards for engineers). Once the threat of litigation arises, however, all firms must build a portfolio; the construction of the portfolio is essentially a process of seeking filings on interesting developments that emerge from the research (that is already motivated by the need to keep up with competitors). The photography case (see below) suggested an additional role for a patent portfolio: to define one as a "player." Apparently, it was, in part, the strength of different firms' patent portfolios that led to the choice of the firms to participate in the consortium to develop the Advanced Photo System. Presumably under pressure of antitrust considerations, the patents were then licensed to those not in the consortium.
[9] These uses are becoming extremely significant. Two examples show the issue of allocating rents among different production or development steps. One is aircraft manufacture another biotechnology. In the latter firms (and universities) are seeking IP on "research tools" such as reagents or pharmaceutical screening procedures and seeking to license the use of these for developing final products in return for a royalty defined as a percentage of the sales of that product. In neither of these examples will the IP significantly affect the final rent (the airframe company's or the pharmaceutical firm's ability to extract a rent on the product); rather it affects the allocation of that rent between the different entities involved in the research effort. The result of IP is to give several entities a veto on final product development and therefore to affect the terms and negotiability of arrangements to deal with the rights of these entities at different levels of product development.
[10] Illustration by the case Intergraph versus Intel (cf. below the section on computer chips).
[11] The report surveyed a sample of 900 firms, broken down into four groups: Top R&D performers (100), High technology firms (300), medium and low technology firms (400) and Major copyright users (100).
[12] Smaller firms with sales less $5 million used IPRs less than larger firms and were less satisfied with Canadian IPRs.
[13] These responses have to be considered today in a proper perspective. Amendments to the *Copyright Act* introduced in June 1988 extended copyright protection to computer programs, strengthened the right of artists to control who uses their work and improved systems to collect copyrights. The new act also increased penalties for infringement of copyright up to a maximum of $1 million, with prison terms ranging from 6 months to five years. The *Canadian Patent Act* also underwent significant changes in 1989.Thus the dissatisfaction and criticism that the Canadian IPRs did not provide sufficient protection and had not kept pace with technological developments may not any more be valid today.

[14] Baldwin's study is based on the Statistics Canada (1993) Survey of Innovation and Advanced Technology which surveyed both small and large manufacturing firms. The more recent Statistics Canada Survey of Innovation, 1999 surveyed only larger manufacturing firms. For this and other methodological reasons, the two studies are not strictly comparable (Hanel, 2001).

In Table I below is presented the percentage of larger firms (firms in Business register of Statistics Canada) that used of IPRs in 1989-91.

Table I. Use of intellectual property by innovators and all manufacturing firms, 1989-1991
(% of firms*)

	Intellectual Property Rights							
Status	**Patents**	**Trade marks**	**Copyright**	Trade **secrets**	**Integrated circuit design**	**Industry design**	**Plant breeder's right**	**Others**
Innovators	24.66	31.31	9.44	17.99	1.99	13.48	0.451	1.02
All	16.32	22.96	6.35	11.7	1.14	9.05	0.51	0.82

Source: Statistics Canada, Survey of Innovation and Advanced Technology, 1993 (Special tabulation, from Hanel (2001).

Note: This special tabulation is representative of larger firms included in the business register. In contrast to this tabulation of IPR use by larger firms, Baldwin's (1997) results are representative of firms of all sizes, i.e. his sample includes also the smallest firms therefore the results in his paper are different.

[15] See the classification of industries in Core, Secondary and 'Other' technology sector in Appendix I.

[16] Note that firms may not have confidence in the effectiveness of patents to protect their inventions from imitation (or other IPRs) and use them anyway for other strategic reasons (Cohen et al., 2000), such as to signal their technological prowess on the stock market or on the labor market to attract highly qualified manpower etc.)

[17] The index takes into account the coverage, memberships in international patent agreements, protection against the loss of IPRs, enforcement mechanisms and duration of patent protection Girante and Park (1997)

[18] Lazarus' study includes an interesting discussion of the real meaning of patent-count based indicators and their use, misuse and interpretation in empirical studies.

