Chapter 21

SUMMARY AND REFLECTIONS UPON FURTHER DEVELOPMENTS[1]

Ove Granstrand
Chalmers University of Technology, Dept. of Industrial Management and Economics, Göteborg, Sweden

Chapter contents:

Abstract: This concluding chapter summarizes the preceding chapters, using a common structure, which throughout the chapters highlights their main focus, key/novel concepts, approach/empirical data, main findings/arguments, and suggestions for further research. The diversity of the chapters in these respects is rich, which is perhaps not so surprising, but there are also clear differences between the two groups of chapters representing economics and law. This observation gives reason to reflect over the past and future interaction between these two disciplines in the IP field. The need for pluralism in choice of research problems and methods, as well as the need for disciplinary perspectives complementary to economics and law, is pointed out. At the same time, the advent of the IP era has led to a rapidly growing research agenda, calling for some priorities. The chapter also reflects on some priorities for interdisciplinary research and teaching on the economics and law of intellectual property. The chapter ends with a speculative reflection about the future of the IP system and its interaction with the economic and legal systems.

[1] Helpful comments on this chapter have been received from Ulf Petrusson.

21.1 Summary of Previous Chapters

What can be learnt from the foregoing chapters, viewed as a collection or sample of cases of discourses on IP? To summarize into a whole that becomes more than its parts is not easy. IP, with all its facets and pervasiveness, is hardly coherent enough to be coherently dealt with in the first place, let alone in a comprehensive way. This fact is reflected in the present book's intellectual variety, which has also been fertilized by a deliberate diversity in disciplinary perspectives. The variety pertains to focus, concepts, methods, empirical data, theory, findings and suggestions for further research. Table 21-1 attempts to give a summarizing overview of the chapters. A few observations will be made below regarding each of the headings in Table 21-1.

21.1.1 Main focus

All chapters focus on IP in one way or another. They are all written by economists or lawyers, coming by and large from industrialized Western countries. They focus on international conditions, but more on the US than any other part of the world. The focus is mainly on contemporary IP issues, although accompanied by several historic accounts. Thus extensions of time and space perspectives would have been possible, as well as extension of disciplinary perspectives.

Several papers focus on IP within the broader context of knowledge and information and the type of economy based on these entities. Most of these papers are by economists (e.g. Arrow, Arora *et al*., Foray and Hall, among others) while this perspective is perhaps less represented among lawyers, with the notable exception of Radin. IP issues in connection with trade secrets, know-how and databases have scarcely been focused on at all in the law chapters. One may of course ask whether this difference is representative for economics and law of IP more generally, and whether trade secrets and databases need more attention in law.

In the general context of production and distribution of information and innovation, the relative effectiveness and efficiency (in a broad sense) of the IP system versus alternative economic and legal arrangements and policies (procurement, grants, prizes, taxes etc.) are focused on in several chapters. The clearest focus on a new alternative to the IP system, and the patent system in particular, is in William Kingston's chapter. However, it seems fair to say that more systematic comparative studies, empirical and theoretical, of

the pros and cons of the IP system and its alternatives are needed in general.[2] (See also the suggestion for further research offered by Bronwyn Hall.) This applies not only to economics but to law as well. The identification of comparable alternatives (be they substitutes or complements) to the IP system is then influenced by the disciplinary perspective. The economist's traditional set of alternatives is defined in terms of public vs. private provision of knowledge and information, then mostly in financial terms, while the lawyer would look for alternatives in other areas of law, such as contract and competition law.

Closely related to a focus on alternatives to the IP system is a focus on various alternative IP regimes, a somewhat loose but frequently used concept. This concept is often further qualified as open or closed, mainly in order to contrast the IP regimes in university vs. industry settings. Several authors do this and then mainly in US contexts (e.g. Hall, Nelson, Colyvas *et al.*). This focus also relates to the long-standing issue of how – if at all – to tailor the IP system as codified in law to the variety of needs in different industries. As the university sector transforms more and more into an economic institution (for better or worse), the sector could be considered an industry in itself at some point with specific needs for a tailor-made IP system. The US university industry is internationally leading, highly market (rather than government) oriented, competitive and entrepreneurial. It also has a precursory role when it comes to IP and what could perhaps be considered a legal experiment like the Bayh-Dole Act.

The pervasiveness of IP leads to a variety of IP issues, in turn leading to a variety of tailoring needs for the IP system(s), which comes as no surprise. The tailoring of IP systems to various types of countries is focused on in the chapters by Anawalt, Barton and Verspagen. Harmonization and one-size-fits-all approaches reduce legal uncertainty and transaction costs (at least some types of them), but these savings do not come without other costs incurred, something which is well recognized. All countries are not equal and some are more unequal than others. If the one size has been chosen to fit some more than others, there are also legal issues of justice, human rights and cultural values involved beyond economic issues, as illustrated by Howard Anawalt. A critique from initially fairly silent academic quarters on the issue has been rising against the fitting of TRIPs and the WTO "costume" to the US size while misfitting many other types of countries, the developing

[2] Needless to say, many good studies are available, although mostly theoretical or qualitative. Pioneering ones are Arrow (1962) and Wright (1983). More recent ones are David (1993) and Gallini and Scotchmer (2002).

world in particular. The level of development is the key dimension for tailoring here, as argued by Bart Verspagen. Tailoring of this kind could provide not only for locally appropriate technologies, but also for increased competition globally, thereby enhancing welfare locally as well as globally, as argued by John Barton. The IP system could very well be used in a protectionist way, as it historically always has been used in periods and places, but now for a kind of protection of leading positions rather than protection to help catching up. Country-comparative studies, and studies in comparative law and comparative economics, are of course interesting in this connection. The chapter by Wesley Cohen *et al*. is a good example of such a focus. From this and other studies it appears as if country differences are larger than industry differences (the university industry being one possible exception). This suggests that IPR tailoring should focus on country differences in the first place (assuming costs of error are not too asymmetric). A certain country-tailoring has evolved historically, of course, so international harmonization should perhaps not be pushed too far too fast. A certain industry-tailoring of IPR features has also evolved over the years, but has not gone as far as country-tailoring.

Several chapters focus more specifically on some IPR type. Patents dominate the focus on this level (e.g. in chapters by Domeij, Granstrand, Harhoff *et al*., Kingston, Koo and Wright, and Petrusson), but trademarks (Adams), databases (Hall) and copyrights (Hall and Towse) enter the picture as well. However, other IPRs (trade secrets, designs, utility models etc.) are not particularly focused on. Some chapters also focus on particular industries like pharmaceuticals (Domeij) and publishing (Towse), the latter being part of "copyright industries" and "cultural industries". The cultural sector with its idiosyncratic IP regime is also being transformed into an industry – just like the university sector – begging tailored IPRs, copyright being an old and perhaps increasingly obsolete example of an originally industry-tailored IPR.

At a higher level of resolution, particular features of patents and requirements for patentability are focused on, such as patent scope or breadth (Domeij, Verspagen), patent lifetime (Koo and Wright) and inventive step requirement (Granstrand, Petrusson). It is interesting to see how these features at micro-legal level could conceivably have a macro-economic impact.

Technological changes are finally focused on in a majority of papers, especially changes in infocom technologies but also in biohealth technologies, while less in more traditional ("mature", "old") technologies (like material and energy technologies). The challenges of these changes to laws and legal concepts are pointed out (e.g. by Peggy Radin). Views on their disruptive

impact differ, however. John Adams views them as less disruptive in the context of e-commerce, while Ruth Towse views them as a major source of disruption in the publishing industry.

Thus, there is a wide selection of IP issues, representing a large space with large possible variations. Naturally, comprehensiveness is far away; several missing foci have been indicated above, and there are others as well (e.g. IP issues in environmental technologies, educational technologies and military technologies, and IP issues in different legal systems, nations, sectors etc.). Many IP issues are old but with enlarged proportions (such as cumulation of IPRs and IP power) and some are fairly new (such as IP impact on sequential innovation).

As to features of coherence in the collection of papers, there are no conceptual or logical inconsistencies in them, nor are there any clearly conflicting views or controversies. This is probably only on the surface, in light of the long history of academic controversies surrounding IP issues and the controversial nature of IPRs, being imperfect private solutions to public problems, with a number of difficult-to-handle side-problems, rapidly magnified in the pro-IP era. The controversies have also been magnified by the interdisciplinary relations between economics and law, as well as by intradisciplinary relations around the IP field, a field traditionally being treated as some kind of minor stepchild. As new entrants from economics and law appear in the IP field, however, one could expect competition and controversies to grow. Not least, this is likely to be spurred by economists with competitive methodological tools, models and theories, probably providing "harder" armour and cutting edges of analysis than the traditional methods of legal analysis (see below), although basically dealing with the same soft and subjective matter of analysis. Hanns Ullrich's quest for IP theories with a unifying potential is indeed a justifiable goal, but there will be many contestants. Whether some economic or legal theories or some mixture will be best equipped is an open question. One may note in this connection that many, if not most, chapters are reformist in one way or another, with apparently no outright conservatists, advocates, revolutionaries or iconoclasts among the authors. In summary, there appears after all to be a great deal of convergence in the various foci on IP. Hopefully, unfruitful polarization can be postponed further.

Table 21-1: Overview of the chapters in the book

[1] "Economics and Law of Intellectual Property – an Introduction and Overview" *Ove Granstrand*	
Main focus	The role and development of intellectual property studies as an academic field of inquiry.
Key/novel concept	IP studies, science convergence
Approach/empirical data	Argumentative. Bibliometric analysis.
Main findings/arguments	Long-standing interaction between IP- related economic, legal and technological changes contrasts sharply with long-standing separation of economics and law in IP studies. Thus a need for more interdisciplinary IP research and teaching, especially since the emergence of the pro-IP era. Rapid growth of IP studies, dominated by US and by law with a "re-entry" of economists, with signs of science convergence.
Suggestions for further research	1. History of IP studies in economics and law 2. Review of recent IP studies 3. Further bibliometric analysis

[2] "E-Commerce: The Consumer, the Trade Mark and the Credit Card" *John N. Adams*	
Main focus	Consumer protection for Internet buyers and the role of trademarks and supplier/credit card company liability.
Key/novel concept	Distance contract, inertia selling.
Approach/empirical data	Argumentative. Law text analysis.
Main findings/arguments	Encountered problems in Internet-mediated e-commerce (e.g. with defective products, slow delivery and fraud) have market rather than government solutions, aided by the emergence of global trademarks and extended supplier/intermediary liability.
Suggestions for further research	1. History of IP studies in economics and law 2. Review of recent IP studies 3. Further bibliometric analysis

Table 21-1: Overview of the chapters in the book (cont.)

