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This Article is the first part of a wide study of the role of intellectual property in the software industry. Unlike previous papers that focus primarily on software patents—which generally are held by firms that are not software firms—this Article provides a thorough and contextually grounded description of the role that patents play in the software industry itself.

The bulk of the Article considers the pros and cons of patents in the software industry. The Article starts by emphasizing the difficulties that prerevenue startups face in obtaining any value from patents. Litigation to enforce patents is impractical for those firms. Efforts to

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obtain patents divert the firm's focus from the central task of designing and deploying a product, and the benefits of excluding competitors are limited for firms that cannot themselves exploit the relevant technology. Once the firm is larger, a number of potential benefits appear. First, despite concerns that patents are not effective to appropriate profits from innovation in the software industry, a substantial number of software startups do have patents of sufficient strength to exclude competitors. That important finding, taken with the fact that the principal targets of those patents are much larger firms, suggests patents are more beneficial to small firms than to large firms. The Article then considers indirect effects related to the use of patents in cross-licensing transactions and in providing information about the firm. The first benefit may be substantial to firms that obtain patents, but the Article rejects patent use in cross-licensing as a net benefit to the industry: absent some other benefit, all firms would be better off saving the costs of obtaining patents. The information benefits, in contrast, seem to be net improvements to the innovation system. The central question, which I do not attempt to answer here, is whether those benefits are sufficiently substantial to justify the costs of obtaining the patents.

The Article then turns to the prominent claims that the enforcement of software patents has hindered innovation in the software industry through creation of a patent "thicket." The Article rejects those claims for two broad reasons. First, notwithstanding the empirical analysis of R&D spending in papers by Bessen, Maskin, and Hunt, direct evidence of high R&D spending in the software industry undermines claims that software patents cause firms to reduce R&D spending. Second, the actual structure and practices of the industry belie any claim of a patent thicket. Relying on interviews that I conducted and publicly available information, I show that the development of young firms in the software industry is not significantly constrained by large patent portfolios in the hands of incumbent firms.

The Article also contextualizes the role of patents by examining the relatively weak protections that copyright and trade secret afford. At bottom, neither of those systems can provide a useful mechanism that allows small firms to appropriate the values of their inventions. If such protection is a significant positive benefit of the patent system, it is equally true that neither copyrights nor trade secrets contribute (or can contribute) significantly in that respect, however useful they might be in other roles (such as preventing piracy).

The Article closes by considering critically the possibility of middle ground responses that would limit patent rights in the industry but not abolish them entirely. First, I criticize a possible registration system that might provide information benefits without the costs of excluding competitors. I argue that such an approach is impractical both because it would be difficult to disentangle the information benefits from the right to control technology and because of my sense that software firms would have an inadequate incentive to participate in such a system. Second, I consider the possibility of special limits on the rights of "trolls," small nonoperating firms formed solely to litigate patents. Trolls serve a useful function as specialized intermediaries and thus in fact may have a positive role in promoting innovation in the industry. Third, I consider the possibility that slight alterations in the patent rules for enablement and disclosure might mitigate the risks trolls pose to the licensing equilibrium that currently minimizes the costs of patenting in the software industry.

I. Introduction

The U.S. software industry is characterized by astonishing levels of growth, innovative activity, and competition.[1] Some argue that innovation in software and related industries has driven much of the innovation in other industries in recent decades.[2] Federal government statistics suggest that it is one of the few information technology sectors that consistently shows a large trade surplus,[3] and as the pressures of globalization dilute the comparative advantage of American employees in many sectors, it is worth noting the remarkable level of employment growth in the software industry over the last decade, from 854,000 jobs in 1992 to more than 2.1 million jobs in 2000 (a 12% annual growth rate).[4]

Academics, however, generally see a different picture. They see an industry burdened by an intellectual property (IP) system which grants so

1. David C. Mowery, *The Computer Software Industry*, *in* SOURCES OF INDUSTRIAL LEADERSHIP: STUDIES OF SEVEN INDUSTRIES 133 (David C. Mowery & Richard R. Nelson eds., 1999).

2. *See id.* at 164 (arguing that computer software's "influence within the innovation processes of other capital-goods and consumer durable industries appears to be growing steadily").

3. *See* U.S. DEP'T OF COMMERCE, ECON. AND STATISTICS ADMIN., DIGITAL ECONOMY 2002, at 53, *at* https://www.esa.doc.gov/reports/DE2002r1.pdf (Feb. 2002) (noting trade surpluses in the software industry of more than $2.5 billion a year during the late 1990s).

4. *Id.* at 43. During that period, employee wages grew at an average annual rate of 7.8%, for an average wage in 2000 of $80,900, the highest in any of the information-technology-producing industries. *Id.*

many software patents[5] that small companies cannot effectively innovate.[6] That perspective interests me for several reasons. First, unless it is merely a broader attack on the entire IP system,[7] it assumes that innovation in software is so different from innovation in other areas that traditional IP protections are inappropriate. It also is at odds with my general skepticism about the deterministic effect of legal institutions. My intuition is to doubt that legal rules granting patent protection have a sufficiently substantial effect to alter the course of innovation in *either* direction.

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5. As I explain below, it is difficult to get precise numbers. *See infra* text accompanying note 9. It is clear, however, that the Patent and Trademark Office (PTO) is granting far more than 10,000 software patents each year. Allison and Lemley document 18,000 software patents during a two-year period from 1996 to 1998. John R. Allison & Mark A. Lemley, *Who's Patenting What? An Empirical Exploration of Patent Prosecution*, 53 VAND. L. REV. 2099, 2115 (2000). Their number is extrapolated from a sample of all patents issued during that period, using a methodology that treats a patent as a software patent only if it is "completely embodied" in software. *Id.* at 2110, 2115. Greg Aharonian's somewhat broader measure (which appears to encompass any patent that includes an element of software) estimates 13,000, 17,500, and 21,000 in 1997, 1998, and 1999, respectively. *See* Posting of Greg Aharonian to patents@aful.org, *at* http://www.aful.org/wws/arc/patents/2000-02/msg00014.html (Feb. 15, 2000).

6. *See* FED. TRADE COMM'N, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY 52–53 (2003) [hereinafter FTC REPORT] (reporting testimony at FTC hearings on the role of patents in the software industry); LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD 205–15 (2001) (criticizing the patent system in light of recent developments that have greatly expanded patent law doctrine); Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting*, *in* INNOVATION POLICY AND THE ECONOMY 119, 121 (Adam B. Jaffe et al. eds., 2001) (stating that the U.S. patent system "is in danger of imposing an unnecessary drag on innovation by enabling multiple rights owners to 'tax' new products, processes, and even business methods"); James Bessen & Eric Maskin, Sequential Innovation, Patents, and Imitation 2 (Jan. 2000) (unpublished manuscript, on file with the Texas Law Review) [hereinafter Bessen & Maskin, Sequential Innovation] (proposing that strong intellectual property protection in the software and computer industries actually inhibits innovation); James Bessen, *Patent Thickets: Strategic Patenting of Complex Technologies*, *at* http://www.researchoninnovation.org/thicket.pdf (Mar. 2003) [hereinafter Bessen, *Patent Thickets*] (arguing that patent thickets reduce research and development incentives generally, while aggressive cross-licensing allows incumbent firms to "obtain a greater share of profits").

7. Adam Jaffe and Josh Lerner emphatically present a broader criticism in their recent book, ADAM B. JAFFE & JOSH LERNER, INNOVATION AND ITS DISCONTENTS (2004). Generally, they argue that the creation of the Federal Circuit has tilted the scales so far in favor of easier patentability as to create a cloud of uncertainty that stifles innovation generally. John Barton similarly argues that the growth of IP lawyers at a faster pace than R&D spending indicates a serious problem in the design of our patent system. John H. Barton, *Reforming the Patent System*, 287 SCI. 1933, 1933 (2000); *see also* Don E. Kash & William Kingston, *Patents in a World of Complex Technologies*, 28 SCI. & PUB. POL'Y 11, 11 (2001) (arguing that patents do not work in complex industries because they are used as bargaining chips). Doubts about whether the patent system as a whole causes an increase in innovation are not new. *See* Arnold Plant, *The Economic Theory Concerning Patents for Inventions*, 1 ECONOMICA 30, 33–37 (1934) (addressing the impact of the patent system on invention by first examining the array of additional factors that may influence the amount of invention that takes place); *see also* Edwin Mansfield, *Patents and Innovation: An Empirical Study*, 32 MGMT. SCI. 173, 173–75 (1986) (presenting data on inventions that would have been made without patent protection).

The existing literature on the subject[8] focuses on the nature and effects of software patents. Most writers proceed by identifying patents that fall within the PTO or IPC classes that correspond most closely to software innovation; they then examine data about the performance and behavior of the firms that hold those patents. That approach—although useful in examining the nature of software patents and the work of the PTO—has two major disadvantages for the broader agenda of evaluating the effects of software patents. First, the quality of the research depends entirely on the propriety of the definition of a "software" patent. Because software is a recently devised technology, it does not fall naturally within any particular class or classes. Thus, any definition that relies on patent classes is to some degree arbitrary.[9] Moreover, large manufacturing firms (Ford, GM, and the like) outside the software industry hold the overwhelming majority of the patents that such papers analyze.[10] Thus, it is unclear whether the empirical results reflect the effects of the software patents or whether similar results would be obtained for firms that receive substantial revenues from the sale of software products or services.

This Article rejects that approach, opting instead to analyze innovation in the software industry itself.[11] My approach identifies firms that develop software and then studies the effects of IP on the behavior of those firms. Thus, I focus on firms like IBM, Microsoft, and their smaller competitors that often are ignored in the existing research. My project also examines the smaller firms in the industry, rather than looking exclusively at large, publicly traded companies.[12] Given the importance of small companies to

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8. Although Lessig publicizes the issue, he does not present any new data. His contribution is to provide a perspective on the implications of the existing literature. LESSIG, *supra* note 6, at 211–15. The most important empirical contributions to the debate are Stewart J. H. Graham & David C. Mowery, *Intellectual Property Protection in the U.S. Software Industry*, *in* PATENTS IN THE KNOWLEDGE-BASED ECONOMY 219 (Wesley M. Cohen & Stephen A. Merrill eds., 2003), and a series of unpublished papers by James Bessen and his co-authors: Bessen & Maskin, Sequential Innovation, *supra* note 6; James Bessen & Robert Hunt, An Empirical Look at Software Patents (Mar. 2004) (unpublished manuscript, on file with the Texas Law Review) [hereinafter Bessen & Hunt, An Empirical Look]. The description in the text refers to those papers collectively.

9. *See* Allison & Lemley, *supra* note 5, at 2115 & n.51; Bessen & Hunt, An Empirical Look, *supra* note 8, at 8–9.

10. *See, e.g.*, Bessen & Hunt, An Empirical Look, *supra* note 8, at 16 (noting that "[t]he manufacturing sector acquires 75 percent of software patents").

11. In this respect, my work is parallel to the work of Hall and Ziedonis on the semiconductor industry. Bronwyn H. Hall & Rosemarie Ham Ziedonis, *The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979–1995*, 32 RAND J. ECON. 101 (2001).

12. Graham and Mowery also analyze patents in the software industry. Graham & Mowery, *supra* note 8. That paper makes many contributions, but it necessarily focuses on publicly traded firms for which quantitative data is readily available. Another useful analysis of the role of innovation in the industry is Robert P. Merges, *A Comparative Look at Intellectual Property Rights and the Software Industry*, *in* THE INTERNATIONAL COMPUTER SOFTWARE INDUSTRY 272 (David C. Mowery ed., 1996), which compares innovation in the United States and Japan. Because that

software innovation—a major theme of this Article—that extension is a substantial analytical advance.

My methodology is empirical and analytical. I rely on a set of about 60 interviews[13] with a variety of professionals[14] knowledgeable about the software industry: software developers, venture capitalists, angel investors, banks that lend to software startups, large software and hardware firms, and knowledgeable attorneys. Those interviews are designed to provide qualitative information about the motivations and practices that form the institutional environment within which software firms operate.

Analytically, I connect the interviews to well-developed literature relevant to questions the project raises. Initially, I account for a substantial body of doctrinal scholarship examining the question of how to accommodate existing IP law to the nature of innovation in the software industry.[15] Because my goal is to understand the relation between IP and innovation, I also engage the rich and varied economic analysis of innovation. That literature includes formal and informal analyses of how best to allocate the profits from ideas among the various actors in a sequential scheme of innovation,[16] historical analyses about the effects patents have had over time,[17] and empirical analyses (relying primarily on questionnaires)

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paper was written before the rise in patenting that has sparked the present debate, it necessarily does not address the industry as it has developed during recent years.

13. A methodological appendix summarizes the protocols that governed the interviews.

14. I spoke to twenty executives at startup firms, thirteen investors, thirteen executives at large firms, six executives at banks, and six lawyers.

15. Mark Lemley has argued that several characteristics of the industry justify giving software patents a narrow scope. Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1582–90 (2003); Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CAL. L. REV. 1 (2001). More broadly, the early work of Samuelson, Davis, Kapor, and Reichman advocates a *sui generis* scheme designed specifically for the industry. *E.g.*, Pamela Samuelson et al., *A Manifesto Concerning the Legal Protection of Computer Programs*, 94 COLUM. L. REV. 2308 (1994); Pamela Samuelson, Benson *Revisited: The Case Against Patent Protection for Algorithms and Other Computer Program-Related Inventions*, 39 EMORY L.J. 1025 (1990). At this time, such a scheme probably would conflict with our obligations under TRIPS, the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights. *See* Burk & Lemley, *supra*, at 1634–35.

16. The work of Suzanne Scotchmer is impressive. *See* Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and the Patent Law*, 5 J. ECON. PERSP. 29 (1991); Jerry R. Green & Suzanne Scotchmer, *On the Division of Profit in Sequential Innovation*, 26 RAND J. ECON. 20 (1995); Pamela Samuelson & Suzanne Scotchmer, *The Law and Economics of Reverse Engineering*, 111 YALE L.J. 1575 (2002). For a useful survey of the literature, see Roberto Mazzoleni & Richard R. Nelson, *Economic Theories About the Benefits and Costs of Patents*, 32 J. ECON. ISSUES 1031 (1998).

17. *See, e.g.*, Robert P. Merges & Richard R. Nelson, *On Limiting or Encouraging Rivalry in Technical Progress: The Effect of Patent Scope Decisions*, 25 J. ECON. BEHAV. & ORG. 1 (1994) [hereinafter Merges & Nelson, *Encouraging Rivalry*]; Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839 (1990) [hereinafter Merges & Nelson, *Patent Scope*]; PETRA MOSER, HOW DO PATENT LAWS INFLUENCE INNOVATION? EVIDENCE FROM NINETEENTH-CENTURY WORLD FAIRS (Nat'l Bureau of Econ. Research, Working Paper No. w9909, 2003), *available at* http://www.nber.org/papers/w9909. Merges has also written

regarding the value of patents in reaping the profits of innovation in various industries.[18] Finally, because I am interested in the ability of patents to facilitate financing of software firms, I examine empirical studies of entrepreneurial innovation, which consider the nature and effects of venture capital investing.[19]

Any effort to examine the relation between patents and innovation must proceed with modest goals. It is not plausible to think that researchers can obtain the evidence necessary to determine whether patents cause innovation in an industry to proceed at an optimal rate in optimal directions.[20] Thus, my work here is consciously imprecise. My goal is to provide a richer understanding of the possible effects that patents have in the software industry. Using this methodology, I can only exclude explanations that are inconsistent with events "on the ground." I cannot hope to provide a comprehensive or definitive account of the effects of patents on innovation.

With that in mind, I set the stage in Part II with an overview of the software industry's structure and the debate about patenting in that industry. I follow with three substantive Parts that discuss in turn the potential benefits of patents in the industry, the potential costs of patents in the industry, and the role of copyright, trade secret, and other alternative schemes that a firm might use to protect its software-related innovations. Although the analysis is often contextual, it does have an overriding theme: The effects of patents are much more likely to benefit small firms and contribute to industry fragmentation than to benefit large firms and contribute to industry

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about the likelihood that businesses will develop private institutions for disseminating technology. Robert P. Merges, *A New Dynamism in the Public Domain*, 183 U. CHI. L. REV. 183 (2004) [hereinafter Merges, *New Dynamism*]; Robert P. Merges, *Institutions for Intellectual Property Transactions: The Case of Patent Pools*, *in* EXPANDING BOUNDARIES OF INTELLECTUAL PROPERTY: INNOVATION POLICY FOR THE KNOWLEDGE SOCIETY 123 (Rochelle Cooper Dreyfus et al. eds., 2001) [hereinafter Merges, *Institutions*]; Robert P. Merges, *Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations*, 84 CAL. L. REV. 1293 (1996) [hereinafter Merges, *Contracting into Liability Rules*].

18. Richard C. Levin et al., *Appropriating the Returns from Industrial Research and Development*, 1987 BROOKINGS PAPERS ON ECON. ACTIVITY 783; WESLEY M. COHEN ET AL., PROTECTING THEIR INTELLECTUAL ASSETS: APPROPRIABILITY CONDITIONS AND WHY U.S. MANUFACTURING FIRMS PATENT (OR NOT) (NBER Working Paper Series, Working Paper 7552, 2000), *available at* http://papers.nber.org/papers/w7552; *see also* Mansfield, *supra* note 7, at 176–79.

19. *See, e.g.*, PAUL A. GOMPERS & JOSH LERNER, THE MONEY OF INVENTION: HOW VENTURE CAPITAL CREATES NEW WEALTH (2001) [hereinafter GOMPERS & LERNER, THE MONEY OF INVENTION]; PAUL A. GOMPERS & JOSH LERNER, THE VENTURE CAPITAL CYCLE (2000) [hereinafter GOMPERS & LERNER, THE VENTURE CAPITAL CYCLE].

20. Most modern studies assume that increases in innovation are uniformly good and thus do not consider the possibility that the patent system might cause excessive innovation. *E.g.*, Merges & Nelson, *Patent Scope*, *supra* note 17, at 878 (recognizing the problem, but explicitly assuming that more innovation is better). The classic counterexample is Yoram Barzel, *Optimal Timing of Innovations*, 50 REV. ECON. & STAT. 348 (1968) (offering a formal analysis of the possibility that patents will cause innovation that is greater or earlier than optimal).

concentration.[21] Among other things, I find the common thesis that large firms use a patent "thicket" to fence out potential competitors most implausible. I close with a brief and skeptical discussion of several possible responses to the imperfections of the existing system.

II. The Software Industry

It is important to begin with an understanding of the industry's structure. The industry is young. It generally is regarded as originating in the mid-1960s.[22] The concept of the software product—a product designed by firm *A* and sold to firm *B* for use on firm *B*'s computer—first originated because of the increasing complexity of software[23] and a shortage of the labor needed for each hardware firm to make its own software.[24] The most crucial event was IBM's decision in late 1968 to "unbundle" its software from its hardware.[25] Sales of software products grew rapidly throughout the 1970s. By the 1980s, the United States had a large and well-developed corporate software products industry with more than 1,800 firms.[26]

The industry was not, however, fated to retain the unitary status it had when it first evolved out of the IBM-dominated days of the 1960s. On the contrary, the last quarter-century has seen a succession of events that have repeatedly broadened the industry's traditional focus on software for use by business enterprises. The number of developments makes any list of key events arbitrary, but for my purposes the first salient landmark in the fragmentation of the industry was the introduction of the personal computer in the mid-1970s. That development rapidly led to a largely separate set of companies producing software for personal computers.[27] The popularization of the graphical user interface in the early 1990s brought with it an increasingly large role for Microsoft, but to this day dozens of competitors

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21. This analysis contradicts the increasingly widely accepted notion that patents systematically favor incumbent firms over entrants. *E.g.*, GIDEON PARCHOMOVSKY & R. POLK WAGNER, PATENT PORTFOLIOS 64–65 (Univ. of Pa. Law Sch. Pub. Law & Legal Theory Research Paper Series, No. 56, 2004) (arguing that "the size-effects of [a significant patent] portfolio . . . offer a powerful leveraging tool" that can enhance the holder's bargaining position vis-à-vis competitors, suppliers, and distributors), *available at* http://papers.ssrn.com/abstract=582201.

22. *See* MARTIN CAMPBELL-KELLY, FROM AIRLINE RESERVATIONS TO SONIC THE HEDGEHOG: A HISTORY OF THE SOFTWARE INDUSTRY 89–119 (2003).

23. Observers at the time—including IBM management—were profoundly shocked when it took 5,000 man-years for IBM to develop its OS/360 program. *Id.* at 95.

24. The shortage was driven in part by the rapid deployment of general purpose computers: the number in the U.S. grew from 4,400 in 1960 to 48,500 in 1970. CAMPBELL-KELLY, *supra* note 22, at 90; VERNON W. RUTTAN, TECHNOLOGY, GROWTH AND DEVELOPMENT: AN INDUCED INNOVATION PERSPECTIVE 338 (2001).

25. *See* MICHAEL A. CUSUMANO, THE BUSINESS OF SOFTWARE 93–95 (2004). Although IBM has more complicated explanations for the decision to unbundle, external observers attribute the decision to pressures from antitrust litigation. *See* CAMPBELL-KELLY, *supra* note 22, at 109–10.

26. *See* CAMPBELL-KELLY, *supra* note 22, at 165–73.

27. *See id.* at 201–28; RUTTAN, *supra* note 24, at 338–39; Graham & Mowery, *supra* note 8, at 3–4.

continue to provide significant products for personal computers.[28] Another sector of the industry that arose by the late 1990s is the massive sector producing games and other entertainment software.[29] With the maturation of the software industry, the last decade saw the emergence of yet another large sector that specializes in software specifically designed to facilitate software development and design.

The relations among these sectors are complicated by the fact that the line between software products and services is a shifting one, with substantially different business models for firms that specialize in the sale of products and the sale of services.[30] Complicating that point, many firms operate in multiple sectors, developing complex strategies to sell hardware or one type of software product at below-market prices to foster profitable businesses in other sectors. So, for example, Microsoft markets the Xbox at a price below its cost, hoping in the future to profit from sales of games.[31] Adobe markets software to consumers for free, hoping to profit from sales of enterprise software.[32] Finally, the rise of the Internet brought first a tremendous influx of capital into the industry and then a subsequent crash and weeding out when companies were not able to produce results that justified the elevated equity valuations of 2000 and 2001. Indeed, that weeding out continues even now, as consolidation continues to be a prominent trend in the industry.[33]

As I write, many believe that a major fissure is developing between proprietary and open source models of software development.[34] The traditional model of development has been a proprietary one in which a firm develops a product and then profits through sales of that product. Recently, some firms have rejected that model, at least in part, to engage in open source development.[35] Open source development generally proceeds on the premise that software products developed under that model are not subject to the proprietary control of any individual or firm.[36] I discuss the relation

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28. *See* CAMPBELL-KELLY, *supra* note 22, at 231–66.

29. *See id.* at 269–301.

30. I draw here on the work of Michael Cusumano. Generally, Cusumano argues that products firms are characterized by higher operating margins, higher growth rates, and less stable market shares, while services firms have lower operating margins and lower growth rates, but more readily can establish stable market positions. *See generally* CUSUMANO, *supra* note 25.

31. *See* Matt Richtel, *Who's Blocking the Xbox? Sony and Its Games*, N.Y. TIMES, Feb. 16, 2003, at 3-4 ("Even while losing on selling consoles, Microsoft still could make a lot of money from game makers").

32. *See* Laurie J. Flynn, *Adobe Tries to Create Image of a Moneymaker*, N.Y. TIMES, July 6, 2003, at C1 (discussing Adobe's business strategy).

33. *See* CUSUMANO, *supra* note 25, at 47.

34. For a brief overview, see Jonathan Zittrain, *Normative Principles for Evaluating Free and Proprietary Software*, 71 U. CHI. L. REV. 265, 265–66 (2004).

35. *Id.*

36. *Id.*

between open source development and patent protection in subpart IV(B), but two points are important to the present discussion. First, the demarcation between the two models is not as complete as open source proponents might suggest. As suggested above, proprietary firms often can take advantage of open source development of one product to foster a profitable market position in a related product.[37] Second, to the extent there is in fact an important demarcation between proprietary and open source development, this project is focused on firms that expect to receive revenues from the sale of software products or services.

