Fordham Intellectual Property, Media and Entertainment Law Journal

Volume 28 *XXVIII*
Number 4

Article 1

2018

A Bridge Between Copyright and Patent Law: Towards a Modern-Day Reapplication of the Semiconductor Chip Protection Act

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Recommended Citation

Timothy T. Hsieh, *A Bridge Between Copyright and Patent Law: Towards a Modern-Day Reapplication of the Semiconductor Chip Protection Act*, 28 Fordham Intell. Prop. Media & Ent. L.J. 729 (2018).
Available at: https://ir.lawnet.fordham.edu/iplj/vol28/iss4/1

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Cover Page Footnote

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This article is available in Fordham Intellectual Property, Media and Entertainment Law Journal: https://ir.lawnet.fordham.edu/iplj/vol28/iss4/1

A Bridge Between Copyright and Patent Law: Towards a Modern-Day Reapplication of the Semiconductor Chip Protection Act

Timothy T. Hsieh*

This Paper analyzes the history of the Semiconductor Chip Protection Act (SCPA), 17 U.S.C. §§ 901–914, and asks why the statute is so seldom used in intellectual property litigation. Afterwards, this Paper makes the argument that the SCPA should be used more in intellectual property litigation, perhaps in tandem with patent litigation, and can be a viable form of protection for semiconductor micro-fabrication companies or integrated circuit design companies engaged in pioneering innovations within the cutting-edge field of semiconductor technology.

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INTRODUCTION

Semiconductor chips, or integrated circuits, are the basic building blocks of the modern information age.[1] They are the most pervasive and widespread component of the digital era, figuring into everything from smartphones to laptops, PCs, and tablet devices to digital cameras. Indeed, anything that can be considered even remotely "electronic" is likely composed of semiconductor chips.[2] It follows that the semiconductor chip also plays a critical role in the global economy. The semiconductor industry has positioned itself prominently as an international multibillion-dollar business, with worldwide sales of $213 billion in 2004,[3] $300 billion by 2008,[4] and $341 billion in 2016.[5]

In 1984, at the behest of the semiconductor industry, Congress passed the Semiconductor Chip Protection Act ("SCPA") to protect the costly and time-consuming process of designing semiconductor chips.[6] The SCPA grants protection to a "mask work" that is "fixed in a semiconductor chip product."[7] A "mask work" is an intricate and highly individualized pattern that is used

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1 STEVEN E. SCHWARZ & WILLIAM G. OLDHAM, ELECTRICAL ENGINEERING: AN INTRODUCTION 5 (2d ed. 1993).

2 *See* H.R. REP. NO. 98-781, at 2 (1984); *Integrated Circuit*, MERRIAM-WEBSTER, https://www.merriam-webster.com/dictionary/integrated%20circuit [https://perma.cc/EP4F-Q72Y] (last visited July 30, 2018); *Integrated Circuits,* PBS, https://www.pbs.org/transistor/background1/events/icinv.html [https://perma.cc/NML7-LHR3] (last visited July 30, 2018).

3 *Global Semiconductor Sales Hit Record $213 Billion in 2004*, SEMICONDUCTOR INDUS. ASS'N, (Jan. 31, 2005), https://www.semiconductors.org/news/2005/01/31/global_sales_reports_2004/global_semiconductor_sales_hit_record_213_billion_in_2004 [https://perma.cc/X2CK-GU5H].

4 *SIA Forecast: Chip Sales Will Surpass $300 Billion in 2008; Semiconductor Sales to Reach $245 Billion in 2006*, BUSINESS WIRE (Nov. 16, 2005, 9:01 AM), https://www.businesswire.com/news/home/20051116005401/en/SIA-Forecast-Chip-Sales-Surpass-300-Billion [https://perma.cc/P6E4-VDWL] [hereinafter *SIA Forecast*].

5 Peter Clarke, *Semiconductor Market Breakdown and 2016 Forecasts*, EENEWS EUR. (Mar. 24, 2016), http://www.eenewseurope.com/news/semiconductor-market-breakdown-and-2016-forecasts-0 [https://perma.cc/PZB9-MXWH].

6 17 U.S.C. §§ 901–14 (1984); *see also* Altera Corp. v. Clear Logic, Inc., 424 F.3d 1079, 1084 (9th Cir. 2005).

7 17 U.S.C. § 902 (1984). "A mask work is 'fixed' in a semiconductor chip product when its embodiment in the product is sufficiently permanent or stable to permit the mask work to be perceived or reproduced from the product for a period of more than transitory duration." 17 U.S.C. § 901(a)(3) (1984).

like a stencil in the semiconductor fabrication process[8] to form the different layers of a semiconductor chip.[9] Mask works were originally thought to be protected by patents, but patent laws do not extend to mask works because mask works are not individually novel, useful, or non-obvious.[10] Mask works also do not clearly fit the type of material traditionally protected by copyright, such as literary works or music,[11] because they are technical by-products more akin to software.[12] Thus, Congress created *sui generis* protection for mask works, and in doing so, used the SCPA to form a "bridge," filling "the gap between copyright and patent law."[13]

However, the bridge between the regimes of patent and copyright law seems to lean more towards the copyright side, because the SCPA was initially proposed as an extension of existing copyright protection.[14] The idea of giving mask works *sui generis* protection is deeply rooted in copyright law.[15] Mask works must be registered and filed with the Copyright Office, not the U.S.

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8 SAMI FRANSSILA, INTRODUCTION TO MICROFABRICATION 290 (2d. ed. 2010) ("Shadow masks (also known as stencil masks) are mechanical aperture plates. Shadow mask patterning is basically lift-off with a mechanical mask instead of a resist mask.").

9 A "mask work" is defined by the SCPA as: "a series of related images, however fixed or encoded—(A) having or representing the predetermined, three-dimensional pattern of metallic, insulating, or semiconductor material present or removed from the layers of a semiconductor chip product; and (B) in which the series the relation of the images to one another is that each image has the pattern of the surface of one form of the semiconductor chip product." 17 U.S.C. § 901(a)(2) (1984).

10 HOUSE COMM. ON THE JUDICIARY, SEMICONDUCTOR CHIP PROTECTION ACT OF 1984, H.R. REP. NO. 781-98, at 3 (1984), *reprinted* in 1984 U.S.C.C.A.N. 5750 [hereinafter H.R. 5525].

11 *See* 17 U.S.C. § 102(a) (2012).

12 Mask works are utilitarian articles and hence, extend beyond the scope of copyright protection. *See id.*

13 Altera Corp. v. Clear Logic, Inc., 424 F.3d 1079, 1081 (9th Cir. 2005). *Sui generis* is Latin for "[o]f its own kind, and used to describe a form of legal protection that exists outside typical legal protections—that is, something that is unique or different. In intellectual property law, for example, ship hull designs have achieved a unique category of protection and are 'sui generis' within copyright law." *Sui Generis*, LEGAL INFO. INST., https://www.law.cornell.edu/wex/sui_generis [https://perma.cc/GP3V-DZSC] (last visited Aug. 1, 2018).

14 Richard H. Stern, *The Semiconductor Chip Protection Act of 1984: The International Comity of Industrial Property Rights*, 3 BERKELEY J. INT'L L. 273, 277 (1986).

15 *See* S. REP. NO. 98-425, at 9, 12–13 (1984).

Patent and Trademark Office.[16] In addition, like copyright law, the SCPA only protects "original"[17] mask works that are "not staple, commonplace or familiar" within the semiconductor industry.[18] SCPA protection also does not extend to any "idea, procedure, process, system, method of operation, concept, principle or discovery, embodied in a [mask work]," as such areas are left to patent protection.[19] There is also a "reverse engineering" exception embedded in the SCPA.[20] This reverse engineering exception is similar to the "fair use" doctrine in Copyright, which is a legal doctrine that permits the unlicensed use of copyright-protected works in certain circumstances such as, for example, criticism, parody comment, news reporting, teaching, scholarship, research, etc.[21] The reverse engineering exception establishes that it is not infringement for a person to "reproduce a mask work solely for the

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16 17 U.S.C. § 908 (1988).

17 17 U.S.C. § 902(b)(1) (1988).

18 17 U.S.C. § 902(b)(2) (1988). *Cf.* 17 U.S.C. § 1302 (1988) (noting that the statute from the Copyright Act states: "Protection under this chapter shall not be available for a design that is—(1) not original; (2) staple or commonplace, such as a standard geometric figure, a familiar symbol, an emblem, or a motif, or another shape, pattern, or configuration which has become standard, common, prevalent, or ordinary; (3) different from a design excluded by paragraph (2) only in insignificant details or in elements which are variants commonly used in the relevant trades; (4) dictated solely by a utilitarian function of the article that embodies it; or (5) embodied in a useful article that was made public by the designer or owner in the United States or a foreign country more than 2 years before the date of the application for registration under this chapter.").

19 17 U.S.C. § 902(c) (1988); *see also* Fred M. Greguras, *Systems-on-a-Chip: Intellectual Property Protection and Licensing Issues*, 1–2, FENWICK & WEST LLP (1998), http://www.fenwick.com/docstore/publications/IP/IP_Articles/Systems-on-a-Chip.pdf [https://perma.cc/Z585-FEK9].

20 *See* 17 U.S.C. § 906(a)(1) (1988) ("[it is not an infringement for] a person to reproduce the mask work solely for the purposes of teaching, analyzing or evaluating the concepts or techniques embodied in a mask work or the circuitry, logic flow, or organization of components used in the mask work"); *see also* 17 U.S.C. § 906(a)(2) (1988) ("[it is not an infringement for] a person who performs the analysis or evaluation described in paragraph (1) to incorporate the results of such conduct in an original mask work which is . . . distributed."); 17 U.S.C. § 906(b) ("[one who owns a] semiconductor chip product made by the owner of a mask work . . . may import, distribute, or otherwise dispose of or use, but not reproduce, that particular semiconductor chip product without the authority of the owner of the mask work.").

21 *See More Information on Fair Use*, U.S. COPYRIGHT OFF. (July 2018), https://www.copyright.gov/fair-use/more-info.html [https://perma.cc/9B6H-9Z6B].

purposes of teaching, analyzing or evaluating the concepts or techniques embodied in a mask work."[22]

For several years the SCPA was thought to be dead by many academics and practitioners: many thought that the SCPA was too narrow and could only be applied to a very limited set of situations. For instance, after the SCPA was enacted in 1984, only a single published case in 1992, *Brooktree Corp. v. Advanced Micro Devices, Inc.,* dealt with or discussed the SCPA.[23] Plaintiff, Brooktree Corporation, alleged that Advanced Micro Devices ("AMD") misappropriated Brooktree's original mask works in the manufacturing of AMD chips.[24] Brooktree owned several original mask works that were registered with the Copyright Office for SCPA protection; the mask works were used to fabricate digital graphics chips used in video screen displays.[25] The trial court denied Brooktree's motion for preliminary injunction but the jury ultimately awarded Brooktree a hefty $26 million in damages.[26] This judgment was affirmed by the Court of Appeals for the Federal Circuit.[27]

For a very long time, little if any SCPA cases were brought in the federal courts.[28] Aside from the *Brooktree* case, the Federal

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[22] 17 U.S.C. § 906(a)(1) (1984).