[3] "Patent Claim Scope: International Intellectual Property, Progress, and the Rule of Law" *Howard C. Anawalt*	
Main focus	Why and how to preserve national legal cultures in general in presence of unifying forces from technology, international business, multinational treaties and communication, and the specific role of IPR laws in this context. The historic evolution of IPR institutions and their recent rise to prominence and source of power in international relations, accompanied by international harmonization and support through WTO and TRIPs. Impact of TRIPs interventions on national legal structures.
Key/novel concept	Legal culture.
Approach/empirical data	Historic discourse. Interpretative and argumentative.
Main findings/arguments	Guidelines for future IP development should include: 1. Insist on non-interference of international IP agreements upon national cultures. 2. Disconnect international IP agreements from trade and taxation policies. 3. Limit IP laws to providing incentives for innovation and appropriate name protection. 4. Give nations freedom to curtail IPR claims advanced to achieve non-IP goals. 5. Limit scope, duration and excess agglomeration of IPRs.
Suggestions for further research	Study and analyze further: 1. Purposes and necessity of international IPRs and the functionality of different property institutions and capital formation mechanisms for innovation and diffusion. 2. Role of accompanying international IP access rights. 3. Functionality of links between IP requirements and membership in international communities.

Table 21-1: Overview of the chapters in the book (cont.)

[4] "Markets for Technology and Corporate Strategy" *Ashish Arora, Andrea Fosfuri, and Alfonso Gambardella*	
Main focus	The growing importance of licensing and technology trade in general and its implications for large and small firm strategies.
Key/novel concept	Technology markets missing markets.
Approach/empirical data	Data on transactions 1985-97 for all countries from Securities Data Corp., screened to include technology transfer, typically in form of licensing, excluding acquisitions of firms. Complementary data from web sites of leading corporations plus cases from previous research. Statistical analysis.
Main findings/arguments	Technology markets and trade have existed for a long time but have grown and become really important for companies in recent years. Buying and selling technology complements in-house R&D and product sales and thereby increases division of labor, e.g. between large and small firms, at the same time opening up more strategic options for them with more emphasis on technology monitoring and absorption. The role of technology as a source of competitive advantage may then be reduced, relative to distinctive resources without corresponding resource markets. Stronger IPRs may foster the development of technology markets, and their associated advantages from greater strategic options, specialization of R&D and wider diffusion of technologies.
Suggestions for further research	Collection of systematic data on markets for technology.

[5] "New International Arrangements in Intellectual Property and Competition Law" *John H. Barton*	
Main focus	Relations between IP and antitrust law and between static and dynamic competition in an international context. Exploration of three contexts in which IPRs sustain the market power of the developed world: (1) licensing, tying and leveraging; (2) research tools and broad patents; (3) oligopolistic licensing and market entry.
Key/novel concept	Oligopolistic licensing.
Approach/empirical data	Case studies. Argumentative.
Main findings/arguments	IPRs enable anticompetitive behavior and trade barriers in an international context. IP portfolio power offers doubtful research incentives in oligopolies. Need for WTO-type of code (not necessarily an international antitrust body).
Suggestions for further research	International comparative joint analysis of IP and competition law.

Table 21-1: Overview of the chapters in the book (cont.)

[6] "R&D Spillovers, Patents and the Incentives to Innovate in Japan and the United States" *Wesley M. Cohen, Akira Goto, Akiya Nagata, Richard R. Nelson, and John P. Walsh*	
Main focus	Patenting behavior in Japan and the US and the role of patents and patent information for appropriation and coordination of R&D and innovation.
Key/novel concept	Complex and discrete products/ industries. R&D coordination.
Approach/empirical data	International intra-industry comparative study of R&D labs in Japan and the US. Large-scale survey in 1994 of R&D labs in medium to large manufacturing firms (with sales at least 50 MUSD). 1478 US responses (response rate 54%) and 643 Japan responses (response rate 52%). 30 follow-up interviews in 2x9 Japanese and US firms. Statistical analysis.
Main findings/arguments	Relative to US firms, Japanese firms have more R&D and higher R&D share on product R&D, have greater intra-industry R&D information lags, rely more on patents for appropriation, and rely less on other means of appropriation (especially secrecy, which was the most important means in the US), and use patents more strategically. Publication, first to file priority and pre-grant opposition rules plus lower infringement costs in the Japanese patent system induce R&D information flows and spill-overs, as does technological interdependence through cross-licensing and less concentrated market structures. Cross-national differences are significant across industries and could be related to differences in patent systems, policies and cultures.
Suggestions for further research	Analyze empirically the welfare costs and benefits of patent information disclosure and its impact on R&D and technology diffusion in general, including its impact on R&D and patenting incentives.

Table 21-1: Overview of the chapters in the book (cont.)

[7] "Intellectual Property Rights and Academic Health Centers" *Jeannette Colyvas, Annetine Gelijns, and Nathan Rosenberg*	
Main focus	The role of academic health centers (AHCs in general) in university-generated new medical technologies (consisting of tools for research, diagnostics and therapeutics) and in particular in patenting and licensing. The role of patents on research tools.
Key/novel concept	Patents as research tools (cf. patents on research tools).
Approach/empirical data	Case studies (rDNA, FACS, cardiac catheter, MRI, PET), historical and statistical analysis. Data from top universities (Columbia, Stanford in particular).
Main findings/arguments	Role of AHCs is dominant and increasing as source of innovations, patents and licensing revenues. Research tools a critical output of AHC research. Analysis of patenting and licensing of research tools must consider their need and potential for further improvement, the needs of large and small firms, and the need for tradeoffs of various approaches. Patents on research tools could increase transaction costs as well as hampering the evolvement of research tools into diagnostic and therapeutic tools. Universities ought to consider a more nuanced approach in licensing, adapted to technology and industry characteristics.
Suggestions for further research	1. Further study of IP on research tools of various kinds, used by actors of various kinds. 2. Analyze cost/benefits of various approaches to university patenting and licensing, taking technology and industry characteristics into account.

[8] "Initial and Follow-On Pharmaceutical Inventions in the European Patent System" *Bengt Domeij*	
Main focus	The role of breadth and claim structure of pharmaceutical patents for the proper balancing and coordination of initial and follow-on inventors and their R&D. Comparison of economic explanation in patent claim interpretation and case law.
Key/novel concept	Follow-on inventions, broad claims, patent scope, R&D coordination.
Approach/empirical data	Qualitative legal case analysis, especially based on cases in German, Swedish, Danish and UK courts and EPO Board of Appeal, and EPO guidelines for examinations.
Main findings/arguments	Courts tend to limit patent scope on the basis of mostly implicit judgments of economic value of follow-on inventions, which could be seen as a process of inter-firm R&D coordination, comparable and complementary to intra-firm R&D management. More explicit consideration of the economic value of follow-on R&D and inventions rather than technical analysis, as is currently dominating, ought to guide courts in order to bring more valuable results of R&D to consumers.
Suggestions for further research	More legal/economic studies of initial and follow-on inventions and the role of dependent patents in research.

Table 21-1: Overview of the chapters in the book (cont.)

[9] "On the Creation of Fundamental Knowledge: Finding the Right Balance between the Public and Private Domains" *Dominique Foray*	
Main focus	The problematic nature of efficient production and distribution of knowledge as a special case of public goods and different public/private ways to deal with the different problems, ways such as IPRs, procurement, subsidies and consortia.
Key/novel concept	Anti-commons, property regime, coordination problem, collective production of public goods, innovation system.
Approach/empirical data	Argumentative, based on previous research and illustrative examples.
Main findings/arguments	The mechanisms designed to cope with the general problems with knowledge as public goods, tend to create three coordination problems: (1) excessive exploitation (tragedy of commons); (2) obstacles to exploitation (tragedy of anti-commons); (3) obstacles to cumulation (overly broad patent rights). For the latter problem, a private/public innovation system and/or a collective invention mechanism with a pool of managed common resources, as in a consortium, offer two types of potential remedies.
Suggestions for further research	

[10] "Are we on our way in the new economy with optimal inventive steps?" *Ove Granstrand*	
Main focus	Consequences of too low inventive step (non-obviousness) requirements in granting of patent rights and the notion of optimal inventive step
Key/novel concept	IP assembly problem, multi-technology products, technological distance, evergreening.
Approach/empirical data	Argumentative. Informal and formal economic analysis. Interviews.
Main findings/arguments	Low inventive step requirement together with multi-technology products and technological interdependencies lead to IP assembly problems with high transaction costs, possibly favoring incumbents. High inventive step requirement could lead to underprotection, indicating the existence of optimal requirement levels. Interviews indicate too low levels currently.
Suggestions for further research	1. Empirical research on IP assembly problems and their possible remedies. 2. Research on transaction costs related to inventive step and related patentability criteria. 3. Empirical research on standards and examination procedures for inventive step assessment. 4. Optimality conditions for different institutional arrangements for innovation and diffusion, taking total governance costs into account.

Table 21-1: Overview of the chapters in the book (cont.)