A remarkable feature of the industry as it has matured is its lack of concentration—a facet that has considerable implications for the competitive structure of the industry and its openness to innovation.[38] Although press reports (and much of the academic writing) are preoccupied with concerns about the dominance of Microsoft, the industry is populated with an unusually large number of significant commercial players. Census Bureau statistics report more than 40,000 firms in the industry as of 2000.[39] Nearly 500 firms in the industry had $1 million or more in sales in 2003, even after contractions in the industry at the turn of the millennium.[40] In 2002, 156 firms received their first round of venture capital financing, receiving a combined total of $691 million—an average of more than $4 million for each firm—during a markedly down year.[41] Moreover, despite the existence of some prominent firms, the number of large firms is very small; there are only three software firms in the current Fortune 500.[42] Indeed, the top ten firms in

37. A common tactic is to rely on open source development and consequent standardization of auxiliary products in which a firm is unlikely to obtain a comparative advantage, coupled with profitable marketing of an ancillary product or service over which the firm can maintain such an advantage. *See* MARTIN FINK, THE BUSINESS AND ECONOMICS OF LINUX AND OPEN SOURCE 175–89 (2002) (discussing how proprietary firms can profit from association with open source products); *see also* DOROTHY LEONARD-BARTON, WELLSPRINGS OF KNOWLEDGE: BUILDING AND SUSTAINING THE SOURCES OF INNOVATION 18–27 (1995) (discussing core capabilities and their importance to strategic decision making); RONALD J. MANN & JANE K. WINN, ELECTRONIC COMMERCE (2d ed. forthcoming 2005) (discussing hybrid open source licenses that permit proprietary exploitation of derivative products).

38. The fractionation is not new, *see, e.g.*, CAMPBELL-KELLY, *supra* note 22, at 167 (noting that the software industry by the early 1980s was much less concentrated than the parallel hardware industry out of which it had grown), but it has accelerated since the rise of the Internet.

39. I aggregate data from NAICS 5112 (Software Publishers) and 541511 (Custom Computer Programming Services). For the data, see http://www.census.gov/epcd/ec97/industry/E5112.HTM and http://www.census.gov/epcd/ec97/industry/E54151.HTM (both last visited on February 24, 2005).

40. *The 22nd Annual Ranking of the World's Largest Software and Services Suppliers*, SOFTWARE MAGAZINE (2004), at 42–60 [hereinafter 2004 Software Ranking].

41. During 2002, 652 software companies received a total of $4.3 billion (that is, 443 firms received second or subsequent rounds during 2002). Since 1995, 2,907 new firms have received venture capital financing. THOMSON VENTURE ECONOMICS, 2004 NATIONAL VENTURE CAPITAL ASSOCIATION YEARBOOK 48 (2004).

42. 2004 Software Ranking, *supra* note 40, at 42–60.

revenue had less than thirty percent of the revenues of the industry as a whole.[43]

Another important aspect of the software industry is the ebb and flow of IP software protection for much of the industry's history. Although the form of the protection has changed over time, I share Rob Merges's view that "[t]he United States has traditionally embraced strong protection for computer software."[44] In the early days, it was generally believed that it was "trivially easy to replicate" the software program of a competitor.[45] When initial efforts by major industry players to obtain patents on their products were unsuccessful,[46] firms and Congress turned to copyright as an alternative.[47] The Copyright Office formally decided to permit registration of programs in the mid-1960s.[48] Initially, this was a promising arrangement based on analogizing literary expression to the lines of code that compose a software program[49] and until the late 1980s, copyright provided relatively strong protection for software.[50]

Over the years, however, as courts became familiar with software cases, they narrowed copyright so that it ceased to provide robust protection.[51] The problem that courts increasingly confronted was that "there is nothing in the statute nor in the legislative history to indicate that Congress intended for copyright to protect the *results* (that is, behavior) brought about by the execution of program instructions."[52] Thus, in *Computer Associates v. Altai* in 1992, the Second Circuit adopted a "hard-look" framework that made it difficult to obtain copyright protection for the broader structural features of programs.[53] The court limited protection to specific pieces of the program that constituted "expression."[54] Two years later, the Ninth Circuit refused to protect Apple's graphical user interface from appropriation by Microsoft.[55]

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43. *Id.*

44. Merges, *supra* note 12, at 277.

45. CAMPBELL-KELLY, *supra* note 22, at 107.

46. *See id.*; Peter S. Menell, *Envisioning Copyright Law's Digital Future*, 46 N.Y.L. SCH. L. REV. 63, 75–76 (2002–2003) (discussing *Gottschalk v. Benson*, 409 U.S. 63 (1972)).

47. Congress codified a definition of computer program as "a set of statements or instructions to be used directly or indirectly in a computer in order to bring about a certain result." 17 U.S.C. § 101 (Supp. II 2002); *see* Menell, *supra* note 46, at 76–80.

48. Menell, *supra* note 46, at 16.

49. *See, e.g.*, Apple Computer, Inc. v. Franklin Computer Corp., 714 F.2d 1240, 1247 (3d Cir. 1983) (granting copyright protection for Apple's code).

50. Graham & Mowery, *supra* note 8, at 224–25; Menell, *supra* note 46, at 80–82; Merges, *supra* note 12, at 277–78.

51. Graham & Mowery, *supra* note 8, at 225–26.

52. Samuelson et al., *supra* note 15, at 2351.

53. 982 F.2d 693, 711–12 (2d Cir. 1992).

54. *Id.* at 703; Merges, *supra* note 12, at 277–78.

55. Apple Computer, Inc. v. Microsoft Corp., 35 F.3d 1435, 1439–40 (9th Cir. 1994); Menell, *supra* note 46, at 45–46.

The façade of pervasive copyright protection came crashing to a definitive ruin with the celebrated decision of the First Circuit three years later in *Lotus Development Corp. v. Borland International, Inc.*[56]

Yet long before those decisions limited the overarching importance of copyright protection, major firms in the industry had begun to turn to patent protection. Direct protection of software patents was difficult in the wake of the Supreme Court's 1972 decision in *Gottschalk v. Benson*.[57] Still, several of my interviews suggest that software patents were easy to obtain. Because much of the software through the 1980s was produced by hardware firms, patents easily could be obtained on an object (a microprocessor) programmed to accomplish the relevant function.[58] To be sure, that artifice was not effective in the 1990s when pure software firms like Microsoft started to play major roles because those firms could appropriate the innovation of those patents in a software program without infringement. By that time, however, patent doctrine had changed so that patent protection was available for software, at least to those firms that were sufficiently familiar with the process to exploit it.[59]

In sum, despite the contrary mythology of a golden age of IP freedom, it is not clear that there was any time when software was not protected by IP.[60] When copyright protection seemed likely to provide adequate protection, many who were active in the industry thought that patent protection would be counterproductive.[61] Nevertheless, as it became increasingly clear that copyright protection was inadequate, supporters of patent protection in the industry gained force, and many of the leading firms now have large numbers of patents.[62] This Article considers the role patents have come to play as the industry has matured.

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56. 49 F.3d 807 (1st Cir. 1995) (denying copyright protection for pulldown menus in spreadsheet program).

57. 409 U.S. 63 (1972) (barring patents on algorithms); *see* Menell, *supra* note 46, at 16.

58. Interview with Keith Witek, Legal Counsel, Advanced Micro Devices, in Austin, Tex. (Nov. 13, 2003) (transcript unavailable); Interview with Anonymous Semiconductor Executive, in Austin, Tex. (Nov. 19, 2003), at 2.

59. Graham & Mowery, *supra* note 8, at 226; Menell, *supra* note 46, at 75; Merges, *supra* note 12, at 278–81.

60. My understanding is bolstered by the intriguing empirical findings in Josh Lerner & Feng Zhu, What is the Impact of Software Patent Shifts?: Evidence from *Lotus v. Borland* (Sept. 28, 2004) (unpublished manuscript), *available at* http://papers.ssrn.com/abstract=596144. That paper argues that the evidence of a marked rise in patenting by the firms most likely to be hurt by the withdrawal of copyright protection connected with *Lotus* indicates that, for those firms at least, patent and copyright protection serve as substitutes. *Id.*

61. LESSIG, *supra* note 6, at 208 (noting that "[w]hat was most striking about this explosion of law regulating innovation was that the putative beneficiaries of this regulation—coders—were fairly uniformly against it"); Graham & Mowery, *supra* note 8, at 224–25; Menell, *supra* note 46, at 75.

62. Graham & Mowery, *supra* note 8, at 225, 234.

III. Do Patents Induce Commercialization in the Software Industry?

As suggested above, it is difficult to develop any concrete understanding about the effects patents might have on innovation in a particular industry. Even if we assume that all increases in innovative activity are positive,[63] it is difficult to separate economic effects related to the patent protection from the economic effects of the innovation for which the patent is granted.[64] Recognizing that difficulty, this Part of the Article examines the potential positive effects of patents in the software industry.[65]

To understand the effect of patents on software development, I focus on small firms, which typically are venture backed. Several related considerations support that choice. First, and most obviously, many of the most important innovations in the software industry come from relatively small firms.[66] Yet the scholarship to date focuses exclusively on large publicly traded firms.[67] Second, the complex capital arrangements of public firms make it harder to analyze the relation between patent portfolios and the flow of capital into and out of those firms. Thus, a study of the simpler arrangements of venture-backed firms is preferable. The final point relates to the nature of qualitative interviews. Generally, it is easier to obtain reliable interviews from smaller firms and their venture capital investors than from large firms. It is less common at a large firm to find a person with complete hands-on responsibility for both the financing arrangements and the policies with respect to IP development and protection. Executives at larger firms also are much more likely to articulate views constrained by the legal positions underlying the broader interests of the firm and are thus relatively unlikely to engage in the kinds of wide-ranging conversations likely to provide useful information to the quasi-anthropological research that I conduct. Moreover, venture capital investors have highly diversified experiences relevant to my inquiries. Many venture capital investors have experienced good and bad returns on literally dozens of investments and have considerable insight into what makes those investments good and bad, and many of these investors have had previous careers as entrepreneurs themselves, giving them a more complete perspective.

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63. *See supra* note 20.

64. *See* MOSER, *supra* note 17, at 27 (noting that "the absence of patent laws did not unambiguously hinder innovation in countries without patent laws").

65. The closest approach to such an examination in the existing literature is the discussion in Merges, *supra* note 12, at 290, which suggests that the stronger patent protection in the United States (as compared to Japan) helped support the development of custom software developers in the in the early 1990s.

66. Mark A. Lemley, *Romantic Authorship and the Rhetoric of Property*, 75 TEXAS L. REV. 873, 903 (1997) (book review).

67. Zoltan J. Acs & David B. Audretsch, *Innovation in Large and Small Firms: An Empirical Analysis*, 78 AM. ECON. REV. 678, 678 (1988) (noting that "most of the empirical research has examined only the innovative activity contributed by relatively large firms").

This Part proceeds in three steps. First, I discuss the goals of the venture capital investors, which relate to the likelihood that a portfolio firm can differentiate itself from its competitors in a reliable way. Second, I analyze the ability of patents to provide that reliable differentiation. Although the discussion evinces pessimism about patents as a mechanism for appropriating the value of innovations in the software industry, it also emphasizes a shift in the efficacy of patents as firms pass through the early stages of growth. To that end, I discuss a number of reasons why patents are not likely to allow such appropriation in the earliest stages of a software firm, before it has revenues or begins shipping a product. Then, I show how once the firm moves beyond infancy—to a stage with revenues or a product—patents can have a variety of beneficial effects. That section provides a framework for relating the evidence drawn from my interviews to the existing analytical literature, teasing out of that pattern a set of direct and indirect positive effects that patents can have in various circumstances.

A. Venture Capitalists and Sustainable Differentiation

The development of software is expensive and time consuming. Thus, it is not common for a successful product to be developed by an individual developer working in his spare time. Rather, most commercial software products are the result of years of effort. That effort, in turn, inevitably requires the expenditure of considerable monetary resources. Of course, young firms can—and normally are expected to—go a considerable way toward developing their concept without using the funds of third parties. At some point, however, the individuals within young firms will exhaust their own resources and the readily available resources of friends and family members.[68]

In most cases, the firm then will turn to institutional investment. One of the most prominent and common[69] sources of that investment is a venture

68. *See* JOHN MAY & CAL SIMMONS, EVERY BUSINESS NEEDS AN ANGEL 32–33 (2001).

69. Angel investors provide a source of financing that is parallel (or, in some cases, preliminary) to venture capital investment. Their role in the very early stages is evident in the results of one survey finding that angels provide initial funding for more small, high-growth companies than venture capitalists. *Id.* at 32. That does not suggest that angels finance more firms than venture capitalists, only that they are particularly common in the earliest stages of a firm's development. Even in those cases, venture capital funding is likely to be important at some stage of the firm's development. Angel investors tend to be successful business executives investing the profits from their earlier endeavors in a much less formal way than venture capitalists. My limited interviews with angel investors and the scant literature on the subject suggest that the perspective of the typical angel investor is quite similar to the venture capital perspective. *See id.* at 170–71 (reporting advice from Guy Kawasaki, a former Apple Computer employee who runs a business that advises startups); Telephone Interview with William Jackson, Brown University Research Foundation (Mar. 21, 2003), at 1 (describing the typical path of angel investors in funding companies); Telephone Interview with Hambleton Lord, Launch Pad (Apr. 15, 2003), at 1 (describing the structure and investing strategy of Launch Pad, a Boston-based angel group).

capitalist.[70] Venture capital firms are intermediaries that raise funds from institutional investors (corporate pension plans and the like) and invest those funds in startup companies in technology areas.[71] There is a vast literature on the structure of the venture capital industry, including detailed studies of many aspects of the contract structures that firms use in dealing with their investors and with the portfolio companies in which the firms invest.[72] For the purposes of this project, however, the structure of the venture capitalist is relatively unimportant. What is important is to understand as precisely as possible what characteristics of a portfolio that lead venture capitalists to invest. Although there is little quantitative empirical work on that question,[73] the most obvious role that IP protection might play in that process is that the monopoly that IP protection grants on the exploitation of a covered technology could cause investment to flow into the firm that has created the technology. The monopoly supports such a flow of investment—at least in theory—by creating market power that allows the firm to earn supranormal profits by exploiting the technology in question.

The first point to understand about startup companies is that the uniqueness of a firm's product is not likely to be one of the primary issues a potential venture capital investor will analyze in deciding whether to invest in the firm.[74] The investor is likely to examine a large number of plans and invest in only a small number of them—perhaps 6 out of every 1,000.[75] In deciding whether to invest, the investor is likely to start by focusing on issues that validate the firm's competency to execute its concept successfully.[76] For example, investors will be interested in such things as experience in the

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70. For a discussion of the impact of venture capital financing on small firms and the economy as a whole, see GOMPERS & LERNER, THE MONEY OF INVENTION, *supra* note 19, at 41–83.

71. For a discussion of how venture capital organizations operate, see *id.* at 87–115.

72. For a collection of quantitative analyses of those topics, see GOMPERS & LERNER, THE VENTURE CAPITAL CYCLE, *supra* note 19. For a good summary, see Michael Klausner & Kate Litvak, *What Economists Have Taught Us About Venture Capital Contracting*, *in* BRIDGING THE ENTREPRENEURIAL FINANCING GAP 54, 59–69 (Michael J. Whincop ed., 2001).

73. Hellman and Puri present data indicating that venture capitalists are more likely to invest in "innovative" first movers than "imitative" second movers. Thomas Hellman & Manju Puri, *The Interaction Between Product Market and Financing Strategy: The Role of Venture Capital*, 13 REV. FIN. STUD. 959, 980 (2000). The generality of that argument deprives it of much force on the questions about IP that are the heart of my work. To the extent it is relevant, it tends to support my intuition that much of the most important innovation in the industry comes from small venture-backed firms.

74. A typical comment is that entrepreneurs are naïve if they think they have discovered a valuable product idea for which there is no competition. ROB ADAMS, A GOOD HARD KICK IN THE ASS: BASIC TRAINING FOR ENTREPRENEURS 20–21 (2002). Indeed, the absence of competition generally is regarded as a bad signal because it suggests that the idea is not worth pursuing. *See id.* at 21; MAY & SIMMONS, *supra* note 68, at 170.

75. *See* CUSUMANO, *supra* note 25, at 198.

76. *See* Telephone Interview with Alan Harding, CFO, Datacert (Oct. 24, 2002), at 2 ("There are competitors that probably have equally as good software [as we do, but] they can't do the implementations [for the customers].").

relevant market and the skills of the management team.[77] One remarked: "Every company of mine that has failed has been [due to] mismanagement of executives, not technical failure."[78] Similarly, even before investors consider whether a firm can protect a market leader position, they will want to know whether the product is one that customers need so desperately that the firm could earn significant revenues from sales of the product.[79]

Still, for firms that have a credible product idea and the expertise to implement it, venture capitalists plainly accept the idea that their goal is to identify firms that will have sufficient market power to earn extraordinary profits.[80] IP protection is important only indirectly, as a tool that might provide that market power. The key is "sustainable differentiation"[81]: something special about the particular firm that will enable it to do something that its competitors will not be able to do for the immediate future. The interviews reflect more picturesque terminology—referring to "secret sauce"[82] or "magic dust."[83] But it is clear that the key to a desirable investment opportunity is in the expectation of market power, and all other attributes of the company are indirect predictors of that ultimate goal.[84]

For example, investors commonly referred to lead time or first-mover advantages.[85] The premise is that a portfolio company that truly is the first to

77. *See* ADAMS, *supra* note 74, at 27–39, 125–52 (discussing "execution intelligence" and the importance of the management team in securing funding); MAY & SIMMONS, *supra* note 68, at 71.

78. Interview with David M. Lee, Managing Director, Sentient Ventures, in West Lake Hills, Tex. (Oct. 25, 2002), at 2; Telephone Interview with Sanjay Subheder, General Partner, Storm Ventures (Apr. 4, 2003), at 1 ("The most important thing is execution.").

79. *See* ADAMS, *supra* note 74, at 49–68 (discussing "market validation" and the need to develop a product that responds to customer "pain"); Telephone Interview with Jim Gauer, General Partner, Palomer Ventures (Mar. 10, 2003), at 2 ("The point is whether there is a pain point in the market to which these people are going to apply a pain reliever."); Interview with Mark A. Kielb, President, DNA Software, Inc., in Ann Arbor, Mich. (June 18, 2002), at 1 (discussing how "80 percent of the value" of a product is derived from the fact that it is "usable and solves a problem").

80. To the extent that it is more difficult for services firms to obtain the market position necessary to produce those profits, they are less suitable investments for venture capitalists. *See* CUSUMANO, *supra* note 25, at 236–52.

81. Lee Interview, *supra* note 78, at 1.

82. *Id.*

83. Telephone Interview with Hank Weghorst, CEO, Troux Technologies (Mar. 21, 2003), at 3.

84. *See* Interview with Jerry Rightmer, Senior Vice President, 360 Commerce, in Austin, Tex. (Dec. 18, 2002), at 1 ("[IP] is a check-list item on [VC's] list. What they're really looking for is barriers to entry."); Subhedar Interview, *supra* note 78, at 1 ("[T]here could be patent protection, but that in and of itself is not what you're looking for. Really what you're looking for is how are you going to sustain your position . . . .").

85. *See* ADAMS, *supra* note 74, at 73–94; Interview with Michael D'Eath, Vice President, Business Development, Waveset, in Austin, Tex. (Oct. 24, 2002), at 6; Interview with Eric Jones, General Partner, CenterPoint Ventures, in Austin, Tex. (Nov. 25, 2002), at 2 (discussing benefits of an "installed base" of users in maintaining recognition as a market leader); Rightmer Interview, *supra* note 84, at 1 (explaining that his firm's success hinges on getting customers to "lock-in" to his product because they can afford to change products "only once every ten years"); Interview with David Sikora, CEO, Pervasive Software, in Austin, Tex. (Jan. 16, 2003), at 1 (explaining that "public interest in software" is proportional to "how far ahead of the market you are").

provide a sophisticated and functional response to an important problem can expect to earn a supranormal return for years to come. Interestingly enough, that expectation rested on the perception that a firm can maintain a lead on its rivals as long as it keeps improving its technology as quickly as its competitors.[86] I rarely if ever heard investors (as opposed to developers) voice an expectation that portfolio firms obtain and keep a strong market position through "lock-in" or "bandwagon" effects.[87]

That is not to say that IP protection is unimportant. It is clear, however, that different investors have different views about it.[88] Some feel that intellectual property always is important and claim that they never invest without strong patentable technology.[89] Even those investors, however, go on to say that they are not as interested in the IP protection as they are in technology that is sufficiently cutting edge to warrant protection.[90] Others, however, particularly those that emphasize early-stage companies, say IP protection is unimportant for software investments.[91] Still others take a

86. D'Eath Interview, *supra* note 85, at 6 (discussing the importance of getting the initiative and forcing competitors to play catch up); Kielb Interview, *supra* note 79, at 1 (remarking on the importance of being a first-mover); Weghorst Interview, *supra* note 83, at 3 ("[S]ustainable differences are typically time and materials put into [the software]). Additionally, David Sikora argues that his firm's lead time of six months over its competitors is important. Sikora Interview, *supra* note 85, at 1 ("[Nine] women can't make a baby in one month. There are problems that just take a certain amount of time to solve."). His remark apparently is an allusion to a famous comment by IBM chairman Tom Watson Jr. related to development of the seminal OS/360 software product: "The bearing of a child takes nine months, no matter how many women are assigned." MARTIN CAMPBELL-KELLY & WILLIAM ASPRAY, COMPUTER: A HISTORY OF THE INFORMATION MACHINE 199 (1996).

87. "Lock-in" or "bandwagon" effects occur when the value of a particular technology increases with the number of other users and has the potential to allow a particular technology to remain dominant even when superior technologies appear on the market. For a general discussion of these effects, see JEFFREY H. ROHLFS, BANDWAGON EFFECTS IN HIGH-TECHNOLOGY INDUSTRIES (2001); *see also* STAN J. LIEBOWITZ & STEPHEN E. MARGOLIS, WINNERS, LOSERS & MICROSOFT: COMPETITION AND ANTITRUST IN HIGH TECHNOLOGY 117–244 (1999) (arguing that inefficient lock-in rarely occurs, using numerous examples from the software industry).

88. *Cf.* GOMPERS & LERNER, THE VENTURE CAPITAL CYCLE, *supra* note 19, at 47 (discussing a variety of investment perspectives without specifically referring to IP protection).

89. *See* Telephone Interview with Bobby Inman, Lyndon B. Johnson Centennial Chair in National Policy, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin (Sept. 26, 2002), at 1 (highlighting the advantage of having IP just in case the investment does not pay off in the market); Jackson Interview, *supra* note 69, at 4–5 (noting the importance of having IP during cross-licensing negotiations); Lee Interview, *supra* note 78, at 1 (emphasizing the value of IP at different stages of the firm); Telephone Interview with Dennis Murphree, President, Murphree Venture Partners (Nov. 4, 2002), at 1 (discussing the importance of IP to establish a proprietary position).

90. *See* Lee Interview, *supra* note 78, at 1 (suggesting that the "next step" is whether you want to "open your kimono" a little bit by having the technology registered for protection).

91. *See* Telephone Interview with Rob Adams, Partner, Austin Ventures (Nov. 5, 2002), at 1 ("Quite frankly from an investor's standpoint, IP protection doesn't mean a whole lot."); Interview with John Denniston, Chief Executive Officer, Kleiner Perkins Caufield & Byers, in Menlo Park, Cal. (Feb. 7, 2003), at 1 ("Software is unique in that we don't look for IP protection."); Gauer Interview, *supra* note 79, at 2 ("[P]atentable work tends to correlate with working in new areas and

middle position, holding that IP protection matters some, but not all, of the time.[92] Most of those who addressed the subject recognized differing perspectives on the point and argued that those with the other perspectives are misguided.[93] The most likely explanation is that investors are simply implementing different investment models based on their particular expertise.

B. Patents and Sustainable Differentiation

If understanding what venture capitalists want answers the first question, the second question is whether they believe that patents can provide it. This subpart looks quite closely at the various stages of relatively small private firms and suggests that investors and developers discern a balance of interests that shifts as firms grow from the earliest stage, where patents are not often helpful, through intermediate stages to the terminal stage of venture-backed firms (just before an acquisition or IPO), where patents are almost universally viewed as useful.