[23] 705 F. Supp. 491 (S.D. Cal. 1988). There are three decisions involving the *Brooktree* litigation—the Federal Circuit decision is mentioned last: (1) Brooktree Corp. v. Advanced Micro Devices, Inc., 705 F.Supp. 491 (S.D. Cal. 1988) (denying Brooktree's motion for preliminary injunction) [hereinafter *Brooktree I*]; (2) Brooktree Corp. v. Advanced Micro Devices, Inc., 757 F.Supp. 1088 (S.D. Cal. 1990) (denying AMD's motion for JNOV, *judgment non obstante veredicto,* or judgment notwithstanding the verdict and AMD's motion for new trial), *aff'd,* [hereinafter *Brooktree II*] (3) Brooktree Corp. v. Advanced Micro Devices, Inc., 977 F.2d 1555 (Fed. Cir. 1992) [hereinafter *Brooktree III*].

[24] *See Brooktree I*, 705 F. Supp. at 494.

[25] Steven P. Kasch, *The Semiconductor Chip Protection Act: Past, Present and Future*, 7 BERKELEY TECH L.J. 71, 99–101 (1992).

[26] Greg Johnson, *Jury Awards Brooktree $26 Million in Damages,* L.A. TIMES, Sept. 29, 1990, at B2; *Brooktree II*, 757 F. Supp. at 1088.

[27] *Brooktree III,* 977 F.2d at 1570.

[28] *See, e.g.,* Anadigics, Inc. v. Raytheon Co., 903 F. Supp. 615 (S.D.N.Y 1995) (involving a manufacturer of microwave integrated circuits, Plaintiff Anadigics, Inc., bringing an action against a competitor, Defendant Raytheon Co., alleging infringement of Anadigics' "mask work" rights in violation of the SCPA); Sega Enterprises Ltd. v. Accolade, Inc., 785 F. Supp. 1392, 1398–99 (N.D. Cal. 1992) (mentioning, in dicta, that "[t]he Copyright Act does not provide an exception for immediate copying of software

Circuit has only addressed the SCPA before in one footnote.[29] In recent years, if the SCPA is mentioned at all, it is merely as dicta or for illustrative and/or comparative purposes.[30] However, in April of 2005, a case on appeal from a Northern District of California federal district court appeared in the Ninth Circuit. The case was *Altera Corp. v. Clear Logic,* and it is the only case after *Brooktree* to litigate or discuss the SCPA in over thirteen years.[31] *Altera* centered on plaintiff Altera's ASIC[32] products and the reverse engineering defense of defendant Clear Logic.[33] *Altera* seemed to breathe new life into the long-dormant SCPA, opening the door for future applications that have been long overdue. Eleven years later, that doesn't seem to be the case, as the statute has not been applied or litigated since the 2005 *Altera* decision.

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for the purpose of 'reverse engineering'" and if "Congress intended such an exception, it would have provided for it as it did in the Semiconductor Chip Protection Act . . . . Unlike the Copyright Act, the Semiconductor Act specifically provides that one may make intermediate copies of a protected mask work (i.e. a silicon chip) in the course of reverse engineering. Congress chose not to amend the Copyright Act and make reverse engineering a form of 'fair use' . . . but instead created a separate right to reverse engineer mask works under the Semiconductor Act. Congress was concerned that 'to call reverse engineering [of semiconductor chips] a form of fair use under Section 107 of the Copyright Act might encourage a more expansive interpretation of this limitation on exclusive rights in the case of literary works").

29 *See* Atari Games Corp. v. Nintendo of America Inc*.,* 975 F.2d 832, 842 n.5 (Fed. Cir. 1992) (mentioning in a footnote that the SCPA "permits, in some limited circumstances, reverse engineering to reproduce a mask work" but also stating that "[t]his Act [the SCPA], while supporting reverse engineering to help disseminate the ideas embodied in a mask work, does not apply in this case. Atari did not reproduce or copy Nintendo's chip or mask work. In fact, Atari used an entirely different chip. Atari instead allegedly copied the program on Nintendo's chip. Therefore, the 1984 Act [the SCPA] does not apply.").

30 *See, e.g.*, Sorenson v. Wolfson, 170 F. Supp. 3d 622, 631 (S.D.N.Y. 2016) (mentioning the SCPA when trying to clarify the scope of IP protection in the Vessel Hull Design Protection Act in that both acts are directed to "new and *sui generis* form[s] of intellectual property, 'separate from and independent of the Copyright Act.'"); Cohen v. U.S., 100 Fed. Cl. 461, 476, 483 (2011) (analyzing lost profits for future lost sales in a copyright infringement claim for works published on a website maintained by the Federal Emergency Management Agency (FEMA) by citing to *Brooktree III*, 977 F.2d at 1579, where actual damages under the SCPA were analogized to actual damages under copyright law).

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

32 ASIC stands for "Application Specific Integrated Circuit." *Id.* at 1082.

33 *Id.* at 1079.

The primary issue surrounding the SCPA has been its effective "death" in a real-world litigation context. This Article provides a solution to the paucity of SCPA usage, and suggests a wide spectrum of possible future SPCA applications.[34] Since the SCPA is such a critical bridge between patent and copyright law, a basic theme throughout this Article is how to "reapply" the SCPA to current legal contexts, and how its "reapplication" will hopefully generate a strong, real-world interest in the SCPA.

Part I of this Article covers the fundamental basics of the semiconductor. Part II details a brief legislative history of the SCPA. Part III analyzes the *Brooktree* case in depth: the one case in which the SCPA was applied and litigated. Part IV analyzes the case of *Altera v. Clear Logic* and its far-reaching implications. Finally, Part V explores solutions and contemporary applications of the SCPA to the modern high-tech economy in the wake of *Altera,* as well as how to improve present-day practices for meeting SCPA compliance. In this final part, a cost analysis approach is applied to the economics of today's semiconductor industry—with a focus on Silicon Valley—and various factors such as chip piracy, reverse engineering, and semiconductor research/production costs are discussed and analyzed in detail. This Article aims to encourage the use of the SCPA in the courts, and is essentially an effort to resolve the dearth of SCPA usage by "bringing back" the SCPA as a powerful legal tool.

I. SEMICONDUCTOR FUNDAMENTALS

This Part covers what an integrated circuit is, and the process used to manufacture an integrated circuit. Afterwards, a system-level view of semiconductor design is discussed, followed by an overview of design, simulation and testing: a common practice in

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34 Potential SCPA applications include the protection of chip architectures in a way that is quicker, more efficient and less expensive than patent protection. "Designers should revisit the SCPA and consider incorporating its provisions. It lets them protect architectures quickly and inexpensively while weighing the pursuit of patent protection." Warren S. Heit, *Court Broadens IP Protections,* EE TIMES (Nov. 21, 2005), https://www.eetimes.com/document.asp?doc_id=1157684 [https://perma.cc/943H-CFKP].

the semiconductor industry performed before chips are released and sold to the general public.

A. Integrated Circuits

A semiconductor chip is the same thing as an integrated circuit ("IC").[35] Basically, ICs are complex, multi-layered compositions that are composed of many smaller semiconductor devices.[36] ICs are also considered to be great works of engineering art and architecture; famous ICs include the Intel "Pentium" processors and the AMD "Athlon" series used to power personal computers and mobile devices, and the 741 operational amplifier used to make signals stronger.[37] Semiconductor devices are usually resistors, capacitors, or transistors fabricated in "semiconductor" metals such as Silicon or Gallium-Arsenide.[38] Semiconductor metals are so-named because they are materials that exhibit "semi" electrical conductivity properties between those of insulators (porcelain, clay) and conductors (copper and aluminum).[39] Semiconductors are very valuable because their semi-conductive electrical properties can be greatly altered in a highly controllable way by adding small amounts of impurities or dopants.[40] Such

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35 Compare the "Semiconductor Chip Protection Act" title to Canada's equivalent yet more appropriately titled, "Integrated Circuit Topography Act," which was enacted in 1990. *See* Integrated Circuit Topography Act, c 37, S.C. 1990 (Can.).

36 Semiconductor devices include transistors, resistors, capacitors, inductors and other similar components. Schwartz, *supra* note 1, at 3.

37 PBS, *supra* note 2; PAUL HOROWITZ & WINFIELD HILL, THE ART OF ELECTRONICS (2d ed. 1989).

38 RICHARD C. JAEGER, INTRODUCTION TO MICROELECTRONIC FABRICATION 1 (2d ed. 2002) (stating "Silicon is the dominant material used throughout the IC industry today."). Simply put: Resistors resist and impede the flow of electricity in a circuit, Capacitors store electricity and charge in a circuit, and Transistors are arguably the most important device in the modern IC, because not only can they act as advanced logic switches or amplifiers but they can also mimic the properties of resistors, capacitors, and many other semiconductor devices. *Id*.

39 Ian Poole, *Semiconductor Materials Types List*, RADIO-ELECTRONICS.COM, http://www.radio-electronics.com/info/data/semicond/semiconductor/semiconductor-materials-types-list.php [https://perma.cc/2WLS-ZZBP] (last visited July 28, 2018).

40 *Semiconductors*, U. OF WASH., https://depts.washington.edu/matseed/mse_resources/Webpage/semiconductor/semiconductor.htm [https://perma.cc/J9YS-2T6L] (last visited July 30, 2018); *The Doping of Semiconductors,* GEORGIA ST. U., http://hyperphysics.phy-astr.gsu.edu/hbase/Solids/dope.html [https://perma.cc/WK47-YK3C] (last visited July 28, 2018).