[11] "On Copyright and Patent Protection for Software and Databases: A Tale of Two Worlds" *Bronwyn H. Hall*	
Main focus	The basic incentive problems in a market economy for producing disembodied information such as software and databases and for producing information embodied in physical products. The tensions between appropriation and spill-overs (disclosure, diffusion) and between the incentive structures and the nature of information in the two worlds of university research and industrial R&D/commercial innovation when using private rights to information as remedies to the basic incentive problems. Policy issues when these two worlds (sectors) with their sector-specific IP regimes interact, especially regarding software, databases, university patenting and university research. Brief summaries of studies of university patenting in the US, and studies of database protection.
Key/novel concept	Spill-overs, pure information products, complementary investments.
Approach/empirical data	Mainly argumentative, based on secondary sources, mainly focusing on US. Economic policy analysis. Examples from US university-industry research centers and the Bayh-Dole Act, and from the software and database areas.
Main findings/arguments	Two important distinctions for incentivizing information production through IP protection are (a) the size of R&D investments vs. complementary investments necessary for marketing an information product, and (b) the extent to which embodiment of the information in a physical product or association of the information to the agent producing it could be used for appropriation of benefits from the information. Scientific research and industrial physical innovations differ in these respects, calling for different IP regimes, with need for complementary investments suggesting need for IP rights. Strengthening of IP protection in universities has not shown clear benefits, at least not yet.
Suggestions for further research	1) Study empirically the impacts of IP protection in various forms on incentives to produce software and databases in particular, with a survey of how database provision has worked in the past. 2) Model (theoretically) in a game-theoretic setting the knowledge production in science/university and technology/industry, accounting for spill-overs, transaction costs, and differences in production function and incentive structures, with and without strong IP protection. Welfare analysis of IP policies and multiple reward-systems.

Table 21-1: Overview of the chapters in the book (cont.)

[12] "Exploring the Tail of Patented Invention Value Distributions" *Dietmar Harhoff, Frederic M. Scherer, Katrin Vopel*	
Main focus	Nature of the value distribution of top-valued patents.
Key/novel concept	Value tail distributions, patent valuation.
Approach/empirical data	Asset value approach (in contrast to renewal value approach), obtaining value estimates from West German and US patent holders of German patents (with high renewal fees) held to full term, expired in 1995, using questionnaires (with one counterfactual question) and follow-up interviews. Data for 772 patents held by West Germans (58% response rate) and 225 patents with US patent holders (48% response rate). Econometric analysis.
Main findings/arguments	Top-value distribution extremely skewed. Although a log normal distribution provided best fit to the data, a Pareto-Levy distribution with neither finite mean nor variance could not be ruled out. The asset value approach used gives higher values and higher skewness than in previous studies. Top 5% of German-held patents accounted for 61% of patent sample value, while top 8.5% of US-held patents accounted for 80% of patent sample value. No particular value difference between product and process patents. Drug and surgical supply patents most valuable. Extreme skewness implies difficulties at firm level in stabilizing returns from patent portfolio strategies and in estimating patent portfolio value through simple patent counts and at policy level in "picking winners". A large share of failing or low-value projects is naturally concomitant to a few outstanding successes.
Suggestions for further research	1. Find patent weight correlates for patent portfolio valuation ex ante. 2. Identify underlying stochastic processes that generate observed value distributions. 3. Review of recent IP studies 4. Further bibliometric analysis

Table 21-1: Overview of the chapters in the book (cont.)

[13] "Unlocking the Potential of Intellectual Property" *William Kingston*	
Main focus	The misfits between the present international IP system and the evolving nature of creation, R&D and innovation and their effects on the world, on university research and on S&T progress in general.
Key/novel concept	Direct protection of innovation, innovation warrant, market power.
Approach/empirical data	Closely-argued policy analysis, drawing on previous works of the author and others, supported by short historical illustrations.
Main findings/arguments	Serious strains in the IP system have developed over long periods of time in face of the shift from individual invention to corporate R&D investments and the emergence of new technologies – software and biotech in particular – and increasing technological complexity. Favours *sui generis* arrangements, provides empirical support for arbitration proposal, and claims many advantages from improved measurement of grants.
Suggestions for further research	1. Develop accounting measures and procedures to enable the implementation of the proposed new form of protection. 2. Study the roots behind the limitations of the IP system in adjusting to new forms of information and information production.

[14] "Economics of Patenting an Input Essential to Further Research" *Bonwoo Koo and Brian D. Wright*	
Main focus	Welfare aspects of patenting and licensing in sequential innovation, especially regarding patent life as a policy instrument.
Key/novel concept	Sequential innovation, licensing
Approach/empirical data	Theoretical analysis of patenting in a two-stage sequential innovation model with an exogenously given first invention stage, followed by a second stage with perfectly competitive free entry. An invention (patent) from each stage as jointly necessary and sufficient for the innovation. Optimization of patent lifetime for maximal welfare.
Main findings/arguments	Limitations on patent lifetime may have benefits different from traditionally recognized ones (i.e. reduction of dead-weight losses), such as inducement of subsequent innovation and reduction of rent dissipation.
Suggestions for further research	Develop sequential innovation models further to explore the nature of the advantages derivable from patent lifetime limitations and various licensing schemes.

Table 21-1: Overview of the chapters in the book (cont.)

[15] "Is University Patenting Necessary or Sufficient to Make University Research Valuable Economically?" *Richard R. Nelson*	
Main focus	American research university system and the problematic nature of patenting and licensing. Causes and consequences of rise in recent decades of university patenting, licensing and start-up activities and the role of the Bayh-Dole act in this context. Pros and cons, myths and downsides of university patenting and licensing.
Key/novel concept	Ex post royalty collection.
Approach/empirical data	Essayic, based on ongoing research with primary and secondary data primarily from the top three universities regarding license revenues – Stanford University, University of California and Columbia University.
Main findings/arguments	Rise in university contributions to industrial innovations in the last decades even in absence of strong IPRs and technology transfer offices. Rise in university patenting and licensing mainly associated with rise of biohealth and infocom technologies and court and Patent Office decisions to enlarge patentability in these technologies. No evidence of shift away from fundamental research. Evidence that exclusive licensing not always necessary for embryonic inventions. University technology transfer offices important for dissemination in some embryonic cases while superfluous in other, and mostly acting as royalty collectors ex post of university inventions. University patenting and licensing give rise to intra-university tensions as well as to university-industry tensions (about unfair competition from universities), possibly giving rise to inefficiencies, especially in fundamental research, compared to an open, public science regime, e.g. regarding research tools.
Suggestions for further research	Explore further the role of university patenting in basic research and effective technology transfer.

Table 21-1: Overview of the chapters in the book (cont.)

[16] "Patents as Structural Capital – Towards Legal Constructionism" *Ulf Petrusson*	
Main focus	The evolutionary nature of legal systems and the IP system in particular in a Scandinavian legal realist perspective. The nature and role of the patent system in communication processes for legal, economic, technical, and managerial control purposes, particularly in the new type of knowledge-based economy.
Key/novel concept	Intellectual property vs. intellectual property right. Structural tool and structural brick. Governance position. Intellectual capital. Structural capital.
Approach/empirical data	Argumentative with a historical and philosophical discourse. Conceptual analysis.
Main findings/arguments	Considerable confusion surrounds basic IP concepts and institutions such as patents, which by and large are social constructions. A patent can be understood as a possibility to enforce an infringement claim; a process of communication; a property and a property right and a piece of structural capital. Confusion derives from lack of awareness of law as a structural phenomenon. Legal constructionism is decisively important for collective governance of structural transformation.
Suggestions for further research	To develop a legal constructionist approach to IP issues and to create a common research agenda with evolutionary approaches in economics.

Table 21-1: Overview of the chapters in the book (cont.)

[17] "Information Tangibility" *Margaret Jane Radin*	
Main focus	Tangibilization of information through new technologies and reconceptualizations.
Key/novel concept	Commodification / tangibilization /assimilation/propertization of information. Contract-as-product.
Approach/empirical data	Analysis of concepts, cases and examples in a legal-philosophical discourse, in a mainly US context of IPR and information control issues.
Main findings/arguments	Technology leads and law generally follows in conceptualizations, where old dichotomies and physical metaphors die hard. Assimilation of information to categories of physicality leads astray, e.g. when using real estate metaphors in cyberspace ('cyber-squatting', 'sites', 'domain', 'trespassing', etc.). Information commodification has increased through a number of expedients, especially generated by new technology for embodying information, reinforced by use of physical property analogies, giving better access to broad rights and rent control. Recent US case law indicate that information is not only increasingly commodified through linking it to physical embodiments and metaphors, but is being reconceptualized as being an inherently tangible or physical object from the outset, thereby alienating the concept of information from human personhood, linked e.g. to freedom of speech and privacy, and aligning it with property.
Suggestions for further research	1. To study the impact of growing links between information and its physical embodiments, and in particular how propertization of information enabled by such links will impact freedom of expression and free communication. 2. To contribute to the history of ideas a study of how physicalist reductionism has permeated the law and in particular how it has fostered information commodification.

Table 21-1: Overview of the chapters in the book (cont.)

[18] "Copyright and Cultural Policy for the Creative Industries" *Ruth Towse*	
Main focus	The supply and demand characteristics of artists' labor markets, the role of copyright as an incentive to artists and as a vehicle for asset formation for publishers, and the role of new digital technologies and business models on these markets.
Key/novel concept	Creative (including cultural) industries, rights management, superstar phenomenon.
Approach/empirical data	Cultural economics applied to artists' labor markets with an empirical approach to copyright law, drawing upon the author's previous work.
Main findings/arguments	Copyright, essentially retaining its basic economic and legal principles over centuries, despite a long series of technological changes, is unable to offer artists in general sufficient economic incentive to create, while enabling intermediaries (publishers, distributors) to cumulate market power. The transition from analogue to digital technologies has a significant potential to change market structure and therefore poses challenges to copyright policy, being part of cultural as well as economic policy.
Suggestions for further research	1. Further study of the relation between copyright law and digitalization from both legal and economic points of view. 2. Analyze the artists' labor markets and the role of copyright, e.g. upon income distribution and concentration.

Table 21-1: Overview of the chapters in the book (cont.)