1. The Basic Problem: Patents and Appropriability.—A basic problem for software firms at all stages is the sense that even with a patent it often is difficult for a firm to "appropriate" the value of its invention.[94] Specifically, my interview subjects agreed that competitors usually could, without infringing a patent, implement most of the aspects of a patented software product.[95] One reason for that problem is the multifarious nature of software

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being world-class in those areas but I would never make an investment decision based on whether there is a patent or not or whether I thought a patent application would be successful."); Jones Interview, *supra* note 85, at 2 (advocating looking for "something unique" rather than something that is patented because patents are not worth the expense in most software investments); Telephone Interview with Jimmy Treybig, Venture Partner, New Enterprise Associates (Apr. 10, 2003), at 1 (arguing that patents are not necessary for success but are merely part of the equation to gauge success).

92. *See* Telephone Interview with Tom Stephenson, Team Member, Murphree Venture Partners (Dec. 4, 2002), at 1 (discussing the difficulty of generalizing the importance of IP to all areas of the software industry).

93. *Compare* Inman Interview, *supra* note 89, at 1 (criticizing investors who "claimed that IP was nonsense"), *with* Gauer Interview, *supra* note 79, at 3 (arguing that emphasis on copyright and patent protection illustrates that the Southern California venture capital industry is "less mature" than the Northern California industry).

94. For a discussion of appropriability, see David Teece, *Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing & Public Policy*, 15 RES. POL'Y 285 (1986), and Levin et al., *supra* note 18. The insights of these papers are (1) the ability of businesses to appropriate the value of innovation differs from industry to industry and (2) the mechanisms that businesses use to appropriate the value of innovation differ in their effectiveness from industry to industry. Teece, *supra*, at 287, 293–95; Levin et al., *supra* note 18, at 796–97.

95. *See* Telephone Interview with Rob Beauchamp, Chief Technology Officer, Journée (Apr. 3, 2003), at 4 (discussing ease of working around software patents); Harding Interview, *supra* note 76, at 1 ("There are a lot of ways to work around patents."); Jones Interview, *supra* note 85, at 2 ("[I]n software it is so easy to change things that it is so easy to do the same function, but do it in a different way."); Interview with Cory Van Arsdale, General Manager, MSN Business Development, Microsoft, in Redmond, Wash. (Feb. 4, 2003), at 3 ("Most patents you can get around. . . . There's

innovation, which permits many solutions to any particular problem. Another contributing factor is the poor match between patents and products in the industry: it is difficult to patent an entire product in the software industry because any particular product is likely to include dozens if not hundreds of separate technological ideas. Thus, it may take a number of novel ideas—and patents—to build a defensible barrier[96] around a product.[97] Another problem is that technology tends to develop so rapidly that by the time a patent is issued—and the formal right to exclusivity commences—the technology may be obsolete.[98] Litigation at that point will involve efforts by the patent owner to challenge technology of a subsequent generation to which application of the patent may be less clear.[99] Yet another problem emphasized in my interviews is the problem of detectability—the difficulty of being sure that a competing product infringes a patent.[100]

The problem of appropriating the value of software through patents is not universal. As I discuss below, some patentees manage to obtain patents of sufficient breadth to cover all possible solutions to an important problem. More broadly, some knowledgeable observers attribute the difficulty of appropriation not to the nature of software technology, but to the infancy of the industry. Because the industry is developing so rapidly, some argue, the nature of technology and even of technological developments is so poorly understood that firms do not recognize the value they could appropriate from patents if they pursued them in an informed way.[101] From this perspective,

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always a way to do it different. Sometimes you have to spend as much money as the patent holder spent, but that doesn't mean you can't.").

96. It should be clear from this discussion that I am generally unpersuaded by the reasoning of PARCHOMOVSKY & WAGNER, *supra* note 21, with respect to patent portfolios. Although this project does not focus on the questions that they address, my interviews strongly support the idea that the number of patents firms obtain is driven largely by the need to build the most effective barrier around an idea or set of ideas.

97. A biotech startup, by contrast, can build a defensible barrier around its product with one patent or only a few patents on the relevant composition or process. Thus, a biotech startup more readily can use patents to appropriate the value of its invention.

98. *See* Rightmer Interview, *supra* note 84, at 1 ("The technology moves so fast and the Patent Office moves so slow."); Weghorst Interview, *supra* note 83, at 4 (explaining that the exclusivity period of the patent is "out of sync" with the timing of the value of the innovation).

99. *See* Cohen & Lemley, *supra* note 15, at 45–47 (warning of the possibility that software patent owners can capture the value of third party improvements under the traditional doctrine of equivalents framework).

100. Anonymous Semiconductor Executive Interview, *supra* note 58, at 4–5. In the pharmaceutical industry, for example, it often will be quite easy to determine if a competing pharmaceutical infringes a patent because it will be easy to identify the precise compound that the pharmaceutical contains. In the case of software, however, without access to the source code it might be quite difficult for a patentee to determine whether a particular program infringes a particular patent.

101. That view is stated most clearly in my interview with Sam Dinkin. *See* Interview with Sam Dinkin, Chief Technology Officer, Alkera, Inc., in Austin, Tex. (Mar. 24, 2003), at 11–12 (discussing the different strategies available after patent issuance). It resonates strongly with DEBORA L. SPAR, RULING THE WAVES: CYCLES OF DISCOVERY, CHAOS, AND WEALTH FROM THE

the relatively limited appropriability provided by software patents should be compared not to the relatively high appropriability of hardware patents,[102] but to the even more limited appropriability that software patents provided a decade ago. Those observers expect that in a matter of decades software technology will be as effectively subject to patent protection as the related hardware technology is at this time.

For now, despite those qualifications, the relevant point is that for most firms, most of the time, there is little prospect that the patents they obtain will provide market power that they can use to exclude competitors. That point is underscored by the relative infrequency with which venture-backed software startups obtain patents. For comparative purposes, consider that only about twenty percent of venture-backed software companies have a patent within five years of their first financing (with each of those firms holding, on average, about two patents), while more than half of biotech startups have patents by that time (with each of those firms averaging about seven patents).[103] Thus, even the tenuous exclusivity such patents could provide is usually not a factor for early-stage software startups because so few of them in fact have patents.

The point is further underscored by the statistical relation between the success of venture-backed software startups and their patenting practices. The general theme of the preceding pages is that there are many factors that play into the ability of a startup firm to obtain funding and success and that intellectual property has a low place on the list of factors, if it appears on that

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COMPASS TO THE INTERNET 15–18 (2001) (noting examples of how firms rush to market as quickly as possible rather than carefully strategize to extract the most value from their intellectual property).

102. Many of my interview subjects expressed the view that software patents generally are not as valuable as hardware patents. *See, e.g.*, Interview with Tom Bishop, Chief Technology Officer, Vieo, in Austin, Tex. (Jan. 28, 2003), at 2 (endorsing the view that software patents generally are easier to work around than hardware patents, particularly when they are method patents partly because "[s]oftware is so malleable that it is easy to exploit the idea"); Jones Interview, *supra* note 85, at 1 (explaining that patents on software are generally less useful than patents on hardware); Kielb Interview, *supra* note 79, at 1 (emphasizing the range in utility of patents among industries, with software generally at the low end); Treybig Interview, *supra* note 91, at 2 (suggesting that hardware patents currently have more potential to exclude competitors than software patents). For a contrasting view, see Dinkin Interview, *supra* note 101, at 12, 15 (arguing that the difference in valuation of patents relates to the relative youth of the software industry); Treybig Interview, *supra* note 91, at 7 (suggesting that when the industry matures software patents and hardware patents will have similar values).

103. Details of that empirical research are in a forthcoming paper with Tom Sager. Ronald J. Mann & Thomas W. Sager, The Relation Between Patents and Success of Venture-Backed Software Firms (Jan. 7, 2005) (unpublished manuscript, on file with the Texas Law Review). The research is based on a dataset of all venture-backed firms in the software and biotech sectors that received their first financing in 1998 or 1999 (about 800 software firms and 170 biotech firms) and analyzes the patents that those firms held on December 31, 2003. *Id.* at 2–3. I emphasize that the biotech data probably understates the rate of patenting by biotech firms (and thus the relative infrequency of software patenting) because of the relatively high likelihood that biotech startups have access to in-licensed university patents that the startups do not technically own (patents that will not be located by my research in public databases of patent ownership).

list at all. The data I have collected with Tom Sager supports that view—indicating that patenting practices have at best a minuscule ability to predict the success of a venture-backed software startup.[104]

2. Patents and Prerevenue Startups.—In addition to the problem that patents often are not an optimal mechanism for appropriating the value of software innovation, a number of considerations make it particularly difficult for early-stage companies to employ patents effectively. The key points here are the limited efficacy of litigation for those firms, the constraints on resources that make it infeasible to focus on patenting, and the limited value to prerevenue firms of excluding competitors.

a. The Perils of Small-Firm Litigation.—On the first point, even if an early-stage company had a patent, it is unlikely that it would have resources available to enforce the patent through litigation against a competitor.[105] That is particularly true when the competitor is a large firm. One problem is the disparity in litigation resources. One investor emphasized the concern that a large defendant would "rain lawyers on your head and tie you up in court for the next ten years."[106] A somewhat different concern is the likelihood that the large firm might have a patent that the small firm infringes. If so, the lawsuit might simply alert the large firm to the presence of the small firm.[107]

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104. The data in that paper finds a statistically significant relation between patenting practices and firm success (measured by rounds of financing, total investment, or ability of the firm to survive), but the explanatory power of that relation is quite small—in the range of one percent. Moreover, even that relation dissipates in a more sophisticated model that includes data on the duration of a firm's existence. Specifically, in a model with variables for patents and duration as explanatory variables, the patenting variables do not contribute significantly to explaining the number of rounds of financing or total investment that the firm will obtain.

105. *See* Interview with Kinloch Gill, Associate, Andrews & Kurth LLP, in Austin, Tex. (Sept. 27, 2002), at 1 (emphasizing that the cost of enforcement is more of a barrier than the cost of obtaining the patent); Harding Interview, *supra* note 76, at 1 ("We just don't have a large enough war chest at this point in our life cycle. Down the road we might be more aggressive once we have enough cash to do it.").

106. Murphree Interview, *supra* note 89, at 1; *see also* Telephone Interview with Michael Abbott, President, Composite Software (Mar. 21, 2003), at 5 ("[W]e don't have the money to go pursue other people that are infringing on [our patents] . . . ."); Adams Interview, *supra* note 91, at 1 ("The ability to defend your patents is only as big as your bank account. And nobody wants to . . . do that before you have money to fund that from operating income. . . . [I]f your only hope to make the company work is to go to court and win nobody is going to invest."); Beauchamp Interview, *supra* note 95, at 5 ("[A]s a start-up, it's unlikely that we are going to leverage [our] patents in any kind of lawsuit."); Weghorst Interview, *supra* note 83, at 4–5 (explaining that a patent would have little value for an early-stage startup because competitors would doubt its will and ability to enforce it). This point is not new, of course. COHEN ET AL., *supra* note 18, at 14–16, report a similar finding in their cross-industry surveys.

107. Rightmer Interview, *supra* note 84, at 1–2. For a similar perspective, see ERIC VON HIPPEL, THE SOURCES OF INNOVATION 53 (1988) (discussing the strategy of responding to a charge

A related concern is that firm culture is degraded when a firm must rely on licensing revenues instead of developing its own product.[108] Interestingly enough, that sentiment was expressed even at firms that rely heavily on licensing revenues. Those firms encouraged efforts to maintain a product-centered culture that emphasizes production of the firm's own products.[109] One executive explained that a cultural risk arises when a company pursues patent litigation and licensing, explaining that such a strategy unfavorably affects the company's needs. "You don't need sales people; you need attorneys. You don't need solutions architects; you need accountants. So you wind up losing the very people who are, who were, and who continue to be constructive . . . and innovative and help you build things and would give us a continuing competitive advantage."[110]

Indeed, the one interviewee whose firm had a major licensing program related that the entire program was entrusted to third-party professionals so that it would not interfere with the focus of the onsite software engineers.[111]

b. Diversion of Focus.—Similarly, many investors and developers emphasized that attention to patents can be damaging to a startup because it has the potential to divert limited time and resources from what is likely to be a highly time-pressured effort to develop a product and convince customers and investors of its worth before the firm runs out of capital resources.[112] One investor explained: "[We] typically find that the companies that focus on just patents don't have the right view of what is important, and they really are therefore not successful in business. And they're usually not around to prosecute their patents."[113] Developers understand the point well. As one said: "Every dollar we spend on [patenting] is a dollar we can't spend on a

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of infringement in the semiconductor industry by mailing back to the complainant "'a pound or two' of its possible germane patents").

108. Van Arsdale Interview, *supra* note 95, at 2. In response to a question, Van Arsdale emphasized that IBM is *not* a counterexample to that reasoning, explaining that despite the "huge asset" of IBM's patent portfolio, IBM has managed to maintain a culture firmly focused on developing its own competitive products. *Id.* at 2.

109. Telephone Interview with Ken Kalinoski, Chief Technology Officer, Forgent (Feb. 19, 2003), at 2–3; Interview with Shawn P. Thomas, Chief Executive Officer, Bluecurrent, Inc., in Austin, Tex. (Nov. 5, 2003), at 3.

110. Thomas Interview, *supra* note 109, at 3.

111. *Id.* at 5.

112. *See* Denniston Interview, *supra* note 91, at 1 ("For Series-A firms, there just isn't the budget for patenting."); Jones Interview, *supra* note 85, at 3 ("It was better to spend the time continuing to advance the technology than it was to push people off to the side and have them focus on creating the patents and work on it."); Kielb Interview, *supra* note 79, at 1 (asserting that the cost of diverting the "time, energy, attention, and focus" of personnel to a "suboptimal" use is more important than the monetary cost of obtaining a patent); Treybig Interview, *supra* note 91, at 6 ("If you're a small company, and unless you have a hell of a patent, it's pretty hard to spend money on patents versus another salesman or something.").

113. Subhedar Interview, *supra* note 78, at 4.

software engineer."[114] Another, with a patent-leaning background from his days at IBM, commented: "Patentability is something we will pursue, but let's get the product out first."[115]

Thus, a young company is presented with a challenging task. If the nature of the firm's innovation is such that IP is *ever* likely to be important, it must spend sufficient resources on the protection and development of intellectual property from the earliest days of the company—as an investment in the possibility that the firm *might* grow to the point at which IP is useful.[116] The firm that fails to protect its IP at the earliest stage is like a desperate ship at sea that empties its drinking water in the hope of evading a faster pursuer: it might survive for the time being, but it may have sown the seeds of its inevitable failure if it survives to a later stage.[117] On the other hand, it must not spend so much that the company fails before it is able to recoup its investment.

Firms have developed a number of strategies for dealing with that problem. Some involve using half measures to protect the IP, such as filing provisional applications[118] or omitting standard practices related to documentation of the work of engineers.[119] Those practices do not directly abandon the IP, but they may make it more costly and difficult to protect it in the future. The bottom line is that even for companies that have begun to earn substantial revenues it often does not seem appropriate to devote the resources necessary to ensure that all of the firm's innovations are patented.[120] Others—it must be said that executives with prior experience at large IP-sensitive firms like IBM[121] or Bell Labs populate this category—

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114. Harding Interview, *supra* note 76, at 1; *see also* Bishop Interview, *supra* note 102, at 2 (explaining, from the perspective of a former IBM executive now leading a startup, the shift in philosophy among investors and suggesting that now "there is a lot more interest in getting the product out than in having patents"); Rightmer Interview, *supra* note 84, at 1 (discussing the costs of documentation necessary to protect the ability to obtain patents on the firm's innovation).

115. Bishop Interview, *supra* note 102, at 2.

116. *See* Gill Interview, *supra* note 105 (explaining that the strategy is to obtain patents early "knowing that you won't enforce [them] until later").

117. The metaphor will be plain to readers of Patrick O'Brian.

118. *See* Beauchamp Interview, *supra* note 95, at 3; Weghorst Interview, *supra* note 83, at 4.

119. *See* Weghorst Interview, *supra* note 83, at 6 ("[W]e'll almost always tell the engineers to take copious notes, but to not necessarily worry about the time and energy devoted to that . . . ."). The costs of a vigorous pursuit of that process are considerable. One executive with experience at IBM and elsewhere suggested that, as a rule of thumb, he commits four to eight engineer hours *per week* for the life of the application, examining, and issuance process. *See* Bishop Interview, *supra* note 102, at 2.

120. *See* Sikora Interview, *supra* note 85, at 1 ("Software companies are not 3M. We don't organize our offices to get patents.").

121. IBM's dominant patent portfolio is not an accident. It plainly has one of the most—if not the most—patent intensive environments among American companies. *See* Dinkin Interview, *supra* note 101, at 4. IBM has been the leading U.S. patentee every year since 1993 and also appears to be the leading software patentee. Manny Schecter, *IBM's Strategies for the Creation, Protection and Use of Intellectual Property in Software*, *in* MANAGING KNOWLEDGE ASSETS: CHANGING RULES

seem to relish the discipline of making sure that the IP is pinned down no matter how difficult it may seem to find the time and resources to do so.[122] The difficulty of this strategic choice, coupled with the difficulty in accurately predicting the future prospects for their products and their IP, is a problem about which startup software executives worry constantly.[123]

Investors, of course, are aware of this problem. Their approach typically does not extend to forcing (or even urging) their portfolio companies to seek patent protection.[124] However, they do go to considerable lengths to evaluate the IP that potential portfolio companies have. In a typical process, the venture capitalist (VC) knows most of the reputable patent attorneys in the local community. If one of those attorneys has filed a patent for a potential portfolio company, the VC discusses the patent with that lawyer. If an attorney with whom the VC did not have a preexisting relationship filed the patent application, the VC has the patent studied by an attorney in whom he has confidence. In the context of the interviews, it was clear that the intent of this examination is not purely technical—whether this is a patent likely to be granted—but also a broader exercise to understand what type of market power the patent might (or might not) provide.[125] Indeed, the current practice-oriented literature characterizes examination of market power as central to careful due diligence practices.[126] The practice at first seems to be in tension with the thesis of this section—that patents have little value for the earliest-stage startups. In fact, however, it leads into the

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AND EMERGING STRATEGIES 7, 7, *at* http://emertech.wharton.upenn.edu/ConfRpts_Folder/WhartonKnowledgeAssets_Report.pdf (Nov. 30, 2001); Mark Voorhees, *A Perfect 10*, *available at* http://www.law.com (Apr. 23, 2003) (discussing IBM's patent portfolio).

122. *See* Kalinoski Interview, *supra* note 109, at 3 (describing how, as a former IBM engineer leading a startup company, he has implemented a comprehensive incentive program designed to emphasize the importance of patenting to the engineering team).

123. *See* Abbott Interview, *supra* note 106, at 6 (explaining that the decision has to be made "looking at the amount of time, dollars, and effort required that potentially could pay off huge in a couple of years"); Kalinoski Interview, *supra* note 109, at 5–6 (discussing the choice between development and IP, emphasizing that patents can be thoroughly protected only through a conscious commitment, and suggesting that "[y]ou have to make a conscious decision—either you're gonna do it, or you're not gonna do it"); Thomas Interview, *supra* note 109, at 1–2 ("[I]t's a mindset issue.").

124. *See* Lee Interview, *supra* note 78, at 1; Murphree Interview, *supra* note 89, at 1.

125. *See* Lee Interview, *supra* note 78, at 1 (stating that if he doesn't know the attorney who patented the IP, he will bring his own attorney to make sure there is "sustainable differentiation" from his competitors); Murphree Interview, *supra* note 89, at 1 (emphasizing the interest in how "defensible" the market position is); Stephenson Interview, *supra* note 92, at 1–2 (stating that one reason he examines patents is that patents contribute to establishing competitive differentiation and add value to the business).

126. *See* Christopher R. Fine & Donald C. Palmer, *Patents on Wall Street: Investment Banking Meets Intellectual Property*, *in* FROM IDEAS TO ASSETS: INVESTING WISELY IN INTELLECTUAL PROPERTY 511, 513 (Bruce Berman ed., 2002) (discussing modern due diligence practice for IP assets); Mark Haller et al., *Avoiding Transaction Peril: Value-Based IP Due Diligence*, *in* FROM IDEAS TO ASSETS: INVESTING WISELY IN INTELLECTUAL PROPERTY, *supra*, at 373, 375.

point of the next section: the firms that survive their earliest days may reap substantial value from patents.

c. The Limited Benefits of Exclusion.—One final element of the patenting calculus for small firms may seem obvious, but is so important to the overall framework as to warrant brief notice. Because those firms do not yet have a product, they have no opportunity for revenues. Thus, the benefits they reap from excluding competitors are minimal at best. Only if they survive to a later stage—in which they can hope to profit from their own exploitation of that product—will they be able to reap any substantial value from the exclusion of competitors.

3. The Increasing Value of Patents for Later-Stage Startups.—When firms mature to the point of having revenues, the systematic difficulties that plague the efforts of prerevenue startups to obtain and exploit patents dissipate. That does not mean, however, that patents suddenly become a philosopher's stone that will turn their creative endeavors into IPOs. Rather, the underlying problem of appropriability continues to plague most efforts to use patents directly to exclude competitors. Still, my interviews suggest a series of benefits that patents might provide for later-stage software startups. This section describes those benefits by reference to the bodies of existing literature that have offered them as theoretical possibilities.

a. Direct Effects: Protecting a Space for Innovation.—The most important point concerns the direct ability of a software patent to carve out for the firm a space in which it can innovate without competition. I explain above that my interview subjects often complain about how difficult it is to use patents to exclude competitors. Although there is some truth in this complaint, it is an overgeneralization, at least once a firm reaches the stage at which it has designed a product that it can market to customers.

First, it is clear that *some* firms in the industry obtain a substantial amount of revenues by licensing the use of their patents to competitors that need to use the patented technology in their own products. Indeed, even in my limited sample, three small Austin companies—Applied Science Fiction,[127] Bluecurrent,[128] and Forgent[129]—have obtained substantial

127. Interview with Mark Urdahl, former Chief Executive Officer, Applied Science Fiction, in West Lake Hills, Tex. (Nov. 18, 2003), at 6. Details regarding the amount of revenues do not appear to be public. For press releases announcing licensing transactions, see, for example, Press Release, Eastman Kodak Co. Austin Dev. Cent., Konica and Applied Science Fiction™ to Integrate Digital ICE™ Technology into Konica's HRS Film Scanner, *at* http://www.asf.com/events/press/092402_Konica_RS1.shtml (Sept. 24, 2002); Press Release, Eastman Kodak Co. Austin Dev. Cent., Durst Phototechnik and Applied Science Fiction™ Announce Agreement to Incorporate Digital ICE™ Technology into Sigma Scanner, *at* http://www.asf.com/events/press/DurstSigma.shtml (Feb. 11, 2001); Press Release, Eastman Kodak Co. Austin Dev. Cent., Gretag Imaging Group and Applied Science Fiction Announce Agreement to Incorporate Digital ICE Technology into Master

revenues from patent licenses. I do not believe that industry wide statistics quantify the size of that market, but it plainly is substantial. Those transactions—and others like them—demonstrate that *some* software patents are sufficiently robust to allow their holders to appropriate substantial value from the underlying inventions. Licensing transactions are noteworthy given the difficulties small firms face in enforcing patents against large firms. As discussed above,[130] the small firm with a revenue producing product must be quite confident in the value of its technology before it wisely can cross swords with a company like IBM.

More generally, it seems clear that the received wisdom that patents are not useful to appropriate software-related inventions is overstated. Two separate points are important. The first is the distinction between the relative rarity of observed offensive patent use—for out-licensing or litigation—and the use of patents to exclude competitors. The relative rarity of offensive use of patents does not prove that the patents are insufficiently robust to exclude competitors. As discussed in the previous section, there are many reasons why a firm might want to wait until late in its development to advertise the nature of its technology and its proprietary claims to that technology.

A firm can refrain from offensive use of its patents and still derive important value from the patents as an exclusion device. Contrary to the perception that patents tilt the playing field in favor of large incumbent firms to the disadvantage of small firms,[131] patents in this context afford a unique opportunity to the small startup.[132] The patent system grants the small firm an automatic stay of competitive activity that remains in force long enough for the firm to attempt to develop its technology. For large firms, the marginal increase in appropriability that comes from patents may have little benefit: IBM could compete quite successfully against smaller firms even if it did not have patents protecting its product from copycat competitors.[133]

Flex Digital Minilab, *at* http://www.asf.com/events/press/Gretag.shtml (Sept. 19, 2000). Applied Science Fiction has been acquired by Kodak. Press Release, Eastman Kodak Co. Austin Dev. Cent., Kodak Announces Agreement to Acquire Applied Science Fiction™ Technologies, *at* http://www.kodak.com/US/en/corp/pressReleases/pr20030512-01.shtml (May 12, 2003).

