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PATENT INCENTIVES IN THE SEMICONDUCTOR INDUSTRY

*Dan Callaway**

INTRODUCTION

The semiconductor industry comprises organizations of all sizes, from single engineers contracting their work to companies as large and powerful as have ever existed. The rapid advancement of technology in the semiconductor field makes it a crucible for theories about the patent system as a whole. It is arguably desirable that as new technologies come to market, patents should be issued with appropriate scope so that other inventors retain incentive to innovate.¹ But it is not only the Patent Office which can offer or hinder incentives for inventors. The semiconductor industry is subjected to various incentives, both negative and positive, from Congress, the courts, and from within.

Part A of this paper will survey the semiconductor industry and the incentives for patenting integrated circuits. Part B will look at disincentives, and problems that have arisen in the industry. Part C focuses particularly on patent issues relating to “interface circuits”—those circuits that directly connect a chip to the outside world.

I. PATENT INCENTIVES IN THE SEMICONDUCTOR INDUSTRY

1. The semiconductor market’s rapid development and reliance on fresh ideas make it a laboratory for intellectual property law. The story of the

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1. See Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 843 (1990).

555 Timer illustrates the nature of the market.

The market for semiconductors is broad and diverse, incorporating the entire consumer electronics field, among others. The computers, music players, and cell phones purchased by consumers almost always contain semiconductor chips from various manufacturers. Some of these chips are designed with a very specific use in mind, and may even be manufactured by the consumer electronics company itself.² Such chips are called “ASICS,” or Application-Specific Integrated Circuits.³ While such customization is cost-effective and may be a desirable form of vertical integration for electronics companies,⁴ it drastically complicates the process of designing a product.⁵

While ASICS are on the cutting edge, the more traditional process of designing an electronic product involves using “off-the-shelf” or general-purpose chips that perform common functions.⁶ For example, one common type of general-purpose chip is a timer. Timer chips both provide signals of stable frequency and measure frequencies coming from other chips.⁷ One timer design, the “555” style, was introduced by Signetics in 1971.⁸ The chip became so popular that other companies copied the design and manufactured it, and today numerous companies manufacture their own interchangeable variants of the 555 chip, many still identical to the original.⁹ Over one billion of the chips, under various trade names, are sold every year worldwide,¹⁰ making it the most popular chip every single year

2. Junko Yoshida, ‘Synergy’ plan in play at Sony, EE TIMES ONLINE, Mar. 11, 2005, <http://www.embedded.com/showArticle.jhtml?articleID=159901574> (last visited Apr. 2007).

But Sony wasn’t willing to live with lower margins, especially for Playstation. In unveiling the Playstation Portable in Tokyo last fall, Kutaragi said the game division relied on Sony’s semiconductor operations for 50 percent of the box’s component value. Aggressive pricing was only possible, he said, because key ICs were designed and fabricated internally, using a 90nm process. ‘You can’t pull off this kind of pricing by depending on off-the-shelf components,’ Kutaragi said. The first-generation Playstation, by contrast, used ASICs from LSI Logic, a graphics chip from Toshiba, and memory from NEC, Mitsubishi, Toshiba and Hitachi. The only key internally developed component was a Sony disk drive, Kutaragi said.

Id.

3. FRANCO MALOBERTI, RANDEEP SINGH SOIN, ANALOGUE-DIGITAL ASICS: CIRCUIT TECHNIQUES, DESIGN TOOLS AND APPLICATIONS 13 (José Franca ed., IEE 1991).

4. Yoshida, *supra* note 2.

5. *Id.*

6. *Id.*

7. PAUL SCHERZ, PRACTICAL ELECTRONICS FOR INVENTORS 270 (1st ed. 2000).

8. HANS CAMENZIND, DESIGNING ANALOG CHIPS 11-3, 11-4 (BookSurge Publishing, 2005), available at <http://www.designinganalogchips.com> (follow “Download Book” hyperlink).

9. *Id.* at 11-3.

10. The 555 Timer IC An Interview With Hans Camenzind - The Designer Of The Most Successful Integrated Circuit Ever Developed, <http://semiconductormuseum.com/Transistors/LectureHall/Camenzind> (follow “Camenzind_Index.htm” hyperlink).

since its introduction.¹¹ Hans Camenzind, the original developer of the 555 Timer, describes its early history:

There are no patents on the 555. Signetics did not want to apply for a patent. You see, the situation with patents in Silicon Valley in 1970 was entirely different than it is now. Everybody was stealing from everybody else. I designed the 555 and Signetics produced it, and before a year later, National had it, Fairchild had it, and nobody paid any attention to patents. The people at Signetics told me they didn't want to apply for a patent, because what would happen if they tried to enforce that patent is, the people from Fairchild would come back with a Manhattan-sized telephone book and say, "These are our patents, now let's see what you're violating."¹²

The proliferation of the 555 by other companies illustrates the cutthroat nature of the semiconductor industry in its infancy. But today, more than ever, large semiconductor companies encourage their rivals to enter cross-licensing agreements.¹³ In these agreements, one firm may have to pay a one-time licensing fee to the other, depending upon the quantity of IP at stake and the volume of the sales involved.¹⁴ For example, I.B.M. paid a one-time 'balancing payment' of \$10 million to Intergraph in 2003, in a cross-licensing agreement that was the result of a patent dispute.¹⁵ Seldom the debtor in such arrangements, I.B.M. generates over \$1 billion in yearly revenue simply from licensing its patent portfolio to other companies.¹⁶ Qualcomm, which holds patents essential to the function of many of the world's cell phones,¹⁷ earned about sixty percent of its 2005 profits in royalties from agreements licensing its technologies to other semiconductor companies.¹⁸

11. George Rostky, *The 555: a timer nobody needed*, EE TIMES ONLINE, http://www.eetimes.com/special/special_issues/millennium/milestones/camenzind.html.