"semiconductive" properties are absolutely critical to modern electronics because they allow engineers to customize the amount of electrical flow through a chip by changing the number of positively charged (holes) and negatively charged particles (electrons).[41] The positively and negatively charged materials are known commonly as "dopants," and different circuit components are fabricated on a silicon substrate by varying the concentration of dopants.[42]

B. Microfabrication and Photolithography

These multi-layered semiconductor chips or ICs are made using a process known as "microfabrication,"[43] which is broken down into several main steps.[44] The most critical step of microfabrication is "photolithography": a procedure in which ultraviolet light is shone through individually distinct and stencil-like "mask works," to expose complex patterns of resistors and transistors onto a piece of semiconductor material, such as silicon dioxide on a silicon wafer.[45] Afterwards, exposed areas are etched away layer-by-layer until the final semiconductor chip or IC is obtained.[46] Due to the intricate and highly-individualized nature of a "mask work," each semiconductor chip or IC end-product is unique and carries its own individual blueprint.[47]

A quick run-down of the main steps involved in microfabrication is as follows: First, a pure silicon wafer is procured. The second step involves "Thermal Oxidation," where

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[41] *See* DICK WHITE & ROGER DOERING, ELECTRICAL ENGINEERING UNCOVERED 249, 206–07 (2d ed. 2001).

[42] JAEGER, *supra* note 38, at 51. "Because of the minute dimensions involved and high purities required, [microfabrication] is a lengthy process that requires meticulous quality control." Kasch, *supra* note 25, at 90.

[43] SCHWARZ, *supra* note 1, at 532.

[44] JAEGER, *supra* note 38, at 5.

[45] *Id.*; *see also What is Photolithography?,* The Tech-Faq, http://www.tech-faq.com/photolithography.html [https://perma.cc/G93H-4DQZ] (last visited Aug. 24, 2018).

[46] Kasch, *supra* note 25, at 74; *see also* WHITE, *supra* note 41 (stating that photolithography is a light-based "refinement of the process that fine artists have used for centuries to make lithographs, which are drawings reproduced by pressing sheets of paper onto flat blocks of stone (*lithos* is the Greek word for stone) to which ink adheres in carefully drawn patterns.").

[47] S. REP. NO. 425, 98th Cong., 2d Sess. at 7–9 (1984).

the silicon wafer is then heated to a high temperature (1000–1200°C) in the presence of oxygen in order to form a layer of silicon dioxide (SiO_2) on the surface of the wafer.[48] The third, and most significant step, is "Photolithography": (a) A thin layer of light-sensitive material known as "photoresist" is applied on top of the layer of silicon dioxide,[49] and (b) complex patterns are then imprinted onto the photoresist layer by using an individually distinct mask work.[50] The mask work functions like a stencil by filtering ultraviolet light through a complicated pattern to be imprinted upon a layer of photoresist (with silicon dioxide in step four).[51] The fourth step involves "Etching," a process in which the exposed photoresist is washed away with a developer solution, leaving bare silicon dioxide in the exposed areas which are effectively "etched" away with the use of chemicals such as hydrofluoric acid ("HF").[52] In step-five, known as "Diffusion or Ion Implantation," impurities or dopants (either positively or negatively charged) are introduced into the silicon to control the electrical properties.[53] Step six is "Sputtering or Chemical Vapor Deposition": These processes are then used to deposit metal interconnects (wires and contacts) on the IC.[54] The seventh, and final, step is "Annealing" in which the finished IC product is heated with lamps in order to activate implanted impurities.[55] These steps are often repeated in a cycle until the finished IC product is achieved.[56]

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48 JAEGER, *supra* note 38, at 5.
49 *Id.* at 17.
50 *Id.* at 22–23.
51 WHITE, *supra* note 41, at 249.
52 JAEGER, *supra* note 38, at 25.
53 *Id.* at 67.
54 *Id.* at 129. Wires and contacts (also referred to as "interconnects") are metal connections between the various electronic components. *See generally* Marco Rovitto, Electromigration Reliability Issue in Interconnects for Three-Dimensional Integration Technologies (Dec. 2016) (unpublished Ph.D. dissertation, Vienna University of Technology) (on file with Institute for Microelectronics), http://www.iue.tuwien.ac.at/phd/rovitto/node12.html [https://perma.cc/8QP5-YQS2].
55 JAEGER, *supra* note 38, at 123.
56 *Id.*

C. A System-level View of Semiconductor Design

IC design has historically been a costly and labor-intensive process.[57] After a high-tech company hires an industry analyst firm to perform a market study of the specific functions a customer base may desire, an IC systems engineer analyzes these specific functions to determine the feasibility of implementing such IC features.[58] A systems engineer can organize a large and potentially unwieldy IC system into smaller "system blocks" to make the system more cost-effective.[59] For instance, consider the following overly-simplified hypothetical: An IC microprocessor design is contrived to make the conversion of digital data into analog audio or video output extremely efficient. After market research is done, a semiconductor company, such as Analog Devices or NXP Semiconductor,[60] may realize that there is a strong demand for such an IC system. For example, Apple may want to buy such a component for use in their iPads or iPhones, Canon may want such an IC in their digital cameras, or Sony and Samsung may want to use this feature in their high-definition TVs. A systems engineer at Phillips Semiconductor would then determine the most cost-effective and efficient method of manufacturing this specific IC by

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57 Kasch, *supra* note 25, at 85.

58 Industry analyst firms include companies such as IC Insights, Inc.. *See About Us,* IC INSIGHTS, http://www.icinsights.com/about-us/ [https://perma.cc/TJL3-F9JJ] (last visited Aug. 8, 2018).

59 *See* Robert Half, *What it Takes to be a Software Engineer or Systems Engineer*, ROBERT HALF INT'L INC. (Nov. 4, 2014, 3:00 PM), https://www.roberthalf.com/blog/salaries-and-skills/what-it-takes-to-be-a-software-engineer-or-systems-engineer [https://perma.cc/P24D-DRPT]; *see also System Definition*, GUIDE TO THE SYSTEMS ENGINEERING BODY OF KNOWLEDGE (SEBoK), http://www.sebokwiki.org/wiki/System_Definition [https://perma.cc/3QTS-RTKZ] (last visited Aug. 8, 2018).

60 *See Corporate Information*, ANALOG DEVICES, www.analog.com/en/about-adi/corporate-information.html [https://perma.cc/AC6P-4N5D] (last visited Aug. 8, 2018) ("Analog Devices (NASDAQ: ADI) is a world leader in the design, manufacture, and marketing of a broad portfolio of high performance analog, mixed-signal, and digital signal processing (DSP) integrated circuits (ICs) used in virtually all types of electronic equipment."); *see also About NXP*, NXP SEMICONDUCTORS, https://www.nxp.com/about/about-nxp/about-nxp:ABOUT-NXP [https://perma.cc/B43L-MGWJ] (last visited Aug. 8, 2018) ("NXP Semiconductors N.V. enables secure connections and infrastructure for a smarter world, advancing solutions that make lives easier, better and safer. As the world leader in secure connectivity solutions for embedded applications, NXP is driving innovation in the secure connected vehicle, end-to-end security and privacy and smart connected solutions markets.").

trying to determine the optimal use of devices in such a system based on metrics that include power consumption, battery lifetime, speed, bandwidth, processor performance, video/image quality and so on.[61]

In order to simplify the design process, many large ICs are defined with block diagrams.[62] For primarily digital IC systems used in computer microprocessors or other digital applications, block diagrams can represent components such as shift registers, memory blocks ("RAM" or "ROM"), or arithmetic logic units ("ALUs").[63] For primarily analog IC systems, block diagrams representing amplifiers (which amplify electrical signals) and diodes (which act like switches) are more prevalent.[64] Most modern ICs are a combination of digital and analog systems, so they often feature both elements. All of these block diagrams, regardless of whether digital or analog based, are eventually placed in a large "floor-plan" layout.[65]

The floor-plan layout is similar to an architect's blueprint. Essentially, the floor plan is a diagram of the actual placement of

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61 The systems engineer does not want to use too many devices, but at the same time realizes they may need to use a lot of devices in order to achieve more complicated tasks. For instance: "smaller chips are easier to test and design and produce a greater yield but their use must be balanced against the higher cost of handling, testing, and packaging a larger number of chips." *See* Kasch, *supra* note 25, at 85, n. 77.

62 Christian Tuttas, *Description of Power Electronic Circuits by Block Diagrams*, 7 EUR. TRANSACTIONS ON ELECTRICAL POWER 421 (1997); Harry K. Charles, Jr., Timothy G. Boland & G. Donald Wagner, *Very Large Scale Integrated Circuitry*, 7 JOHNS HOPKINS APL TECHNICAL DIG. 271 (1986).

63 Shift registers, memory blocks, and ALUs are all common components of computer architecture. A shift register holds numerous binary values and an ALU is a section of a computer's central processing unit ("CPU") that makes logical comparisons in order to execute arithmetic functions. All an arithmetic function really is, when broken down into 1s and 0s, is the use of many different logic operations (and/or gates). *See* WHITE, *supra* note 41, at 184–85.

64 *Id.* at 211.

65 Kushagra Khorwal, Naveen Kumar, & Sonal Ahuja, *Floorplanning: Concept, Challenges, and Closure,* EDN NETWORK (Sept. 19, 2012), https://www.edn.com/design/integrated-circuit-design/4396580/Floorplanning—concept—challenges—and-closure [https://perma.cc/U3W7-GX8G] ("The complex integrations and smaller design cycle emphasize the importance of floorplanning, i.e., the first step in netlist-to-GDSII design flow. Floorplanning not only captures designer's intent, but also presents the challenges and opportunities that affect the entire design flow, from design to implementation and chip assembly.").

major functional blocks within the chip area, expressing the physical and spatial relationship of the high level functional modules to one another.[66] The proportional area given to each functional block is decided by the number, type, and size of transistors in that certain block.[67] A transistor is essentially the basic-building block of all ICs.[68] Other architectural considerations present in a floor plan include the interconnections (or wires) between the various functional blocks, as well as the functional blocks that share common buses.[69] Floor plan designs are usually done on computer-aided design ("CAD") software, and simulated with a variety of advanced circuit simulation software.[70]

D. Design, Simulation, and Testing

After the block diagrams are finalized, circuit simulation software translates high-level modules into masses of logic gates, each of which perform a basic logic operation.[71] The circuit simulation software effectively creates a "netlist," or a "bitstream," a computer file that contains the complete description of all the

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[66] PBS, *supra* note 2; Kasch, *supra* note 25, at 85.

[67] Andre Hassan, *Fundamentals of Floor Planning A Complex SoC*, ELECTRONIC DESIGN (Mar. 21, 2012), https://www.electronicdesign.com/products/fundamentals-floor-planning-complex-soc [https://perma.cc/T38X-U2KE].