128. Thomas Interview, *supra* note 109, at 4.

129. Forgent's patent on the JPEG file format has produced tens of millions of dollars in revenues. Robert Elder, Jr., *Patents May Bring Firm More Riches*, AUSTIN-AMERICAN STATESMAN, July 29, 2004, at A1.

130. *See supra* note 107 and accompanying text.

131. I discuss that perception in detail in Part IV.

132. My analysis here resonates with the general discussion in Jonathan M. Barnett, *Private Protection of Patentable Goods*, 25 CARDOZO L. REV. 1251 (2004). If we differ in anything other than my contextual approach, it is in my view that the benefits of patents arise from a much larger number of interrelated effects than those that he discusses and in my view that patents are quite valuable for large firms in addition to small firms.

133. The catchphrase in the industry for decades has been that "nobody ever got fired for buying IBM." For a typical example, see John C. Dvorak, *Microsoft's XML: The New EBCDIC*, PC MAG., *at* http://www.pcmag.com/article2/0,4149,1046120,00.asp (Apr. 28, 2003). That is not to

For the smaller firm, however, the ability of the implicit threat of patent litigation to prevent incumbents like IBM and Microsoft from taking its technology can be the difference between life and death. As one executive put it: "What's protected me from other people ripping [off our product] has been the specter of patent infringement."[134]

It is instructive to think of the offensive uses of software patents reported in the press. Among the most famous incidents are the successful attempts by small firms—Stac in the mid-1990s[135] and Eolas in 2003[136]—to force alterations in Microsoft products that arguably infringed patents held by those firms, and the similar attempt by InterTrust to assert rights to digital rights management technology that was important to several Microsoft products.[137] The profits from suing other small firms seem to be so much smaller that it is easy to see why that kind of "horizontal" litigation is apparently less common. I note that the story depicted in the press is consistent with empirical work suggesting that patents held by small firms are more likely to be litigated than patents held by large firms.[138] This also finds strong support in Bronwyn Hall's recent work suggesting that patent rights in complex product industries are more valuable for younger firms than they are for older incumbent firms.[139]

Second, the ability of a patent to appropriate the value of an innovation is often said to vary along several dimensions. One of the most common is the nature of the particular innovation. Thus, it is often thought futile to rely

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say that patents are not valuable to IBM. As discussed below, IBM derives substantial revenues from its software patent portfolio. I do argue, however, that patents play completely different roles in small venture-backed firms than they do in larger established firms like IBM and Microsoft. The relevant intuition here is that IBM's legendary marketing prowess will allow it to win most contests between reasonably equivalent products. The startup, however, can win those competitions only by depriving IBM of the freedom to market a reasonably equivalent product. Thus, the patent's ability to exclude is considerably more valuable to the startup than it is to IBM and similar firms.

134. Thomas Interview, *supra* note 109, at 2.

135. *See* Christopher S. Cantzler, *State Street: Leading the Way to Consistency for Patentability of Computer Software*, 71 U. COLO. L. REV. 423, 441–42 (2000) (discussing that litigation).

136. Eolas Techs., Inc. v. Microsoft Corp., 274 F. Supp. 2d 972, 974 (N.D. Ill. 2003) (allowing plaintiffs to seek "damages for units of Windows with Internet Explorer which are produced and sold outside this country").

137. *See* InterTrust Techs. Corp. v. Microsoft Corp., 275 F. Supp. 2d 1031, 1074 (N.D. Cal. 2003) (construing a variety of disputed words and phrases and denying Microsoft's motion for summary judgment). For discussion of the InterTrust litigation, see Roger Parloff, *Can This Man Bring Down Microsoft?*, FORTUNE, Dec. 30, 2002, at 144. The recent victory by MercExchange over eBay surely deserves honorable mention. *See* MercExchange, L.L.C. v. eBay, Inc., 275 F. Supp. 2d 695, 722 (E.D. Va. 2003) (upholding an earlier judgment against eBay for "direct" patent infringement).

138. John R. Allison et al., *Valuable Patents*, 92 GEO. L.J. 435, 438 (2004) (noting that "litigated patents . . . tend to be issued to individuals or small companies, not large companies").

139. Bronwyn H. Hall, Exploring the Patent Explosion 13–16 (June 2004) (unpublished manuscript) (noting that for the 1985–1989 period, "patient yield[s] of entrant [firms] . . . [were] valued at a substantial premium over incumbent firms"), *available at* http://www.nber.org/papers/w10605.

on a patent if the innovation lies in a method of writing software code.[140] At the other end of the continuum, patents that protect an ultimate functionality that the software provides or an algorithm necessary to provide that functionality are more likely to be important in excluding potential competitors.[141] Interestingly, that distinction seems to undermine the conventional wisdom dividing patents along another dimension, in which "process" patents tend to be less valuable than "product" patents.[142] In the software industry, a patent on the product tends to have relatively little value because of the ease of designing a distinct product. A patent on the process that the product implements is much more likely to be valuable, if only because it often is possible for the claimed process to be defined broadly enough to include all practicable methods of competition.[143]

A sectoral variation in patenting appears to be related to those dimensions of analysis. As the empirical data presented in a related paper I authored with Tom Sager demonstrates, there is a strong variation in the rate of patenting by venture-backed firms in different sectors of the software industry.[144] For example, the average number of patents in the dataset was about 0.6 patents per firm.[145] Several sectors, however, had markedly higher rates, including graphics and digital imaging, expert systems and natural language, multimedia, and security.[146] At the same time, some relatively important sectors had unusually low rates of patenting, including email and

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140. Denniston Interview, *supra* note 91 ("Is there value in patenting lines of code? Almost never.").

141. *See* Interview with Dan Crouse, Deputy General Counsel, Microsoft Corporation, in Redmond, Va. (Feb. 4, 2003), at 1 (discussing the range of patent significance at different sectors of Microsoft's operations); D'Eath Interview, *supra* note 85, at 5 (contending that his firm's patents create a "competitive barrier," albeit not one of sufficient significance that it would interest investors); Telephone Interview with York Eggleston, Chief Executive Officer, Crane Technologies, Inc. (Apr. 23, 2003), at 1–2 (emphasizing the importance of patents to his company's development, but acknowledging that they are less important for most software companies); Jackson Interview, *supra* note 69, at 4 ("If you can get [patents that protect business methods or overall processes], I would say that that's quite important because of your ability to exclude others. . . . Not having a patent doesn't mean you can't build a business, but having a patent, in my view, certainly strengthens your position."). The perspective of a biotech executive was (as the data would suggest) starkly different: "Intellectual property in our industry is the number one reason people fund you or don't fund you." Telephone Interview with Steve O'Connor, Chief Executive Officer, Nanostream (Apr. 11, 2003), at 4.

142. *See* COHEN ET AL., *supra* note 18, at 10 (announcing the empirical finding based on cross-industry surveys that process patents are significantly less valuable than product patents). For a different categorization of software innovation, see Richard S. Gruner, *Better Living Through Software: Promoting Information Processing Advances Through Patent Incentives*, 74 ST. JOHN'S L. REV. 977, 984–87 (2000) (describing software advances as "based on new information processing ideas and insights").

143. Anonymous Semiconductor Executive Interview, *supra* note 58, at 12; Thomas Interview, *supra* note 109, at 2; Urdahl Interview, *supra* note 127, at 9; Witek Interview, *supra* note 58 (transcript unavailable).

144. Mann & Sager, *supra* note 103, at 7–8.

145. *Id.* at 5.

146. *Id.* at 22.

internet software, applications software, and financial software.[147] That variation is interesting because it can be discerned in a quantitative way even though patents are thought to be less valuable for software than they are for hardware, and even though patents are much less common in the software industry than in some other industries.

This is not a topic on which my interviews produced constructive results. I focused several of my interviews on firms known to me to have commercially valuable patents. Notwithstanding the discussion and empirical evidence above, executives of those firms that expressed a view as to why their patents were valuable generally believed it had nothing to do with the nature of the innovation. Rather, they attributed it to the firm's ability to obtain a patent that staked out a sufficiently large field to cover all plausible variations on the relevant technology.[148] Still, it seems likely that variation is related at least in part to the nature of innovation in different sectors, with higher rates of patenting associated with types of innovation more susceptible to appropriation by patent. However strongly my interview subjects rejected such a distinction, the data powerfully suggest that further inquiry is warranted. For now, my intuition is that the patterns of patenting rates most likely relate to the distinction between product firms (for which patents would be more useful) and service firms (for which patents would be less useful).[149]

Taken together, those two points portray a world in which small firms struggle to innovate, facing the pervasive concern that a competitor might appropriate any useful invention at any time. Given the difficulties those firms face in sustaining differentiation, the possibility that patents can provide shelter for some firms is important. The extent of shelter may be difficult to predict because it depends primarily on the breadth of market protection a patent has by the time it is issued.[150] Furthermore, the frequency of shelter is open to doubt; it plainly was not relevant to most of the firms that I interviewed. The interviews that I discuss above, however, do suggest that shelter is real in the place where its effect would be most important—in the minds of firms doing the innovation. It certainly would be valuable to

147. The variance in the number of patents each firm has, and in the likelihood that a firm will have any patents, is significant at the 1% level. *Id.* at ii.

148. Interview with David Oles, Chief Technology Officer, Pixel Magic Imaging, Inc., in San Marcos, Tex. (Feb. 25, 2004), at 2 (describing how some companies that hold valuable technology patents often "pitched" their companies' strategy of "aggressively filing" patents for "every way that we could think of [solving a technology problem]"); Thomas Interview, *supra* note 109, at 2 (analogizing the breadth of the Bluecurrent patent to control of all possible roads between Dallas and Oklahoma City, not just the major interstate).

149. Preliminary data from a project analyzing patenting practices for the largest 500 software firms suggest that the rate of patenting is negatively related to the share of the firm's revenues that comes from services. *See supra* note 30 (discussing the work of Michael Cusumano emphasizing the importance of that distinction to understanding business models in the software industry).

150. *See* Dinkin Interview, *supra* note 101, at 11.

know more about the frequency with which small firms obtain patents of sufficient strength to use in this way. However, even without quantitative information, it is difficult to believe that this is not a major part of what makes patents and their breadth an item of interest to investors.

b. Indirect Effects.—The most intriguing information from my interviews relates to patent benefits that do not involve direct exploitation of the patents. Those benefits fall into two classes: facilitation of a litigation-free zone through a pattern of cross-licensing; and a set of what I call "information" effects—beneficial effects that patents have on information related to the firm's technology.

(1) Facilitating a Licensing Equilibrium.—As suggested above, many in the industry completely deny any substantial use of patents to exclude competitors. Rather, the most prominent explanation for patents in the interviews was that patents are useful as "barter" in cross-licensing agreements that the firm enters if it reaches a sufficiently mature stage to be a significant player in the industry.[151] Those with whom I discussed the subject articulated a common vision of the way that firms gain access to protected technology in the industry: they obtain a cross-license from existing industry members that have patents related to their technology. To the extent that a growing firm has patents on its own technology, it can reduce the cost of licensing technology from existing market players by providing that technology as part of a cross-license agreement.[152] The likelihood that a firm will be asked at some point to enter such an agreement seems quite high. Interview subjects acknowledged, for example, that their products might infringe a patent in IBM's large portfolio of software

151. Gans, Hsu, and Stern provide a model indicating that this kind of cooperative licensing works better with stronger patents, which is consistent with the more pervasive reliance on cross-licensing in recent years. Joshua S. Gans et al., *When Does Start-Up Innovation Spur the Gale of Creative Destruction*, 2002 RAND J. ECON. 571, 572.

152. *See* Abbott Interview, *supra* note 106, at 6 (offering IBM as the example of a potential cross-license partner); Crouse Interview, *supra* note 141, at 2–3 (discussing the value to Microsoft of building a patent portfolio for defensive purposes); Gauer Interview, *supra* note 79, at 2 ("The patent comes in as a defensive mechanism down the road in the event that we stumble upon something else that we've infringed on so that we have our arsenal in order and can use it in a cross-license arrangement or the like."); Kalinoski Interview, *supra* note 109, at 4 (describing the use of a patent to offset a request from IBM to pay royalties); Rightmer Interview, *supra* note 84, at 1 ("[D]efensively, if we come to their attention, a patent might help us cross-license."); Subhedar Interview, *supra* note 78, at 2 ("You can usually trade, you can usually cross-license if you have patents, so as the company grows bigger, there is value to patent portfolios."); Treybig Interview, *supra* note 91, at 1 ("Patents may give them protection against the bigger company's patent portfolio. I mean, IBM has a room full of patents and it's huge, to the wall, ceiling, and on and on, so, it's somewhat protection against the bigger companies if they have to come after them."); Interview with Derek Witte, General Counsel, Silicon Valley Bank, in Santa Clara, Cal. (Feb. 6, 2003), at 1 ("And a classic case is IBM will show up and say, 'I have this huge portfolio and you must infringe some of mine because I have so many.' [If you have] some strategic technology to patent that they may infringe . . . [you can] use that as a shield.").

patents.[153] Yet, a patent to offset IBM's potential claim is of little value until IBM demands royalties, and IBM usually does not ask for royalties until a firm is earning sufficient revenues to justify the inquiry.[154]

As a matter of policy, it is difficult to know how to evaluate that arrangement. One perspective is that it reflects a classic instance in which sophisticated parties with repeat dealings can reach a state of equilibrium, operating in the shadow of the law with relatively little active conflict.[155] The premise is that firms with large portfolios will refrain from "mutually assured destruction" litigation—a situation produced by two large-portfolio firms in conflict. The destructive capacity of those portfolios is enhanced by the nature of technology in the industry, which could involve dozens of patentable innovations in any single product that a large firm might bring to market. From that perspective, it is natural to believe that litigation occurs most often when equilibrium fails, when someone other than an active developer holds the patents,[156] or when the developer fails and loses all incentive to cooperate.

More broadly, however, it is difficult to see how equilibrium can be regarded as a positive benefit attributable to patents. The only benefit that cross-licensing agreements provide is freedom from patent litigation. The cross-license agreements in question provide only freedom of action; they do not involve the disclosure of technology or transfer of any knowledge beyond material on the face of existing patents.[157]

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153. Rightmer Interview, *supra* note 84, at 1 ("IBM probably could sue us on 20 patents if they looked hard at what we do.").

154. *See* Abbott Interview, *supra* note 106, at 6 (suggesting that IBM only pursues companies "with a certain revenue baseline" and noting the need to get a patent "before you get on that radar"); Treybig Interview, *supra* note 91, at 2 (discussing value of a patent for cross-licensing once you get on IBM's "scope"); Voorhees, *supra* note 121 (discussing IBM's practices in eliciting licensing revenues); *see also* Gauer Interview, *supra* note 79, at 3 ("Most of the time . . . we're too small to bother with, but we have to have a strategy for how to deal with [IBM or another big company] when it comes up—what might we have to trade them for license rights when we get bigger.").

For a good example from the hardware industry, consider the early history of Dell, when IBM called seeking royalties shortly after the distribution of an early Dell product. Although those royalties were a "significant hit" to the bottom line, Dell quickly obtained a few patents of its own, which it used to alter the terms of its arrangement to one in which neither side pays royalties. Inman Interview, *supra* note 89, at 1–2.

155. The seminal discussion is Robert H. Mnookin & Lewis Kornhauser, *Bargaining in the Shadow of the Law: The Case of Divorce*, 88 YALE L.J. 950 (1979).

156. Thus, much of the offensive patent litigation in the industry is brought by patent holding companies that have no operating products and exist solely to collect licensing revenues for patents that they have purchased from inventors. *See* KEVIN G. RIVETTE & DAVID KLINE, REMBRANDTS IN THE ATTIC: UNLOCKING THE HIDDEN VALUE OF PATENTS 132 (2000); Dinkin Interview, *supra* note 101, at 11; Gauer Interview, *supra* note 79, at 3; Sikora Interview, *supra* note 85, at 1; Subhedar Interview, *supra* note 78, at 2; Witte Interview, *supra* note 152, at 1. For further discussion of that problem, see *infra* subpart VI(B).

157. Anonymous Semiconductor Executive Interview, *supra* note 58, at 8–12; Dinkin Interview, *supra* note 101, at 7–8.

I can postulate ways in which cross-licensing *might* provide net benefits. For example, patents might provide an effective way to evaluate the value of each firm's technology and thereby determine the amount and direction of payment that is appropriate for each cross-license. This might be particularly important in an industry, like the software industry, in which there are a large number of players with widely varying patent portfolios. By contrast, in an industry with a small number of relatively equal participants, a straight patent pool (without pair-by-pair determinations of value) would make more sense.

Those types of arguments, however, strike me as ad hoc justifications for a practice that at best simply reduces the transaction costs firms face in gaining access to patent-protected technology. We know little about the terms of license agreements in the industry, or even the frequency and extent to which license agreements involve the payment of license fees. We do know, however, that it cannot be costless to acquire the patents that firms use to enhance their licensing position. If those costs are incurred solely to minimize the costs of patents that other firms have, and if patents provide no other benefit, then it seems plain that patents are not providing any net benefit to the industry. Thus, however pervasively they were discussed in my interviews, and however important they are to understanding actual patenting practices, I do not give great weight to the benefits of cross-licensing as a policy justification for patents in the industry.

(2) Information Effects.—The last set of effects relates to information generated through a firm's participation in the patent system. Moving along the course of a firm's development, these effects fall into three classes: (A) the ability of patents to facilitate the firm's efforts to codify tacit knowledge, (B) the firm's subsequent ability to signal the discipline and technical expertise that allowed it to codify that knowledge, and (C) the use of the patent as a signal of the underlying technology.[158]

Facilitating the Codification of Tacit Knowledge. One of the most intriguing benefits of patents relates to Ashish Arora's recent writings on innovation. He argues that a key problem in transferring knowledge between firms is the ability to convert tacit knowledge—which is difficult to verify or transfer—into codified knowledge, which can be readily evaluated and transferred.[159] Because a patent by definition—at least if it satisfies the statutory criteria—includes the knowledge necessary to enable a person having

158. For a thorough discussion of the value of patents as signals, see Clarisa Long, *Patent Signals*, 69 U. CHI. L. REV. 625 (2002). PARCHOMOVSKY & WAGNER, *supra* note 21, at 15–18 discounts the value of signaling largely because the authors do not believe that patents generally signal anything important about a firm or its technology. The discussion in the text explains why patents do convey valuable information in this context, and thus sidesteps Parchomovsky and Wagner's concern.

159. ASHISH ARORA ET AL., MARKETS FOR TECHNOLOGY: THE ECONOMICS OF INNOVATION AND CORPORATE STRATEGY 95–99 (2001).

ordinary skill in the relevant art to replicate the invention, the existence of a patent is strong evidence both that there is substantial knowledge *of some kind* and that the knowledge is not so bound up with the abilities of particular individuals as to be immovable.

To the extent that a patent facilitates that process, it can provide real benefits to the firm: codification of knowledge enhances its transferability and thus its value.[160] This analysis has found its way recently into the law review literature in Paul Heald's work on transaction costs and patents.[161] More generally, the idea resonates with the notion that productive assets can have no value until they have been brought into a documentary system in which they readily and reliably can be transferred from person to person.[162] Thus, although my interview subjects do not discuss "codification" of knowledge, they do emphasize the importance that patents play in the acquisition of a startup firm.[163] It seems plain to me that there is more work to be done in understanding how patents facilitate the transfer of knowledge—and whether alternate systems could serve the same purpose without the costs of exclusivity. I discuss those questions briefly below,[164] but it is clear that more research is necessary to formulate any definitive views on the topic.

Signaling Discipline and Expertise. Once knowledge has been codified in a patent, the existence of the patent itself can send a signal regarding the skills necessary to obtain it, primarily engineering discipline and market understanding. The premise is that firms that obtain patents tend to be more careful in their engineering work and have a better understanding of what is special about their products than competitors that do not have patents. One serial startup developer explained:

> [I]n my experience, all a software patent buys you is the fact that you are disciplined in your engineering approach and that it is reflected in your ability to execute technically. Not that it is a means of protection

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160. *Id.*

161. Paul J. Heald, *A Transaction Costs Theory of Patent Law*, 66 OHIO ST. L.J. (forthcoming 2005).

162. *See generally* HERNANDO DE SOTO, THE MYSTERY OF CAPITAL: WHY CAPITALISM TRIUMPHS IN THE WEST AND FAILS EVERYWHERE ELSE (2000) (arguing that the lack of systems for the documentation of property rights in developing nations prevents such countries from generating capital off of their assets and creates barriers to the success of capitalism in non-Western countries).

163. *See* Beauchamp Interview, *supra* note 95, at 5 ("It is a tangible asset that during an acquisition, the investors can hold up to make the argument that they can increase the valuation of the company."); Lee Interview, *supra* note 78, at 2 (discussing the "knowledge you get beyond the patent"). That perspective appears to be justified—to a limited extent—by the attitudes of people at potential acquirers. *See* Crouse Interview, *supra* note 141, at 2–3 (discussing the importance of patents in Microsoft acquisitions); Van Arsdale Interview, *supra* note 95, at 1 (same); Witte Interview, *supra* note 152, at 4 (suggesting that a typical patent would be "asset number 31" in the list of important assets being acquired).

164. *See infra* subpart VI(A).

> for the investors to believe that you're gonna be the only person that's gonna be able to solve this particular problem.[165]

Those who articulate this line of reasoning generally view the signal as a true one—a plausible indicator of valuable information about the firm that otherwise would be difficult to discern.[166] Notice, of course, that this use of patents says nothing about the uniqueness of the technology or the firm's ability to exclude competitors. Rather, it reflects something positive about the ability of the management team to focus and execute. That does not mean, however, that the signal is not taken seriously. As discussed above, many investors think that inadequate market analysis and execution are among the most common reasons startup companies fail.[167]

Signaling Technology. When a firm reaches the stage at which it considers acquisition or a public offering, its patents may send a more direct signal regarding the underlying technology. As the discussion below explains in more detail, larger firms are likely to value patents for reasons quite different from those that motivate small firms; larger firms value patents because they facilitate freedom of action by helping the company avoid claims of infringement.[168] Thus, investors consider the existence of a patent to play a key role in influencing the "build-or-buy" decision of a larger company. The hope is that the potential cost of patent infringement will make it cheaper for the larger company to purchase the portfolio company rather than build the technology in-house.[169] Even in these situations,

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165. Beauchamp Interview, *supra* note 95, at 4.

166. *See* Gauer Interview, *supra* note 79, at 2. Gauer remarked:

> The fact that they were working on something that might be patentable does tend to be tied with them working on new problems and suggests that they are up on the leading edge of people tackling the kind of problems in which we'd like to invest. The patent itself, however, isn't the point. . . . The fact that people may have patentable work tends to correlate with working in new areas and being world-class in those areas but I would never make an investment decision based on whether there is a patent or not or whether I thought a patent application would be successful.

Id.; *see also* Treybig Interview, *supra* note 91, at 1 ("[P]atents give you some idea of 'are these smart people I'm dealing with, that want to start this company?'").

167. The focus on the importance of execution is exemplified by the current New York Times bestseller LARRY BOSSIDY & RAM CHARAN, EXECUTION: THE DISCIPLINE OF GETTING THINGS DONE (2002), a fixture on the desks of the startup executives I interviewed.

168. Claims of infringement might be more of a concern for a large firm because its revenue base is so much larger; even a small royalty percentage could result in significant damages. The recent Eolas case against Microsoft is a good example. Eolas received a $500 million verdict for technology that affects, at most, a tiny portion of Windows Explorer. Hiawatha Bray, *Few Celebrate This Defeat for Microsoft*, BOSTON GLOBE, Sept. 22, 2003, at C3. One report calculated that the dispute involved only 305 lines of the 56 million lines of code in Windows, but the plaintiff still received a royalty of $1.47 for each copy of Windows. *Id.* Viewed on a pro rata basis, this judgment would suggest a value per copy of Windows of about $500,000. *Id.* It is worth noting that the technology in question was invented at the University of California. The patent was licensed to Eolas, but the University of California will receive 25% of the proceeds from the litigation. Michael Kanellos & Jim Hu, *Microsoft Ordered to Pay $521 Million*, CNET NEWS.COM, *at* http://news.com.com/2100-1012-5062409.html (Aug. 11, 2003).