[19] "Legal Protection of Innovative Technologies: Property or Policy?" *Hanns Ullrich*	
Main focus	The nature of the IP system and its interaction with competition law and economic policy, especially technology/innovation policy and trade policy.
Key/novel concept	Horizontal and vertical dilemmas. Property vs liability vs policy.
Approach/empirical data	Argumentative, based on legal case analysis and a wide range of sources.
Main findings/arguments	The IP system is a misguided tool of economic policy and needs to be fundamentally rethought as a legal system, since the IP system creates problems beyond its classical problem of trading off static and dynamic efficiency, e.g. loss of public control.
Suggestions for further research	Overall task is the proper balancing of IP protection as an instrument for achieving public policy objectives and as an instrument for achieving private company policy objectives. Specific suggestions: 1. Develop operational legal-economic principles for WTO, on which TRIPs could be based. 2. Develop substantive legal principles governing IP protection and its economic functions as well as legal functions. 3. Develop a theoretical paradigm for promoting technological and economic progress, which could unify various forms of IP protection.

Table 21-1: Overview of the chapters in the book (cont.)

[20] "Intellectual Property Rights in the World Economy" *Bart Verspagen*	
Main focus	Main economic rationales for an IP system, especially for a patent system and how economic analysis can guide the design of a patent system, e.g. regarding proper patent breadth. Main arguments in the debate on the role of IPRs in the world economy, especially regarding the TRIPs and the relation between developed and developing nations, and the possible need for IP systems tailored to countries at different stages of development, with different technological infrastructures, technology transfer needs and possibilities, and trade situations.
Key/novel concept	Technology transfer, international trade, spill-overs.
Approach/empirical data	Mainly argumentative, based on secondary sources and history accounts. Economic policy analysis.
Main findings/arguments	Formal models developed so far of the patent system do not offer very concrete guidance for patent system design. The provision of technology spill-overs, e.g. by patent disclosures and limiting patent breadth, is a specific feature of patents among IPRs, and such spill-overs are important for growth and dynamic economic performance. IPR policies for developing countries have to be integrated with more comprehensive technology and economic policies. International differentiation of IP systems may be conducive to global welfare as long as economic and technological asymmetries between countries remain large, while reducing them may make a uniform IPR system optimal.
Suggestions for further research	1) More empirical research on the impact on global welfare of differentiated (country-tailored) IP systems, e.g. with differences in patent breadth. 2) Focus on the extent to which international technology spill-overs are product/FDI-embodied or disembodied, and incorporate IPRs in models of such spill-overs, especially north-south spill-overs. 3) Focus on the relation between IP systems and the generation and transfer of "appropriate technologies", i.e. technologies appropriate for specific levels of development of a country.

For structuring purposes, the macro-micro distinction between levels of foci as commonly used in economic analysis can be applied to legal analysis as well, either in its own right or in combination with economic analysis as illustrated in Table 21-2. Of course this is a crude distinction and more levels than macro and micro could be distinguished. For example, a trichotomy with a meso level inserted between the macro and micro levels can be more useful in many cases. The macro-micro distinction can be applied to and combined with other areas as well such as technology and innovations, and also combined with the distinctions between short and long term (or between short/medium/long term).[1]

Most authors focus on some combinations of or interactions between micro and macro levels of analysis. Such a type of focus is important since the macro-micro distinction easily creates a watershed in analysis. If the interaction between legal and economic changes at both micro and macro levels is focused upon, it moreover appears important to focus on the diagonal relations, that is, between micro/macro-economics and micro/macro-law, in order to attain a more adequate understanding of causal links and the aggregation/disaggregation problem. In the same spirit it is important to focus also on relations between transient microbehavior and long-term aggregate behavior.

[1] See Granstrand (1994, Ch. 19), for examples of combined use of macro/micro "lenses" in studying economics of technology.

Table 21-2: Principal levels of foci in economics and law of IP with examples

		Law	
		Micro	Macro
Economics	Micro	• Extension of patentable subject matter (e.g. business method patents) • Bayh-Dole Act • Patent right adjustment for sequential invention	• Impact of litigation costs on IP legal developments in civil and common law systems • Specific companies lobbying for creation of *sui generis* rights (e.g. database rights) or stronger IP regimes • Shift from contract-as-consent to contract-as-product
	Macro	• Impact of patentability criteria on national industrial competitiveness • Impact of judicial changes on the development of technology markets • Macro-economic impact of key precedence cases or legislative acts	• TRIPs • Alternative incentive systems for innovation • Role of the IPR system in the new economy

21.1.2 Key/novel concepts

Needless to say, concept formation and new classifications are inherent in scientific progress. At the same time, it is a natural propensity in any science to utilize existing language. Some sciences are also for various reasons overly plagued by new concepts, or new terms rather, often vaguely defined. (Economists are said to use each other's toothbrush sooner than each other's concepts.) This contrasts with the strong propensity in law to preserve and stretch legal concepts, for both practical and more fundamental reasons. The chapter by Radin actually illustrates how this is done, not only to economize on the applicability of existing law in the public interest, but also to exploit existing law for private interests. As to concept formation in the collection of chapters there are fairly few novel (or recent) concepts, although a great deal of novel (or perhaps only magnified) phenomena are dealt with. Examples of novel or recent concepts are anti-commons problems, complex vs. discrete industries, innovation warrant, innovation system, intellectual capital, commodification, contract-as-product and cultural industry. As to key concepts,

a general observation is that there is hardly (at this level of analysis) a severe language divide between economics and law of IP.

21.1.3 Approach/empirical data

While all chapters focus on the same topic, i.e. IP, their methodological approaches differ widely. The major divide is between economics and law. Judging from type of approach and frequency of its use, the interdisciplinary differences appear large compared to intradisciplinary differences. Still, there is a considerable overlap between the set of approaches used by economists and the set used by lawyers, an overlap which could serve as a common methodological ground. This common ground consists of approaches such as policy analysis, historical analysis and case analysis, apart from more general conceptual analysis (language or text analysis) and philosophical discourses. One could also add to the common "tool pool" a kind of industrial organization analysis, although not as explicit among the chapters (occurring mainly in the chapters by Barton and Towse). The approaches common to economics and law are mainly qualitative, although both policy analysis, historical analysis and case analysis could adopt quantitative approaches (cf. "cliometrics" and jurimetrics).

The case study approach is an interesting approach for interdisciplinary research (see e.g. the chapter by Domeij) as well as for teaching. Its uses in economics and law differ substantially, however. It is mostly used in business economics, but is (slowly) gaining ground in economics at large – especially when allowing for both qualitative and quantitative analysis. The latter requires samples of, say, at least 8-10 cases, in turn allowing for some case-based theorizing.[2] From a methodological point of view, the sampling of cases is usually more controlled (but not necessarily more controllable) in economics than in law, e.g. when it comes to court cases. The research-oriented analysis in law tends to be more sequential case by case, more language-oriented, qualitative and contextual, less quantitative and variable-oriented, less experimental (e.g. less oriented toward action research) and more influenced by the tradition of legal case analysis for practical purposes. Besides, key legal variables are more often binary, i.e. dichotomised. It is beyond the scope of comments here to pursue this theme further, except to

[2] Systematic case-based theorizing may in turn ultimately provide stronger links between common law and civil law systems through improvements in the codification process. However, case analysis is no panacea, either for research or for research-based developments of law, but has to be used as part of more comprehensive methodological approaches, e.g. as in triangulation.

point out the possibilities of developing more similar case study methodologies in economics and law, as there appear to be few inherent basic differences.

As to the dominating differences between approaches used in economics and law, one could crudely characterize them by claiming that approaches used in the economist chapters involve a wider variety of scientific methods, including quantitative techniques in statistics and mathematics besides qualitative techniques, and a wider use of empirical data bases. This is probably a crucial issue for future research in law in general, not only in IP law, and for the status of and relations between research in economics and law in terms of "scientific power". Supply and demand of economic and legal data from old and new sources will grow, as will techniques for database production and distribution, data mining and statistical data analysis, not least when full texts will be available on line with a variety of software tools for content analysis etc. In this general scenario with relevance for many disciplines, fields such as econometrics, jurimetrics, technometrics, scientometrics, bibliometrics, sociometrics etc. will develop. Considering the state (and status) of econometrics vs. jurimetrics prompts the question of how research in law will develop in response to this type of technological changes. Needless to say, these "X-metrics" do not replace but complement qualitative analysis. They are also likely to become an increasingly important complement, actually in line with an increasingly knowledge- and information-based society.

One may also note that empirical studies with large data sets are more team-oriented (with associated economies of scale, scope and speed). Several chapters by economists in the book are also co-authored, while all chapters by lawyers are single-authored.

A final comment in this context concerns the possibilities to use experimental approaches, which are very limited but still available in social sciences (besides counterfactual thought experiments). Experimental economics is a coined term, but hardly experimental law. Terminology apart, the question is whether a more experimental approach in law research and lawmaking is feasible (perhaps as an experiment in itself), especially when facing more rapid and complex changes. Law is traditionally built to last (as is mathematics grounded in logic, although discovery of contradictions cannot be excluded), i.e. to be cumulative with as little substitution or creative destruction as possible.[3] However, in the spirit of legal constructionism (as ad-

[3] Appeals notwithstanding, several legal doctrines and principles work for preservation, stability and cumulativeness and against substitution and creative destruction. The use of irrebuttable presumptions serves to preserve a set of facts, once established, by not permitting later

vocated in the chapter by Petrusson), an experimental approach seems natural, perhaps even as a legal realist extension.[4] Regardless of jurisprudence, one may claim that a closer interaction between law and technology would likely lead to more substitution of laws (i.e. legal obsolescence), just as there is a considerable rate of technological substitution, still in parallel to technological cumulation. New laws adapted to new technologies may become obsolete due to even newer technologies, at least partially.