[68] All IC systems, no matter how large or complex, are always made up of transistors. Transistors are simple Silicon devices made up of a drain, gate, and source, and are often known as a MOSFET: Metal-Oxide-Semiconductor Field Effect Transistor. The doping of the Drain and Source determines whether the Transistor is a NMOS (N for negative) or PMOS (P for positive) transistor. WHITE, *supra* note 41, at 213.

[69] Interconnections are preferably constructed in metal (Aluminum). Space must be allocated in the floor plan for such interconnection routing between various functional blocks. The "buses" are usually: Vdd (power) and Vss or Vgnd (ground). *Id.* at 222.

[70] SPICE and PSPICE remain the main software tools used in academia to simulate circuits. Various vendors in the industry, such as Avanti!, Cadence, Magma, Synopsys, and Altera, create circuit simulation and design software. *See* Cabe Atwell, *Ten Circuit Design Simulation Apps for Pros & DIYers*, EE TIMES (June 9, 2015, 1:55 PM), https://www.eetimes.com/document.asp?doc_id=1326778 [https://perma.cc/QS5Q-UM5L].

[71] Bilal Malikuet, *Best Free Circuit Simulation Software,* MICROCONTROLLERS LAB (2016), http://microcontrollerslab.com/circuit-simulation-software-free/ [https://perma.cc/5B7J-HB3C]; Gerry Chen, *Electronic Circuit Simulation*, EASY EDA, https://easyeda.com/gerrychen/Electronic_Circuit_Simulation_Sofware-RrJDVdvpH [https://perma.cc/56FF-PGX5] (last updated Oct. 2016).

logic gates in the schematic, in digital or binary.[72] A software program then performs computer simulations on the netlist or bitstream to verify that the logic operations are correct and that the circuits are fired and timed properly.[73] This process of "timing verification" can be difficult with increasingly complicated designs, because it must focus on various complicated logic problem areas within a large, unwieldy IC structure.

A finished IC is also rigorously tested before it is sold. Effective testing programs must be created and evaluated to ensure adequate verification of IC designs, as well as the detection of manufacturing defects.[74] This is especially true for Very Large Scale Integration ("VLSI") circuits, where complex circuit design must be checked with complex simulation software.[75] Once this computer-based testing aspect is done, a (human) circuit schematic designer must translate each logic gate into individual and distinctively-sized semiconductor devices.[76]

The layout design engineer effectively translates the circuit elements into corresponding colored graphics.[77] A designer usually uses a form of a Graphic User Interface ("GUI") to click and drag different colored blocks and modules, and shades of the IC with

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72 THOMAS M. FREDERIKSEN, INTUITIVE IC CMOS EVOLUTION: FROM EARLY ICS TO MICROCMOS TECHNOLOGY AND CAD FOR VLSI 142 (National Semiconductor Corp., 1984).

73 Rohit Kumar et al., *Timing Verification for Adaptive Integrated Circuits,* DESIGN, AUTOMATION & TEST IN EUROPE CONFERENCE & EXHIBITION, IEEE (2015), http://ieeexplore.ieee.org/document/7092645/?reload=true [https://perma.cc/4A94-8MUG]; *Timing Verification*, U. OF MICH., EECS, http://www.eecs.umich.edu/courses/eecs627/timing.html [https://perma.cc/G6HK-H34K] (last visited Oct. 1, 2018); *Dynamic Timing Analysis,* VLSI ENCYCLOPEDIA, http://www.vlsiencyclopedia.com/2011/06/dynamic-timing-analysis.html (last visited Oct. 1, 2018); *see also* FARZAD NEKOOGAR, TIMING VERIFICATION OF APPLICATION-SPECIFIC INTEGRATED CIRCUITS, 2–16 (Prentice Hall, 1999).

74 FREDERICKSEN, *supra* note 72, at 142.

75 *Very Large-Scale Integration (VLSI)*, TECHNOPEDIA, https://www.techopedia.com/definition/714/very-large-scale-integration-vlsi [https://perma.cc/382H-CR8X] (last visited Oct. 1, 2018); Kasch, *supra* note 25, at 87.

76 *See How's the Daily Life (In Terms of Work) of a Professional Analog IC Designer?*, QUORA, https://www.quora.com/Hows-the-daily-life-in-terms-of-work-of-a-professional-analog-IC-designer [https://perma.cc/6HHB-E8CD] (last visited Aug. 11, 2018).

77 *See* H.R. 5525, *supra* note 10, at 12.

different patterns, as one would in an advanced painting program.[78] The collective mask work is usually expressed by a collection of different layered patterns and colors.[79] A final composite-layer mask work represents the culmination of all these various design tasks.[80] Without an individually distinct mask work, the grand summation of a design team's work and ingenuity, an IC simply cannot be created through the highly important process of photolithography.

II. A BRIEF LEGISLATIVE HISTORY OF THE SCPA

A. The Road Leading up to the SCPA

In the mid-1980s, the semiconductor industry perceived a need for protection against unfair copying.[81] As a preliminary economic example, consider the cycle of "learning-curve" pricing.[82] Say for instance the established semiconductor manufacturer, "New Technologies," comes out with "newChip," an innovative semiconductor chip product bringing rise to a new and exciting

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78 *See Graphical User Interface*, BRITANNICA, https://www.britannica.com/technology/graphical-user-interface [https://perma.cc/Z9N9-DF4T] (last visited Aug. 11, 2018).

79 *See Designing Integrated Circuits*, COMPUTER HIST. MUSEUM, http://www.computerhistory.org/revolution/digital-logic/12/287 [https://perma.cc/9B6P-4DNC] (last visited Aug. 11, 2018); *High Resolution Exhibit Pictures, Integrated Circuits*, SCI. SERV. SMITHSONIAN, https://web.archive.org/web/20180124172524/http://scienceservice.si.edu/pages/exhibit5.htm [https://perma.cc/MZL2-W4ZK] (last visited Aug. 11, 2018).

80 Kasch, *supra* note 25, at 89.

81 *Id.* at 78*; see also* Douglas A. Irwin, *The U.S.-Japan Semiconductor Trade Conflict*, *in* THE POLITICAL ECONOMY OF TRADE PROTECTION 5–14 (Anne O. Krueger ed., 1996) , http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.854.7468&rep=rep1&type=pdf [https://perma.cc/6KTS-WX77].

82 "A learning curve is a concept that graphically depicts the relationship between cost and output over a defined period of time, normally to represent the repetitive task of an employee or worker. The learning curve was first described by psychologist Hermann Ebbinghaus in 1885 and is used as a way to measure production efficiency and to forecast costs. In the visual representation of a learning curve, a steeper slope indicates initial learning translates into higher cost savings, and subsequent learnings result in increasingly slower, more difficult cost savings."

Learning Curve, INVESTOPEDIA, https://www.investopedia.com/terms/l/learning-curve.asp [https://perma.cc/MK8E-B7MV] (last visited Aug. 11, 2018); *see also* Robert W. Kastenmeier & Michael J. Remington, *The Semiconductor Chip Protection Act of 1984: A Swamp or Firm Ground?*, 70 MINN. L. REV. 417, 453 (1985).

high-tech market. Initially, newChip products are highly priced so that New Technologies can recover their investments—research & development expenses, marketing costs—as quickly as possible. Eventually, as the process that New Technologies uses to sell newChips becomes increasingly efficient, the company reduces newChip pricing in order to broaden its market and quell competition. Sooner or later, "second-source products," a.k.a. high-tech "knock-offs," saturate the already-competitive market, triggering further price cuts from New Technologies.[83] Historically, many semiconductor companies thought that second-source products were the result of unfair copying.[84]

This fear was aggrandized for two main reasons[85]: First, the cost of research & development ("R&D"), and marketing and design expenses necessary to create a cutting-edge semiconductor chip began to soar in the early 1980s.[86] For example, in 1983, one year before the SCPA was passed, development of a state-of-the-art IC ranged from anywhere between $40 to $50 million; these costs today easily exceed billions.[87]

Second, these expensive designs could be copied for as low as $50,000 very quickly.[88] Consequently, "pioneering companies facing competition from copycat imitators were forced to cut

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83 "Second-source products" are defined as "chips electrically and mechanically compatible with the pioneering product." Kasch, *supra* note 25, at 78; *see also infra* Part IV*,* (discussing Clear Logic, an example of a second-source vendor because it basically "piggybacks" its products off of Altera's products via compatibility.)

84 *See, e.g.,* Leon Radomsky, *Sixteen Years After Passage of the U.S. Semiconductor Chip Protection Act: Is International Protection Working*, 15 BERKELEY TECH. L.J. 1049, 1060–61 (2000).

85 Kasch, *supra* note 25, at 78–79.

86 *Understanding ASIC Development*, ANYSILICON (Oct. 23, 2017), http://anysilicon.com/understanding-asic-development/ [https://perma.cc/7LJS-56KB].

87 The $40 million statistic was the low-end of the maximum estimates at that time. *See* Kasch, *supra* note 25, at 78–79. The $50 million estimate is considered low by today's standards. *Copyright Protection for Imprinted Design Patterns on Semiconductor Chips: Hearings on H.R. 1007 Before the Subcomm. on Courts, Civil Liberties and the Admin. of Justice of the House Judiciary Comm.,* 96th Cong., 135 (1979) (statement of Richard H. Stern) [hereinafter H.R. 1007].

88 *The Semiconductor Chip Protection Act of 1983: Hearings on S. 1201 Before the Subcomm. On Patents, Copyrights, and Trademarks of the Senate Judiciary Comm.,* 98th Cong., 66, 75–76 (1983) [herein S. 1201] (statement of Thomas F. Dunlap, General Counsel, Intel Corp.); Kasch, *supra* note 25, at 79; Kastenmeier, *supra* note 82, at 437–38.

prices before they could recover their investment[s]."[89] As a result, U.S. high-tech companies began to observe that market share and IC sales lost to foreign competitions could be directly explained by the time and cost saving advantages granted by unfair chip copying.[90]

Accordingly, attempts were made to persuade the Register of Copyrights to recognize chip masks as copyrightable material.[91] Before 1977, IC designs submitted in the form of layout floor plans or mask work diagrams could be registered with the U.S. Copyright Office.[92] However, the Copyright Office advised copyright applicants that such registrations would be difficult to obtain.[93] Take for instance the attempt of Intel Corporation in 1977 to register several new IC designs by submitting them to the Copyright Office in chip form.[94] The Copyright Office denied registration on the basis that the artistic features embodied on the IC designs were not conceptually separated from the IC's utilitarian aspects.[95] Therefore, pursuant to 17 U.S.C. § 101, the IC designs failed to meet the definition of "pictorial, graphic or sculptural works," and hence did not classify as copyrightable subject matter.[96] As a result, Intel filed a mandamus suit to compel

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89 Kasch, *supra* note 25, at 79; Kastenmeier, *supra* note 82, at 420.