169. *See supra* note 163.

however, it is clear that the sophisticated acquirer focuses on the business model the company has adopted and whether that model makes sense apart from the IP that might protect the underlying technology.[170] For example, consider the following comments about Google (a firm that, incidentally, has two patents):

> Do you think the big asset for Google is patents? No, it's a business model that's working and making money. Do you think patents are something they're not being stupid about[?] They're filing patents and being careful on the off fear that Microsoft might sue them. Do you think they've built into their S-1 or their business plan that they plan on using their patent portfolio directly? No way.[171]

That same explanation can be seen in a much more negative way if it is thought that patents will not ultimately bring value to the balance sheet of an acquiring firm. This view of the role of patents in acquisition characterizes them as valuable for "marketing,"[172] convincing investors in public markets that the company's technology is valuable.[173] The idea is that sophisticated investors at the early stage can evaluate the "true" value of the technology based on a careful analysis of such factors as the company's product, the customers' needs for that product, and the personnel the company employs to execute its business plan. Thus, the patent has only secondary significance to those investors. Customers or later-stage investors, by contrast, are said to be less willing to undertake such careful evaluations.[174] Thus, the argument goes, they tend to rely (less thoughtfully) on the mere existence of patents in the company's portfolio.[175] That argument is made particularly with respect to protecting the downside in the event of a company's failure.[176]

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170. *See* Van Arsdale Interview, *supra* note 95, at 2 ("I don't go look at a company on the basis of its patent strength . . . . I go and look at it on the basis of its business model and its customer appeal.").

171. *Id.* at 3.

172. In contrast to the "signal" that the patent provides to the sophisticated investor, from this negative perspective, the value of the patent is characterized as "optical"—something that enhances the appearance of the company but does nothing for the underlying economics or prospects of the firm. *See* Abbott Interview, *supra* note 106, at 5 (describing patents as "optical component[s]" for his firm). Ann Bartow makes this point vigorously. Ann Bartow, *Separating Marketing Innovation from Actual Invention: A Proposal for a New, Improved, Lighter, and Better-Tasting Form of Patent Protection*, 4 J. SMALL & EMERGING BUS. L. 1, 8–9 (2000).

173. *See* Weghorst Interview, *supra* note 83, at 4 (discussing "marketing leverage" with investors).

174. *See* Interview with Timothy Costello, President & CEO, Builder Homesite (Nov. 26, 2002), at 1 (describing his company's patent as "more valuable from a marketing standpoint than anything"); *see also* Abbott Interview, *supra* note 106, at 5 (explaining that "the stack of patents . . . [is] something to value [the company] on").

175. *See* D'Eath Interview, *supra* note 85, at 5 (explaining that his firm's patents would be important to potential acquirers though probably not to venture capital investors).

176. *See* Interview with Andy Enroth, Senior Credit Officer, Silicon Valley Bank, in Austin, Tex. (Jan. 9, 2003), at 1 (discussing a "perception that's around that if you have patented something that there's really got to be some level of perceived value there, so if you're liquidating it there is a

Interestingly, developers often present a similar argument about venture capitalists, arguing that companies obtain patents that have no real value to them, in part because they will look good to venture capitalists.[177] The truth of that view in any particular context is of course difficult to assess.

4. Patents and Large Firms.—Although the bulk of my interviewing base is small venture-backed startups, the interviews and publicly available information do provide enough information to give a good idea of the role that patents play in large firms. Because much of the information is plain from the discussion above, I discuss that topic briefly solely to complete the picture.

First, as discussed above, large firms gain *relatively* little through litigation or the exclusion of competitors from patented spaces because large firms often can compete successfully with small firms without excluding the competitor. The saying that "nobody ever got fired for buying IBM [or Microsoft]"[178] is not baseless, and in a contest between IBM and a small startup, both with equivalent products, IBM (or Microsoft) often will prevail. In contests among large firms, litigation is rare because of cross-licensing of portfolios.[179]

Second, patents provide considerable benefits to large firms by enabling them to participate in cross-licensing agreements that give them the freedom of action to design and deploy products as they wish, without regard to the IP portfolios of competitors. It may be, as I argue above, that large firms that use their portfolios solely for that purpose would be better off without the

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different level of ability to get some value out of that compared to something that is viewed as not proprietary"); Inman Interview, *supra* note 89, at 1 (discussing "residual value" in intellectual property that returned some value to investors when a startup failed in the market); Stephenson Interview, *supra* note 92, at 1 ("IP is something that in the downside case we can sell off and make something.").

177. *See* Abbott Interview, *supra* note 106, at 5 (noting that "one of the few ways that [venture capitalists] can evaluate [a firm] is to look at [its] patent portfolio"); Rightmer Interview, *supra* note 84, at 7 (saying that patents are useful as "[p]urely defensive or to establish value to a venture capitalist").

178. *See supra* note 133.

179. As discussed below, that equilibrium may not be stable in the presence of trolls. Some (but not all) of the large firms in the industry are engaged in a program to purchase patents that otherwise might find their way into the hands of trolls. Among others, investors include Microsoft, Intel, eBay, Sony, and Google. Edward Khan, *Patent Mining*, INTELL. ASSET MGMT., July/August 2003, at 7, 9–10, *available at* http://www.m-cam.com/downloads/IAM_patentmining.pdf. It appears that the large firms that declined to participate in that program (including companies like Yahoo! and Amazon) have reason to expect that they will be asked to pay royalties for using the technology covered by the patents acquired in that process. *See* Brad Stone, *Factory of the Future?*, NEWSWEEK, Nov. 22, 2004, at 60 ("[Intellectual Ventures, the company buying patents on behalf of investors,] could demand licensing fees from its investors' rivals, companies like Yahoo and Amazon.").

costs of developing and maintaining those portfolios, but in the existing milieu, each firm has a strong incentive to collect patents for that purpose.[180]

Third, many—though certainly not all—large firms obtain substantial revenues from directly exploiting their patent portfolios. IBM, for example, earns literally billions of dollars each year exploiting its patent portfolio; a significant share of the revenue comes from its software patents.[181] Thus, although different firms have different strategies, the potential for large firms to earn substantial revenues from direct exploitation of patents does exist. Information about the amount of those revenues would be valuable in assessing the net effect of patents, but that data is not readily available.

C. Summary

Much remains unclear about the ability of patents to induce commercialization in the software industry. For example, although the ability of small firms to use patents to protect themselves is important, it is difficult to tell from the available data how widespread that benefit is. If it is widespread, then it may contribute to the fragmented and highly competitive structure of most sectors of the software industry by providing startups a sufficient time to commercialize their products without competition.[182] Similarly, it is difficult to disentangle the local effects that motivate firms to obtain patents—as cross-licensing collateral, for example—from the direct effects and the information effects that might provide a justification for the system as a whole. Further, any understanding of those effects must account for the differentiation of their weight as firms progress through the development cycle. Finally, even if those effects elicit funds for the firms that have patents,[183] we cannot be sure that they increase total investment. It

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180. This discussion should make clear that my understanding of the value of these portfolios is quite different from that of Parchomovsky and Wagner, who argue that firms in general, and IBM in particular, build portfolios largely for the purpose of increasing the likelihood that later in-house innovation will be protected. PARCHOMOVSKY & WAGNER, *supra* note 21, at 30–31, 44–48. That argument reflects a fundamental misunderstanding of patents, at least as they work in the software industry. No matter how many patents IBM has in its portfolio, and no matter when it got them, it is entirely possible—indeed likely—that Microsoft would have patents that successful IBM products would infringe. The only stable equilibrium response of IBM is to obtain a sufficiently large portfolio of patents to induce Microsoft to enter into a formal or informal cross-licensing arrangement under which neither side will sue the other for patent infringement.

181. *See infra* note 252 (discussing software patent licensing by IBM).

182. This effect resonates with the analysis in Ashish Arora & Robert P. Merges, *Specialized Supply Firms, Property Rights and Firm Boundaries*, 13 INDUS. & CORP. CHANGE 451, 470–71 (2004), suggesting that strong IP rights facilitate organization of an industry with independent suppliers rather than integration into an existing firm. *But see* PARCHOMOVSKY & WAGNER, *supra* note 21, at 64–65 (arguing that the rise of patent portfolios favors large incumbent firms over small entering firms).

183. Bessen & Hunt, An Empirical Look, *supra* note 8, at 17 & tbl.5 finds that newer firms are less likely to get software patents than older firms. Because Bessen and Hunt's database involves larger firms, however, even their "newer" firms apparently are larger and older than the oldest of the

is also possible that they simply alter the direction of investment towards patent-protected investments without altering the total amount of investment.[184] Another possibility is that larger firms against whom small firms' patents are enforced would have invented the same products almost as quickly. If so, then small firms' patents may be imposing costs on the industry that exceed the value of the innovation they stimulate.

To clarify the overall import of the discussion, Table One summarizes these effects. As that table shows, my research indicates a basic tradeoff between several effects that are not readily quantifiable. The major burden I discern is the acquisition and use of patents for cross-licensing purposes, which seems to be a deadweight loss for the industry. On the other side are three benefits. The first two largely accrue to later-stage startups: the benefits patents provide in sheltering those firms and the information benefits patents deliver to later-stage startups. Both of those are difficult to quantify: the first because it depends on an understanding of whether and to what extent the startup firms invent technology sooner than large firms would have invented it without a patent system, and the second because it is almost inherently subjective. The third benefit is the potential licensing revenues that accrue most commonly to IBM and other large firms. That might not be difficult to quantify but, as discussed above, it is not something about which quantitative data is easy to locate.

TABLE ONE: POSITIVE EFFECTS OF PATENTS

	Prerevenue Startups	*Later-Stage Startups*	*Large Firms*
Litigation	Impractical	Useful	Unnecessary
Resources	Scarce	Available	Bountiful
Exclusion Benefits	None	Large	Minimal
Licensing Benefits	Rare	Occasional	Varied
Cross-Licensing Benefits	None	Potential	Large
Information Benefits	None	Significant	Trivial

venture-backed startups that I consider. Accordingly, I doubt that their findings affect my analysis here.

184. Moser provides historical empirical evidence which supports that possibility. MOSER, *supra* note 17, at 23–33 (examining data on inventions exhibited at nineteenth century World's Fairs and finding that a country's patent laws affected the type of inventions but not the number of inventions originating from the country).

IV. Potential Costs of Patents in the Software Industry

A. Patent Thickets

The literature criticizing software patents for the most part focuses on a single potential problem: the costs that patents impose when they exclude third parties from development. Most famously, Larry Lessig argues that the proliferation of software patents has created an "anticommons"—a term Lessig draws from Michael Heller's work with Becky Eisenberg[185]—or a patent "thicket" (Carl Shapiro's term[186]). Lessig supports this claim largely by reference to the work of Jim Bessen (by himself and with other co-authors).[187] Specifically, the concern is that there are so many overlapping patents in the industry that potential innovators cannot readily obtain the approvals necessary to conduct their research.[188] The thesis gains some credibility from the nature of software innovation because, as explained above, a software product might involve dozens of innovations and several firms might hold patents on one or more aspects of a firm's technology.

I address first the claim that proliferation of patents has stifled R&D spending. I then address the anecdotal claim that a thicket of patent claims deters small firms from pursuing promising innovations.

1. R&D Spending.—The two papers advancing the claim that patents have stifled R&D spending are Bessen's unpublished papers with Maskin,

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185. Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698, 698–99 (1998) (arguing that an increase in private intellectual property rights in biomedical research may reduce the total amount of such research). Formal economic modeling of this problem appears in James M. Buchanan & Yong J. Yoon, *Symmetric Tragedies: Commons and Anticommons*, 43 J.L. & ECON. 1, 5–10 (2000); *see also* Francesco Parisi et al., *Duality in Property: Commons and Anticommons*, INT'L REV. L. & ECON. (forthcoming 2005) (applying the commons and anticommons model to intellectual property), *available at* http://papers.ssrn.com/abstract=224844.

186. I use the term from the extended discussion in Shapiro, *supra* note 6, at 1. That discussion is considerably more guarded than Lessig's. Shapiro simply notes the possibility of a thicket and discusses how it might arise and what its effects might be.

187. *See generally* Bessen, *Patent Thickets*, supra note 6 (demonstrating that non cost-related aspects of patent thickets can reduce innovation); Bessen & Hunt, An Empirical Look, *supra* note 8, at 39–40; Bessen & Maskin, Sequential Innovation, *supra* note 6 (arguing that aggressive patent protection may inhibit valuable forms of imitation). Bessen's relevant work is unpublished. I respond to it here because it has been widely cited even in its unpublished form. A search on Westlaw in July of 2004 found 22 citations to Bessen & Maskin, Sequential Innovation, *supra* note 6. Kash and Kingston ultimately rest their criticisms of patents in complex industries on a similar concern, that large firms will "intimidate" outsiders and prevent them from competing. Kash & Kingston, *supra* note 7, at 16–17.

188. Heller and Eisenberg argue that a similar condition afflicts the biotech industry. Heller & Eisenberg, *supra* note 185, at 699–700. For a contrary view, see John P. Walsh et al., *Effects of Research Tool Patents and Licensing on Biomedical Innovation*, *in* PATENTS IN THE KNOWLEDGE-BASED ECONOMY 285, 297–305 (Wesley M. Cohen & Stephen A. Merrill eds., 2003) (finding that biomedical researchers do not report that intellectual property issues impede research progress). For a rebuttal, see Arti K. Rai & Rebecca S. Eisenberg, *Bayh-Dole Reform and the Progress of Biomedicine*, 66 J.L. & CONTEMP. PROBS. 289 (2003).

Sequential Innovation, Patents, and Imitation,[189] and with Hunt, *An Empirical Look at Software Patents*.[190] Bessen and Maskin compare a dataset of software patents—defined by patent classes—held by large publicly traded firms to R&D expenditures of those firms.[191] They find a correlation between increases in software patenting and declining R&D expenditures.[192] The evidence, however, terminates in 1995—a very early stage of the software industry—and includes only leading software patentees, rather than leading firms in the industry.[193] Thus, their dataset includes companies like Ford, General Electric, and Japanese firms like Mitsubishi and Matsushita, but excludes companies like Microsoft and Oracle, which were not large software patentees at that time.[194] Furthermore, given the limited importance of software development to the firms they examine, it seems important to determine the amount of R&D spending those firms allocate to software development; Bessen and Maskin are unable to do so with the Compustat data on which they rely. More fundamentally, the basic object of the Bessen and Maskin paper is not to analyze the software industry specifically, but to analyze firms that obtain software patents. As they explain in the paper, the software industry is not the principal industry that obtains those patents—so their paper does not specifically address the relation between patents and R&D in that industry.

Bessen's more recent paper with Robert Hunt collects a dataset of patents based on key words that are reasonably likely to reflect software innovation.[195] The paper plainly reflects the most serious effort to date to collect a dataset of software patents; the authors have collected all patents including the relevant key words from 1976 to 1999—about 131,000 patents.[196] Most of the patents in their dataset are assigned to large manufacturers.[197] Software publishers own only five percent of the patents in their dataset. Their dataset also excludes most private firms.[198] Thus, they do not analyze the firms that generate about one-third of the successful patent applications they collected from the PTO database.[199] The primary finding of

189. Bessen & Maskin, Sequential Innovation, *supra* note 6.

190. Bessen & Hunt, An Empirical Look, *supra* note 8.

191. Bessen & Maskin, Sequential Innovation, *supra* note 6, at 7–24.

192. *Id.* at 35–39.

193. *Id.* at 49.

194. *Id.*

195. Bessen & Hunt, An Empirical Look, *supra* note 8, at 8–10.

196. *Id.* Their wordsearch methodology produces results that are similar to, though slightly broader than, the methodology John Allison and I are using in our work to identify software patents by direct examination of the patents.

197. *Id.* at 15.

198. Their sample starts with firms that were listed on CompuStat as of 1989, and is supplemented by adding the 25 largest publicly traded software firms and an unspecified number of private firms based on data provided by CHI Research, Inc. *Id.* at 12. Finally, they matched an additional 100 of the largest R&D performers to their patents. *Id.* at 12–13.

199. *Id.* at 13.

Bessen and Hunt of relevance here is that the propensity to patent has increased in the software industry since the late 1980s.[200] For the reasons discussed in Part II, that finding is not surprising.[201]

Bessen and Hunt also analyze the relation between R&D spending and patenting, concluding that the data is consistent with the view that patents are a substitute for R&D spending. The implication is that R&D spending would be higher if changes in the law had not made software patents more attractive.[202] They conclude that the results are more consistent with strategic patenting than with incentive effects of patents.[203] Although the data is intriguing and the analysis considerably more robust than that in the Bessen and Maskin paper, the paper has the same basic focus on software patents rather than the software industry. As Bessen and Hunt emphasize, "software patenting [as they define it] by and large has little to do with the pre-packaged software industry."[204] Rather, their emphasis is on the other industries in which many software patents are held.[205] Thus, because such a large portion of the dataset lies outside any plausible boundary for the software industry, it is entirely possible that their findings reflect issues of firm governance and industrial structure that have little to do with the software industry.[206] Also, as in the earlier paper, the analysis relies exclusively on data about relatively large firms and thus has almost no overlap with the topic of relevance here: whether patents held by large firms stifle investment in software startups. Thus, at most the paper establishes doubts about the role patents play in large public firms. The preceding sections of this Article, of course, articulate a similar degree of skepticism about those benefits.[207]

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200. *Id.* at 21–22.

201. For a similar result using a dataset that focuses on the software industry, see Graham & Mowery, *supra* note 8.

202. Bessen & Hunt, An Empirical Look, *supra* note 8, at 27–34.

203. *Id.* at 38–40.

204. *Id.* at 38.

205. It is important that the significant effect they find in the two-digit SIC code 73 (which would include much of the software industry) would disappear if IBM's data were removed. *Id.* at 34 n.40.

206. For an example, consider the literature on the relation between market power and the incentive to innovate. *E.g.*, Federico Etro, *Innovation by Leaders*, 114 ECON. J. 281 (2004) (arguing that parties with monopoly power in industries with sequential innovation may have a *greater* incentive to invest heavily in R&D than outsiders in the industry); *see also* Luis Cabral & Ben Polak, Does Microsoft Stifle Innovation? Dominant Firms, Imitation, and R&D Incentives (July 2004) (unpublished manuscript) (arguing that increases in the dominance of a firm increase the incentive of that firm to engage in R&D, but lower the amount of industry R&D overall because of a reduction in duplicative research), *available at* http://papers.ssrn.com/abstract=604466.

207. I note also that Robert Hahn and Scott Wallsten have disseminated a trenchant methodological critique of Bessen and Hunt's work. Robert W. Hahn & Scott Wallsten, A Review of Bessen and Hunt's Analysis of Software Patents 14–17 (Nov. 2003) (unpublished manuscript), *available at* http://papers.ssrn.com/abstract=467484. It is beyond the scope of this paper to assess the technical statistical questions at the heart of that debate. Suffice it to say that Bessen and Hunt have responded forcefully to Hahn and Wallsten's criticisms. *See* James Bessen & Robert M. Hunt,

Against these studies, which suggest a puzzling relation between software patents and overall R&D outside the software industry, it is easy to examine data that directly describes the current state of R&D in the software industry. That data suggests a different picture, one in which software R&D is impressively robust. For example, *Technology Review*'s Corporate R&D Scorecards report the annual research and development spending of the world's top 150 technology companies.[208] Each company is assigned to one of 12 sectors based on its primary business.[209] The scorecard figures are derived from annual reports and U.S. Securities and Exchange Commission filings.[210] Data from the Scorecards indicate that R&D spending for the software industry is higher than in similar high-tech industries. For example, R&D spending as a percentage of revenues in the software industry for 2002 was 14.5%.[211] By way of comparison, R&D spending in the same period was 6.7% for computer hardware, 7.4% for electrical/electronics, and 8.1% for telecommunications.[212] Thus, for the top technology companies, the R&D intensity ratios are high in the software industry in comparison to other industries.[213] National Science Foundation data regarding industrial R&D intensity provides a similar picture. That data shows that R&D intensity for firms in the software industry (NAICS code 5112) was 19.3%, 20.0%, 16.8%, and 20.5%, for the years 1997–2000, respectively.[214] This is far above the average for all industrial R&D firms of about 3.6%.[215] Indeed, according to the National Science Foundation, the software industry for the past four years has had an R&D intensity substantially higher than any industry other than Scientific R&D Services (NAICS code 5417).[216] Because software development does not depend heavily on the existence of manufacturing facilities and other fixed assets, those high figures should not

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A Reply to Hahn & Wallsten (Mar. 10, 2004) (unpublished manuscript), *available at* http://www.researchoninnovation.org/hahn.pdf.

208. *See, e.g.*, *Corporate R&D Scorecard 2002*, TECH. REV., Dec. 2002/Jan. 2003, at 60.

209. *Id.*

210. *Id.*

211. *Id.* at 61. It was 14% in 2001 and 14.5% in 2000. *Id.* This figure seems to have been quite stable over time. Prominent industry estimates in the early 1980s suggested that the costs of "program development" were at that time about 15% of revenues. CAMPBELL-KELLY, *supra* note 22, at 211 fig. 7.1.

212. *Corporate R&D Scorecard*, *supra* note 208, at 61–63.

213. Examples from other countries do not seem to be useful. For example, the software industry in Europe—where patent protection is considerably more ambiguous than it is here—is strikingly underdeveloped compared to the United States. *See* CAMPBELL-KELLY, *supra* note 22, at 22–23. However, it is plain that the relative levels of development can be attributed to historical factors that have little to do with patent protection. *See id.* at 103–11; Mowrey, *supra* note 1, at 147–49.

214. NATIONAL SCIENCE FOUNDATION, DIVISION OF SCIENCE RESOURCE STATISTICS, RESEARCH AND DEVELOPMENT IN INDUSTRY: 2000 (2001).

215. *Id.*

216. *Id.*

be surprising. However, it is hard to credit the argument that R&D spending in the industry is systemically depressed.

As the data shows, software R&D spending tends to be relatively stable over time as a percentage of sales. Indeed, company size seems to be more important in explaining variations in R&D spending within the industry. For example, data from Compustat indicates that median R&D spending for large public companies (over $100 million in sales) in SIC 7372 (prepackaged software) is only 15.9% of net sales, while mid-sized firms (between $30 million and $100 million) spent 22.6%, and small firms (under $30 million) spent 32.8%.[217] Those figures have not changed substantially over the last three years.[218] The Software 500 provides similar statistics for the 500 largest firms in the industry, including both public and private firms. For 2001, firms with more than $100 million in sales had an average R&D intensity ratio of 12.83%,[219] firms with sales between $30 and $100 million had an R&D intensity of 20.49%, and firms with less than $30 million in sales had an R&D intensity of 23.89%. If patents facilitate a fragmented industry structure by sheltering small firms, they may help to support the high level of R&D spending characteristic of those firms.[220]

The questions that Bessen, Maskin, and Hunt raise are answered best by looking at patenting practices and R&D spending in the software industry. That work, however, is beyond the scope of this Article. For now, perhaps the most that can be said with clarity is the basic point with which I began this section: the patent system is not systematically preventing the initiation of product development. Beyond that, it is plain that the system is functional. In the world that we have—which includes patents—there are literally hundreds of small firms using institutional financing to develop new technologies. The smaller firms are spending relatively more on R&D than the bigger firms. It is as difficult to be sure that all of those firms would exist if there were no patent protection as it is to be sure that there would not be even more firms if there were no patent protection.

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217. Compustat is a database available from Standard and Poor's at http://www.compustat.com.

218. 2001: 16.5%, 26.9%, 41.7%; 2000: 15.9%, 28.0%, 52.4%; 1999: 15.1%, 20.0%, 41.4%. R&D intensity is much higher in SIC 7372 than in the rest of the 7370s (at least for larger firms). The average R&D intensity of the other firms in the 7370 series (in 2002) was 7.10% for large firms, 13.5% for medium firms, and 34% for small firms. The average R&D intensity in the 7370 series as a whole was 9.2% for large firms, 17.7% for medium firms, and 38.5% for small firms.

219. IBM's R&D intensity is far below the industry average—6% in 2001, 5.8% in 2000, and 6% in 1999—although it amounts to more than $5 billion each year, while Microsoft's is considerably above the average: 17% in 2001, 16.3% in 2000, and 15% in 1999 (about $3.8 billion each year).

220. I do not mean to suggest here that higher R&D spending is optimal. It is of course possible that R&D spending in the software industry is higher than the optimal level. I only mean to rebut the idea that the proliferation of software patents has stifled R&D spending in any measurable way.

2. Stifling Small Firms.—Turning from the empirical evidence about R&D spending to the more fundamental question of industry practice, my interviews and the publicly available information I have located about the industry make it difficult to credit the idea of a "thicket" or "anticommons" in the software industry.[221] When raised in my interviews, that thesis universally was rejected.[222] The premise of the model is that assets will go unused because of the costs of obtaining the permissions necessary to use them.[223] There is of course nothing theoretically impossible about that outcome. The important question, however, is whether this is in fact what has happened in the software industry.