21.1.4 Main findings/arguments

Eclectic variety, rather than coherence or convergence, characterizes also the main findings and arguments in the collection of chapters. This is quite natural for a rapidly developing field of inquiry into a rapidly changing, although old, phenomenon. Thus new as well as old research questions are opened or reopened. Some of these get new or altered answers based on new findings, but a fair amount of inconclusiveness and open questions remains, pointing out directions for further research as a companion finding. A fundamental and recurrent theme dealt with by many if not most of the authors concerns the differences and relations between knowledge and information on the one hand and physical goods and embodiments on the other, and the implications of these differences for the co-functioning of markets and rights. Here, a number of arguments, so far mainly theoretical and perhaps mainly economic, cumulate in a promising way. This hopefully leads both to a basis for a certain unification or integration of IPR rationales (as pledged for by Hanns Ullrich) and to a basis for differentiation of IP regimes and other alternatives for provision of information and knowledge in an economy (as pledged for by Foray, Nelson and others). Such a theoretically based integration and differentiation should preferably be robust and operational enough to accommodate a range of new technologies. This in turn would probably call for more economically oriented principles, requiring more empirical economic and legal analysis, sacrificing some legal certainty. The latter in turn is perhaps also fairly illusory in general, and not least regarding IPRs as claimed by Petrusson. Legal certainty is, moreover, volatile and severely limited by the impact of new technologies on basic conceptualiza-

---

evidence to the contrary. The "law of the case" principle serves to preserve the decisions of a judge in the event that the judges are replaced at the same level. The legal doctrine of precedence (*stare decisis*) has the presumption that legal principles established in previous court decisions are followed in similar subsequent cases (see e.g. Adams and Brownsword 1999).

[4] The legal areas most receptive to experimental approaches would probably be those with strong economic underpinnings, such as competition law and IP law.

tions, as illustrated by Radin. The empirical economic analysis needed for proper application of economic and legal principles may be quite costly, on the other hand. Such costs may even exceed transaction cost increases from increased legal uncertainty. For example, if the requirement that an invention should have technical character in order to be patentable is replaced by a more economically oriented requirement that the invention should be patentable if it otherwise would be underprovided, the latter requirement would conceivably be more costly to apply. A more grandiose example, in the same line of thought, would be to use the US constitutional language directly as a basis in the US for the wording of a requirement that an exclusive time-limited patent right is granted to inventors for their discoveries if it promotes the progress of science and useful arts.[5]

The relation between IPRs and new technologies – infocom technologies (ICTs) in particular but also bio-health technologies – is also a recurrent connected theme, dealt with by most authors. New technologies are normally conceived of (in a Schumpeterian spirit) as presenting challenges to and disruptions of legal and economic structures (as illustrated by Towse), but new technologies may have complex mixed effects, sometimes stabilizing and facilitating rather than destabilizing and misfitting. This is what John Adams finds regarding problems arising from a new form of trade, enabled by ICTs (e-commerce), problems which also have legal and economic solutions enabled by ICTs.

[5] The Constitution of the United States of America states that "The Congress shall have Power… To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries;" (Article I, Section 8, the 8th clause in authentic wording, spelling and capitalization, unaffected by amendments (as of 2002).) This wording in the US Constitution from Sept. 17, 1787 can be interpreted as well as criticized in many ways, and has of course been a point of departure for formulating patentability requirements in the US. The point here is that as a legal framework develops in more detail, overall legal uncertainty is not necessarily monotonically reduced but may increase beyond some point, at which a movement *ad fontes* is called for. At the same time the use of empirical tests more or less on a case-by-case basis may be even more costly than an imperfect legal language test. It is notable that US constitutional language neither directly excludes scientific discoveries, nor requires any technical character. However, scientific discoveries may be excluded on the grounds that granting patents to them does not promote the progress of science and useful arts (e.g. due to excessive transaction costs associated with numerous transactions deriving from the generic nature of scientific discoveries and the existence of superior means for their provision). If this is judged to be valid in comparable cases, it may be cheaper to rule them out once and for all, depending upon the expected relative costs of the two types of possible errors, i.e. improper exclusion and improper inclusion.

The causes and in particular the consequences of the rapid emergence on a global scale of the pro-IP era are also a recurrent theme, quite naturally. This legal-economic change has magnified old phenomena like technology trade.[6] Thereby division of intellectual labor and its associated economic efficiency are increased, as argued by Arora *et al*. However, the advent of the pro-IP era also likely magnifies earlier less costly IPR misfits, especially since local judiciary changes rather than global legislative changes were behind its inception, changes subsequently reinforced by various self-interested actors. The many reformers among the authors, not least among the legal scholars, thereby acquire magnified reasons for reform. As mentioned, there are not really any conflicting findings about the nature of misfits but rather about their treatment.

An emerging but so far little researched theme is the relative effectiveness and efficiency of the governance mode or coordination mechanism in science and technology, induced by IPRs and their associated patent disclosures and court decisions. This theme in turn involves not only transaction cost analysis but management analysis as well. Although courts sometimes may picture themselves as a kind of "transaction cost engineers", they hardly refer to themselves as technology managers or "technology governors", which in fact they are to some extent as found by Bengt Domeij.

It remains to be seen whether the pro-IP era will revert, stagnate or continue, and what basic qualitative changes will occur if any. A quite conceivable scenario is that the pro-IP era will be accompanied by a pro IP-research era (to be distinguished from a pro-IP research era), which will contribute to qualitative change. This leads us into the next section.

21.1.5 Suggestions for further research

A major purpose of this book is to further research on IP, and the various chapters generate a multitude of more or less explicit suggestions for further research. It is inappropriate here to go on evaluating them and suggesting some kind of synthesized research program, not least since a rapidly developing field needs a variety of research strategies. The many misfits of IPRs and needs for IP reforms found in the chapters naturally call for further research on a number of frontiers. So does a more experimental and evidence-based approach to policy-making, as do legislative and judiciary processes facing increasingly complex interactions between economic, legal and technological changes.

[6] The pro-IP era could thus lead into a "pro-licensing" era as well (see Granstrand 2004).

Thus, the most obvious suggestion implicit in the book as a whole is that the rapid, many-faceted growth of pervasive IPR use should be accompanied by a corresponding growth of understanding of IP. This in turn needs a corresponding growth of IP studies with an intra- and interdisciplinary structure fitted to meet the need for understanding and action. As misfits grow larger and more costly, any uncoordinated growth of quasi-functional IP laws has to be disciplined by solid legal and economic principles.

Hence, interdisciplinary research seems needed. This is also a major suggestion for further research, explicitly made by several authors but implicit in the book as a whole.

Within the law discipline, unification of the various IPRs and integration of the relevant legal subsystems for IPRs, competition and contracts with a fair amount of international harmonization are old quests for research, growing strong in the pro-IP era. This is much in line with what Hanns Ullrich suggests. However, international harmonization of IPR laws and regimes is not naively advocated, either by legal scholars such as Anawalt, Barton and Ullrich, or by economists like Verspagen. Again, tailoring enters the research agenda, confronting standardization (harmonization, unification). Thus, complex and dynamic trade-offs have to be made in numerous dimensions. For some trade-offs legal principles are prime, for others economic principles are prime, and for still others no single discipline is clearly in charge. However, principles and flashes of insight do not come as manna from heaven but have to be patiently searched and researched. Experiments – natural and artificial – are necessary, as is realistic theory-building, especially in the face of complexity. Legal realism leads to legal constructivism, elaborated upon by Petrusson and probably accepted in principle if not in practice by many contemporary legal scholars. However, to push the development, constructivism leads further into relativism, experiments and theories. Will the ambition to build lasting law lead to experimental law, and perhaps even further to some kind of "mathematical law" (e.g. involving a search for legal "axioms", e.g. as in Rawls 1971)?[7]

Within the economic discipline, a number of suggestions for further research on IP are implicit in the more general quest for additional economic research on technology and innovation. Such research will spur a natural evolution from static to dynamic economics, including evolutionary economics and dynamic systems thinking. The inherently dynamic features of IPR

[7] Legal anthropologists have difficulties in empirically finding universally valid "natural" legal notions, something that should frustrate foundational searches, although without implying that universal foundations cannot exist naturally or artificially.

issues make them well suited for playing a prominent role in further dynamizing of economic models and theories, providing bridges to law and technology at the same time.

In the IP field, research on the economics of patenting over time (sequential patenting, sequential invention) is an example of evolution from static to dynamic analysis. This is a complex and demanding research area, still in its infancy, but its growth is simply necessary for understanding IP dynamics. Past and proposed research has mainly been theoretical as illustrated by Koo and Wright, proposing a class of staged models, as well as by Harhoff, Scherer and Vopel, proposing a continued search for stochastic processes generating increasingly skewed distributions over time. In this context it should be noted that economic valuation, which is a commonly suggested area for further IP research, involves dynamic analysis in an essential way.

Other, mainly intra-disciplinary, areas suggested for further research in IP economics concern a comparative analysis and more theory-based integration of the various alternative incentives and policy schemes for innovation and diffusion, as well as of various IP regimes. Within the latter category, more comparative and integrative research on the IP regimes in industry, academia and culture is clearly advocated. This calls for more economic welfare analysis of IP matters, which in turn could very well lead to new tools for economic analysis in the longer run. A particular type of analysis in this context is transaction cost analysis or, more broadly, governance cost analysis, well recognized but so far not much used in IP research, despite a long-standing quest (see e.g. Cheung 1986).

All in all, the IP field is in demand of much research but also supplies many promising opportunities to enrich received theories, models and methods. It is a fair bet that efforts to overcome the difficulties with information, knowledge, innovations and IP will eventually make economic and legal research in general more inventive, valuable and righteous.