12. The 555 Timer IC, *supra* note 10, available at http://www.semiconductormuseum.com/Transistors/LectureHall/Camenzind/Camenzind_Page9.htm.

13. Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting*, in 1 INNOVATION POL'Y AND THE ECON. 119, 129-30 (2001), available at <http://faculty.haas.berkeley.edu/shapiro/thicket.pdf> (if viewing online, go to page 12) (last visited Apr, 2007).

14. *Id.*

15. Agreement to Resolve Patent Infringement Claims, available at <http://contracts.onecle.com/intergraph/ibm.settle.2003.01.30.shtml>

16. Bruce V. Bigelow, Patent payoff; By cultivating revenue growth through licensing, more U.S. companies are marketing their intellectual property, *SAN DIEGO UNION-TRIBUNE*, May 14, 2006 at H1.

17. *The Year In The Real Markets: 1999 Highlights; The Ring of Real Money*, N.Y. TIMES, Jan. 3, 2000, at C17 available at <http://www.nytimes.com> (search for "ring of real money" (with quotes)) (last visited Oct. 10, 2007).

18. Bigelow, *supra* note 16.

2. The nature of semiconductor manufacturing originally allowed companies to duplicate each other's chips with little or no original effort.

The 555 Timer was by no measure a complicated chip, containing only twenty-five transistors,¹⁹ compared with Intel's 4004 microprocessor, also released in 1971, which had 2,300 transistors.²⁰ But despite the 555's simplicity, other companies barely tried to conceal the overt nature of their clones. The process by which chips are manufactured involves photolithography, where microscopic circuit patterns are inscribed upon a chip by bright light, which is shone through a complex stencil.²¹ This stencil is called a mask.²² Hans Camenzind describes evidence of just how identical the competing chips were to the original 555 Timer:

There was one resistor, which I had made just a straight line. So the resistance is given by the [length] and the width. It turned out that it would be better to make this resistor larger, but of course if we had made it larger, then we would have had to change the whole mask. So we put in a meander—a snake line meandering back and forth so the total distance was longer. Well, the identical resistor was found in all the copies. So, it was strictly that they took a photograph and remade a mask without actually going to the bother of designing the circuit. This was just common practice by everybody. Signetics did it, and this was done by the biggies—Fairchild, Texas Instruments, Motorola—all the big competitors.²³

3. The Semiconductor Chip Protection Act (SCPA) was enacted with the intention of preventing unscrupulous copying of chip designs. It has seldom been litigated.

Frustrated with the unscrupulous copying that was common in the industry, manufacturers tried to obtain copyright protection for their semiconductor masks.²⁴ The U.S. Copyright Office, while it would accept schematic design drawings for protection, refused to protect the masks

19. CAMENZIND, *supra* note 8, at 11-4.

20. Chris Gaither, *Technology Briefing: Hardware; Moore Leaving Intel Board*, N.Y. TIMES, Apr. 12, 2001, at C6.

21. VIVIE IRISH, *INTELLECTUAL PROPERTY RIGHTS FOR ENGINEERS* 57 (IEE 2005).

22. STEVE M. KAPLAN, *WILEY ELECTRICAL AND ELECTRONICS ENGINEERING DICTIONARY* 454 (John Wiley & Sons, Inc. 2004)

23. Interview with Hans Camenzind, President, Array Designs, in S.F., Cal. (Mar. 30, 2007).

24. Carl A. Kukkonen, *The Need To Abolish Registration For Integrated Circuit Topographies Under TRIPS*, 38 IDEA 105, 107-08 (1997).

because of their utilitarian nature.²⁵ Lobbying efforts escalated, and in 1984 Congress passed the Semiconductor Chip Protection Act, or SCPA.²⁶ The SCPA creates a distinct form of IP protection to prevent chip “cloning,” which is the process of creating masks from photographs of the inside of a competitor’s chip, so that a duplicate chip can be fabricated with no design effort.²⁷ However, the SCPA contains an exception for reverse engineering, which is the process of photographing the inside of the chip and studying and analyzing the photograph, in order to create another semiconductor chip product that competes with the first one.²⁸ This clause narrows the protection of the SCPA, so that the process of copying a chip will pass muster if it involves sufficient efforts by the copyist.²⁹ In reviewing an infringement verdict involving the defense of reverse engineering, the Court of Appeals for the Federal Circuit approved jury instructions that told jurors to “place great weight on the paper trail” of the defendant.³⁰ This test may be manipulable by a defendant, as it “accentuates the requirement that the defendant expend great time and effort in studying the plaintiff’s design in order to create an original mask work.”³¹

A 1990 paper by Robert Risberg questioned the SCPA’s efficacy after it had gone largely unlitigated for six years since its enactment, despite that patent infringement suits in the semiconductor industry continued.³² Two years later, the Federal Circuit affirmed a jury finding that AMD infringed another company’s masks under the SCPA, along with a \$25-million damages verdict.³³ And a 2005 decision by the Ninth Circuit affirmed a liability verdict under the SCPA where \$30.6 million in damages was awarded.³⁴ But these notable cases notwithstanding, there have been few claims brought under the SCPA since its inception. This may be attributable to the manufacturing capabilities of the largest semiconductor companies, which have become so advanced that other companies simply do not have the capacity to replicate them.³⁵ Also, modern microprocessors and other highly complex chips are sold with a high level of manufacturer support, including development tools, advertising, and customer support,

25. *Id.*

26. Semiconductor Chip Protection Act of 1984, 17 U.S.C. §§ 901-914 (2000).

27. Kukkonen, *supra* note 24, at 110.

28. Semiconductor Chip Protection Act, 17 U.S.C. § 906 (1988).

29. Lee Hsu, *Reverse Engineering Under the Semiconductor Chip Protection Act: Complications for Standard of Infringement*, 5 ALB L.J. SCI. & TECH. 249, 263-264 (1996).