[19] ***Table 2. Use of intellectual property by innovation status***
(% of all manufacturing firms)

Status	**Share of population**	**Patents**	**Trade-marks**	Copyright	**Trade secrets**	**Confiden-tiality**	**Others**	**Any IPR**
Innovation	80.7	29.3	39.8	13.6	28.4	48.4	2.7	72.6
Unsuccessful	7.2	14.1	25.3	6.4	14.4	32.6	1.8	49.7
Not involved	12.1	8.3	19.1	4.5	7.5	16.9	2.3	35.9
All	100.0	25.7	36.0	12.0	24.7	43.2	2.5	66.1

Source : Preliminary results of Statistics Canada Innovation Survey, 1999

Note: The statistics from the 1999 Survey presented in this and all other tables and figures are weighted by the gross business income and are representative of the population of Canadian manufacturing "provincial enterprises".

[20] Including most high-tech industries except aircraft industry.

[21] However, the econometric analysis taking into account the complex interdependence between firm's decisions to invest in R&D, to innovate and to patent suggest, along the lines of (Baldwin et al., 2000), that the causal nexus is stronger from innovation to patenting than the other way round.

[22] A brief account of the European patent system (European Patent Convention), its relationships to various national systems in Europe, including the chronology of main events is presented in Pitkethly (1999) "The European Patent System : Implementing Patent Law Harmonization", *Electronic Journal of Intellectual Property Rights,* WP/99; Oxford Intellectual Property Research Centre, http://www.oiprc.ox.ac.uk/EJINDEX.html

[23] The comparison is only approximate due to differences in sampling, questionnaire differences and definitions used in both surveys.

[24] Defined as the % of firm's innovations for which a patent application was made in the last three years.

[25] Formerly, a Japanese patent covered a single claim.

[26] The assessment regards the Japanese patent system before the reform that replaced the single claim by the multiple claim principle.

[27] The best known example of such a 'submarine' patent is the Lemelson patent filed in 1954 and granted after 38 years in 1992 (Granstrand, 1999, p.173, note 23). However, according to Sears (2002), U.S. Court of Appeals for the Federal Circuit refused this practice in a recent ruling.

[28] Ibid, p.48.

[29] Ibid, pp.137-175. See also Granstrand (1999)

[30] Ibid, pp.180-191.

[31] Ibid, pp. 202-208.
[32] Ibid, pp. 210-216.
[33] Ibid, pp. 234-255.
[34] Given the limited size of the sample (24 observations) the information may be considered as a series of case studies rather than a statistical picture of responses of large Japanese corporations.
[35] Ibid, pp. 290-299.
[36]Ibid, pp. 357-365
[37] Ibid, pp. 318-325. See also Granstrand, 2000, in Research Policy.
[38] Detailed industry responses are available in the paper.
[39] The Kefauver Committee on Administered Prices and Drugs, (Washington, 1961) found that patents are of vital importance in the formation of drug cartels.
[40] Discrete industries include: those with ISIC code<2900 (e.g. food, textiles, chemicals, drugs, metals and metal products. Complex industries are those ISIC code>2900 (e.g. machinery, computers, el. equipment, electronic components, instruments and transport eqpt. and exclude ISIC 3600, other manufacturing (Cohen et al., 2000).
[41] However, this is not the case with new organic chemical products! See Merges and Nelson, 1994 discussing the effect of patent scope (breath of the patent claims) on rivalry in technical progress in case of cumulative (sequential) technologies. In case of inventions that are a starting place for inventions of tomorrow (sequential inventions) patents with broad scope allow today's inventors proceed into the next stage of inventing without fear of encroachment by outsiders; outsiders are deterred from participating because of the likelihood that their invention will be held infringing. In contrast, if allowed scope is narrow, outsiders are less deterred from competing in the next round of inventing (Scotchmer, 1991; Green and Scotchmer, 1990). Merges and Nelson argue with the help of case histories that the recent court practice that awarded overly broad patent claims (Genetech, the Harvard mouse) in terms of a principle rather than in terms of product actually produced is a way of privatizing public science and as such is socially not desirable because of its potential of blocking future technical progress. Mandeville (1996) comes to the same conclusion from the information theory perspective.
[42] ***Table 3. Use of IP mechanisms used by innovating firms in chemical industries***

Industry	% of innovating firms using any IPR	Of these % using		
		patents	trademarks	secrets
Petroleum and coal	93	31	58	58
Chemical	87	48	67	55
Pharmaceutical	94	59	75	56
All manufacturing	73	40	55	39