21.2 Reflections upon Further Interdisciplinary Research

21.2.1 Economics and law

As seen from the collection of papers, there is a strong quest for more interdisciplinary research on IP. Thus, a few more arguments for further interdisciplinary research, and interdisciplinary interaction more generally, are justified, leaving aside a deeper discussion of nature of and rationales for interdisciplinarity in general. One can first observe that a long period of separation of two fundamentally related disciplines such as economics and

law, as described in Chapter 1, promises new types of fruits from cross-fertilization. Second, if there is a fast-growing phenomenon of common interest such as IP and innovation, related problems and concerns are likely to grow in many quarters beyond the realm and capabilities of a single discipline. Third, there are standard arguments for interdisciplinary work referring to benefits (outweighing the considerable problems and costs involved) deriving from natural input/output relations among disciplines, usually mutual benefits but asymmetric and changing over time. For example, mathematics provides tools in physics and physics feeds problems back that can give rise to new offspring in mathematics. Physics has in fact been characterized as the mother (or engine, with a mechanical metaphor instead) of natural sciences, at least until the 21st century. Now the popular prediction is that biology will take over that role, also with respect to mathematics. This is to say that, in some sense, physics (so far) has by and large been feeding (exporting) more into other natural sciences than being fed by (importing from) them.

It is beyond the scope here to discuss natural input/output relations between economics and law in general. They are of course many and close, as could be expected from two social sciences that have, so to speak, grown up together. The movement referred to as "Law and Economics", with origins in the 1950s at the University of Chicago, should of course be mentioned in this context as a most visible attempt at bi-disciplinary work in analyzing legal issues in a market economy. The movement also illustrates some of the input/output relations between economics and law, and will therefore be briefly elaborated upon here. In this joint venture, economics provided concepts and objectives (economic efficiency in particular) that, in a revived utilitarian rationalistic spirit, promised to somewhat reduce the inherent indeterminacy of policy-oriented legal judgements. This legal indeterminacy had been disturbingly pointed out by the pre-war movement of legal realists in their criticism of earlier attempts to formalize law based on uncertainty-reducing scientific principles, much inspired by successful attempts in natural sciences.

Economics moreover provided tools and models for analysis of joint economic-legal problems (e.g. in the form of decision trees to support judicial decision-making). The analysis then often became formalized, just as economics became increasingly formalized and "mathematized" in the post-war era. To some extent it could summarily be said that economics exported to law more than it imported from law.

In the seminal article of the law and economics movement (Coase 1960), Prof. Ronald Coase in fact showed that in certain situations (involving e.g. no transaction costs) economic efficiency could be achieved by market mechanisms unaffected by the way certain property rights were allocated, as long as these rights were precise and proper damages would accrue in case of violations. In other words, multiple legal optima (equilibria) could exist, yielding the same maximal economic efficiency. Thus, legal reasoning in searching for a single best legal solution in a situation like this would not only be wasteful but futile, since none exists. Consequently there exist situations where legal indeterminacy is impossible to eliminate even in the presence of full and precise information and perfect judges. A reallocation of property rights between a buyer and a seller would change their objective functions and their surpluses but not total welfare (unless some constraints become binding). Still another way to put the result is that legal indeterminacy may follow from economic determinacy regarding the objective of a certain law simply because there may be several equally good solutions.

Once the objective of law becomes indeterminate – as when considerations of equity or justice are introduced and weighed imprecisely against efficiency – legal as well as economic indeterminacy of solutions rapidly grows.

Thus, the law and economics movement could help reduce legal indeterminacy (uncertainty) but only up to a point, depending upon the extent of economic determinacy (certainty) and the well-functioning of markets. The movement has grown and diversified, but has also aroused criticism on many fronts – of its pro-market ideology, of its focus (at least initially) on efficiency rather than equity and other values, of its conservative bias, of its overassimilation of stereotype economic assumptions and models, of its pretentiousness etc. In fact any interdisciplinary movement runs the risk of coming under cross-fire from interdisciplinary criticism (e.g. of economists by lawyers and vice versa) joining forces with intradisciplinary criticism (e.g. of neo-classical economics by evolutionary economists, or of legal formalism by legal realists). The point made here is that when a bi-disciplinary offspring such as the law and economics movement develops, it inherits and acquires certain features that typically do not represent the entire spectrum of desirable features of interaction between the two disciplines in question. As the movement attracts criticism as any scholarly movement will and should, there is always a risk that further bi-disciplinary cooperation inside as well as outside the particular movement will be hampered. This is not to say that

the law and economics movement currently is right or wrong, but perhaps that it is too limited[8].

There are several principal ways to foster further research cooperation between economics and law on a broader front. One is to bring into common focus another discipline such as technology (engineering sciences) or management. Another is to bring into common focus a sub-discipline not much focused on by previous interdisciplinary research, such as intellectual property.[9]

21.2.2 Law, science and technology

The relation between law, (natural) science and technology (S&T) is interesting and deserves much serious attention. Law and S&T have of course frequently been focused upon in the book in relation to IP, and in relation to economics. However, law and S&T become more closely connected in other areas as well (such as environment, health, product liability, safety, privacy etc.), with different areas of law (criminal law, competition law, contract law, tort law etc.) becoming cross-connected to different areas of S&T (ICTs, BHTs, weapons technologies, transportation technologies, etc.). As to research (and teaching) in universities, centers or programs in law, science and technology are also emerging, perhaps more in law schools than at technical universities.

A number of justifications could be formulated for increased bi-disciplinary interaction between law and S&T. Four general ones will briefly be given here. First, science and technology penetrates virtually all aspects of society, including legal ones, at the same time as laws and regulations stimulate as well as constrain S&T progress. Many of these interactions are immersed in economic concerns, but far from all, and reductionist approaches rooted in economics are insufficient (e.g. in some areas of bioscience, medical technology and criminal law, or regarding ICTs and constitutional rights). Second, S&T and law change at different paces and with different logic. As misfits and time lags between them tend to become more severe, closer alignment becomes necessary, calling for closer communication and interaction and more upstream integration of technological R&D with "legal R&D" (i.e. research and development for new laws and legal

[8] A law and economics tradition in a more generic bi-disciplinary sense has existed for centuries in Europe.

[9] The law and economics movement has traditionally not focused particularly on IP. See, however, Besen and Raskind (1991) for an example. For a general work by a leading scholar in the movement, see Posner (1992).

processes and systems). This involves analysis of legal and technological conceptualizations, and timely reconceptualizations and redefinitions (including analysis of deceptive rhetorics used by interested parties). Various methods for technology analysis could also be useful, e.g. technological forecasting and technology assessment methods. As legal developments and legal research are organized differently in different legal systems, the interaction between legal R&D and technological R&D must be structured and financed accordingly.[10]

As to the logic of S&T and law changes, standardization and compatibility are important for both types of changes. However, backward compatibility in law is far more important. This is so for good reasons, but in certain areas it may have to be sacrificed to some extent for closer alignment of legal changes to S&T changes. Forward compatibility may also be used more frequently (e.g. through legal "platform solutions" or general clauses in new S&T areas).

Third, a closer interaction between law and S&T could be instrumental in internationalising law. S&T flies no flag but law does, as laws of nature apply across jurisdictions. New technologies will continue to push for international legal harmonization (compatibility) just as e.g. transportation technologies and communication technologies have in the past (with the Internet as a palpable recent example, largely unanticipated in the international legal community, despite being developed for years before breakthrough). As argued in the book, international harmonization could be carried out in wrong ways. More pro-active than reactive interaction at earlier stages of technological and legal developments across jurisdictions will lower such risks in view of increasing globalization prompting for some form of harmonization.

Fourth, current and future ICTs in particular have important applications in the legal system on the whole. One may argue that this creates a normal user/producer relation not in need of bi-disciplinary research. However, there are studies showing the importance of integrating user and producer R&D in certain cases.[11]

Finally, one can make the reflection that knowledge diversification into other disciplines rather proceeds step by step, and the route to more compre-

[10] Proper forms for the organization and financing of "legal R&D" in this context are important to analyze. For instance, solutions based on markets with slow feedback structures have limitations, which moreover may increase as litigation costs increase.

[11] See e.g. works by von Hippel, e.g. von Hippel (1988), on the importance of lead users as sources of innovation. (Legal researchers and practitioners being lead users in this case.)

hensive interdisciplinary research had better start with a bi-disciplinary stage.

21.2.3 Mathematics and law

Considering the key role of mathematics in S&T, and also the mathematization of parts of social science, what about the use of mathematics in law? Mathematics has a tendency to slowly creep into almost every discipline as it develops, despite resistance, backlashes, rejections etc. Sometimes parts of the discipline become hijacked by math and carried away beyond what are recognized as disciplinary borders. Bi-disciplinary labels such as mathematical physics, mathematical biology, economics, sociology etc. emerge. What, then, about the prospects for "mathematical law"? The term seems not to have surfaced yet. Certainly many if not most legal scholars would shiver or shrug at the idea (if they ever bother to take it seriously). No plea is made here for use of more mathematics in law, nor in economics, but for raising questions above and below. The rejection and absence of mathematically oriented models and representations (including graphs, diagrams etc.) in teaching and research in law are palpable. Content (information) representation in the form of text, and qualitative text and language analysis, have a monopolistic position, but for how long? Will some form of creative destruction set in on the further scientification of law, analogously to what has happened in economics (for better or worse)?[12]

21.2.4 Economics, law and technology

As far as IP and innovation are concerned, bi-disciplinary interaction is not sufficient. The contemporary IP systems are essentially utilitarian-based, and innovation is a utilitarian concept with technological innovations as a most important category. Thus, at least economics, law and technology have to be among the key disciplines in interdisciplinary research on IP and innovation.

Tri-disciplinary interaction in research involves far more dynamics (e.g. in catalyzing cross-fertilization or in checking reductionist tendencies) and

[12] The history of legal thought is clearly not devoid of attempts at scientification, leading to some form of legal formalism, depending upon the employed notion of science. Despite significant subsequent criticism of such attempts, they are likely to continue. It is interesting to note that law as an explicitly recognized academic subject (explicitly present in university curricula) is older than economics – which as an academic subject has roots in law – while economics has perhaps in modern times become precursory in certain academic respects. (See e.g. Strömholm 1985.)

uncertainties than bi-disciplinary (just like a three-body problem in physics). Adding a third discipline triples the number of binary relations, in which challenges and opportunities might accrue. As to economics, law and technology (engineering), the relations between economics and law and between law and technology have been dealt with above (and in the entire book for that matter), and the relation between economics and technology has been dealt with elsewhere in the literature (see e.g. Granstrand 1994). As is widely recognized in this literature, technology and innovation have for long penetrated our economies far more than economics, although economics of technology and innovation is now a rapidly growing field. The need for a closer interaction between economics, law and technology at different levels (legislation, practice, research, teaching etc.) has been emphasized at various places in the book, starting in Chapter 1, so there is no need to open up a new discussion here, but to reemphasize the need for this troika of disciplines in particular in pulling IP studies ahead.