30. *Brooktree Corp v Advanced Micro Devices, Inc*, 977 F.2d 1555, 1570 (Fed. Cir. 1992).

31. Hsu, *supra* note 29, at 263.

32. Robert L. Risberg, Jr., *Five Years Without Infringement Litigation Under The Semiconductor Chip Protection Act: Unmasking The Spectre Of Chip Piracy In An Era Of Diverse And Incompatible Process Technologies*, 1990 WIS. L. REV. 241, 262-63 (1990).

33. *Brooktree*, 977 F.2d at 1583.

34. *Altera Corp. v. Clear Logic, Inc.*, 424 F.3d 1079, 1081 (9th Cir. 2005).

35. Kukkonen, *supra* note 24, at 136.

which potential copyists are ill-equipped to provide.³⁶

Risberg argues that the SCPA is less relevant in view of a “virtual renaissance” in the predictability and protection of patent law since the creation of the Court of Appeals for the Federal Circuit.³⁷ But he hints that “more subtle types of copying still occur.”³⁸ Echoing this sentiment more flippantly, independent chip designer Hans Camenzind says, “Everyone was hoping [the SPCA] would stop direct optical copying. It doesn’t work—nobody’s using it, period.”³⁹ Perhaps the paucity of SCPA lawsuits belies a sense of lawlessness in the market for small-volume chips.

4. Trade secret law cannot protect integrated circuits that are shipped into commerce, ripe for reverse engineering.

In bringing a new chip to market, thwarting copyists is so strong a concern that it can negatively affect a semiconductor company’s incentive to file a patent application.⁴⁰ While patents provide strong protection against proven infringers, the requisite disclosure of a patent filing often outweighs the potential enforcement benefits because infringement can be so difficult to detect in semiconductor chips.⁴¹ Some large companies seeking to enforce patents hire pseudo-legal teams of “patent miners” to identify valuable patents and search industry publications for evidence of infringement.⁴² Other semiconductor manufacturers may prefer to operate under the patent radar, considering their work to be “secret,” either in the legal sense or in a more prosaic one.⁴³ Legal protection of trade secrets has long been available for fabrication processes that are not made evident by the finished product.⁴⁴ A semiconductor executive describes the decision to retain one such technique as a trade secret: “There’s a huge amount of IP that goes into where we place [a particular circuit] within the chip. There’s no way anyone outside could see how we do it. We felt a patent would be

36. *Id.* at 137.

37. Risberg, Jr., *supra* note 32, at 245.

38. *Id.*

39. Interview with Hans Camenzind, *supra* note 23.

40. Interview with David Lidsky, Vice President of Design Engineering, Volterra Semiconductor, in Oakland, Cal. (Apr. 7, 2007) (“If we do a neat, innovative little circuit inside, we’re not going to patent it . . . that’s just telling someone how to do it. We’re not going to tear [into] someone’s silicon . . . to see that they’re doing it. So patenting it isn’t going to give us any advantage.”).

41. *Id.*

42. Shapiro, *supra* note 13, at 121 (if viewing online, go to page 3).

43. Interview with Hans Camenzind, *supra* note 23. (“I don’t think ideas are dying off; they’re strong as ever. It’s just that . . . some ideas are simply not disclosed anymore. They’re treated as secrets, rather than as public knowledge. I don’t know whether it’s a disadvantage. It probably slows progress a little bit. The big ideas are still in the framework of the patent system.”).

44. *Kewanee Oil Co. v. Bicron Co.*, 416 U.S. 470, 475 (1974).

a recipe for doing it.”⁴⁵

If a secret is manifested on a chip, though, it is not likely to be eligible for trade secret protection. Circuits themselves are placed in the stream of commerce once a chip is sold, making it unfeasible to meet the trade secret standard⁴⁶ of “efforts that are reasonable under the circumstances to maintain . . . secrecy.”⁴⁷ Some semiconductor companies spare no effort to reverse-engineer competitors’ chips, taking microscopic pictures of the layers of metal and silicon sandwiched within.⁴⁸ This has become more difficult as the manufacturing process has enabled incremental reductions in the size of semiconductor chips.⁴⁹ As chips have shrunk in size and burgeoned in density, companies have struggled to cope with the sprawling scale of reverse-engineering projects. “We’d have to take thousands of pictures,” said one industry professional.⁵⁰ The pictures had to be painstakingly matched and stitched together, so the company would rely on contractors.⁵¹ “They were retirees, art majors—a very interesting collection of people. Some said it was better than doing a puzzle, but other people would try it once and never come back again. By the early ‘90s, we needed to take the photographs off the carpet.”⁵² In reverse engineering, companies also use chemical solvents to dissolve a chip’s topmost layers of circuitry, so that buried layers can be examined and photographed.⁵³

All of this makes trade secret protection a very risky bet for circuits, because there is simply no way to prevent the determined (and well-funded) reverse engineer from delving into a chip and documenting its inner workings. To protect semiconductor IP, a chip designer must either be very confident that his chip cannot be reverse engineered to reveal his secret, or he must apply for a patent.