A few objective indicators suggest that the patent thicket thesis has little to contribute to an understanding of the software industry. For one thing, *none* of the startup firms to which I spoke suggested a practice of doing prior art searches before beginning development of their products.[224] As far as I can tell, the only occasion in the software industry in which a startup is likely to experience such costs is when the startup is founded on a specific piece of existing technology spun off from an existing company or from a university laboratory.

For another thing, no investor suggested any concern about the possibility that their portfolio firms might be infringing the IP of others in the industry. That is not because they were sure that the startups were not infringing; it was because they thought it was unlikely to pose a significant difficulty if they were. As discussed above, industry executives do accept

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221. My reactions are based on the history and practices of the software industry. More generally, Rob Merges has long championed the idea that contracting practices often will ensure the effective dissemination of IP throughout an industry. *E.g.*, Merges, *Institutions*, *supra* note 17, at 140–46; Merges, *Contracting into Liability Rules*, *supra* note 17, at 1296–97. His current project extends that line of reasoning to private investments in the public domain. He contends that those investments have the potential to limit potential costs from "overpropertization," particularly in the software industry. Merges, *New Dynamism*, *supra* note 17, at 185–86.

222. *See, e.g.*, Abbott Interview, *supra* note 106, at 10; Beauchamp Interview, *supra* note 95, at 6; Eggleston Interview, *supra* note 141, at 6; Subhedar Interview, *supra* note 78, at 3; Treybig Interview, *supra* note 91, at 7–9; Weghorst Interview, *supra* note 83, at 6.

223. *See, e.g.*, Buchanan & Yoon, *supra* note 185, at 4. At its core, the thicket analysis is an analogy to a post-Gorbachev apartment in Moscow that would sit vacant because of the inability of any particular user to obtain consents from all of the various parties with interests in the apartment. *See* Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621, 647–50 (1998) (offering that example, among others).

224. *See* Interview with Thomas A. Harlan, Chief Executive Officer, Emergent Technologies, in Austin, Tex. (Nov. 19, 2003), at 2–3; Thomas Interview, *supra* note 109, at 1; Urdahl Interview, *supra* note 127, at 7. Mark Lemley and Ragesh Tangri point out that startup firms have a strong incentive not to do such searches, both because the results must be included in later patent applications and because they can affect the determination of willfulness in later litigation. Mark A. Lemley & Ragesh K. Tangri, *Ending Patent Law's Willfulness Game*, 18 BERKELEY TECH. L.J. 1085, 1100–02 (2003); *see also* FTC REPORT, *supra* note 6, at 49–50. Conversations with industry professionals suggest that Lemley and Tangri's explanation is consistent with industry practice and with the advice that leading law firms provide their clients. *See, e.g.*, Telephone Interview with Brian O'Higgins, CTO, Entrust Inc. (Nov. 13, 2003), at 6; Urdahl, *supra* note 127, at 15.

one premise of the patent thicket thesis: that software patents are multiplying so rapidly that it is likely that many products that startups develop ultimately will infringe patents held by large existing companies.[225] The textbook example is IBM, which apparently holds far more software patents than any other company in the industry. Indeed, as I explained above, several of my interview subjects joked that they thought it likely—without any investigation or particular knowledge—that their product did infringe *something* in IBM's portfolio.

Yet that poses no significant concern for those firms. It is perhaps an artifact of the particular history of the industry, but IBM has firmly set a course of *relatively* lenient enforcement of its IP rights.[226] The lenience of its practices is attributed to an attitude developed during its long subjection to government antitrust scrutiny, an attitude of wishing to refrain from conduct that would interest federal antitrust regulators in its practices.[227] It is now a circumstance long forgotten by many (as IBM is now regarded most prominently as a dominant hardware manufacturer), but there was a time when IBM's dominance in the software market was as complete as any dominance it has had in the hardware market.[228] Indeed, the most authoritative history marks the beginning of the commercial software industry as the date when IBM began to sell its proprietary software unbundled from its hardware products.[229] If the antitrust litigation tempered IBM's willingness to press its advantages to their fullest, it has limited the rise of a patent thicket in the industry.

IBM's relative lenience also is attributed to the asymmetric risks IBM faces in patent litigation. A finding that IBM's widely distributed products infringe a valid patent is likely to cost IBM much more than a finding of infringement by a small party with a limited customer base involved in litigation with IBM.[230]

That is not to say that IBM allows people to use its IP freely.[231] It is to say, however, that licenses to use its IP are freely available to all legitimate users.[232] Indeed, it appears that the principal, if not the only, reason that IBM

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225. *See supra* note 153.

226. Dinkin Interview, *supra* note 101, at 8–9.

227. *See* Crouse Interview, *supra* note 141, at 3 (discussing the history of IBM's patent licensing practices); Dinkin Interview, *supra* note 101, at 5.

228. CAMPBELL-KELLY, *supra* note 22, at 108, 113 (noting that at one time the "biggest single source of early software products salespeople was IBM" and recounting a lawsuit by ADR alleging that IBM's practice of "bundling" software and hardware had "suppressed the potential software market for a decade").

229. *Id.* at 109–19.

230. *See* Dinkin Interview, *supra* note 101, at 8.

231. For a discussion of the profitability of the licensing to IBM, see LOUIS V. GERSTNER, JR., WHO SAYS ELEPHANTS CAN'T DANCE: INSIDE IBM'S HISTORIC TURNAROUND 146–52 (2002).

232. IBM's website reports that it "is generally willing to grant nonexclusive licenses under reasonable and nondiscriminatory terms and conditions to those who in turn, respect IBM's intellectual property (IP) rights." IBM, *IBM Worldwide Patent Licensing Practices*, *at*

would be unwilling to grant a license to use its patents would be if the party requesting the license refused to grant IBM parallel access to the party's own IP.[233] Thus, IBM has followed a consistent two-pronged strategy: gaining as much access as it can to all IP in the industry (giving IBM the freedom to market and sell as freely as possible),[234] and at the same time generating a steady stream of revenues from its now massive software patent portfolio.[235] As Rosemarie Ziedonis has shown, this strategy of heavy patenting is common for large firms like IBM in an environment characterized by fractionation of technology.[236]

The focus on freedom of action is a rational strategy for a large firm like IBM. Considering its advantages in prestige, resources, marketing, and other forms of infrastructure, it is reasonable for IBM to conclude that it can succeed in the marketplace without using the relatively ineffective tool of IP to appropriate the value of its inventions. Thus, the principal relevance of IP to IBM is to ensure that it is able to commercialize whatever products it desires. If the patent portfolio that it uses to ensure that freedom also happens to generate substantial revenues, that is a useful thing, but not nearly so central to the firm's core strategy.

Nor is this strategy unique to IBM. Microsoft, for example, has an impressively large portfolio, but does not appear to enforce it aggressively.[237] Its recent adoption of an open licensing policy that resembles IBM's policy[238]

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http://www.ibm.com/ibm/licensing/patents/practices.shtml (last visited Jan. 13, 2005) [hereinafter *IBM Worldwide Patent Licensing Practices*]; *see also* ARORA ET AL., *supra* note 159, at 235–36 (discussing requirements imposed on IBM by consent decrees in antitrust litigation with the United States); ALFRED D. CHANDLER, JR., INVENTING THE ELECTRONIC CENTURY 250 (2001) (same).

233. IBM's website reports only that it "includes in the terms and conditions of a license an option for a comparable license-back of the licensee's patents under similar terms and conditions," and that "[i]n cases where a licensing partner has a significant patent portfolio, IBM will consider entering into a patent cross license agreement." *IBM Worldwide Patent Licensing Practices*, *supra* note 232.

234. *See* Treybig Interview, *supra* note 91, at 5 ("IBM[']s strategy] is to keep anybody with a patent from hindering what they want to do. . . . The role of patents was to protect the company against innovation so the company could not be stopped from doing anything it wanted.").

235. IBM's website states that patents are licensed at "market rates" based on a combination of "up front payments and royalties." *See* IBM, *IBM Intellectual Property & Licensing, Technology Practices*, *at* http://www.ibm.com/ibm/licensing/technology/practices.shtml (last visited Jan. 13, 2005). IBM normally charges between 1% and 5% of the selling price per patent licensed. *See* Alan S. Brown, *American Superconductor Wins Key Patent*, IEEE SPECTRUM CAREERS, *at* http://www.spectrum.ieee.org/careers/intel.jsp (Dec. 2002).

236. Rosemarie Ham Ziedonis, *Don't Fence Me In: Fragmented Markets for Technology and the Patent Acquisition Strategies of Firms*, 50 MGMT. SCI. 804, 808 (2004).

237. *See, e.g.*, Jeff Meisner, *Microsoft Aspires to Double Patent Portfolio*, PUGET SOUND BUS. J., Aug. 13, 2004 (noting that, although Microsoft has aggressively expanded its patent portfolio in recent months, the company appears to be more interested in developing cross-licensing agreements and protecting itself from patent suits than in pursuing any litigation on its own behalf), *available at* http://seattle.bizjournals.com/seattle/stories/2004/08/16/story7.html.

238. Press Release, Microsoft, Microsoft Announces Expanded Access to Extensive Intellectual Property Portfolios, *at* http://www.microsoft.com/presspass/press/2003/dec03/12-03ExpandIPPR.asp (Dec. 12, 2003). It is perhaps not a coincidence that Microsoft a few months

suggests at least an implicit acknowledgment that IBM has discerned the correct strategy. There is the possibility, of course, that Microsoft's current strategy is motivated as much by its experience with antitrust litigation as IBM's is. Finally, other large firms that I interviewed in related industries suggested that their IP strategies were similar.[239]

The noted paper by James Bessen and Eric Maskin[240] articulates a contrary view, reasoning that sequential innovation in an industry with complementarity of inventions is likely to lead to an anticommons.[241] The paper is flawed by its central logical step: it reasons from the wide dispersion of IP rights to the conclusion that IP is not generally available to firms in the industry. The paper does not account for the literature indicating that the effectiveness of licensing depends to a great degree on context.[242] Rather, the paper rests on the explicit assumption that firms are not able to reach value-increasing licensing agreements that make technology widely available in the industry.[243]

To the extent that the literature supports any theoretical conclusions that are independent of historical context, Merges and Nelson argue that a positive outcome is particularly likely in cases—as in the software industry—in which there is not a single pioneering patent or group of patents that gives one firm control.[244] The numerous sectors into which the software industry is divided have made it difficult for any single patent or group of patents to control a major part of the whole industry.[245]

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before this announcement hired one of IBM's leading patent policy executives, Marshall Phelps. *See* Andrew Orlowski, *Microsoft Aiming IBM-Scale Patent Program at Linux?*, REGISTER, *at* http://www.theregister.com/2003/12/08/microsoft_aiming_ibmscale_patent_program (Dec. 8, 2003) (discussing Microsoft's emerging patent strategy and the hiring of IBM's Marshall Phelps to achieve its implementation).

239. I had two such interviews with representatives of Fortune 500 technology firms. Both requested anonymity with respect to that discussion.

240. As discussed above, the paper is the principal empirical support that Lessig offers for his discussion of the subject. *See supra* note 8.

241. Bessen & Maskin, Sequential Innovation, *supra* note 6.

242. *See, e.g.*, COHEN ET AL., *supra* note 18, at 25–29; Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 TEXAS L. REV. 989, 1061–67 (1997); Merges & Nelson, *Encouraging Rivalry*, *supra* note 17, at 13–16; Merges & Nelson, *Patent Scope*, *supra* note 17, at 894–97, 908; Scotchmer, *supra* note 16, at 33–34.

243. Bessen & Maskin, Sequential Innovation, *supra* note 6, at 5.

244. Merges & Nelson, *Encouraging Rivalry*, *supra* note 17, at 4–5; Merges & Nelson, *Patent Scope*, *supra* note 17, at 908–11.

245. Nevertheless, there certainly have been important patents that have allowed a single firm to dominate a particular sector for a while. The Rambus patent is the most common example mentioned in my interviews. *E.g.*, Subhedar Interview, *supra* note 78, at 3. Interestingly enough, the interviews suggest that the need to patent is particularly high in sectors dominated by such a patent, apparently out of a desire to obtain collateral for cross licensing. *E.g.* Lord Interview, *supra* note 69, at 7. It is possible that much of the sectoral variation that appears in my related empirical study is attributable to such historical artifacts. However, for the present purpose, the key point is that dominance by a firm of a single sector for a time is far from dominance of the entire industry. Moreover, that kind of patent-based dominance has *never* occurred in favor of an incumbent like IBM or Microsoft. *See, e.g.*, Ziedonis, *supra* note 236, at 804; *see also* Mark A. Lemley,

James Bessen's recent paper articulates a more complex model of the same problem. He recognizes the possibility that optimal incentives for research and development can occur when firms develop a culture of "mutual non-aggression."[246] He argues, however, that "aggressive" cross-licensing is a distinct pattern that is likely to lead to sub-optimal incentives for innovation in industries in which patent standards are too low, particularly in cases in which mature incumbents populate the industry.[247] Whatever the merits of that analysis, there is little reason to think that it is applicable to the software industry. As discussed above, it is clear that the licensing culture in the industry depends to a considerable degree on the practices of the industry's leader. In addition, it is clear that IBM has determined for reasons of its own—influenced to be sure by federal antitrust enforcement—that it should refrain from pressing its patent portfolio aggressively.[248] Thus, although it is always possible to imagine that aggressive practices *could* lead to a suboptimal pace of innovation,[249] the historical events that have made IBM and now Microsoft as cautious as they are make it difficult to argue that those patterns have emerged,[250] whatever might happen in the future.[251]

What this means for purposes of this discussion is that innovators know that IBM and Microsoft hold a large number of patents and that they are likely to use those patents to seek some share of revenues from any major new product. There is, of course, nothing wrong with that. IBM does spend billions of dollars each year on research and development related to the soft-

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Intellectual Property Rights and Standard-Setting Organizations, 90 CAL. L. REV. 1889, 1893, 1895 (2002) (discussing how IBM's and Microsoft's patent assertions have caused enhanced antitrust scrutiny from the government and controversy within the IP community). Thus, those patents are much less troublesome than, for example, the Edison light bulb patent that Merges and Nelson discuss. Merges & Nelson, *Encouraging Rivalry*, *supra* note 17, at 15; Merges & Nelson, *Patent Scope*, *supra* note 17, at 885–87.

246. Bessen, *Patent Thickets*, *supra* note 6, at 1.

247. *Id.* at 14–15.

248. *See supra* note 232.

249. The possibility that a disadvantageous structure *could* have developed doubtless explains many of the fears regarding software patents expressed in the early days of the industry. *See* LESSIG, *supra* note 6, at 205–15 (discussing such fears); Stephen P. Fox & Guy J. Kelley, *Making Innovation Pay: Aligning Patent Rights with Business Strategy*, *in* FROM IDEAS TO ASSETS: INVESTING WISELY IN INTELLECTUAL PROPERTY, *supra* note 126, at 191, 193–94 (discussing those fears and how they have dissipated with actual experience in the industry). A number of public statements on that point were delivered at a 1994 Department of Commerce hearing in San Jose, at which several firms (including Adobe, Borland, and Oracle) argued against software patents, while several others argued in their favor (including IBM, Intel, and Microsoft). To view the statements, see *Corporate Statements on Software Patents*, *at* http://lpf.ai.mit.edu/Patents/testimony/statements (Jan. 26, 1994).

250. For a typical news story, see *Patents: A Necessary Evil*, NEWS.COM, *at* http://news.com.com/2009-1001-801896.html (Jan. 5, 2002) (discussing IBM licenses that permitted development of technologies for DVD, PalmPilot, Handspring, and TiVo).

251. There is some possibility that the equilibrium I describe here may change in the future. It remains to be seen, however, whether it will alter the basic pattern, in which the smallest startups are left relatively free to develop their products without constraints from the patent portfolios of large firms.

ware technology on which it receives patents. It is not alone in that practice.[252] The fact that it can earn royalties from those patents through freely licensing them to all comers does not suggest a patent thicket. On the contrary, a patent thicket would exist only if industry licensing practices were such that firms in the industry commonly were unable to agree on terms for licenses and thus retreated from the field of innovation. That is not a realistic portrait of the commercial software industry as it now exists.

Another more plausible possibility is that the "tax" created by cross-licensing fees is detrimental to innovation in the industry. From this perspective, it is not that existing patents are so widely distributed as to make it impossible for firms to obtain access to the technology; it is just that the cost of paying for access to that technology lowers the return on investment in the industry to the point that investments in innovation are less than they would be without patents. Part of the difficulty in assessing that possibility is the intractability of determining whether a typical five percent license fee is a sufficient drag on a small firm's profitability to amount to a substantial burden. The problem would be more severe if firms often had to pay multiple licensing fees, but that seems uncommon based on the interviews I conducted.[253] In the end, my instinct is that it is not a substantial burden. I am driven particularly by the point that licensing fees normally are paid only on revenues—not on the use of the patented technology—and thus impose no costs on firms that are in a prerevenue development stage.[254] I am also driven by the reliance of many of those firms on venture capital investments. Given the large returns on investments that are necessary for venture capitalists to obtain an adequate return on their risky portfolios, it seems unlikely that individual investments are often forgone because of the likelihood that a firm will be sufficiently successful to earn revenues against which IBM will likely seek royalties.

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252. *See* Crouse Interview, *supra* note 141, at 1–2 (suggesting that the ability to generate patent royalties from Microsoft's research department helped justify that section's budget allocations). It is difficult to get details about revenues from software patents, but overall patent licensing revenues have risen from less than $20 billion in 1990 to well over $100 billion by 2000. RIVETTE & KLINE, *supra* note 156, at 6. At IBM alone, IP licensing revenues were more than $351 million in 2002. IBM, 2002 ANNUAL REPORT 52, *at* http://www.ibm.com/investor/financials/annualreport.phtml (2003). IBM does not report separately the figures for software patent licensing, but it has reported that about a third of the patents it has received in the last decade (7,500 out of 25,000) and the last year (1,250 out of 3,400) are software patents. IBM, *IBM Tops U.S. Patent List*, *at* http://www-3.ibm.com/software/swnews/swnews.nsf/n/mmaa5hrqgp?OpenDocument&Site=default (last visited Jan. 13, 2003). So, it is reasonable to estimate that its software-related patent licensing revenues are in the range of $150–$200 million a year.

253. For instance, representatives of many small companies suggested the possibility of licensing IBM's entire patent portfolio in exchange for a percentage of revenues. *See, e.g.*, Treybig Interview, *supra* note 91, at 3; Urdahl Interview, *supra* note 127, at 6.

254. *See, e.g.*, Urdahl Interview, *supra* note 127, at 3 (describing a normal licensing arrangement with IBM based on a percentage of the revenues of the licensee).

B. Patents and Open Source Development

In my mind, the biggest question about the effectiveness of software patents involves the interrelation between commercial software development—the topic of this Article—and open source development. This Article explores almost exclusively the commercial software industry, where software is developed and commercialized in an institutional way. My evidence suggests that within that framework patents may be useful, and that if they are it will be largely because they offer more benefits than costs to small firms. However, coexisting with the commercial software industry is an open source community attempting to foster the development of software largely without commercial investment or affirmative IP protections.[255] Those who work in that community may have little need for patents. The cooperative nature of development in that environment obviates any need for actual or implicit cross-licensing that disseminates access to technology throughout the commercial software sector. Similarly, because open source developers at least theoretically do not depend on outside equity investment to any significant degree, the limited ability to appropriate a software invention might pose little harm to them.

One problem, however, is that the open source community does not exist in a vacuum. It exists in a world in which the commercial software industry is building up large portfolios of protected IP, portfolios that pose a serious threat to open source development.[256] To put the matter in a current context, suppose for a moment that the Linux operating system in fact infringes in a substantial way patents held by some major proprietary software firm. That could result in liability for all of the many firms using the Linux operating system. The problem is that the open source community has set itself outside the cooperative IP framework of the mainstream software industry. Thus, its members often have no patents of their own with which they might protect themselves in litigation. At the same time, this community has developed its software with the same cavalier attitude regarding the possibility of patent infringement as commercial software firms exemplify. Those two habits cannot coexist in the end.

That raises the question, in turn, whether the potential for high quality software development through the open source model justifies eradication of software patents for the commercial software industry. To put it another way, one potential cost of permitting ready enforcement of software patents

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255. The literature on that subject is large and contentious. The classic source is ERIC S. RAYMOND, THE CATHEDRAL AND THE BAZAAR (1998). For a lucid, accessible, and reasonably balanced introduction, see FINK, *supra* note 37.

256. *See* JOSH LERNER & JEAN TIROLE, THE ECONOMICS OF TECHNOLOGY SHARING: OPEN SOURCE AND BEYOND (Harvard NOM, Research Paper No. 04-35, 2004) (examining the open source community's position within current legal and economic frameworks), *available at* http://papers.ssrn.com/abstract=620904.

is the disabling of the open source model.[257] It is difficult to answer that question definitively without evidence that would allow a comparative weighing of the benefits of open source development against the benefits that the commercial software industry derives from IP. It does seem relevant, however, that the reluctance of the open source community to obtain patents is largely a political statement, not something necessary to the development of the improvements in functionality that the movement promises.[258] This is proven most clearly by the recent applications for patents filed by noted Linux distributor Red Hat.[259] To the extent the open source community is put at risk solely because of moral distaste for patents, the claim that the proprietary community should not be able to use patents to advantage its own operations is weakened.

In any event, a thorough analysis of that question is beyond the scope of this Article. Among other things, such an analysis has to account for the rapid convergence of commercial and open source licensing models: even proprietary licenses now commonly allow access to source code and purportedly open source licenses regularly permit commercial development of proprietary works derived from the covered products.[260] It also must account for the effects of those licenses on the character of commercial investment in open source software. For example, it is plausible that restrictions in common open source licenses might tend to tilt the scales of proprietary investments in favor of service firms rather than products firms. If, as seems likely, it is more difficult for startups entering the industry to compete in service sectors than in product sectors, this suggests in turn that the spread of open source software in fact could promote concentration in the software industry. I note these issues here only to define the bounds of my analysis. The primary goal of this Article is to consider the role of IP in the commercial software industry. I leave for another day the relation between open source development and that industry.

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257. Zittrain discusses the difficulties that the open source movement faces in responding to attacks from proprietary firms (like SCO) who allege that open source code has been contaminated by copying proprietary software code. Zittrain, *supra* note 34, at 267. My point here is a more systemic one that cannot be avoided even by thorough review of code incorporated into an open source project: the open source project would infringe the patent even if the open source code were created independently and without any knowledge of the patented technology.

258. For a clear discussion of the distinction between the moral and pragmatic segments of the open source community, see *id.* at 274–84. Merges views investments in open source development as an example of property-preempting investments—investments designed to create a field of innovation from which IP exclusivity will be absent. Merges, *New Dynamism*, *supra* note 17, at 185–86.

259. Matthew Broersma, *Red Hat Defends Controversial Patent Applications*, ZDNET UK, *at* http://news.zdnet.co.uk/business/0,39020645,2111257,00.htm (May 31, 2002).

260. *See* MANN & WINN, *supra* note 37 (discussing those developments).

V. The Role of Other Existing Systems

If the ultimate question is whether patents facilitate the ability of software firms to appropriate gains from innovation, the picture must include some understanding of alternate methods that firms might use to appropriate the value of inventions. These alternate methods are particularly important given the clear evidence that in many circumstances patents will do little to allow a firm to exclude competitors from a firm's innovation. This Part discusses the two main existing legal systems that complement the protections afforded by patents: copyright and trade secrets.

A. Copyright

Like patent protection, the role of copyright protection changes markedly as a firm develops. My interviews suggest that copyright is of relatively little value in protecting the startup from competitors. It does have value, however, in two particular circumstances: preventing piracy at a company's later stage when it has developed a product and preventing "theft" of materials by outgoing employees.

1. The Role of Copyright in Startups.—For purposes of this Article, the key question regarding copyright is the extent to which copyright protection can provide the kind of sustainable differentiation that is important to investors. The preceding Parts reveal considerable ambiguity on the ability of patents to provide that differentiation. With respect to copyright, however, the question is much less ambiguous. Rather, it seems quite clear that copyright is not suited to providing that protection. The problem with copyright protection for software is that the legal system for copyright is not designed to protect functionality. Because functionality in most cases is what makes software products attractive to customers,[261] the differentiation that is important to investors is differentiation in functionality. Thus, if the legal system works as designed, copyright is useless at this point.