90 H.R. 1007, *supra* note 87, at 31–33 (statement of Andrew Grove, President, Intel Corp.).

91 Pamela Samuelson, *Creating a New Kind of Intellectual Property: Applying the Lessons of the Chip Law to Computer Programs,* 70 MINN. L. REV. 471, 476 (1985).

92 The Copyright office also advised copyright applicants, in its opinion, that such registrations did not cover the "final chip product." Kasch, *supra* note 25, at 80. "The Copyright Office historically has refused, and presently does refuse, to register claims to copyright in the design or layout of . . . and the . . . chips themselves . . . [c]ourts have consistently refused to extend copyright to useful articles as such." *Copyright Protection for Semiconductor Chips: Hearings Before the H. Select Comm. on Courts, Civil Liberties, and the Admin. of Justice on H.R. 1028,* 98th Cong. (1983) (statement of Dorothy Schrader, Associate Register of Copyright for Legal Affairs) [hereinafter *H.R. 1028*].

93 The Register was willing to accept chip design layouts, but refused to accept registration of the chips themselves, or of the masks used to make them because they were utilitarian works. Samuelson, *supra* note 91, at 478.

94 Kasch, *supra* note 25, at 79; Samuelson, *supra* note 91, at 480.

95 H.R. 5525, *supra* note 10, at 15; S. 1201, *supra* note 88, at 29 (statement of Dorothy Schrader, Associate Register of Copyrights for Legal Affairs).

96 "Pictorial, graphic or sculptural works" include "two-dimensional and three-dimensional works of fine, graphic, and applied art, photographs, prints and art

registration, but the court in which the suit was filed dismissed the lawsuit without prejudice[97] when H.R. 14,293—a bill proposing the extension of the Copyright Act to semiconductor designs—was introduced in Congress.[98] By adding photographic mask works to the list of copyrightable subject matter enumerated in 17 U.S.C. § 102, the bill proposed to protect IC designs.[99] This provision would eventually have an effect in terms of other Copyright Act provisions, but it was consistent with the rest of title 17 of the U.S. Code. No action was taken on H.R. 14,293 before the 95th Congress adjourned, but it set the stage for the rise of the SCPA.

B. SCPA Legislative History

1. The 1979 San Jose Hearing

H.R. 1007, a bill identical to H.R. 14,293, was introduced during the 96th Congress.[100] On April 16, 1979, the House Judiciary Subcommittee held a hearing to obtain testimony from representations of the semiconductor industry.[101] This hearing would be known as the "San Jose Hearing," due to the fact that many industry leaders that showed up to testify were from

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reproductions, maps, globes, charts, diagrams, models, and technical drawings, including architectural plans. Such works shall include works of artistic craftsmanship *insofar* as their form but *not their mechanical or utilitarian aspects* are concerned; the design of a useful article, as defined in this section, shall be considered a pictorial, graphic, or sculptural work only if . . . such design incorporates pictorial, graphic or sculptural features that can be *identified separately from, and are capable of existing independently of, the utilitarian aspects* of the article." 17 U.S.C. § 101 (1988) ("Definitions") (emphasis added).

97 Kasch, *supra* note 25, at 80 n.37.

98 *Id.* at 80; The bill, 125 CONG. REC. 28 at 36,628 (1979), was introduced and the suit was discontinued on Oct. 12, 1987. *Id.*

99 Copyrightable subject matter, or "original works of authorship" included the following categories: "(1) literary works; (2) musical works, including any accompanying words; (3) dramatic works, including any accompanying music; (4) pantomimes and choreographic works; (5) pictorial, graphic, and sculptural works; (6) motion pictures and other audiovisual works; and (7) sound recordings." 17 U.S.C. § 102(a) (1988); *see also* Ralph S. Brown, *Eligibility for Copyright Protection: A Search for Principled Standards,* 70 MINN. L. REV. 579, 580 (1985).

100 H.R. 1007, *supra* note 87; Kastenmeier & Remington, *supra* note 82, at 424–25.

101 Kastenmeier & Remington, *supra* note 82, at 426.

companies based in San Jose, the heart of Silicon Valley.[102] At the San Jose Hearing, members of the House Judiciary Subcommittee were "surprised to find sharply divided industry opinion on whether copyright protection for chip designs was beneficial."[103] On one side, opponents of the H.R. 1007 bill dreaded that the widespread practice of reverse engineering would be rendered illegal.[104] These opponents were also not convinced about whether mask work protection would actually deter foreign copying of U.S. chips.[105] On the other side, supporters of H.R. 1007 thought mask work protection was an excellent idea; one supporter even went so far as to accuse another company opposing the bill of having pirated and copied its IC designs in the past.[106] Thwarted by internal industry bickering, the enactment of legislation protecting semiconductor chips stalled.[107]

Some industry leaders voiced a concern about "chip piracy" at the San Jose Hearing, decrying the malign intent of "chip pirates" who engaged in the wholesale copying of their competitor's IC designs.[108] The procedure that these copycat pirates utilized was explained later during the course of the hearings: the pirates would

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[102] Also, the Hearing itself took place in San Jose, California as well. Kastenmeier & Remington, *supra* note 82, at 424.

[103] Kasch, *supra* note 25, at 81; Samuelson, *supra* note 91, at 478.

[104] H.R. 1007, *supra* note 87, at 57 (statement of James M. Early, Director, Fairchild Camera & Instrument Corp.). This company was a subdivision of the large and successful semiconductor company, Fairchild Semiconductor.

[105] *Id.* at 51–52 (statement of John Finch, National Semiconductor Corp.); Kastenmeier & Remington, *supra* note 82, at 426.

[106] Intel actually openly accused one semiconductor competitor of having pirated its "8-K programmable reload memory chip" and its "8080 microprocessor," which are some of their main products. H.R. 1007, *supra* note 87, at 72.

[107] Kasch, *supra* note 25, at 81. After the H.R. 1007 hearings, the 96th Congress brought no more attempts to legislate the protection of semiconductor chips. However, the 97th Congress did introduce chip protection bills in the House and Senate, but these bills were referred to each House's Judiciary Committee and no subsequent action was taken.; *see, e.g.,* H.R. 7207, 97th Cong., 2d Sess., 128 CONG. REC. 26, 129 (1982) (introduced by Rep. Edwards on Sept. 29, 1982). No "meaningful" congressional action was taken for the next three and a half years. Kasch, *supra* note 25, at 81; Kastenmeier, *supra* note 82, at 426–27.

[108] Kasch, *supra* note 25, at 81. "[V]arious members of the industry . . . have resorted to copying . . . [Intel], [o]ur company . . . has never done it . . . [only the less novel] segment of the industry feels it necessary to resort to [copying] periodically." H.R. 1007, *supra* note 87, at 28 (statement of Andrew Grove, President, Intel Corp.).

first make blowup photographs of an IC's topmost layer, or the layer viewable from a bird's eye view, and then copy the photograph line-by-line.[109] One industry representative stated that the widespread and accepted practice of "reverse engineering" was *not* "line-by-line" copying.[110] The San Jose Hearings established that the definition of "reverse engineering" was a restrictive one, only allowing competitors to learn from other designs, and nothing more.[111]

2. The 1983 Senate and House Hearings

Intel led a renewed battle for IC design protection, rallying the Semiconductor Industry Association ("SIA"), which numbered fifty-seven members at the time, to pass the bills S. 1201 and H.R. 1028 in 1983.[112] These bills were remarkably similar to H.R. 1007, the subject of the San Jose Hearing, and they aimed to protect chip designs by forging a new copyrightable subject matter exclusively for mask works.[113] H.R. 1028 contained several provisions drafted specifically to include mask works, including a ten-year term of protection, modified exclusive rights for mask work owners, and a

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109 H.R. 1007, *supra* note 87, at 26–27 (statement of L.J. Sevin, President, Mostek Corp.); Kasch, *supra* note 25, at 91; *see also* Leo J. Raskind, *Reverse Engineering, Unfair Competition, and Fair Use,* 70 MINN. L. REV. 385, 390 (1986).

110 "We have no quarrel with [reverse engineering]. It is fair game." H.R. 1007*,* supra note 87, at 27 (statement of L.J. Sevin, President, Mostek Corp.). Also, a definition of "reverse engineering" was provided, but it failed to clarify the distinction between impermissible copying and permissible reverse engineering: "We certainly reverse engineer, as do all of our competitors, which is defined as looking in great detail at competitive chips and utilizing either in future designs or improved designs, the things we learn from those chips. It is standard industry practice." *Id.* at 69 (statement of John Finch, National Semiconductor Corp.); Raskind, *supra* note 109, at 394–97.

111 An early definition of "reverse engineering" in Mostek Corp. v. Inmos Ltd., 203 U.S.P.Q. 383, 386 (N.D. Tex 1978), explained it as "analyzing a competitor's product to discover its design and fabrication processes"; *see also* Kathryn A. Fugere, *Reverse Engineering Under the Semiconductor Chip Protection Act: An Argument in Favor of a "Value-Added" Approach,* 22 GOLDEN GATE U.L. REV. 515, 519–20 (1992) (analyzing Atari Games Corp. v. Nintendo of America, Inc., 975 F.2d 832 (Fed. Cir. 1992)).

112 *The Semiconductor Chip Protection Act of 1983: Hearing on S.1201 Before the Subcomm. On Patents, Copyrights, & Trademarks of the Comm. on the Judiciary,* 98th Cong. 1 (1983); H.R. 1028, 98th Cong., 1st Sess., 129 CONG. REC. 937 (1983). The SIA, interestingly enough, was not present at the 1979 hearing. Kasch, *supra* note 25, at 82.

113 S.1201, 98th Cong., 1st Sess., 129 CONG. REC. 10,974 (1983); H.R. 1028, 98th Cong., 1st Sess., 129 CONG. REC. 937 (1983).

compulsory licensing provision for innocent infringers.[114] However, an exclusive "reverse engineering" right was not included among these provisions. H.R. 1028 relied on the Copyright Act's fair use provision to implicitly confer such a right upon mask work owners.[115] By contrast, the Senate Bill S. 1201 explicitly conferred "a right of reverse engineering," but limited it to just the evaluation and analysis of protected mask works.[116]

Reverse Engineering was also a big issue during the 1983 hearings in the House and Senate. For instance, the "paper-trail" requirement was suggested as a way of proving reverse engineering.[117] Furthermore, reverse engineering models were also presented.[118] Finally, whether or not *sui generis* protection should

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[114] Yet, no reverse engineering right was mentioned. H.R. 1028, 98th Cong., 1st Sess., 129 CONG. REC. 937 (1983).