B. DISINCENTIVES TO PATENTING INTEGRATED CIRCUITS

The first part of this paper addressed strong incentives for patenting circuit IP. This section raises some negative considerations that militate

45. Interview with David Lidsky, *supra* note 40.

46. Kukkonen, *supra* note 24, at 108.

47. Unif. Trade Secrets Act § 1, 14 U.L.A. 433 (1990).

48. Jeffrey D. Sullivan & Thomas M. Morrow, *Practicing Reverse Engineering In an Era Of Growing Constraints Under the Digital Millennium Copyright Act and Other Provisions*, 14 ALB. L.J. SCI. & TECH. 1, 16 n.58 (2003).

49. Andrew Pollack, *BUSINESS TECHNOLOGY; New Chip Method May Be Put Off*, N.Y. TIMES, Dec. 12, 1990, at D1.

50. Alan S. Brown, *Tearing Down the Nearly Invisible*, MECHANICAL ENGINEERING, Aug., 2006, available at <http://www.memagazine.org/aug06/features/tearing/tearng.html>.

51. *Id.*

52. *Id.*

53. Sullivan & Morrow, *supra* note 48, at 16 n.58.

against patenting.

1. A new chip will almost certainly infringe some patents.

It is very difficult to design a microprocessor or other large chip without infringing some competitor's patent.⁵⁴ Chips are composed of hundreds of circuits and assemblies, many of which may already be patented.⁵⁵ Determining whether a new product infringes the patents of a competitor may involve a patent search spanning years of disclosures by both the competitor and other companies. A new chip, designed as an original effort, may still contain thousands of technologies owned by rivals, suppliers, or manufacturers.⁵⁶ Some of this may be attributable to the movement of design engineers among semiconductor companies, and the impossibility of their memorizing a "chain of title" for every individual circuit block they employ in their work.⁵⁷ This problem frequently arises in the context of trade secrets, with semiconductor companies suing former employees who appropriate their trade secrets in working for competitors.⁵⁸

A chip made for a limited market will probably never be scrutinized for infringement by other companies. Asked about the job of pursuing infringement in the modern world of circuit design, Hans Camenzind says,

54. Shapiro, *supra* note 13, at 121 (if viewing online, go to page 2).

55. Risberg, Jr., *supra* note 32, at 265.

In practice, however, many new chips are not developed from scratch. More typically, new chips often include previously patented circuits or processes. Because broadly claimed patents can cover more than one embodiment, a fundamental idea in any structure can be protected. And while the average chip product may have only a two or three year life, most meaningful technological advances often have a far longer life.

Id.

56. Rosemarie Ham Ziedonis & Bronwyn H. Hall, *The Effects of Strengthening Patent Rights on Firms Engaged in Cumulative Innovation. Insights from the Semiconductor Industry*, in ENTREPRENEURIAL INPUTS AND OUTCOMES: NEW STUDIES OF ENTREPRENEURSHIP IN THE UNITED STATES 133, 145-46 (Gary D. Libecap ed., 2001).

As some pointed out, a given semiconductor product (say, a new memory or logic device) will often embody hundreds if not thousands of 'potentially patentable' technologies that could be owned by suppliers, manufacturers in other industries, rivals, design firms, or independent inventors. With the strengthening of US patent rights, the expected benefits of amassing portfolios of 'legal rights to exclude' (for offensive and defensive reasons) began to outweigh their costs.

Id.

57. Interwith with David Lidsky, *supra* note 40.

58. Risberg, Jr., *supra* note 32, at 253 n.62. "The subject of the trade secret must not be in the public domain or within the knowledge of a particular trade or business." *Kewanee Oil Co. v. Bicron Corp.*, 416 U.S. 470, 475 (1974). "Trade secret law is often applied against employees or former employees in the semiconductor industry because of high employee turnover rates." Risberg, Jr., *supra* note 32, at 253 n.62.

For dense modern circuits, the pursuit of patent infringement is only carried out for very visible circuits, like a microprocessor, or something like that; high volume, expensive, where you can justify the cost. You may have a team of three people working for six months to just see what your competitor has in their chip But for any other product—a custom circuit that’s made for a little company and they make 50,000 or 100,000 pieces a year—it’s not worth it.⁵⁹

Such economies of scale may encourage smaller companies to avoid filing patents that might attract aggression from larger companies seeking cross-licenses. This suggests that companies with fewer resources will have less incentive to file for patent protection than their larger counterparts.

2. The law of willful infringement discourages engineers from reading patents, stultifying the process of invention. A recent Federal Circuit ruling may address this problem.

As discussed in the preceding section, the process of designing a chip is a complex and creative endeavor, and can incorporate hundreds or thousands of “potentially patentable” technologies for which adverse patents may be held.⁶⁰ A chip designer cannot know that his work is blocked by an existing patent, any more than a musician can know that a tune popping into his head has already been copyrighted. Worse, there is the possibility that after a chip is designed and produced, an adverse patent will issue from an application that has lingered in the Patent Office, creating a wellspring of liability. This situation is called hold-up.⁶¹

One would think that such possibilities would encourage engineers and their managers to survey the patents in their fields, as a soldier sweeps for mines in his path. But the semiconductor industry operates in constant fear of liability for willful infringement. Until 2007, Federal Circuit doctrine permitted judges to impose treble damages⁶² where a potential infringer, having actual notice of another’s patent rights, failed to seek counsel before practicing the patented matter.⁶³ As a result, “actual notice” has been considered the *sine qua non* of willful infringement; the Federal Circuit has stated that “a party cannot be found to have ‘willfully’ infringed a patent of which the party had no knowledge.”⁶⁴ So, the argument goes,

59. Interview with Hans Camenzind, *supra* note 23.

60. Ziedonis & Bronwyn, *supra* note 56, at 145-46.

61. Shapiro, *supra* note 13, at 121 (if viewing online, go to page 3)

62. 35 U.S.C. § 284 (2000).