My interviews strongly supported that perspective. For example, a typical startup executive explained that copyright protection "is not useful to us [because of its inability to protect functionality]. The other person could do just the same thing in a different manner and get around it very easily."[262]

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261. There are, of course, types of software for which functionality is *not* of central importance. Video games, for example, are software products for which the expressive content is the primary market differentiator. What that means for my purposes is that the relevant IP protections for video games should look much more like those for traditional audiovisual works (such as motion pictures). Knowledgeable industry executives recognize this distinction as crucial in the negotiation of contracts related to the exploitation of those works. *See* Interview with Jeffrey M. Koontz, Senior Attorney, Consumer Group, Microsoft, in Redmond, Wash. (Feb. 4, 2003), at 1.

262. Harding Interview, *supra* note 76, at 1; *see also* Beauchamp Interview, *supra* note 95, at 8 ("[T]o what extent does [copyright] keep people from stealing your ideas or your product? None."); Costello Interview, *supra* note 174, at 1 ("Generally, I think that most people in the software area don't think it is worth that much."); Kalinoski Interview, *supra* note 109, at 8 ("I've seen enough of

Another argued: "I've been in the software business for 20 years. Copyrights are worthless. They are totally worthless."[263] One thoughtful executive opined:

> Copyright solves one problem, which is the whole or partial copying of an expressive application. The whole or partial copying of an application by a pirate you can get. But it doesn't really protect us from sharing our technical information broadly and a company then understanding how our products work. Patents are inter-industry mechanisms for creating value. Copyright is creating protection between the industry and the channel or end customers.[264]

The most obvious problem with copyright protection for software relates to reverse engineering.[265] Generally, the expression protected in computer software by copyright is the lines of code of which the program consists.[266] Thus, although copyright does not prohibit a competitor from writing a completely new program that includes the functionality of the existing program, it does bar a competitor from taking the existing code to produce that program.[267] Thus, the effect of that protection turns on an

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copyright litigation and the issues with copyright law that don't have any real bite. . . . [T]here is no impact. . . . [P]eople think that by having copyright . . . that no one can really copy things . . . and it just doesn't stand up in the marketplace."); Telephone Interview with Anne Kelley, Senior Attorney, Microsoft (Feb. 27, 2003), at 1 ("What really it does come down to is what is the thing that is marketable, and if this thing that is particularly marketable is functionality, then the patent is clearly playing a more important role."). Venture capital investors made similar comments. *See* Jones Interview, *supra* note 85, at 2 ("We don't make copyright a big issue."); Lee Interview, *supra* note 78, at 1 (noting that copyright is "[n]ot a focus area for us" because it is not "useful"); Murphree Interview, *supra* note 89 (agreeing that copyright protection was unimportant and "[e]asy to reverse engineer around").

263. Adams Interview, *supra* note 91, at 1.

264. Interview with David Kaefer, Director of Corporate Initiatives, Microsoft, in Redmond, Wash. (Feb. 4, 2003), at 2. For a similar emphasis on the vertical—rather than horizontal—value of copyright protection, see D'Eath Interview, *supra* note 85, at 6 ("If somebody goes and takes the actual code that is a pretty stupid way of competing. No valid competitor is going to just take the product and steal the code."). As I discuss below, copyright's role in preventing piracy is arguably its most important role in the software context. *See infra* subsection V(A)(2)(a).

265. There is a terminological complication in the discussion that follows. To some, "reverse engineering" has a narrow meaning that implies an effort to duplicate existing source code precisely. *See, e.g.*, *infra* note 268 (discussing sources that take that perspective). In most of my interviews, however, it was plain in context that "reverse engineering" referred more broadly to an effort to recreate functionality, without regard to recreating existing source code.

266. *See, e.g.*, Dennis S. Karjala, *A Coherent Theory for the Copyright Protection of Computer Software and Recent Judicial Interpretations*, 66 U. CIN. L. REV. 53, 72–74 (1997). There is also, of course, a literary work protected by copyright in the interfaces through which users interact with programs. And in some cases at least, as with the video games discussed above, it is plausible to think that the interface itself could be important to the market success of the product. To the extent that is true, copyright protection for the interface (which is relatively thin for the reasons discussed above) would have the potential to exclude competitors by making reverse engineering illegal. Karjala suggests, and I agree, that this is an inappropriate application of copyright doctrine. *See id.* at 75–77, 94–112 (arguing that copyright protection does not extend to software interfaces).

267. *See id.* at 72–75.

empirical question: how effective as an exclusionary device is it to require a competitor to rewrite a competing program instead of reusing the code?

Surprisingly, my interviews indicate quite strongly that it is not effective. The perception is that in most instances a software engineer who observes a program in operation can readily understand the functionality the software provides and with that understanding easily can write code that provides the same functionality: "[S]oftware in general is very malleable and is easily reverse engineered."[268] As one venture investor explained: "The difficulty normally is managing the people, not solving the problem. The code won't look the same, but the functionality will."[269] One developer explained that the difficulty in coming up with a successful enterprise software product is not writing the code, but understanding the problem that

268. Weghorst Interview, *supra* note 83, at 3. This is consistent with the understanding of Pamela Samuelson and her co-authors (including the noted software engineer Mitchell Kapor), who contend that the know-how of software is for the most part "near the surface" and readily extractible through testing. Samuelson et al., *supra* note 15, at 2319–20 (arguing that programs with different code but identical behavior are market substitutes). *But cf.* Bruce Abramson, *Promoting Innovation in the Software Industry: A First Principles Approach to Intellectual Property Reform*, 8 B.U. J. SCI. & TECH. L. 75, 128 (2002) (expressing doubt about the utility of "black-box testing" to programmers attempting to decode sophisticated, competing programs); Mathias Strasser, *A New Paradigm in Intellectual Property Law? The Case Against Open Sources*, 2001 STAN. TECH. L. REV. 4, 42 ("[N]ot only is decompiling software, as discussed, a rather futile undertaking, the amount of information that may be obtained by reverse engineering the object code of a piece of software is unlikely to be enough to enable competitors to reconstruct the software's original source code."). Abramson and Strasser address reverse engineering designed to recreate the existing source code. I share their view that it would be difficult to do that. However, it is clear that the goal of the typical reverse engineering process is not to reproduce the existing source code as much as to understand and reproduce the functionality that the source code effects. *See supra* note 265. I see no reason to doubt the value of "black-box testing" for that task.

269. Lee Interview, *supra* note 78, at 1; *see also* Murphree Interview, *supra* note 89, at 1; Stephenson Interview, *supra* note 92, at 1. Describing the weakness of copyright protection for software, Stephenson notes:

> [Copyright] only protects the particular source code, the instantiation, the physical lines of code that you wrote. And in software there are a number of different ways to accomplish the same thing. . . . And plus, the bigger point is that all you really get is protection on that particular instantiation. If they change . . . and they're not violating that copyright, then it's not really doing that much good. Because ultimately what you want to protect is the functionality.

Id. Developers expressed similar views. *See* Bishop Interview, *supra* note 102, at 2 (arguing that reverse engineering is easy when the ideas in a product are "what the customer wants . . . . Like [graphic user interfaces], once you know that's what people want, [it is] easy to do"); Costello Interview, *supra* note 174, at 1 ("[T]he general problem [with copyright protection] is there are a million ways to go around it. And I think that is true for almost all IP in software."); Kalinoski Interview, *supra* note 109, at 9 ("[Your competitors a]re at least smart enough to go modify and have something that's very . . . similar. It's got the same attributes. It's got a lot of the same qualities, but it looks just a little bit [different even if] it's obvious where they got all of their thinking."); Rightmer Interview, *supra* note 84, at 2 ("Reverse engineering is easy. Copyright protects only against blatant theft. Ever since *Lotus* lost protection for look and feel, copyright has not seemed valuable in the industry. We do this all the time for our customers, to mimic the functionality, input, and output of existing products that we are replacing.").

needs to be solved.[270] The only IP protection that makes it difficult to duplicate a program's functionality is patent protection, which bars a competitor from writing code that includes any patented aspects of a software's functionality. If copyright systematically stops short of providing that protection, it cannot provide the vehicle for appropriating value that persuades potential investors.

2. The Role of Copyright in Later-Stage Firms.—Yet, it is plain that copyright plays a crucial role in the industry's ability to appropriate returns from the innovation it produces. That role has several aspects, but two are sufficiently pervasive to be characterized as structural: the prevention of piracy and the control of "theft" of code by departing employees and the like.[271]

a. Piracy.—On the first point, the discussion above explains that copyright protection is unimportant for a startup firm because literal copying of code is not that important to competitors. There is one group, however, that is quite interested in a free right to copy the startup's product: its customers. Thus, although patent and trade secret protection are more important in limiting the ability of competitors—horizontal firms—to take technology from the innovator, copyright is more important in limiting the ability of customers to obtain the product without paying the product's owner.[272]

That problem—piracy, to use the industry's preferred term—affects different types of software differently. For example, it is less important in the enterprise software market in this country. To be sure, there are reliable methods of limiting piracy in that market. In some cases, firms operate as application service providers, so that the code for their program resides entirely on their own server, which can be protected more readily than their customers' servers.[273] Other companies, particularly in the enterprise software sector that is the source of most innovation in the industry, emphasize the practical value of dealing only with large and fiscally responsible

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270. Weghorst Interview, *supra* note 83, at 3 ("[T]ypically, when you're talking enterprise software, . . . the magic dust, if you will, is in the domain expertise . . . [of] knowing that we needed to solve the problems that we needed to solve.").

271. Data from the Northern District of California for 2002 show that 27 out of the 90 copyright cases filed involved software. Of the 22 software copyright cases for which I could obtain a complaint, the majority (15) involved claims of unauthorized distribution of the copyright owner's product. Four involved claims against competitors for wrongful reverse engineering, and three arose out of contract disputes between website developers and their customers.

272. *See supra* note 264 and accompanying text (articulating a distinction between vertical and horizontal protection).

273. *See* Harding Interview, *supra* note 76, at 2–3 (discussing security in the context of Datacert's role as an application service provider).

"Fortune 500" customers.[274] A typical example: "[W]e're selling to an enterprise customer. We're not on a store shelf. So I'm not at risk of somebody copying the disk and just cloning what I do."[275] Key to the effectiveness of these arrangements is the likelihood that the customers are large and creditworthy firms. Those types of firms are unlikely to participate in illicit distribution of software code, if only because of the likely financial exposure they would incur if their participation were discovered.

In some markets, however, such protections are not useful. Most obviously, they are not valuable in markets—such as consumer markets—in which software code (in any form) is freely distributed.[276] In this country, consumers commonly violate the terms of license agreements, copying and transferring software in ways that would require payment from the new user.[277]

Executives recognize that in other countries the problem is a serious one even in the enterprise software context.[278] For reasons that range from an intentional governmental design to foster piracy to mere lackadaisical toleration of piracy, the extent of piracy in many foreign countries is shocking: industry statistics indicate that in many countries less than twenty percent of the software actually distributed is acquired through lawful channels.[279] To be sure, piracy in those countries is not a total loss to the software developer because it helps to develop a network of users that make

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274. *See* Bishop Interview, *supra* note 102, at 1 (noting that an advantage of dealing with larger companies is not having to worry about marketing to customers); D'Eath Interview, *supra* note 85, at 4 (claiming his company protects itself by dealing primarily with Fortune 500 companies); Rightmer Interview, *supra* note 84, at 2 (noting that his large clients are not likely to participate in the illicit distribution of software code).

275. D'Eath Interview, *supra* note 85, at 6.

276. *See id.* at 7 ("That answer is going to be very different for somebody who is selling a retail product."); Kelley Interview, *supra* note 262, at 2 (emphasizing the importance of copyright protection for mass market software); *see also* Karjala, *supra* note 266, at 67 ("[O]nce . . . programs are distributed in object-code form, they can be copied almost without cost in large numbers.").

277. *See* BUSINESS SOFTWARE ALLIANCE, U.S. SOFTWARE STATE PIRACY STUDY, *at* http://www.bsa.org/statestudy (Aug. 2003) (reporting a piracy rate of 22.8% for the United States in 2002).

278. *See* Adams Interview, *supra* note 91, at 1 (discussing piracy of Lotus in Italy); D'Eath Interview, *supra* note 85, at 7 ("Because [if you sell overseas] you then in fact could have somebody just copying it, in France or Germany or somewhere where they're not watching."); Interview with Annmarie Levins, Associate General Counsel, Worldwide Sales Group, Microsoft, in Redmond, Wash. (Feb. 25, 2004), at 1 (discussing major businesses engaged in piracy in Eastern Europe); Sikora Interview, *supra* note 85, at 1 (offering examples of piracy in Russia and China); *see also* Interview with Tim Cranton, Senior Attorney, Microsoft & Anne Kelley, Senior Attorney, Microsoft, in Redmond, Wash. (Feb. 4, 2003), at 2 (suggesting that enforcement of copyright protection over the Internet is similar to enforcement in a developing country).

279. *See* INTERNATIONAL DATA CORPORATION & THE BUSINESS SOFTWARE ALLIANCE, EXPANDING GLOBAL ECONOMIES: THE BENEFITS OF REDUCING SOFTWARE PIRACY 5, 12 (Apr. 2, 2003) (reporting piracy rates of 94% for Vietnam, 92% for China, 88% for Indonesia, and 87% for Russia and Ukraine). Nor is the problem limited to Asia and the former Soviet Union. The IDC data suggest that piracy also is rampant in countries in Europe (Bulgaria and Romania 75%, Croatia 67%), the Middle East (Kuwait 76%), and Latin America. *Id.*

the product more attractive to others. Still, it does reflect a loss of revenue that the software developer could obtain if its IP rights were enforced effectively.

For several reasons, copyright is the only effective IP protection against piracy.[280] For example, even if pirated software is protected in part by a patent, a suit against the pirate challenging patent infringement necessarily is more difficult because of the need for the software owner to establish the patent's validity. Because of the relatively high standard of patentability—compared to the copyright standard of originality—it always will be difficult for the patent owner to get over the threshold of patentability.[281] Because of the low threshold of copyrightability, it never will be difficult for the owner of copyrighted software to establish that the software includes copyrightable innovation.[282] In addition, the limitations on copyright protection discussed above, which make copyright useless for the startup trying to protect the functionality of its software, are irrelevant in the case of piracy: the pirate by definition has copied all or substantially all of the product. These problems associated with patent protection in this context are particularly salient in the enforcement of criminal sanctions for piracy. Statistics from the Department of Justice suggest that the federal government often sues pirates for criminal copyright infringement; there is not a statute for criminal patent infringement.[283]

b. Premarket Protection.—Copyright also plays a role before a product goes to market by helping a firm prevent technology from leaking

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280. *See* Crouse Interview, *supra* note 141, at 1 ("[C]opyright remains incredibly important for us [at Microsoft]. Without that, piracy on a worldwide basis as a form of competition—it would be hard for people to sustain a business against [piracy]."); Karjala, *supra* note 266, at 67 ("Because the evil . . . was . . . slavish copying, especially slavish electronic copying, because copyright protects at least against *that*, and because computer programs formally fit the broad definition of a literary work under copyright law, it became a natural candidate for the protection of programs, notwithstanding their inherent functionality."); *id.* at 69 (arguing that "protection against piracy" should be the "policy goal of software protection under copyright"); Samuelson & Scotchmer, *supra* note 16, at 1613 ("Copyright law protects programs from the cheapest and most rapid way to make a directly competing identical product, namely, copying program code exactly.").

281. *See* 35 U.S.C. §§ 101–103 (2000) (setting forth the principal conditions for patentability); D.C. TOEDT, THE LAW AND BUSINESS OF COMPUTER SOFTWARE §§ 3.3–3.4 (2002) (discussing patentability requirements as applied to computer software).

282. *See* 17 U.S.C. § 102(a) (2000) (extending copyright to "original works of authorship fixed in any tangible medium of expression"); ROGER E. SCHECHTER & JOHN R. THOMAS, INTELLECTUAL PROPERTY: THE LAW OF COPYRIGHTS, PATENTS AND TRADEMARKS § 3.1.2 (2003) (discussing the "minimal creativity" requirement for copyright protection).

283. For example, DOJ data shows 25 indictments of 73 defendants for criminal copyright infringement in 2002. DEP'T OF JUSTICE, FISCAL YEAR 2002 PERFORMANCE REPORT & FISCAL YEAR 2003 REVISED FINAL PERFORMANCE PLAN, FISCAL YEAR 2004 PERFORMANCE PLAN, app. C, at 307–11, *at* http://www.usdoj.gov/ag/annualreports/pr2002/AppendixC.htm (2003). For similar views from a former prosecutor, see Levins Interview, *supra* note 278, at 1; Interview with Thomas C. Rubin, Associate General Counsel, Microsoft, in Redmond, Wash. (Feb. 4, 2004), at 2 (expressing a similar view as an executive at Microsoft).

out through the actions of employees and business partners. The obvious problem is policing the activity of departing employees. It is common in all startup sectors—including the software sector—for employees to rapidly move from firm to firm. Indeed, Ron Gilson argues with considerable force that California rules limiting the ability of firms to prevent those moves are crucial to the success of the venture capital industry in Silicon Valley.[284] Yet, it is one thing for employers to allow cross-pollination of employees and their human capital and experiences. It is another for their employees to take substantial pieces of "product" out the door with them and sell that product from their new company.[285] As Rob Merges explains, it is optimal for firms to have *some* control over that activity, and it is not clear that parties can protect themselves adequately through contracts alone.[286] Although at least theoretically this could work to the benefit of early-stage startups, it is much more likely to be a benefit to larger firms (with more code worth plundering) and a detriment to smaller firms (trying to begin operations with employees recently departed from larger firms).

Thus, although the discussion in the next section evinces considerable skepticism about the social value of robust trade secret protections, my intuition is that copyright protection serves an important function. In this context, patent protection is relatively ineffective because of the litigation costs and uncertainty of such litigation. But in cases in which the employees attempt to reuse a substantial amount of code from their previous firm,[287] copyright law provides a simple and effective remedy against the new firm.[288] The importance of that constraint is evident from the discussions of

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284. Ron Gilson, *The Legal Infrastructure of High Technology Industrial Districts: Silicon Valley, Route 128, and Covenants Not to Compete*, 74 N.Y.U. L. REV. 575, 586 (1999); *see also* ANNA LEE SAXENIAN, REGIONAL ADVANTAGE: CULTURE AND COMPETITION IN SILICON VALLEY AND ROUTE 128, 161 (1994) (concluding that "industrial systems built on regional networks are more flexible and technologically dynamic than those in which experimentation and learning are confined to individual firms").

285. *See infra* note 297 (suggesting a distinction between employees departing with patented or copyrighted technology and employees departing with other forms of trade secret information).

286. Robert P. Merges, *The Law and Economics of Employee Inventions*, 13 HARV. J.L. & TECH. 1, 2, 5 (1999).

287. *See* Rubin Interview, *supra* note 283, at 2 ("We have situations all the time during the course of development where our code walks out the door. Or we have rogue employees or contractors who have access to the code who leak it."); *see also* Beauchamp Interview, *supra* note 95, at 9 (suggesting that the primary value of copyright is as "a protection against possibly disgruntled employees or somebody that may have access to the source code").

288. The injunctive and criminal remedies discussed above also are important in that context. *See* Rubin Interview, *supra* note 283, at 2 (discussing the necessity of prosecuting rogue employees); Witte Interview, *supra* note 152, at 5 (claiming that he frequently worries about hiring a software engineer who will borrow much of the code from a previous employer). Accordingly, Witte notes, "[T]he thing that will kill you faster than . . . anything is injunctive relief against [your] product." *Id.*

corporate counsel about their diligence with respect to new employees[289] and from venture capitalists about their investigation of potential investments. The only instance in which I heard venture capitalists express concern about preexisting IP of other firms constraining the ability of their potential portfolio firms is the case in which a startup has engineers with previous experience designing a similar product, which raises the risk of code contamination.[290] Although state law causes of action based on misappropriation of a trade secret, unfair competition, or breach of employment agreements might remedy some of those problems, the clarity and simplicity of the copyright action, the ready availability of federal jurisdiction, and the statutory remedies combine to make it a significant tool in policing such conduct.[291]

A similar problem occurs for large companies engaged in collaborative development projects. In that context, the copyright protection that attaches during the development process is an important part of preserving exclusive rights to the code as it passes among the participants in the process.[292] Although the participants in that process are free to use contracts to define the rights each of them has in the various portions of the project, the lawyers that participate in the process argue that injunctive remedies and statutory damages available under the Copyright Act play an important role in establishing a robust enforcement backdrop for those arrangements.[293] As one executive explained:

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289. *See* Witte Interview, *supra* note 152, at 5. Elucidating the possible benefits of employee theft of software code, Witte explained:

> [T]he way that really happens is when an employee moves from one person to another person, and takes the code with them. The thing that you are most worried about is hiring somebody as an engineer to build code, and who in the interest of moving from point A to point B in the most efficient way just borrows some of what they had from their last employer. . . . I worry a little bit about somebody taking out, but if you think about it, if somebody leaves my company and goes to join Microsoft and stuff finds its way into Microsoft. . . . I've won the lottery!

Id.

290. One venture capitalist explained:

> The only time there is a concern [about copyright] is if you have a team that has come out of another environment, like Sun, we're concerned about having a free working environment up front. If we thought it was encumbered in some way up front, it would be a problem. . . .
>
> It is fairly frequent that we're asking the question: Is there any code at all from your old employer that is in this? And frankly it is always in the way and there is never a clean way of doing due diligence in this other than getting to trust the people not to have walked off with some of this.

Gauer Interview, *supra* note 79, at 1.

291. *See generally* Copyright Act of 1976, 17 U.S.C. §§ 501–513 (2000) (setting forth remedies for copyright infringement, such as injunctions, impounding, and disposition of infringing articles, damages, and attorney's fees).

292. *See* Rubin Interview, *supra* note 283, at 1 (discussing the copyright protection that attaches during the development process as an important part of preserving the exclusive rights in the code).

293. *See id.* at 2 (discussing 17 U.S.C. §§ 502, 504 (2000)).

> The protection of [a major new product], as it is being designed, and built, and tested, and being distributed to third parties, is critical. And anything that diminishes the protection of that pre-release code will impede our ability and willingness to get outsiders to look at the code and test that.[294]

B. Trade Secret

Trade secret protection plainly plays an important role in the software industry if only because many companies have no formal IP protection for their products[295] and take significant steps to keep the details of their technology secret. There are limits, however, to the extent that trade secret protection can provide a robust appropriability mechanism in the software industry.

First, as noted above, my interviews strongly suggest that it is easy for competitors who observe a new product to design and deploy products that include the functionality of that new product. Such conduct does not violate trade secret law.[296] More broadly, trade secrecy does nothing to provide the "foothold" protection that is useful to smaller firms trying to fend off large firm efforts to market competing products. In an industry in which innovation involves many firms trying to do similar things at the same time, it is likely that a large firm like IBM or Microsoft might make the same advance that a small firm has made, even if that large firm has no access to the small firm's technology and thus no responsibility under trade secret law. Although patents arguably give small firms some shelter in those contests, trade secret law does not offer the same protection.

Finally, as suggested above, there is some reason to think that vigorous enforcement of trade secret protections in some contexts—against departing employees, for example—is itself costly to the industry. Saxenian and Gilson present a rich descriptive account arguing that the development of a rich innovative culture in Silicon Valley depends in part on the free transmission of noncodified information[297] by employees moving from firm

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294. *Id.*

295. In my dataset of software companies that first received venture-backed financing in 1998 and 1999, only 20% of the companies (152/778) had received a patent by the end of 2003. Mann & Sager, *supra* note 103, at 4–5. More than half (51%) of comparable biotech firms had received a patent by the same point in time. *Id.*

296. *See* RESTATEMENT (THIRD) OF UNFAIR COMPETITION § 17 cmt. a (1995) ("If a design is functional . . . , it is ineligible for protection regardless of its inherent or acquired distinctiveness. Competitors thus remain free, in the absence of a patent or copyright, to copy functional designs regardless of any association with a particular source.").

297. I do not explore the question in detail here, but it seems to me that it is reasonable to draw an upper limit that cuts off the free transmission of that information at the point at which it has been codified into a patent or specific software code subject to copyright protection. A firm will be more seriously harmed if it loses codified technology than if it loses technology that it has not yet

to firm.[298] Given the picture of cross-pollinating innovation I describe in this Article, that effect should be particularly valuable in the software industry.