[115] H.R. 1028, *supra* note 92, at 126.

[116] The explicit right was created by revising 17 U.S.C. § 119 to include an additional provision, now codified as 17 U.S.C. § 906 (2012).

[117] The "paper-trail" rule was modified by Brooktree Corp. v. Advanced Micro Devices, Inc., 977 F.2d 1555, 1569 (Fed. Cir. 1992) ("A reasonable jury could have inferred that AMD's paper trail . . . related entirely to AMD's failures, and that as soon as the Brooktree chip was correctly deciphered by reverse engineering, AMD did not create its own design but copied the Brooktree design . . . "); *see* H.R. 1028, *supra* note 92, at 34–36 ("If there is substantial similarity between the mask works, the second prong of the test is to look at how much time, effort, and expense was involved in developing the new 'original' mask work. To establish this element, the competitor will normally be required to produce a 'paper trail' chronicling the development of the new mask work."); *see also* MICHAEL D. SCOTT, SCOTT ON INFORMATION TECHNOLOGY LAW 5–52 (Wolters Kluwer, 3d ed. 2017) ("Whenever there is a true case of reverse engineering, the second firm will have prepared a great deal of paper – logic and circuit diagrams, trial layouts, computer simulations of the chip, and the like; it will also have invested thousands of hours of work. All of these can be documented by reference to the firm's ordinary business records. A pirate has no such papers, for the pirate does none of this work."). Therefore, whether there has been a true reverse engineering job or just a job of copying can be shown by looking at the defendant's records. "The paper trail of a chip tells a discerning observer whether the chip is a copy or embodies the effort of reverse engineering. I would hope that a court deciding a lawsuit for copyright infringement under this Act would consider evidence of this type as it is extremely probative of whether the defendant's intent is to copy or to reverse engineer." *Id.* at 5–52 to 5–53 (citing *The Semiconductor Chip Protection Act of 1983: Hearing on S. 1201 Before the Subcomm. on Patent, Copyrights & Trademarks of the Senate Comm. On the Judiciary*, 98th Cong., 1st Sess. 146 (1983)).

[118] S. 1201, *supra* note 88, at 83. One industry representative even stated that reverse engineering should cover "forward engineering design" (not based on competitor designs) and manufacturing enhancements. *Id.* The result was that reverse engineering

be extended to mask works was met with slight controversy. Many critics of this concept expressed doubt of the *sui generis* category, stating that it had the risk of distorting traditional copyright principles and leading to interpretation problems.[119] However, Congress found the testimony of Emory University Law Professor L. Ray Patterson to be most persuasive.[120] Patterson argued that the line between form and function would be eroded if explicitly utilitarian articles, such as mask works, were to become copyrightable.[121]

3. The Final Steps

The House substituted a new bill, H.R. 5525, in place of H.R. 1028, in April of 1984.[122] This new bill added a distinct, separate, and independent *sui generis* chapter to title 17 of the U.S. Code exclusively to protect mask work designs. Furthermore, H.R. 5525 also included an optional notice requirement, a mandatory registration requirement within two years of first commercialization, and a reverse engineering provision.[123] The Senate eventually yielded on the *sui generis* issue and made extensive incorporations of H.R. 5525 into the bill it was currently pushing, S. 1201.[124] Subsequently, both houses of Congress added

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adopted the paper trial requirement, which was later clarified by later case law. *See* SCOTT, *supra* note 117, at 5–53 to 5–54 ("If a legitimate 'paper trail' is established, the legislative history and case law indicate that the plaintiff's burden of proof then shifts from 'substantial similarity' to a showing that the two mask works are 'substantially identical.' Thus, while the existence of a 'paper trail' is not an absolute defense to an infringement claim, it does materially raise the plaintiff's burden of proof. However, *Brooktree* [977 F.2d 1554 (Fed. Cir. 1992)] illustrates a paper trail can also undermine a claim of legitimate reverse engineering if it shows copying. Reverse engineering is [also] a question of fact for the jury to decide.") (internal citations omitted).

119 S. 1201, *supra* note 88 at 104 (statement of Jon Baumgarten); *see also* H.R. 1007, *supra* note 87, at 57 (statement of James M. Early, Director, Fairchild Camera Corp.); Samuelson, *supra* note 91, 485–86. Brown, *supra* note 99, at 587–90.

120 H.R. 5525, *supra* note 10, at 5–7; Kasch, *supra* note 25, at 84.

121 Kasch, *supra* note 25, at 84; H.R. 1028, *supra* note 92, at 51–54. Congress eventually agreed with this interpretation. Samuelson, *supra* note 91, 486–87.

122 H.R. 5525, *supra* note 7, at 5–7. Effectively, a hard "chip compromise." Kastenmeier & Remington, *supra* note 82, at 429.

123 H.R. 5525, *supra* note 10, at 5–8. These provisions are also codified now in 17 U.S.C. §§ 903–10 (2012).

124 *See* 103 CONG. REC. 28,966-71 (1984) (Senate floor statements); *see also* Kasch, *supra* note 25, at 84.

explanatory memoranda and passed the legislation unanimously.[125] The President then signed the SCPA into law on November 8, 1984.[126]

III. THE *BROOKTREE* CASE

A. *The Complaints of the Parties*

After the SCPA was signed into law in 1984, only a single, published case applied it, four years later. Actually, three separate suits arose, stemming from the same litigation—(1) a decision from the U.S. District Court for the Southern District of California in 1988;[127] (2) another decision from the same District Court in 1990;[128] and (3) a decision from the United States Court of Appeals for the Federal Circuit, issued in 1992.[129] All three of these cases stemmed from a dispute between two high-tech giants, Brooktree Corporation and Advanced Micro Devices, Inc. ("AMD").[130] Brooktree, the plaintiff, owned several original mask works that were registered with the U.S. Copyright Office for

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125 Katsch, *supra* note 25, at 84.

126 Now codified in 17 U.S.C. §§ 901–14, the SCPA was passed under title III of H.R. 6163, a five-title bill, and then became Pub.L. 98-620, 98 Stat. 3335 (1984). Kasch, *supra* note 25, at 84–85.

127 Brooktree Corp. v. Advanced Micro Devices, Inc., 705 F. Supp. 491 (S.D. Cal. 1988) [hereinafter *Brooktree I*] (denying Brooktree's motion for preliminary injunction).

128 Brooktree Corp. v. Advanced Micro Devices, Inc., 757 F. Supp. 1088 (S.D. Cal. 1990) [hereinafter *Brooktree II*] (denying AMD's motion for JNOV, *judgment non obstante veredicto,* or judgment notwithstanding the verdict and AMD's motion for new trial), *aff'd, Brooktree Corp. v. Advanced Micro Devices, Inc*., 977 F.2d 1555 (Fed. Cir. 1992).

129 Brooktree Corp. v. Advanced Micro Devices, Inc., 977 F.2d 1555 (Fed. Cir. 1992) [hereinafter *Brooktree III*] (The Court of Appeals for the Federal Circuit had subject matter jurisdiction because patent law was involved).

130 *See Company Overview of Brooktree Corporation*, BLOOMBERG, https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=25840 [https://perma.cc/2SQL-CXXX] (last visited Oct. 1, 2018) ("As of September 1996, Brooktree Corporation was acquired by Rockwell Automation Corporation. Brooktree would be operated as a division of Rockwell Semiconductor Systems. Brooktree Corporation and its subsidiaries, prior to the acquisition, were engaged in designing, developing, and marketing proprietary high-performance digital and mixed-signal integrated circuits for computer graphics, imaging, multimedia, communications, and automated test equipment applications.").

SCPA purposes.[131] Specifically, Brooktree's mask works were used to fabricate ICs that converted visual-binary data (digital) into high-frequency audio-signal data (analog) for high-resolution screen displays.[132] Roughly eighty percent of the chip area for the D-A conversion ICs consisted of a "core cell" of ten transistors ("SRAM"), repeated more than 6,000 times.[133] Brooktree alleged that AMD had misappropriated Brooktree's mask works by making second-source chips based off this SRAM core-cell.[134] As discussed herein, this core-cell played a significant role in determining the definition of infringement under the SCPA's "substantial similarity" test.[135]

B. *Procedural History and the Timeline of Decisions*

1. *Brooktree I:* The 1988 Order

As in a calculated game of chess, Brooktree's first move was to seek a preliminary injunction to prevent AMD from making and distributing the disputed ICs.[136] In response, AMD attempted to

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131 *Brooktree III,* 977 F.2d at 1560 ("Brooktree's Mask Work Registrations").

132 This is known in EE literature as an advanced D-A (Digital to Analog) or A-D (Analog to Digital) converter. Raghu Tumati, *Digital to Analog Converter,* UNIVERSITY OF MAINE (2006), https://ece.umaine.edu/wp-content/uploads/sites/203/2012/05/ECE547_RaghuTumati.pdf [https://perma.cc/9GGF-Q8Q7].

133 *Brooktree III*, 977 F.2d at 1563. Furthermore, SRAM stands for Static RAM, and the ten-transistor SRAM core cell served as memory for the main IC. *Id.*

134 Allegedly, Brooktree argued AMD's mask works were copied from two Brooktree mask works labeled "Bt451" and "Bt458." Kasch, *supra* note 25, at 100. The mask works detailed the precise location of the active areas in the SRAM "core cell." Brooktree argued that their mask works were highly original. The design of the mask works provided several benefits including (1) the use of a high frequency, low power CMOS fabrication technology; (2) the ability to change the colors in the color palette for video screen display without any video-output disruption; and (3) the ability for the IC to operate at high frequencies without being hindered by simultaneous and synchronized reads/writes to the RAM. Brooktree Corp. v. Advanced Micro Devices, Inc., 705 F.Supp. 491, 494 (S.D. Cal. 1988).

135 *Brooktree III,* 977 F.2d at 1563 ("A critical component of the Brooktree chips is the core cell, a ten-transistor SRAM cell which is repeated over six thousand times in an array covering about eighty percent of the chip area. Each core cell consists of ten transistors and metal conductors electrically connecting the transistors throughout the three dimensions of the multilayered cell. Brooktree charged that this core cell was copied by AMD, thus infringing Brooktree's mask work registrations.").