63. *Underwater Devices, Inc. v. Morrison-Knudsen Co.*, 717 F.2d 1380, 1389-90 (Fed. Cir. 1983), *overruled by In re Seagate Tech., LLC*, 497 F.3d 1360 (Fed. Cir. 2007).

64. *Gustafson, Inc. v. Intersystems Indus. Prods., Inc.*, 897 F.2d 508, 511 (Fed. Cir. 1990).

the best way to avoid enhanced damages for infringement is to avoid all contact with issued patents. This axiom has led many technology companies to forbid patent searches among its employees. Linus Torvalds, development coordinator for the open-source Linux kernel, says, "Ask any lawyer in a tech company (off the record, so that he can be honest too), and he'll tell you that engineers should absolutely not try to look up other people's patents. It's not their job, and you don't want them tainted."⁶⁵ Mark Lemley has argued that discouraging engineers from reading patents in order to avoid willful infringement leads directly to a subversion of the patent law's disclosure incentive, because it frustrates the dissemination of ideas through patents.⁶⁶ If engineers don't read patents relevant to their work, to whom are those patents intended to disclose their underlying ideas? Lemley also points out that when companies are ignorant of one another's patents, inventors receive less compensation for their ideas.⁶⁷ Licensing arrangements that might benefit both patent holders and licensees cannot be identified if everyone wears blinders.

In August of 2007, the Federal Circuit revisited the duty to seek counsel in the *en banc* hearing of *In re Seagate Technology, LLC*.⁶⁸ Overruling its own case law, the court declared that "recklessness" is the lowest measure of intent appropriate for a finding of willful infringement.⁶⁹

In contrast, the duty of care announced in *Underwater Devices* sets a lower threshold for willful infringement that is more akin to negligence. This standard fails to comport with the general understanding of willfulness in the civil context, and it allows for punitive damages in a manner inconsistent with Supreme Court precedent.⁷⁰

The court recognized the changing times since *Underwater Devices*: "[The *Underwater Devices*] standard was announced shortly after the creation of the court, and at a time 'when widespread disregard of patent rights was undermining the national innovation incentive.'"⁷¹ One possible inference from the court's rationale is that actual notice of a competitor's patent is no longer sufficient for a finding of willfulness. Time will tell whether *Seagate* eases the minds of corporate attorneys and engineering managers fearful of allowing employees to read patents. The court's explicit overruling of a cornerstone case of willful infringement is

65. Steve Lohr, *Technology: I.B.M.'s Opponent in Suit Criticizes Linux Advocate*, N.Y. TIMES, June 18, 2003, at C6.

66. Mark A. Lemley & Ragesh K. Tangri, *Ending Patent Law's Willfulness Game*, 18 Berkeley Tech. L.J. 1085, 1100-1101 (2003).

67. *Id.* at 1121.

68. 497 F.3d 1360 (Fed. Cir. 2007) (*en banc*).

69. *Id.* at *20-*21 (citing *Safeco Ins. Co. of Am. v. Burr*, 127 S. Ct 2201, 2209 (2007)).

70. *Id.* at *21-*22 (internal citations omitted).

71. *Id.* at *15 (quoting *Knorr-Bremse Systeme Fuer Nutzfahrzeuge GmbH v. Dana Corp.*, 383 F.3d 1337, 1343 (Fed. Cir. 2004) (*en banc*)).

encouraging, along with the suggestion in *Seagate* that the standard for willfulness be an objective risk of infringement, as defined by standards of commerce.⁷²

3. Courts have not adopted a stable doctrine of interpretation for cross-license agreements common in the semiconductor industry.

Semiconductor companies are increasingly outsourcing their manufacturing operations to foundries overseas.⁷³ One consequence of such outsourcing may be collaboration between foundries and design firms to subvert the patent rights of other companies. In *Intel v. International Trade Commission*, Intel and Atmel Corporation both appealed to the Federal Circuit a finding of the ITC that Atmel was infringing Intel's patent by importing certain Erasable Programmable Read-Only Memories (EPROMs) into the U.S.⁷⁴ Atmel had arranged to have EPROMs of its own design⁷⁵ manufactured by a foundry owned by Sanyo.⁷⁶ Sanyo had previously entered a broad cross-licensing agreement with Intel.⁷⁷ In the agreement, Intel granted Sanyo a worldwide, royalty-free license to make,

72. *Id.* at *23 n.5.

73. John Markoff, *Forget Computers. Here Comes the Sun*. N.Y. TIMES, Apr. 14, 2006, at C1.

74. *Intel Corp. v. U. S. Int'l Trade Comm'n*, 946 F.2d 821, 824 (Fed. Cir. 1991).

75. In the agreement, it was *Atmel's* responsibility to develop new EPROM designs. Appellee's Brief at 12, *Intel Corp. v. U. S. Int'l Trade Comm'n*, 946 F.2d 821 (Fed. Cir. 1991) (No. 89-1459).