A brief outlook on some additional disciplines is in place, however.

21.2.5 Behavioral science and management

Research relations between psychology and sociology on one hand, and economics and law on the other hand, have grown in general since fairly long ago, and their merits and justifications in general apply to studies of innovation and IP as well. Just to give a few specific illustrations, psychology may give valuable inputs to IP studies regarding the incentive structures and motivations of IP creators, i.e. inventors, researchers, authors, artists and creative individuals in general. Such knowledge is necessary in order to judge the relative effectiveness and efficiency of various IPRs and of different institutional arrangements for stimulating innovation more generally (IPRs, prizes, grants etc.) in the design of different incentive regimes.

Sociology and anthropology may give valuable inputs regarding IP notions in various communities and cultures; how innovators and imitators are treated; how reputation and fame matter; how codified IPRs interact with internalised norms etc. Criminology may throw light on piracy, counterfeiting and IP crimes in general and on the impact of IP criminalization and prospects of correction. Communication studies are needed of the impact of IP-based information trade on communication behavior. Many other examples could be given, of course.

As to management, there is definitely a need for further studies of IP management, as this has traditionally been a minor area indeed in industry and in management studies. With the advent of the pro-patent era and the

pro-IP era more generally, IP valuation and IP strategies have come into focus, just to mention two examples. Studies of valuation and strategies are needed not only for integration of IP with other areas of management, but also for judging the impact of the IP system on company behavior and vice versa. A more general issue in relation to management is how to design proper governance structures for innovation and diffusion. For example, quasi-integrated organizational forms intermediate to management hierarchies and market organizations might be most conducive to innovation in many circumstances. This issue also involves network studies and organizational theory, incorporating rights allocation.

21.2.6 Arts and humanities

Arts and humanities are increasingly important to consider in IP studies. This must be said not just for the sake of completing an odyssey among disciplines, but because technology and IP issues increasingly penetrate these areas at the same time as these areas can provide many valuable inputs to IP studies, regardless of their main disciplinary orientation. A few examples may illustrate this. First, history studies provide an excellent way to integrate interdisciplinary studies. Second, foundational studies of IP notions and related notions (such as moral rights) are needed, calling upon philosophy. Third, ethical issues are also coming more to the front, especially in relation to IPRs and BHTs, calling upon humanities, involving not only philosophy and ethics but also e.g. religious studies. Fourth, a holistic and imaginative perspective, wherever needed, can also be provided by arts and humanities, being perhaps one of their defining characteristics. Finally, on a more mundane level, cultural innovations constitute a wide range of innovations important to all of us. Do we want more new sculptures, plays, poems, books, architecture, paintings, operas, songs, concerts, movies etc. and more new art forms in general and, if so, how to make best provision of them? Their provision is in transition being increasingly industrialized and "technofied", thus calling for research involving arts and humanities on one hand and economics, law and technology, behavioral sciences and management on the other. Thus, arts and humanities themselves seem to be in need of holistic studies.

21.3 Reflections upon Teaching Intellectual Property

The rapid growth of interest in and concern about intellectual property issues in many quarters naturally generates a need for learning about IP, and a

concomitantly expressed demand for teaching of IP. Even the unlikely event of a major reversal of the pro-IP era in the short run would probably lead at most to a slowing of the growth of IP teaching and learning. The undercurrent towards a more innovation-oriented but still capitalist society pervaded by IP issues is simply too strong. (Compare also the changes and trends described in Chapter 1.) An illustration is the ambitious goal in Europe to approach an investment level of 3% of GDP for R&D and innovation by 2010. This will probably lead to educational efforts in technology and IP management regardless of whether the goal is achieved or not.

At the same time, growth in IP teaching and learning starts from a low point. Before the pro-IP era, IP teaching at higher educational levels (college and university levels) was at most a minor element in the teaching of law, business administration and engineering – and in fact an absent element in many places, just as it was and always has been at lower educational levels.[13]

At higher educational levels, the virtues of integrating teaching and research in the spirit of a "Humboldt university" are widely recognized.[14] The virtues of integrating various disciplines in higher education are less clear, however, at least in formal education. Considering the possible virtues of sequential specialist-generalist learning, and the sequential complementarities (dynamic economies of scope) between formal education and continued education with more opportunities to integrate different areas of expertise in on-the-job training, one could also argue in favor of differentiating formal and continued education with more specialist disciplinary formal education. On the other hand, this is a matter of making trade-offs, and strong sociopolitical tendencies in the university system towards intradisciplinary teaching create risks of too little interdisciplinarity. Looking at an "input/output matrix" of higher education, showing the inputs of various disciplines into the curriculum for higher professional education in economics, engineering and law, one sees fairly small off-diagonal shares. That is, typical education in economics (including business economics) has a minor share at most of

[13] A related concern may be the "under-teaching" of economics and law in general as distinct subjects in compulsory schooling. Some basic rules of economics and law of course enter very early in the education of children through various types of teaching, e.g. respect for physical property rights and quid pro quo principles, but not very much through formal teaching (and basically nothing about IP).

[14] The virtues could be expressed in terms of economies of scale, scope and speed accruing from integrating research and advanced teaching, sharing and cross-fertilizing similar knowledge and learning resources, as well as speeding up dissemination and application of new knowledge and ideas. Needless to say, diseconomies can accrue as well (e.g. in the form of distorted teaching and disturbed research).

law and nothing in technology; typical engineering education has at most a minor share of economics and almost nothing in law; and typical education in law has very little if anything in economics and technology.

It may now be argued – just as for research – that close interaction between rapid economic, legal and technological changes calls for a corresponding interdisciplinarity in teaching, starting already in formal education, in turn connected with research due to the pace of change.[15] Such arguments are not idiosyncratic of our times, however. This is in fact an old idea, succinctly expressed by Charles Babbage in his book "The Decline of Science" from 1830. Babbage, in his efforts to reform British science, also engaged in the related endeavor to reform university education, which he saw as necessary to link to science in general. One of his proposals was (Babbage 1830, pp. 5-6):

> "If it should be thought preferable, the sciences might be grouped, and the following subjects be taken together:
>
> | | |
> |---|---|
> | Modern History. | Political Economy. |
> | Laws of England. | Application of Science to Arts and Manufacture. |
> | Civil Law. | |
> | Chemistry. | Zoology, including Physiology and Comparative Anatomy. |
> | Mineralogy. | |
> | Geology. | Botany, including Vegetable Physiology and Anatomy." |

The essence of his proposal to combine law, economics and engineering with natural sciences, biology not least, and with humanities – represented by history – is surprisingly relevant for our times (just as his proposed computer is). Since the times of Charles Babbage, the Western university system has integrated research and teaching considerably and is currently integrating forwards into industrial activities to an increasing extent. At the same time, the system has developed considerable disciplinary specialization and separation, leading to e.g. separate institutions for professional education and separate professional disciplinary subcultures or epistemic communities.[16]

---

[15] To some extent such teaching is already in place, e.g. in form of "hybrid" engineering degrees, mixing engineering subjects with economics and management or (to a lesser extent) law, as a less demanding and more integrated alternative to dual degrees.

[16] See Snow (1930) for a classic treatise on the separation of S&T from humanities and social science. Features of disciplinary subcultures such as styles of thought and language have been

To accomplish interdisciplinary teaching is not easy. Here, one may reflect not only upon how to facilitate interdisciplinary teaching of IP, melting together e.g. management, economics, law and technology, but also upon how IP can be used as a focusing device to facilitate interdisciplinary teaching more generally. At least for the disciplines mentioned, various pervasive IP issues could be used as an interdisciplinary thread in teaching, as these disciplines develop broader interfaces with each other under labels such as technology management, law and technology, law and economics, economics of technology and innovation etc. IP issues have characteristics such as being not only pervasive but also being concrete as well as theory-based, being short-term as well as long-term oriented, demanding attention to detail as well as to "the big picture", being linked to various disciplines in an operational way etc., plus presently being interesting, engaging and novel to most students. For example, education and training in entrepreneurship could focus on IP issues and intellectual capital formation as a pervasive theme. Similarly, IP issues could provide an integrative teaching platform for more broad in-house competence development in an existing firm.

21.4 Technology and IP – A Final Reflection

On a concluding note it might be appropriate to put IP into a broader context, to remind ourselves of the risk of being overly IP-centric, and to offer some scenarios to prepare for change. One way to interpret at least the Western history of ideas is that mankind displays a ceaseless propensity to form ideas and seek greater insight for survival and well-being. Both religious and scientific ideas can be seen as expressions of this propensity, although these two sets of ideas have been mostly adversary with scientific ones steadily gaining ground over the centuries. Material incentives have obviously played an important role, but only up to a point, variable with periods and cultures. More narrowly but still in sweeping terms, economic incentives provided by codified IPRs have been neither necessary nor sufficient for progress, be it scientific, technological, economic, cultural etc. At the same time technological progress is and has been most decisive for economic progress and vice versa. The effects of the IP system are more localized, perhaps affecting the rate more than the direction of progress. Questions in this context are and

---

described in various writings, but an interdisciplinary comparative analysis is still largely missing. For illuminating writings of this sort, see e.g. Vandevelde (1996) and Adams and Brownsword (1999) on lawyers, Vincenti (1990) on engineers and McCloskey (1998) and Klein (1999) on economists.

will remain open, however, since the variation of "natural experiments" with different types of IP systems in different nations and periods throughout history is too small to permit any firmer conclusions on empirical grounds.