136 The test that the *Brooktree I* court used was the following: "As set out by the Ninth Circuit in Los Angeles Memorial Coliseum Commission v. National Football League,

dismiss the motion by declaring that its IC designs were the result of legitimate reverse engineering, and hence were non-infringing.[137] To prove that it underwent valid reverse engineering, AMD established a "paper trail" of evidence revealing a continual, fifteen-month period of investment, and a R&D expenditure that was nearly equal to the research costs expended by Brooktree in designing their ICs.[138] In rebuttal, Brooktree stated that AMD's paper trail evidence only showed AMD's "incompetent efforts," and should, as a result, be ignored.[139]

The first order was issued by the U.S. District Court for the Southern District of California in 1988, denying Brooktree's motion for a preliminary injunction.[140] The court ruled that AMD's paper trail evidence was sufficient to shift the burden to Plaintiff Brooktree to prove that the allegedly infringed ICs were "substantially similar" to the Brooktree ICs.[141] With regard to this

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634 F.2d 1197, 1200 (9th Cir. 1980), the four traditional criteria for granting equitable relief are: 1. a strong likelihood of success on the merits; 2. the possibility of irreparable injury to the plaintiff if the preliminary relief is not granted; 3. a balance of hardships favoring the plaintiff; and 4. (in certain cases) advancement of the public interest. These criteria have been fashioned into two alternative tests, so that now a party may meet its burden by demonstrating either: 1. a combination of probable success on the merits and the possibility of irreparable injury; or 2. that serious questions are raised and that the balance of hardships tips sharply in the plaintiff's favor." *Brooktree I*, 705 F. Supp. at 493 (citing *L.A. Mem'l Coliseum Comm'n*, 634 F.2d at 1201; Arcamuzi v. Continental Air Lines, Inc., 819 F.2d 935, 937 (9th Cir. 1987)).

137 *Brooktree I,* 705 F. Supp. at 495 (explaining that "AMD argues that Plants discovered his layout through reverse engineering, and that reverse engineering is specifically allowed under the Mask Work Act. AMD has presented evidence of a paper trail showing the various stages of Plants' discovery process. AMD maintains that it has invested an equal or greater amount of funds in developing its chips, and that the Mask Work Act was directed at minimal investment piracy rather than the type of long-term research and reverse engineering it performed.").

138 This began the formulation of the "paper-trail" evidence rule for federal courts. *Id.* at 495–96.

139 *Id. See also* Kasch, *supra* note 25, at 100.

140 *Brooktree I,* 705 F. Supp. at 497.

141 This is a concept from copyright law. *See* S. REP. NO. 98-425, at 16–18 (1984). The *Brooktree I* court, however, adopts a "substantially identical" test: "The parties agree that if the defendant can produce a paper trail establishing reverse engineering, the appropriate standard is substantially identical rather than substantially similar. The court finds that defendant has produced a sufficient paper trail to require the plaintiff to prove that the alleged pirated chip is substantially identical to the original chip." *Brooktree I*, 705 F. Supp. at 495.

high burden, the court believed that Brooktree failed to make a showing of a "strong likelihood of success on the merits."[142] Therefore, the court held that Brooktree failed to demonstrate that it was "sufficiently harmed" by AMD's behavior to warrant a preliminary injunction, and that a preliminary injunction would not be the best possible remedy available to them.[143] Even though the court denied Brooktree's motion for preliminary injunction, it emphasized that there were serious questions as to the substantive issues in the case.[144] With a few unresolved issues at hand and several million dollars at stake, it was clear the case was going to trial.

2. *Brooktree II:* The 1990 Decision

During trial, which also took place in the U.S. District Court for the Southern District of California, Brooktree had two advantages: (1) more discovery and (2) a lower standard of proof than required for a preliminary injunction.[145] After a jury trial that lasted seven weeks, a verdict was returned awarding Brooktree a massive award of $26 million in damages for AMD's infringement, both under the SCPA and patent laws.[146] However, this verdict was not met without some resistance from AMD. AMD filed a motion for judgment notwithstanding the verdict[147] or in the alternative, a motion for a new trial.[148] Both motions were denied by the court, and AMD subsequently appealed those decisions to the United States Court of Appeals for the Federal

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142 *Brooktree I*, 705 F. Supp. at 496. A strong likelihood of success on the merits is required for preliminary injunction. Jacksonville Port Authority v. Adams, 556 F.2d 52, 57 (D.C. Cir. 1977).

143 *Brooktree I*, 705 F. Supp. at 496–97. Monetary damages would undoubtedly be adequate compensation if infringement of the ICs were later proven in a subsequent judicial decision. *Id.*

144 The district court noted that "serious questions as to the appropriate resolution of the substantive issues in the case have been raised." *Id.* at 497.

145 Kasch, *supra* note 25, at 101.

146 Brooktree Corp. v. Advanced Micro Devices, Inc., 757 F. Supp. 1088, 1091 (S.D. Cal. 1990); Johnson, *supra* note 26.

147 Also known as "JNOV" or *Judgment Non Obstante Veredicto*. *Brooktree II,* 757 F. Supp. at 1091–92.

148 *Id.*

Circuit.[149] The Federal Circuit was established in 1982 to primarily "bring uniformity and predictability to [p]atent [l]aw," and hence has exclusive jurisdiction to hear patent law appeals from federal district courts.[150]

3. *Brooktree III:* The 1992 Federal Circuit Decision

On appeal to the Federal Circuit, AMD's primary argument was that the SPCA "requires copying of the *entire* chip" in order to establish "substantial similarity" for the objective of finding infringement.[151] AMD further asserted that it was "undisputed" that at least twenty percent of their chip was not copied (from Brooktree's mask work), and hence the district court's judgment of infringement was erroneous.[152] The Federal Circuit essentially rejected this contention, referring to both SCPA legislative history and principles of copyright law to justify their decision.[153] The Federal Circuit reasoned that "substantial similarity" could indeed be found from some, but not complete, copying, for instance the replication of a major core cell layout in an overall IC.[154] In defense, AMD argued that the core cell in its IC was reverse engineered, and because the reverse engineering was backed by an extensive paper trail, AMD's design was noninfringing.[155]

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149 Brooktree Corp. v. Advanced Micro Devices, Inc., 977 F.2d 1555, 1555–57 (Fed. Cir. 1992).

150 MARTIN J. ADELMAN ET AL., CASES AND MATERIALS IN PATENT LAW 16 (2d ed. 2003). The exclusive right to hear patent appeals is conferred to the Federal Circuit in 28 U.S.C. § 1295. *See* Holmes Grp., Inc. v. Vornado Air Circulation Sys., Inc., 533 U.S. 826 (2002) (holding that in order for the Federal Circuit to have jurisdiction *arising* under patent law, the complaint needs to have a cause of action rooted in patent law—a counterclaim is insufficient for this purpose).

151 *Brooktree III*, 977 F.2d at 1564. The "substantial similarity" concept is analogous to other traditional areas of copyright law: just as the plagiarist who copies only one chapter of a book may be held liable for infringement, a person may be liable for copying a part of a mask work if it is a qualitatively important portion that results in "substantial similarity." S. REP. NO. 98-425, at 16–18.

152 *Brooktree III*, 977 F.2d at 1564.

153 *Id.*

154 *Id.*

155 *Id.* at 1569.

C. *The Aftermath of Brooktree*

The Federal Circuit responded by honing in on the "original mask work" language of the SCPA's reverse-engineering statutory exception.[156] This led to an outright rejection of AMD's reverse engineering argument and a ruling that "the paper trail is evidence of independent effort, but it is not conclusive or incontrovertible proof of originality."[157] Upon reviewing the factual findings of the district court—namely the conflicting expert testimony and the volume of AMD's paper trail—the Federal Circuit held that "reasonable minds could [differ]" about the "originality" of AMD's "original mask work."[158] The judgment of the district court, including the injunction and the damage verdict, was affirmed by the Federal Circuit.[159]

As Steven P. Kasch argues, "since *Brooktree* was tried to a jury, there is no possibility of scrutinizing the decision process leading to the finding of infringement."[160] Furthermore, since the jury instructions went unchallenged on appeal, the Federal Circuit "had little opportunity to develop the reverse-engineering doctrine."[161] Among the unchallenged jury instructions included instructions not only on reverse engineering but also the "substantially similarity" test for infringement.[162] At this point,

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156 The "original mask work" term is used as follows: "it is not an infringement of the exclusive rights of the owner of a mask work for . . . a person who performs the analysis or evaluation described in paragraph (1) [for the purpose of teaching, analyzing or evaluating] to incorporate the results of such conduct in an *original mask work*, which is made to be distributed." 17 U.S.C. § 906(a)(2) (1988) (emphasis added).

157 *Brooktree III,* 977 F.2d at 1569–70. Hence, the "sheer volume of paper" in a paper-trail is not dispositive.

158 *Id.* at 1569.

159 *Id.* at 1569–71.

160 Kasch, *supra* note 25, at 102.

161 *Id.*

162 The jury instruction as to "substantial similarity" was: "To establish infringement, Brooktree must show that AMD's mask works are substantially similar to a material portion of the mask works in the chips covered by Brooktree's mask registration . . . Substantial similarity may exist where an important part of the mask work is copied, even though the percentage of the entire chip which is copied may be relatively small. It is not required that AMD make a copy of the entire mask work embodied in the Brooktree chip." The reverse engineering jury instruction can be summarized as follows: "Reverse engineering is permitted and is authorized by the [SCPA]. It is not infringement of an owner's exclusive right and protected mask work for another person, through reverse engineering, to photograph and to study the mask work for the purpose of analyzing

there appeared to be uncertainty as to the specific rules to apply to these detailed points of law. The one clear rule of law taken away from *Brooktree* is likely that "it is not necessary to copy an *entire* chip" to infringe under the SCPA.[163] Indeed, the finding that a competitor can copy a major core cell and still be liable for infringement is an illuminating holding.[164] Also, an extensive paper trail, although sometimes convincing, is not alone dispositive in establishing the reverse engineering defense.[165] With the issues concerning the SCPA so unresolved, the intellectual property bar seemed to be awaiting a clearer adjudication before deciding to fully explore the SCPA as a viable litigation tool.[166] These various uncertainties were to remain unresolved for nearly a decade and a half.

IV. THE *ALTERA V. CLEAR LOGIC* CASE

A. The Parties

Altera Corporation is a reputable titan in the high technology sector, whereas Clear Logic Incorporated is a smaller and lesser known "design house."[167] Altera is a leading manufacturer of Field Programmable Gate Arrays ("FPGAs") and Programmable Logic

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its . . . circuitry, logic flow, and organization of the components used in the mask work and to incorporate such analysis into an original mask work." The instruction further added that an "original mask work" is original only if the "resulting semiconductor chip product" made from that mask work is "not substantially identical to the protected mask work and its design involved significant toil and investment." *Brooktree III*, 977 F.2d at 1564, 67.