76. *Intel*, 946 F.2d at 826.

77. The licensing arrangement provides:

3.5 Intel hereby grants and will grant to Sanyo an [sic] non-exclusive, worldwide royalty-free license without the right to sublicense except to its Subsidiaries, under Intel Patents which read on any Sanyo Semiconductor Material, Semiconductor Device, Magnetic Bubble Memory Device, Integrated Circuit and Electronic Circuit products, for the lives of such patents, to make, use and sell such products.

3.6 Sanyo hereby grants and will grant to Intel a non-exclusive world-wide, royalty-free, license without the right to sublicense except to its Subsidiaries, under Sanyo Patents which read on any Intel Semiconductor Material, Semiconductor Device, Magnetic Bubble Memory Device, Integrated Circuit and Electronic Circuit products, for the lives of such patents to make, use and sell such products.

Id. at 826 n.9.

The agreement defines the term "Intel Patents" broadly, covering "any and all" patents that Intel "owns or controls," including those of its subsidiaries. The only limitations in paragraph 3.5 are that Sanyo (1) may not sublicense, except to subsidiaries, and (2) may only make, use and sell "Sanyo . . . products. Atmel's argument is that the "Sanyo" limitation precludes *only* "have made" rights, and Sanyo otherwise has an unlimited, royalty-free right to practice all Intel patents. *Id.* Put another way, *anything* manufactured by Sanyo that utilizes *any* Intel patent is subject to the royalty-free license of paragraph 3.5.

Id. at 828.

use, and sell *Sanyo* products covered by any Intel patents.⁷⁸ Atmel argued before the Federal Circuit that its EPROMs did not infringe Intel's patents because they were manufactured under Sanyo's license with Intel.⁷⁹ This amounted to a defense of patent exhaustion.⁸⁰ The court, conditioning the exhaustion doctrine on construction of the license,⁸¹ reasoned that the limitation of the license to "Sanyo products" precluded Atmel from exhausting Intel's patent rights by sourcing its chips from Sanyo.⁸²

In the inapposite Federal Circuit case of *Intel v. ULSI*, Intel sought to prevent ULSI from importing chips made in an HP foundry that operated under a cross-license with Intel.⁸³ ULSI had designed a co-processor that worked in conjunction with Intel's 80386 processor.⁸⁴ ULSI arranged to have the co-processor manufactured at HP's facility, which both believed was shielded from suit under the cross-license agreement with Intel.⁸⁵ The United States District Court for the District of Oregon issued a preliminary injunction against ULSI, which appealed to the Federal Circuit. This time, the Federal Circuit found that the cross-license between Intel and its licensee was not limited to those products that would be marketed by the licensee itself.⁸⁶ The court held that HP's sale of the chips to ULSI, despite that ULSI provided the design, was sufficient to trigger the first-sale doctrine and exhaust Intel's patent rights with respect to those chips.⁸⁷

These cases illustrate that the cross-licensing agreements so prevalent in the semiconductor industry are susceptible of broad, perhaps unintended interpretations. The facts of ULSI create a roadmap for a company wishing to circumvent the patents of a larger rival: Approach the rival's cross-licensee and negotiate a "foundry" arrangement, where the licensee will accept design specifications and manufacture chips under the safe umbrella of the license.⁸⁸ I.B.M. has reportedly begun charging a higher fee when it provides foundry services under circumstances like these, in exchange for indemnification against patent infringement in connection with the arrangement.⁸⁹

In its 2007 term, the Supreme Court will determine whether a patentee's rights are exhausted by a licensee's sale of goods in *Quanta*

78. *Id.* at 826.

79. *Id.*

80. Mark J. Rozman, *Intel v. ULSI System Technology, Inc.*, 1 J. INTELL. PROP. L. 373, 382 (1994) (interpreting Atmel's defense as one of patent exhaustion).

81. *Id.*

82. *Intel*, 946 F.2d at 828.

83. *Intel Corp. v. ULSI Sys. Tech. Inc.*, 995 F.2d 1566, 1567 (Fed. Cir. 1993).

84. *Id.*

85. *Id.* at 1569.

86. *Id.* at 1571.

87. *Id.* at 1569.

88. *Id.* at 1567.

89. Ziedonis & Bronwyn, *supra* note 56, at 171 n.9.

*Computer, Inc. v. LG Electronics, Inc.*⁹⁰ The case involves the license of a patent from LG to Intel. The license permitted Intel to sell certain processors and chipsets to computer manufacturers.⁹¹ In exchange, though, Intel agreed to notify its customers that the license from LG did not permit the Intel chips to be combined with non-Intel products.⁹² LG sued several Intel customers for infringement, and they asserted a defense of patent exhaustion. LG's patent rights, they argued, had been exhausted by Intel's sale of the chips.⁹³ The district court agreed, granting summary judgment of non-infringement.⁹⁴ The Federal Circuit reversed this ruling, holding that the license from LG to Intel, which was conditioned on Intel's notifying its customers about the legal dangers of combining the chips with non-Intel components, did not effect exhaustion of LG's patent rights.⁹⁵

The Federal Circuit noted that LG's patents did not cover the chips sold by Intel, but the combination of those chips with external components.⁹⁶ The Supreme Court's decision will weigh the enforceability of the carefully drawn Intel-LG license against the traditional "first sale" doctrine of exhaustion, which it stated succinctly in the 1942 *Univis* case, involving the sale of patented lenses to a manufacturer of eyeglasses:

Our decisions have uniformly recognized that the purpose of the patent law is fulfilled with respect to any particular article when the patentee has received his reward for the use of his invention by the sale of the article, and that once that purpose is realized the patent law affords no basis for restraining the use and enjoyment of the thing sold.⁹⁷

If the Court invalidates the restrictive terms of LG's license to Intel, it will cast doubt on many of the license arrangements in the semiconductor industry. Companies currently use their patent rights to tailor licensing agreements with each other, creating the potential for complex bargaining and a free market for intellectual property. Insofar as the market is functioning properly, the Supreme Court's decision may limit the ability of licensors to enter into mutually beneficial agreements, resulting in a less efficient market.