[43] The increased patenting by U.S. universities in the wake of the Bayh-Dole Act (irrespective whether it was a direct cause and effect relationship or not (cf. Mowery and Ziedonis, 2001), contributed also probably to the rise of patenting in semiconductors, contributed also probably to the rise of patenting in semiconductors (Henderson, Jaffe, et al., 1995).
[44] Even though not belonging to ITC industries, the introduction of the Advanced Photographic System is a very interesting recent example of various IP strategies in the field of consumer products. It was discussed by Workshop participants and included in the rapporteur's report as well as in Barton's synthesis.
[45] Merges discusses the practical and legal aspects and presents the case against the protection of software and business methods by patents and proposes alternative solutions.
[46] The comparison with the situation in the U.S. is sometimes difficult because the definition of SME in the U.S. and in Canada is not necessarily the same.
[47] The comparison with the situation in the U.S. is sometimes difficult because the definition of SME in the U.S. and in Canada is not necessarily the same.
[48] They tend also to use more frequently patents, but the regression coefficient of the patent variable is statistically significant at 12% level only.
[49] The strength of IPRs in developing countries is assessed by Lall and Albadajo (2002).
[50] The author mentions to have written a guide for licensing by SME.
[51] Patent counts are also used as indicators of innovation input or output of R&D, indicators of technological competitiveness, the rate of technological change and indicators of technology flows and for other purposes.

[52] The value of knowledge-based firms is thus increasingly divorced from their book value (value of their fixed assets). Financial data such as Tobin q, constructed from accounting data, are therefore biased.
[53] Bereman (2001, ch.4) presents an overview of the Brookings study by Blair, one of the authors of the study.
[54] The study used the PATDAT database developed by the Canadian Patent Office. PATDAT classified Canadian patents for new products and processes according to the first three most likely industries of manufacture and the three most likely industries of use of the patented invention. This database was unique of its kind and is being increasingly used in economic and business research- see for example a special issue of Economic System Research dealing completely with PATDAT based applications (Kortum & Putnam, 1997). Unfortunately, the PATDAT initiative has fallen victim to budget cuts and has been discontinued in 1993.
[55] There is also a growing literature on intellectual capital and its management which is more general in nature. One of the most recent ones (Nermien, Al-Ali, 2003) includes a chapter that provides basics on IP and some aspects of its management.
[56] See (Bouju, 1991) on litigation costs.
[57] Reback has been named one of the "100 most Influential Lawyers in America" by the National Law Journal. His clients have included Sun Microsystems, Netscape, Oracle, Apple, Borland and Novell. He also spearheaded the assault to break up Microsoft's operating system monopoly.
[58] The number of US Internet patents jumped by 300% from 1997 to 1998 (2,193 patents issued in 1998) according to Rivette and Kline- (2000).
[59] The two authors are consultants, specialists in appraisal and valuation of intellectual property and intangible assets Their other books on IP (authored jointly or by each author independently) include : *Trademark Valuation ( ) ; Valuation of Intellectual Property and Intangible Assets ( ); Intellectual Property :Licensing and Joint Venture Profit Strategies( ), Investing in Intangible Assets and Profiting from Hidden Corporate Value,),* Intellectual Property Infringement Damages : A Litigation Support Handbook ( ), all published by John Wiley & Sons.

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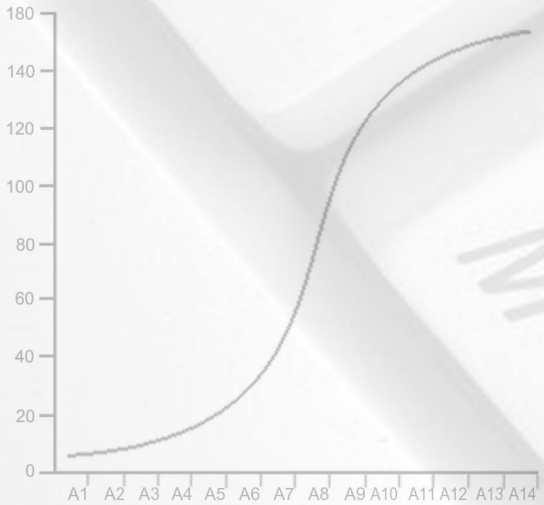

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