Thus, the long-standing debate about the extent and nature of impact of the IP system will continue. One could also argue that the extent or variability of the impact – good or bad – will grow as the importance of intellectual capital grows in the economy. To the extent that any convergence of IP systems in the world takes place, the variation of natural experiments decreases and the role of counterfactual analysis increases in the debate, which probably will add even more fuel to it.

In any case, the economic foundations of the IP system are not valid forever everywhere. Underinvestment in innovation and diffusion does not always take place, and there is always a risk of overinvestment if racing games rather than waiting games from time to time become dominant among investors, or if private returns to innovation exceed social returns. Private and social rates of return on innovation and the gap between them could also be expected to become more volatile in the new type of economy for various reasons, thereby creating more risks and needs for risk allocation schemes and, perhaps, liability rules rather than property rules. A devaluation of progress in parts of society could also occur if technological innovations are perceived to create more problems than they solve in the form of negative side and secondary effects. The nature of technological changes with inseparable, uncertain and skewly distributed good/bad, short/long-term consequences also makes technology as difficult as important to harness and steer by economic and legal institutions of various kinds. There already exist several more or less effective means besides IPRs to provide for innovation and diffusion (prizes, procurement etc.), and more means of provision may be invented, e.g. for financing open science or financing legal R&D.[17]

Similarly the legal foundations of the IP system are not built to last forever. Utilitarian foundations could perhaps be replaced by other areas of law (competition law, contract law etc.). At the same time, moral rights movements could be revived or appear in new forms, although they would hardly by themselves substitute for utilitarian justifications at societal level, especially not in a competitive corporativist world. One should not forget the

[17] It is even conceivable that a novel, useful and non-obvious incentive scheme for financing innovations could be patented as an institutional innovation – say a new contracting scheme invented by a team of university researchers, and licensed out as an alternative to the patent system. (The economic valuation of such a "meta-innovation" would probably call for some additional inventive approaches in turn.)

seemingly endless history of IP notions among humans in a broader sense than codified in law as rights. Thus one could claim that there are deeper cultural foundations for at least certain types of IPRs in line with the claim that there exist certain natural or moral rights in IP. To the extent that this holds, at least some foundations of the IP system could be seen as solid, if not *terra firma*. Even if parts of the economic and legal foundations of the IP system could conceivably be removed or replaced, it therefore seems that some fundamental IP notions could not. IP nihilism appears just as infeasible as IP-centrism.

However, the current issue is not whether the IP system could be abandoned altogether or not, but rather how far it should be allowed to expand. There are strong economic, legal and political forces supporting a strong IP regime. Criticism is growing but has perhaps not yet gained real momentum. There is a heterogeneous set of new entrants into the IP field, some being less than enthusiastic about many of its developments. A (re)entry of economists will certainly challenge many IP laws and practices from economic points of view, and so will many academics as well as practitioners who will find various IPR practices excessive and counterproductive. To the extent that the IP system is seen to limit rather than to foster dynamic competition, it will attract more serious criticism than the traditional one regarding static competition. The concentration of technology and IP power to large firms and to developed countries (the US in particular) will most likely sooner or later fuel criticism not only against the IP system but against capitalism in general. The "old-fashioned" tensions between capital owners and labor will take on a new and probably more potent dimension – a tension between owners (and controllers and managers) of intellectual capital and intellectual labor. Intellectual labor will also experience internal tensions with competition between high/low wage groups in the world as well as between young and old knowledge workers, perhaps to the point where intergenerational roll-over of knowledge becomes impeded by privatization. Besides, all sides will be penetrated by legal disputes over IP, so "frontiers" will be blurred. Nevertheless, "IP wars" could simply take on a new meaning of fighting for and against the IP system rather than fighting over specific IPRs among a mix of pro-IP reformers, IP revolutionaries, IP skeptics, etc.

A form of IP war is already taking place in cyberspace (see e.g. Lessig 2001). Another one is escalating in "biospace". While the former has gained widespread recognition and affected large parts of the public, not least the young generation, the latter will more likely be really crucial for the IP system as a whole.

There are several reasons – that can only be sketched here – in support of this scenario. First, collectivist utilitarian-based IPRs have a strong tendency to conflict with more basic individual rights notions, despite the fact that some IP notions have strong cultural and even biological foundations (e.g. identity marks and secrets). At a general level this type of conflict arises partly because IPRs constitute a capitalist institution, thus becoming a target for standard critique of capitalism (directed against e.g. inequalities, power concentration and exploitation of public resources). Conflicts also arise because IPRs influence the interface (or "social contract"), between the individual and society, capitalist or not (due to e.g. moral rights notions).

Second, at a technology-specific level, different technologies affect basic individual rights notions differently. Privacy and freedom of speech are affected primarily by ICTs, while e.g. rights to reproduction, bodily parts and genetic material are affected more by BHTs. Now, basic individual rights notions affected by BHTs are arguably stronger than those affected by ICTs. When people risk dying because they cannot afford a patented drug and are denied the use of a cheaper but illegal copy, the concept of deadweight loss becomes tragically more serious than if people cannot buy a book. To the extent that BHTs are lagging behind ICTs in their developments and impact, clashes in cyberspace could be seen as precursory to much stronger clashes around IPRs in biospace, reinforced by concern and critique over capitalism from other sources. When BHTs become more powerful not only in curing diseases and malfunctions but in performance-enhancing of species, including humans, will a kind of "bio-divide" arise among people in the world? What about distributional bio-ethics? Bio-piracy? Bio-crime? Etc.? Many BHT developments are as yet unrecognized and, more importantly, inconceivable. This is probably true for some basic individuals rights notions and BHT-related ethical issues as well. Bio-informatics is a particularly interesting area since it might become the nexus or focal point of rights and liability conflicts related to both BHTs and ICTs. What should rights to bodily parts include (parts in scarce supply, stem cells, an embryo, a foetus, right to death etc?) and should they extend to transferable rights to information about them? How should the production, distribution and use of such information be incentivized and controlled?

In this scenario of biospace conflicts, chances are that anti-IP movements, which certainly will brew in some quarters, will grow to proportions sufficient to transform and even reverse the pro-IP era. There are even chances that such movements allied with other forces (e.g. religious ones or forces against some kind of military-legal complex) could transform the

capitalist development on a larger scale. A strength of a capitalist system is its feedback structure, enabling a fair amount of self-construction (Rosenberg 1992). The pro-IP era brought about as capitalism developed could grow out of proportions, jeopardizing itself as well as many features of its embedding system. However, the old but revived IP system with all its virtues and limitations and its embedding system could also be transformed in a more evolutionary way, perhaps even beyond recognition.

In other words, a *nova species* as the next generation changes.

21.5 Literature References

Adams, J.N. and Brownsword, R. (1999), *Understanding Law* (2nd ed.). London: Sweet & Maxwell.

Arrow, K.J. (1962), 'Economic Welfare and the Allocation of Resources for Invention'. In NBER (1962), pp. 609-25.

Babbage, C. (1830), *Reflections on the Decline of Science in England, and Some of its Causes*. London: B. Fellowes.

Besen, S.M. and L.J. Raskind (1991), 'An introduction to the law and economics of intellectual property', *Journal of Economic Perspectives*, 5 (1), 3-27.

Cheung, S.N.S. (1986), 'Property Rights and Invention'. In Palmer (1986), pp. 5-18.

Coase, R. (1960), 'The Problem of Social Cost', *The Journal of Law and Economics*, 3, 1-44.

David, P.A. (1993), 'Intellectual Property Institutions and the Panda's Thumb: Patents, Copyrights, and Trade Secrets in Economic Theory and History'. In Wallerstein *et al*. (eds.), 1993, Ch. 2, pp. 19–61.

Gallini, N. and Scotchmer, S. (2002), 'Intellectual Property: When is it the Best Incentive System?'. In Jaffe *et al*. (2002), Ch. 2, pp. 51-77.

Granstrand, O., ed. (1994), *Economics of Technology*. Amsterdam: Elsevier Science Publ.

Granstrand, O. (2004), 'The Economics and Management of Technology Trade – Towards a pro-licensing era?', *International Journal of Technology Management* (forthcoming).

Jaffe, A.B., Lerner, J. and Stern, S., eds. (2002), *Innovation Policy and the Economy 2.* Cambridge, Mass.: MIT Press.

Klein, D.B., ed. (1999), *What do Economists Contribute?* London: Macmillan Press.

Lessig, L. (2001), *The Future of Ideas*. Random House.

McCloskey, D.N. (1998), *The Rhetoric of Economics* (2nd ed.). University of Wisconsin Press.

NBER (1962), *The Rate and Direction of Inventive Activity*. National Bureau of Economic Research, Princeton, N.J.: Princeton University Press.

Palmer, J., ed. (1986), 'The Economics of Patents and Copyrights', *Research in Law and Economics*, Vol. 8. Greenwich, CT: JAI Press Inc.

Posner, R. (1992), *Economic Analysis of Law* (4th ed.). Boston: Little, Brown.

Rawls, J. (1971), *A Theory of Justice* (rev.ed. 1999). Oxford: Oxford University Press.

Rosenberg, N. (1992), 'Economic experiments', *Industrial and Corporate Change*, 1, 181-203.

Snow, C.P. (1930), *The Two Cultures* (2nd ed. 1964). London: Cambridge University Press.

Strömholm, S. (1985), *A Short History of Legal Thinking in the West*. Stockholm: Norstedts.

Vandevelde, K.J. (1996), *Thinking like a Lawyer, an Introduction to Legal Reasoning*. Boulder, CO: Westview Press.

Vincenti, W. G. (1990), *What Engineers Know and How They Know It*. The Johns Hopkins University Press.

von Hippel, E. (1988), *The Sources of Innovation.* New York, NY: Oxford University Press.

Wallerstein, M.B., Mogee, M.E. and Schoen, R.A. eds. (1993*)*, *Global Dimensions of Intellectual Property Rights in Science and Technology*. Washington, D.C.: National Academy Press.

Wright, B.D. (1983), 'The economics of invention incentives: patents, prizes, and research contracts', *American Economic Review*, 73 (4), 691-707.