That said, it may be that the semiconductor market is not functioning properly, and that a persistent emphasis on licensing has put tremendous legal power in the hands of a corporate oligopoly. If a patentee is able,

90. *LG Elecs, Inc v. Bizcom Elecs, Inc.*, 453 F.3d 1364 (Fed. Cir. 2006), *cert. granted*, 76 U.S.L.W. 3153 (U.S. Sep. 25, 2007) (No. 06-937).

91. *Id.* at 1368.

92. *Id.*

93. *LG Elecs., Inc. v. Bizcom Elecs., Inc.*, 2004 U.S. Dist. LEXIS 29906, at *8 (N.D. Cal. 2004).

94. *Id.* at *33.

95. *LG Elecs*, 453 F.3d at 1370.

96. *Id.* at 1369.

97. *United States v. Univis Lens Co., Inc.*, 316 U.S. 241, 251 (1942).

through private licensing agreements, to exert his rights far downstream of his own sale or license of goods, then even the most diligent of bona fide purchasers can have no hope of determining the provenance of his merchandise. Of course, the LG license that is the subject of the Supreme Court's grant of certiorari requires that Intel notify its customers of LG's residual rights. But can the carrying out of the notice function in property law be delegated to a private company?

C. CIRCUITS THAT PROVIDE EXTERNAL INTERFACES

We have seen that detecting infringement of integrated circuit patents is expensive and difficult. Accordingly, designers are tempted to selectively patent those technologies and circuits that "interface" with other chips. Unlike deeply embedded circuits, these technologies are at the valence of a chip or even outside it, and can readily be traced in an infringement inquiry. The circuits or protocols that a chip uses for external communication must typically be described in product guides and datasheets, which are a welcome shortcut in the detection of infringement. This section will examine the incentives created by a proliferation of patents on this type of technology.

1. FTC investigations suggest that "interface" patents may be used to gain unfair competitive advantage through standard-setting.

The FTC recently affirmed a decision finding that Rambus illegally obtained a monopoly on technologies used in dynamic random access memory (DRAM) chips by strategically participating in an industry effort to standardize memory chip technology.⁹⁸ The FTC found that Rambus deceived the JEDEC standards organization (the largest in the semiconductor industry)⁹⁹ by "participat[ing] in JEDEC's DRAM standard-setting activities for more than four years without disclosing to JEDEC or its members that it was actively working to develop, and possessed, a patent and several pending patent applications that involved specific technologies ultimately adopted in the standards."¹⁰⁰

The FTC opinion cited a 1992 Rambus business plan as "identifying the marketing of RDRAM as the number one strategy while simultaneously articulating a strategy of capturing royalties from SDRAMs by 'be[ing] in a

98. Press Release, FTC, *FTC Issues Final Opinion and Order in Rambus Matter* (Feb. 5, 2007), <http://www.ftc.gov/opa/2007/02/070502rambus.shtm>.

99. See *Jedec Home Page*, www.jedec.org (last visited Oct. 10, 2007).

100. Press Release, FTC, *supra* note 98.

position to request patent licensing (fees and royalties) from any manufacturer of Sync DRAMs.”¹⁰¹ The first RDRAM patent issued to Rambus¹⁰² describes the “field of the invention” as “an integrated circuit bus interface for computer and video systems.”¹⁰³

Once Rambus led JEDEC to base the DRAM standard on its patented technologies, it paid visits to other manufacturers in the same way Hans Camenzind described Fairchild’s aggressive visits in the early 1970’s.¹⁰⁴ ATI and NVIDIA were among those that received “patent presentations” (pageants) from Rambus.¹⁰⁵ Rambus was able to create tremendous leverage with its RDRAM patents not only because the JEDEC standards body broadly adopted technology for which Rambus had patents, but also because the technology was for an unconcealed interface, which made detection of infringement trivial. Any DRAM that was marketed as compliant with the JEDEC standard would almost certainly infringe Rambus’ patents.

This case should serve to indicate the tremendous power of “interface” patents relative to patents on circuits. Circuits are, by their nature, concealed, obscure, and not documented publicly. Interface technology, on the other hand, must be exhaustively described if the chips of one company are to be incorporated into the products of another.

2. Courts have considered the coercive effects of “interface monopolies” unacceptable in cases where electronic interfaces have been protected through software copyrights rather than patents.

Exclusive rights to circuits which perform “interface” or “communication” functions can give a company disproportionate leverage, particularly if the circuit becomes part of a market standard.¹⁰⁶ In *Atari Games Corp. v. Nintendo of America Inc.*, Atari became dissatisfied with a restrictive license granted to it by Nintendo.¹⁰⁷ The license allowed Atari to market only five games per year for the Nintendo Entertainment System console (NES). Atari, a long-time presence in the video game market, sought to market its entire existing catalog of games for the NES. Nintendo employed a copyright “lock-out” system called the 10NES to

101. Opinion of the Commission On Remedy, *In re Rambus, Inc.*, p. 15 n.91 (Feb. 2007) available at <http://www.ftc.gov/os/adjpro/d9302/070205opinion.pdf>.