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Copyrights and trade secrets, then, play an important role in protecting investments in software. But it is a role weighted in the opposite direction of the role that patents play: copyrights and trade secrets, to the extent they are useful, tend to support the efforts of large incumbent firms and to hinder the efforts of smaller entering firms seeking a foothold for competition.

VI. Responding to the Problems

I do not intend to propose a new system for IP protection in the software industry.[299] Indeed, our international treaty obligations make it difficult for us to substitute any system for the systems now in place. I do think, however, that it is useful to explore in a summary way the possibility that some reform short of a full-scale abolition of patents might solve the problems that patents cause while leaving in place the benefits they provide. I start with a brief discussion of a more radical response—a registration regime that would separate disclosure and filing from exclusivity. I then discuss some more incremental possibilities. My discussion is frankly skeptical in tone, reflecting my view that it is difficult to be sure that radical interventions would improve the existing system, but I remain hopeful that minor revisions could limit problems that threaten to destabilize the existing equilibrium.

A. Registration

The direct benefits of patents necessarily depend on the right of the patentee to exclude competitors. That is not so clear, however, with respect to the indirect benefits discussed above.[300] In particular, the indirect benefits that seem to produce social value depend on a range of effects that do not

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developed into a specific implementation. In other words, the benefits of free transmission are enhanced when nothing has been done with information or knowledge because the likelihood that the new firm will produce something the first firm has not is enhanced when the first firm has done nothing sufficiently specific to warrant copyright or patent protection.

298. Saxenian and Gilson studied the contrasting experiences of technology firms in Silicon Valley, California versus Route 128 in Massachusetts. They both concluded that the free exchange of technology in Silicon Valley led to a more dynamic and innovative atmosphere than along Route 128 where firms went to great lengths to keep their technology to themselves. SAXENIAN, *supra* note 284, at 2–4; Gilson, *supra* note 284, at 585–86.

299. A thoughtful and well-informed group of scholars already has undertaken such a project, resulting in the justly prominent *A Manifesto Concerning Legal Protection of Computer Programs*. Samuelson et al., *supra* note 15.

300. *See supra* subsection III(B)(3)(b).

require that codified information be deployed in order to exclude competitors from deploying any particular product. This suggests that those benefits could be obtained through a simpler registration system—one in which the technology is registered with a central office that simply receives the filings but does not evaluate them for novelty or obviousness.[301]

Although such a system theoretically might provide indirect benefits while avoiding some potential costs, it has a number of obvious problems. First, it would be difficult to replicate in a less formal process the benefits that come from the information provided by patents in the current process. For example, the benefits of knowledge codification may not depend on an exclusive right to the knowledge, but they do depend on reduction of the knowledge to a sufficiently precise formulation that can be patented. It is not clear how a private office or a simple registration office (like the Copyright Office) could provide those benefits.

Second, to a lesser degree those benefits depend on the possibility that the patents at some later date in the development of the technology will have the potential to exclude people from the technology. I think of the frequent suggestions in interviews that patents are valuable in making a firm attractive for acquisitions. Although the smaller firm with those patents may not be using them to exclude the potential acquiring firm from those products, the value to the larger firm may rest in part on the exclusive potential of those patents.

Finally, what we know about the behavior of software firms suggests that implementation of such a system might face considerable practical difficulties. We know that firms in the current system strongly resist registering their software with the Copyright Office, even in circumstances where such registration would facilitate lending by enhancing the ability of a lender to obtain an enforceable security interest. As I have discussed, young software firms are reluctant to disclose their technology despite the significant benefits in facilitating financing.[302] The costs of disclosure within a new system presumably would be greater than in the Copyright System[303] because the disclosure actually would reveal the technology.[304] On the other

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301. This discussion builds on a conversation with my colleague Oren Bracha. The suggestion calls for something akin to the German utility model system, under which the German Patent Office issues a Gebrauchsmuster patent as long as the applicant meets requirements for form and content. *See* Reeves Bros., Inc. v. U.S. Laminating Corp., 282 F. Supp. 118, 135 (E.D.N.Y. 1968); Walter S. Bleistein, *The German Law on "Gebrauchsmuster"*, 19 J. PAT. OFF. SOC'Y 126, 129 (1937).

302. *See* Ronald J. Mann, *Secured Credit and Software Financing*, 85 CORNELL L. REV. 134, 148 (1999) (discussing the reticence of software developers to register their source code because doing so makes it easier for competitors to reverse engineer from the code to develop competing applications).

303. This assumes that the registration system would allow the information to become public after a lapse of time parallel to the prepublication period in the existing patent system.

304. In the copyright system, developers resist registration despite rules that allow them to redact trade secrets and provide only a small sample of code. *See* Mann, *supra* note 302, at 148–49.

hand, the benefits—the ability to show potential investors that the firm has, and understands that it has, discrete technological advances—would be considerably less tangible.

In sum, the information benefits I discuss above are likely so intertwined with the existing patent system that it would not be practical to design an alternate system that could disaggregate them from the exclusive rights to technology that characterize the current system.

B. Protecting the Equilibrium

The discussion of the current role of patents suggests a system that is working reasonably well, having settled into an equilibrium. It is far from clear, however, that this equilibrium is stable in light of recent developments in the industry. The basic problem has two aspects. The first is the rise of patent "trolls," firms that have no interest in a licensing equilibrium because they produce no products of their own.[305] The second is a series of relatively small doctrinal problems in the area of software patents that combine to make the problem of trolls—which is by no means a new problem—particularly serious.

As discussed above, a significant portion of the scenarios in which suits are brought in the industry involve small litigation-oriented firms that only exploit patents and do not to develop products, which typically are described as trolls.[306] Because those firms do not develop products of their own, they need not fear the costs of countersuits claiming that the troll's products infringe patents of the defendant. Thus, the risks of patent litigation for trolls are considerably lower than they are for the typical software firm.

A natural response to that analysis is to limit the right of trolls to enforce their patents in some way. An obvious possibility is compulsory licensing, in which a third party sets a "reasonable" rate at which the patent must be licensed. I am dubious that such a proposal can be implemented in a way that unconditionally increases incentives to innovate. For one thing, how would a proposal define a relevant disfavored class of patent plaintiffs and limit their royalty rights to some compulsory license fee? Although the suits of trolls frustrate many in the industry, any effort to design a suitable definition of the term "troll" is likely to lend credence to the view that the status as a troll is in the eye of the beholder. Every firm that has a patent valuable enough to support major litigation against a large firm marketing a product that arguably infringes the patent has acquired that patent from some

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305. Paul McFedries, *Patent Troll*, THE WORD SPY, *at* http://www.wordspy.com/words/patenttroll.asp (Aug. 13, 2003). The term apparently was invented by scientists at Intel. It is a pun on the dual use of the word in English to refer both to a type of fishing in which a hook is dangled while the fisher moves slowly looking for prey and also to the ogre-like Scandinavian creature found in caves and under bridges.

306. *See* Lemley & Tangri, *supra* note 224, at 1112 (observing that "many non-manufacturing owners are holdup artists or 'trolls' who are in the business of litigation, not innovation").

person who has invested the resources to invent that technology. It is difficult to discern any principled distinction between the desire of the inventor to appropriate the value of his invention and the desire of operating firms to appropriate the value of their inventions.

The fact that the invention may have been assigned by the inventor to a third party does not suggest that the right to enforce the patent should be diminished.[307] To use an example from my interviews, if Bluecurrent is entitled to retain a law firm to enforce its controversial networking patents, why should the right to enforce the patents be dissipated if instead it transfers the patents to a holding company so that the existence of the patents will not pollute the firm's entrepreneurial culture?

The complex nature of software products exacerbates this problem. The fact that any single product might involve literally dozens of patentable inventions suggests of course that a single patent will do a poor job of protecting any particular product. At the same time, it also suggests that the small poorly capitalized inventor with a single patent cannot plausibly exploit the patent through sales of a product that implements the patent. Imagine, to choose a not implausible example, a university researcher obtains a patent on technology that could improve the functionality of web browsers.[308] Is it plausible to think that the researcher could develop and market a web browser that would generate revenues approximating the value of the invention? If not, a rule that hinders enforcement of the patent by the trollish inventor is in substance a rule that prevents the inventor from exploiting the patent. Essentially, trolls are serving a function as intermediaries that specialize in litigation to exploit the value of patents that cannot be exploited effectively by those that have originally obtained them. That is not in and of itself a bad thing.

That is not to say that some reforms might not be useful. For example, much of the threat value available to trolls might be reduced if the remedies available to trolls (under some plausible definition) were limited to prevent injunctive relief. For the reasons discussed above, however, those kinds of changes raise serious policy concerns that make me reluctant to support such a significant limitation on the rights of patentees.

Another source of concern surely is the amount of royalties awarded in suits by trolls, which in some cases has been an immense sum of money.[309] However, that concern seems to be a byproduct of the structure of costs and

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307. *See* Stephen M. Maurer & Suzanne Scotchmer, Profit Neutrality in Licensing: The Boundary Between Antitrust Law and Patent Law (2004) (unpublished manuscript) (discussing a principle of profit neutrality in enforcement of patent licenses), *available at* http://papers.ssrn.com/abstract=503467.

308. *See supra* note 136 (discussing the Eolas litigation).

309. Brenda Sandburg, *Battling the Patent Trolls*, RECORDER, *at* http://www.law.com/jsp/statearchive.jsp?type=Article&oldid=ZZZ4DX7MSPC (July 30, 2001) (providing examples of trolls that have made extensive royalties).

benefits discussed above. Despite the fragmentation of the software industry, the largest firms in the industry are quite large by any standard.[310] Thus, a reasonable royalty on any patent that one of their flagship products infringes is likely to be quite large. It may be that courts do not calculate royalties perfectly; indeed, the imprecision of the relevant rules[311] makes it almost impossible to imagine what it means to calculate royalties perfectly. Nevertheless, given the intractability of the questions, there is little reason to think that an alternate method of compensating trolls for their patents would reflect a more appropriate return on invention. Rather, it would simply substitute one imprecise scheme for another, the purpose being to lower the returns available to one particular class of patent holder.

I do not mean to suggest that the existing pattern of litigation in the software industry evinces a perfect system. In my view, the root of the concern about trolls is not that nonoperating firms hold patents. It is simply a more general dissatisfaction with the patent system itself as it currently works for software. For example, in the case of Bluecurrent, the popular press has criticized the patents as covering technology that is so obvious as not to warrant patenting.[312] The general problem is a complex one: how best to design the details of a patent system so as to optimize the pace and direction of innovation in a particular industry.[313] Specifically, three aspects of the current rules for software patents tend to exacerbate the risk trolls pose to the licensing equilibrium in which the industry now operates. If those problems can be ameliorated, it might be that many of the risks trolls pose would dissipate. For present purposes, it is enough to sketch these issues to show how they relate to the threat posed by trolls.

The first problem relates to enablement. One important effect of the weakening of subject matter limitations on patenting is that young firms in the software industry now have an incentive to seek patents at the earliest possible stage, based almost entirely upon a broad and novel idea, long

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310. *See supra* notes 38–43 and accompanying text.

311. The problem is that the royalties for an infringed patent are *not* designed to replicate the royalties that would be paid in any comparable market transaction. Accordingly, the task of the court assessing royalties is so hypothetical that neither precision nor effective appellate review can be expected. *E.g.*, Gyromat Corp. v. Champion Spark Plug Co., 735 F.2d 549 (Fed. Cir. 1984); Panduit Corp. v. Stahlin Bros. Fibre Works, Inc., 575 F.2d 1152 (6th Cir. 1978). Again, to the extent there is a problem here, it is not limited to the software industry or to these particular patentees.

312. Gary McWilliams, *Tiny Texas Firm Hopes to Prevail with Web Patent*, WALL ST. J., Oct. 22, 2003, at B1 ("A tiny Austin, Texas, company has sparked a computer-services controversy with its receipt of a U.S. patent covering the Internet installation of any software or settings on new computers.").

313. For an excellent survey of the relevant theoretical and empirical literature on that topic, see BRONWYN H. HALL, BUSINESS METHOD PATENTS, INNOVATION, AND POLICY (Dept. of Econ., Univ. of Cal., Berkeley, Working Paper No. E03-331, 2003), *available at* http://repositories.cdlib.org/iber/econ/E03-331.

before the firm has developed a product.[314] That incentive has been exacerbated by the steadfast determination of the Federal Circuit to weaken the enablement standard for software.[315] The natural effect of that incentive, of course, is to diminish the likelihood that a patent will be issued to the party best placed to exploit the innovation effectively. In the absence of transaction costs, of course, that is not an important problem. The existence of troll-based litigation, however, strongly suggests the existence of substantial transaction costs.

A second problem, closely related to the first, is the problem of disclosure. As it currently stands, the disclosure rules for software patents do not require disclosure of source code. In part this is an inevitable consequence of the low threshold for enablement because firms can so easily patent software-related innovations without first writing the code that implements them. But more broadly, firms are not obligated to provide source code even if they have written it. Given the importance of source code in making it easy for a person of ordinary skill in the art to implement an invention, it would improve the robustness of the disclosure rules to require disclosure of existing source code at the time of a patent application.

An important aspect of the first two problems that has hitherto gone unnoticed by the Federal Circuit is the pace of development in the software industry and the implications that has for doctrines about enablement and disclosure. Because innovation proceeds so rapidly in the industry, a disclosure that provides enough information to permit a learned practitioner to duplicate the invention after 24 months of careful research is not a particularly valuable disclosure. That might be plausible in an industry like the pharmaceutical industry with product development cycles measured in decades, but it deprives the disclosure in software patents of any real commercial value.

The final software-specific problem is the problem of quality. Much of the criticism of software patents, particularly in the popular media, is based on the notion that many of the patents cover inventions that were obvious at the time of the patent application and thus did not warrant a patent. To the extent problems with patent quality make it hard to predict whether a particular patent is or is not valid, they increase the uncertainty and thus the threat value of trollish litigation.

The answer here, I think, is not a doctrinal revision. Indeed, if anything, it is reasonable to think that the Federal Circuit's cases on obviousness in the

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314. My view that this is an important incentive for startup firms rests on comments from a large group of industry professionals at a conference on entrepreneurship at the Berkeley Center for Law and Technology, where I presented an earlier version of this Article.

315. *See* Dan L. Burk & Mark A. Lemley, *Is Patent Law Technology-Specific?*, 17 BERKELEY TECH. L.J. 1155, 62–64 (2002) (discussing recent Federal Circuit decisions that weakened the enablement standard).

software area have been more than adequately stringent.[316] The problem is probably more one of the historical cycle of innovation. Because the software industry is so young, a large portion of relevant prior art is not in the form of patents, but in the form of nonpatent information (such as source code for programs written before the date of the application). It is not easy for the PTO to deal with that kind of prior art, but as time goes by and the industry matures, the pace of innovation is likely to slow and the proportion of existing inventions covered by patents will rise. Thus, perhaps with patience patent quality problems will subside.

In the biotech area, a series of rules pushing up the standard of patentability has helped ensure that patents are issued to parties who are well placed to exploit the technology in question.[317] Similar rules in the software area could have salutary effects as well. Common law rules might go so far as to require a more substantial reduction to practice. Similarly, on the quality problem, perhaps more could be done to obtain (or accept) input from industry experts during the patent process.[318]

In addition to industry specific issues, there also is a particular type of conduct by trolls that is viewed as especially damaging by industry executives: the strategy of waiting after a patent has been issued while an industry advances using the covered technology and then suing widely for infringement only after the industry has become locked into the technology through independent innovation and development. My reaction is that the viability of that strategy is an artifact of an unduly narrow conception of the doctrine of laches. I can accept the fact that under current caselaw it might be difficult to limit the patentee's conduct through laches,[319] but at the same time it seems to me not particularly controversial to broaden the doctrine to

316. *See id.* at 1166–68. The assumption that obviousness doctrine is unduly lax is more intuitive than analytical. Bob Hunt has written most elegantly on the theoretical framework for assessing the appropriate strength of the obviousness requirement. *See* Robert M. Hunt, *Patentability, Industry Structure, and Innovation*, 52 J. INDUS. ECON. 401 (2004); ROBERT M. HUNT, NONOBVIOUSNESS AND THE INCENTIVE TO INNOVATE: AN ECONOMIC ANALYSIS OF INTELLECTUAL PROPERTY REFORM (Fed. Res. Bank of Phila.-Research Dep't, Working Paper No. 99-3, 1999), *available at* http://ideas.repec.org/p/fip/fedpwp/99-3.html.

317. *See* Sandra Scheimer, *Scope of Biotechnology Inventions in the United States and in Europe—Compulsory Licensing, Experimental Use and Arbitration: A Study of Patentability of DNA-Related Inventions with Special Emphasis on the Establishment of an Arbitration Based Compulsory Licensing System*, 21 SANTA CLARA COMPUTER & HIGH TECH. L.J. 163, 184–93 (2004) (discussing the patentability standards in the United States and possible impacts of such standards).

318. For discussion of such a proposal, see Rebecca S. Eisenberg, *Obvious to Whom? Evaluating Inventions from the Perspective of PHOSITA*, 19 BERKELEY TECH. L.J. 885 (2004).

319. The basic problem is that the so-called "*Aukerman* presumption" in current doctrine tends to limit the laches doctrine to cases in which the patentee withheld suit for six years after gaining knowledge of the infringing activity. Eric W. Guttag, *Laches and Estoppel: The Patentee Who Procrastinates in Filing Suit May Be Lost*, 31 AIPLA Q.J., Winter 2003, at 47, 51–54. In an industry that innovates as rapidly as the software industry, that rule permits an extraordinary delay.

limit the remedies available to patentees who delay litigation despite knowledge of infringing activity.

Again, it is not my purpose here to analyze these kinds of provisions in detail. My point is only to emphasize that the problems with software patents are not unusual in the patent system. The modern response to these problems in other sectors has not been to abandon patents altogether, but rather to modulate the system so as to accommodate the particular nature of innovation in the industry. My comments here are intended to suggest some avenues for beginning such an effort in the software industry.

VII. Conclusion

I do not purport to provide a definitive analysis of IP in the software industry. Indeed, I think that it is impractical to obtain the information that is necessary to specify the precise role that IP plays in the industry. Specifically, my view of patents in the industry reflects a basic tradeoff, in which the main burden is the net costs of the collection of patents solely for cross-licensing and the main benefits are the difficult to quantify benefits of patents in facilitating the formation of small firms and the licensing benefits (also of unknown size) to large firms. A full understanding of the import of that tradeoff will come only from a more developed explanation of the relative import of the contributions of large[320] and small firms to innovation.

Moving forward, I hope that I have made two analytical contributions. First, my discussion of the differing costs and benefits of patents at various stages of firm growth should contribute to a more dynamic understanding of the role a patent plays in fostering investment. Second, my discussion of the patent thicket thesis should give pause to those who so readily assume that patents stifle new investment and innovation. On the contrary, to the extent that the effects of patents in the industry are substantial, it is much more likely that they operate to the benefit of small firms than to the benefit of large firms.

320. On that point, see Etro, *supra* note 206 (arguing that monopolists have greater incentives to invest in R&D than outsiders).

Methodological Appendix

I use interviews to collect information about the common motivations and understandings of business practices that are not readily quantifiable. There are of course a number of risks in relying on interviews. For example, there is the possibility that bias by the interviewer will taint the results of the interviews.[321] That possibility is particularly important in this type of unfocused research because the interview scripts are not standardized.[322] There also is a significant risk that the sample of interview subjects will be biased in a way that reduces the accuracy of the information discovered in the interviews.[323] As discussed below, I have done what seems practicable to minimize those risks. In my view, however, the richness of the information available from this method far outweighs the methodological concerns.[324] The appropriate response is to proceed with caution in making firm empirical conclusions from the interviews.

The interviews typically are about 30 to 45 minutes long. I conduct all of the interviews personally. As is typical in this kind of research, the interviews are open-ended, without specifically scripted questions.[325] When possible, I conduct the interviews in person, but many of them are conducted by telephone. When it is possible and acceptable to the subject, I record the interview. If that is not acceptable, I take notes during the interview. Subject to confidentiality constraints necessary to obtain the interviews, the interview transcripts will be available on the Texas Law Review's website shortly after publication of this Article.[326] All of the subjects are identified in the opening footnote of the Article unless a subject requested anonymity. The transcripts include details about the positions that the subjects hold in the companies at which they are employed.

Because my goal was to understand how intellectual property affects financing practices in the industry, I attempted to speak to people who invest in startup companies—venture capitalists, angels, and banks. I also

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321. *See* IRVING SEIDMAN, INTERVIEWING AS QUALITATIVE RESEARCH: A GUIDE FOR RESEARCHERS IN EDUCATION AND THE SOCIAL SCIENCES 69, 74 (2d ed. 1998) (discussing interviewer bias).

322. *See id.* at 76–77 (discussing why interviewing scripts are inappropriate in this type of research); *see also* Daniel Bertaux, *From the Life-History Approach to the Transformation of Sociological Practice*, *in* BIOGRAPHY AND SOCIETY: THE LIFE HISTORY APPROACH IN THE SOCIAL SCIENCES 29, 38–39 (D. Bertaux ed., 1981) (discussing the need for interview "scripts" to "be modified from one interview to the next . . . according to the progress made in the understanding of [the topic]").

323. *See* SEIDMAN, *supra* note 321, at 44–47 (discussing the problem of interview subject bias).

324. *See id.* at 5 (discussing the benefits of interviews to collect qualitative information).

325. *See id.* at 69–70, 76–77 (describing open-ended questions and discussing how they are more appropriate than scripts for this kind of research).

326. For transcripts of the interviews, see *Software Patent Interviews*, Texas Law Review, *at* http://www.texaslawreview.org/Software.Patent.Interviews (last visited Feb. 24, 2005).

attempted to speak to people at software companies about their experiences in obtaining funding. Additionally, I spoke to people at large software companies to understand the role of IP in their assessment of potential firms for acquisition and about the role it plays in funding R&D in their own companies.[327] I also attempted to diversify geographically the interviews by contacting potential interview subjects in several of the states with large groups of software companies and venture capitalists—California, Massachusetts, Texas, Washington, and Michigan.[328]

The interview subjects were collected using the "snowball" method.[329] As is typical, I first used any available contacts in the industry from previous research, various institutional affiliations, and personal connections.[330] I also read widely in relevant news sources and contacted a large number of investors and developers "cold" based on news stories about recent fundings in the industry. As I interviewed subjects, I also asked for references to other potential subjects that might be willing to speak to me. As is typical for my work of this sort, I was successful in getting interviews from about one out of every four people that I contacted. I discerned no particular pattern in the likelihood that any particular person would agree to an interview.

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327. IBM and Microsoft ranked first and second in the 2004 release of the Software 500 by Software Magazine. 2004 Software Ranking, *supra* note 40, at 42.

328. About 60% of software firms that first received venture financing in 1998 and 1999 are located in those five states. *See* PRICEWATERHOUSECOOPERS ET AL., MONEYTREE SURVEY, *at* http://www.pwcmoneytree.com/moneytree/nav.jsp?page=historical (last visited Jan. 21, 2005).

329. *See* SEIDMAN, *supra* note 321, at 47 (discussing the "snowball" method).

330. This methodology is common in these types of inquiries. For example, see Kevin Hindle & Susan Rushworth, *The Demography of Investor Heaven: International Research on the Attitudes, Behaviour, and Characteristics of Business Angels*, *in* BRIDGING THE ENTREPRENEURIAL FINANCING GAP: LINKING GOVERNANCE WITH REGULATORY POLICY, *supra* note 72, at 10. For examples of a similar methodology by other legal academics, see Tom Baker, *Blood Money, New Money, and the Moral Economy of Tort Law in Action*, 35 LAW & SOC'Y REV. 275 (2001); Lisa Bernstein, *Private Commercial Law in the Cotton Industry: Creating Cooperation Through Rules, Norms, and Institutions*, 99 MICH. L. REV. 1724 (2001); Lisa Bernstein, *Merchant Law in a Merchant Court: Rethinking the Code's Search for Immanent Business Norms*, 144 U. PA. L. REV. 1765 (1996); Lisa Bernstein, *Opting Out of the Legal System: Extralegal Contractual Relations in the Diamond Industry*, 21 J. LEGAL STUD. 115 (1994); Bernard S. Black & John C. Coffee, Jr., *Hail Britannia?: Institutional Investor Behavior Under Limited Regulation*, 92 MICH. L. REV. 1997 (1994); Margo Schlanger, *Inmate Litigation*, 116 HARV. L. REV. 1555 (2003).