102. *Rambus Inc. v. Infineon Techs. AG*, 318 F.3d 1081, 1085 (Fed. Cir. 2003).

103. U.S. Pat. No. 5,243,703 col.1 l. 67-68 (filed Mar. 5 1992).

104. Opinion of the Commission On Remedy, *supra* note 101, at 28 n 163.

105. *Id.*

106. Robert P. Merges, *Who Owns The Charles River Bridge? Intellectual Property and Competition in the Software Industry*, 8 (Apr. 2, 1999) (unpublished manuscript, available at <https://www.law.berkeley.edu/institutes/bclt/pubs/merges/criver.pdf>).

107. *Atari Games Corp. v. Nintendo of Am., Inc.*, 975 F.2d 832, 836 (Fed. Cir. 1992)

prevent unlicensed cartridges from working on its console.¹⁰⁸ This system required each game cartridge to have a “key” chip, which would interface with a “lock” chip on the NES console.¹⁰⁹ Nintendo’s licensing regime required Atari to provide chips containing the finished game code to Nintendo, which would place them in plastic cartridges containing the 10NES “key” chip. Nintendo would then resell the cartridges to Atari, which could finally market them.¹¹⁰ Atari reverse engineered the 10NES chip, which it scavenged from a retail-market NES console. The Federal Circuit found the reverse engineering of the copyrighted chip to be permissible as fair use, although Atari lost the case on other grounds.¹¹¹

In the similar case of *Sega Enterprises v. Accolade, Inc.*, the Ninth Circuit proclaimed that the reverse engineering of a proprietary game system to achieve compatibility, which resulted in a proliferation of video games compatible with the system, was “precisely this growth in creative expression, based on the dissemination of other creative works and the unprotected ideas contained in those works, that the Copyright Act was intended to promote.”¹¹²

These cases involve copyrights, which have always provided narrower rights than patents. Still, they indicate courts’ suspicion of legal arrangements that allow manufacturers to impose restraints on the use of their products even after they have been sold. These kinds of restraints underlie many of the licensing disputes that complicate the patent law today.

108. *Id.*

109. *Id.*

110. *Id.*

111. The court stated:

Reverse engineering, untainted by the purloined copy of the 10NES program and necessary to understand 10NES, is a fair use. An individual cannot even observe, let alone understand, the object code on Nintendo’s chip without reverse engineering. Atari retrieved this object code from NES security chips in its efforts to reverse engineer the 10NES program. Atari chemically removed layers from Nintendo’s chips to reveal the 10NES object code. Through microscopic examination of the ‘peeled’ chip, Atari engineers transcribed the 10NES object code into a handwritten list of ones and Zeros. While these ones and zeros represent the configuration of machine readable software, the ones and zeros convey little, if any, information to the normal unaided observer. Atari then keyed this handwritten copy into a computer. The computer then ‘disassembled’ the object code or otherwise aided the observer in understanding the program’s method or functioning. This ‘reverse engineering’ process, to the extent untainted by the 10NES copy purloined from the Copyright Office, qualified as a fair use.

Id. at 843-44 (footnote omitted).

112. *Sega Enters. v. Accolade, Inc.*, 977 F.2d 1510, 1523 (9th Cir. 1992).

CONCLUSION

The semiconductor market faces skewed incentives in the decision to patent integrated circuit technologies. First, patenting a circuit that is deeply embedded in a chip holds little promise for either a small or a large manufacturer. Small manufacturers face increased attention and aggressive licensing negotiations from larger players if they reveal parts of their chips' inner workings through patent disclosure. When large companies patent deeply embedded circuits, they must put forth expensive and time-consuming efforts to find evidence that other companies are actually infringing their patents, because of the needle-in-a-haystack nature of individual circuits in complex chips. For both large and small companies, there is the threat that a patent disclosure will simply be co-opted by another manufacturer, who will exploit the patentee's technology in a chip too obscure to ever be detected.

Second, there is the temptation to focus patenting efforts on technologies and circuits that "interface" with other chips. Unlike deeply embedded circuits, these are easily detected in an infringement inquiry. Such circuits are often incorporated into industry standards, so that any patents relating to them are assured a steady stream of royalty revenues when consumer demand for a standard picks up.

The incentive for disclosure in the patent system is skewed towards those semiconductor discoveries which are the easiest to detect. Circuits which really do benefit the industry are often not disclosed, because they don't seem enforceable through evidence of infringement. Patents which are obtained primarily for their leverage in non-adjudicated license negotiations and industry cross-licenses are not likely to disclose the most novel innovations of an industry. Therefore, the growing library of patents in the semiconductor field is not adequately disclosing the state of the art to the public. The *quid pro quo* of the patent system is subverted when the patent holder obtains exclusive rights to his invention without fully disclosing how it works.

Finally, industrial paranoia about enhanced damages for willful patent infringement has led to a culture in which engineers and their managers avoid reading or considering patents. The "wisdom" in the industry is that reading patents in the design process, even in good faith, can lead directly to a finding of willful infringement. The efficient exchange of ideas for a reasonable royalty rate is one of the patent system's most tangible promises, but it is thwarted by the widely-held notion that looking at what other companies have done is poisonous to success. Instead of looking in the patent literature for a ready-made solution to an incipient problem, semiconductor companies prefer to reinvent the wheel, barricading themselves from any possible claim of willful infringement.

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