163 *Id.* at 1564.

164 Even considering the fact that AMD argued that the "core cell" only composed twenty percent of Brooktree's IC. *Id.*

165 Apparently, AMD's extensive paper trail was spent pursuing experimental hypotheses. Specifically, a lot of time and money was recorded just to test IC conjectures that went nowhere. Recall that the Federal Circuit held the "sheer volume of paper" in a paper-trail is not dispositive. *Id.* at 1569.

166 Kasch, *supra* note 25, at 102.

167 A quick Google search comparing "Altera" and "Clear Logic" clearly demonstrates this. *See Home Page*, ALTERA, http://www.altera.com [https://perma.cc/LPJ7-YW7M] (last visited Aug. 24, 2018); Alex Romanelli, *Clear Logic Seeks Legal Refuge,* ELECTRONIC NEWS (Feb. 4, 2002), http://www.reed-electronics.com/electronicnews/article/CA194665.html [https://perma.cc/98YA-ATJW] (stating that Clear Logic filed for bankruptcy in 2002).

Devices[168] ("PLDs")—these are basically large IC systems that can be programmed to perform various logic functions.[169] Clear Logic, on the other hand, manufactures Application Specific Integrated Circuits ("ASICs"), smaller ICs that are designed to perform one very specific function.[170] ASICs are usually configured from data taken from FPGAs and PLDs.[171] This is done through a computer data file known as a "bitstream," generated from the PLD.[172] Once you have a bitstream, you will be able to create a specific ASIC for a customer.[173] Altera also sells chips to companies that create ASICs for customers, not to actual ASIC customers themselves.[174]

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168 *See Altera – About*, ALTERA, https://www.altera.com/about.html [https://perma.cc/DNX8-FDSL] (last visited Aug. 24, 2018) ("Founded in Silicon Valley, California, as Altera, we have been supplying the industry with access to the latest programmable logic, process technologies, intellectual property (IP) cores, and development tools for more than 30 years. Recognizing Altera's innovative mindset, Intel acquired the company in 2015. Our combined technology leadership and operational excellence enable today's largest technology and system companies to rapidly and cost effectively innovate, differentiate, and win in their markets. The company brings to Intel its FPGAs, SoCs with embedded processor systems, CPLDs, ASICs, and power solutions. These technologies and solutions are preferred by customers worldwide in a variety of end markets, including communications, networking, cloud computing and storage, industrial, automotive, and defense."). For the purposes of this Article, FPGAs and PLDs will be synonymous. "FPGAs" and "PLDs" will be referred to as "PLDs".

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

170 *Id.* ASICs are usually cheaper, smaller, and use less power than PLDs. *Id.* at 1082.

171 Max Maxfield, *ASIC, ASSP, SoC, FPGA – What's the Difference*?, EE TIMES (June 23, 2014, 3:00 PM), https://www.eetimes.com/author.asp?section_id=216&doc_id=1322856 [https://perma.cc/682Q-JP48].

172 A. ROYCHOUDHURY & Y. LIU, A SYSTEMS APPROACH TO CYBERSECURITY 146 (2017).

173 The bitstreams actually come from Altera's MAX+PLUS® II software. *Altera,* 424 F.3d at 1081; *see also,* Design & Reuse Headline News, *Court Issues Preliminary Injunction Against Clear Logic in Altera Litigation,* D&R HEADLINE NEWS (July 17, 2002), http://www.us.design-reuse.com/news/?id=3583 [https://perma.cc/7P4N-ZZUQ] [hereinafter D&R NEWS]. "A customer uses the Altera's MAX+PLUS® II software to program the PLD to perform a desired function. The software helps to route the functions through the thousands of transistors that make up the PLD, ideally achieving the maximum functionality for the particular function desired. Because the PLD can be programmed and reprogrammed, the customer, working with Altera, can continue to work with the PLD and the software until the PLD meets the customer's exact needs. This process can take months." *Altera,* 424 F.3d at 1081.

174 "Altera sells chips to companies that use those chips to perform logic functions in devices they produce, not to individual consumers. For example, a company that manufactures printers might purchase PLDs from Altera to perform the functions necessary to operate the printer." *Altera,* 424 F.3d at 1081, n.1.

Clear Logic essentially utilizes the following business model: they first take a customer's bitstream or data file from an Altera PLD, and, based off the bitstream information, create a custom-made ASIC for the customer that is fully compatible with the Altera product.[175] This is actually a viable industry practice known as "second-sourcing."[176] As Al Huggins, the president and CEO of Clear Logic, declared, the company's "proprietary technology offers pin-compatible devices to customers that second source the Altera products at a much lower price."[177] Once Clear Logic obtains an Altera PLD bitstream from a customer, it uses a precise laser process to configure the highly compatible ASIC.[178] The Clear Logic laser process uses to create the chips from the Altera bitstream allows for a turnaround time of just a few weeks and rarely produces a chip that is incompatible with an Altera logic device.[179]

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175 *Altera,* 424 F.3d at 1082. Also, Clear Logic ASICs were "fully compatible with Altera functionality, pinouts, and architectures…". Automotive Designline, *Altera Sues Clear Logic, Alleging Unlawful Use of its Technology,* EE TIMES (Nov. 17, 1999), https://www.eetimes.com/document.asp?doc_id=1189146 [https://perma.cc/8R3Z-GLCE] [hereinafter *Altera Sues Clear Logic*]. Furthermore, the other distinguishing characteristics between ASICs and PLDs are: ASICS cannot be reprogrammed whereas PLDs can, ASICS also use "less power, are smaller, and for a customer with a large order, are often cheaper." *Altera,* 424 F.3d at 1082. Customers often start with a PLD and switch to ASICs once they determine exactly what they need the chips to do.

176 Andrew R. Dick, *An Efficiency Explanation for Why Firms Second Source*, 30 ECON. INQUIRY 332 (1992), https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1465-7295.1992.tb01662.x [https://perma.cc/P7LY-ZGXT].

177 *Clear Logic Defends Itself Against Altera's Suit,* EE TIMES (Nov. 18 1999), https://www.eetimes.com/document.asp?doc_id=1189133 [https://perma.cc/47DD-WEGB] [hereinafter Clear Logic Defends Itself]; *see also Altera,* 424 F.3d at 1082 (explaining that a company that converts PLDs to ASICs must traditionally "start from a high level of description and work toward the end product, the ASIC. This can take a few months and there is a substantial risk that even after the initial attempt, the first chip will not work and more time and money will have to be invested in perfecting the product." The business model of Clear Logic appears to solve this problem.).

178 *Altera Sues Clear Logic*, *supra* note 175.

179 *Altera,* 424 F.3d at 1082 (stating that LPD's are also known as Clear Logic's Laser Programmable Devices (LPDs); *See* Craig Matsumoto, *Clear Logic Continues Mimicry of Altera Parts,* EE TIMES (Nov. 24, 1999), http://www.eet.com/news/latest/showArticle.jhtml?articleID=18303050 [https://perma.cc/P45D-RWPF].

B. The Suit

The dispute between the two companies arose as early as 1999. On November 16, 1999, Altera filed suit against Clear Logic in the U.S. District Court for the Northern District of California.[180] Altera claimed that Clear Logic unlawfully appropriated Altera's registered mask works in violation of the SCPA, and that Clear Logic also interfered with Altera's customer relations through a Software License Agreement.[181] Altera sought (1) compensatory damages, (2) punitive damages, and (3) a preliminary injunction to stop Clear Logic from "unlawfully using Altera's technology."[182] Altera's complaint alleged that "[it] has suffered and/or/will continue to suffer reduced sales and/or lost profits" and "irreparable loss and injury" as a result of Clear Logic's entry into the market.[183] Huggins defended this claim by stating that "this suit demonstrates that Altera is afraid of competition and recognizes Clear Logic to be a serious threat," and that the suit's allegations were "totally unfounded" and "completely frivolous."[184] Furthermore, Huggins declared that the lawsuit acknowledges "the rapidly growing popularity of Clear Logic's solution with Altera's major customers. In fact, the lawsuit itself provides confirmation of the ease-of-use and compatibility of Clear Logic products."[185] These comments suggested that the case was destined for an extensive jury trial.

A jury found for Altera on all claims, and issued a judgment of $30.6 million in damages, along with $5.4 million in prejudgment interest, and $394,791.68 in costs.[186] Furthermore, Judge James Ware of the U.S. District Court for the Northern District of California granted Altera's motion for preliminary injunction

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180 Craig Matsumoto, *Altera Files Suit Against Copycat Supplier,* EE TIMES (Nov. 17, 1999), https://www.eetimes.com/document.asp?doc_id=1140673 [https://perma.cc/2UWL-P27S]; *see also* D&R NEWS, *supra* note 173.

181 *Altera Sues Clear Logic*, *supra* note 175; The software license claim was a state law claim brought against Clear Logic for copyright misuse, breach of a license agreement, and intentional interference with those contractual relations. *Altera,* 424 F.3d at 1081–82. Since these claims are not relevant to the SCPA, they will not be addressed.

182 *Clear Logic Defends Itself*, *supra* note 177.

183 *Id.*

184 *Id.*

185 *Id.*

186 *Altera*, 424 F.3d at 1083.

against Clear Logic on July 9, 2002, enjoining Clear Logic from selling any semiconductor device that was made, designed, configured, programmed or otherwise manufactured through Altera's software.[187]

Clear Logic appealed to the United States Court of Appeals for the Ninth Circuit.[188] On April 12, 2005, the case was submitted and argued before a three-judge panel comprising of Circuit Judges Hug, Ferguson and Rymer.[189] Karl J. Kramer[190] represented Altera, and David M. Heilbron, along with C. William Craycroft,[191] represented Clear Logic.[192] On September 15, 2005, Circuit Judge Hug filed a majority opinion in favor of Altera, affirming the district court's judgment and grant of a preliminary injunction, with Judge Rymer writing a brief concurrence.[193]

C. The SCPA Issue

Altera challenged Clear Logic's business model—the method of using Altera bitstreams to custom manufacture compatible Clear Logic ASICs—as infringing its rights under the SCPA.[194] In the district court, Altera argued that Clear Logic infringed its SCPA rights by copying the layout design of its registered mask works for three families of chip products.[195] Clear Logic responded to this by denying the infringement, and asserting the affirmative defense

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187 *Id.* at 1082–83; *see also* D&R NEWS, *supra* note 173. In addition, the district court ruled that Clear Logic breached the Software License agreement, but since that claim is not relevant to the SCPA it is not discussed here.

188 *Altera,* 424 F.3d at 1083.

189 *Id.* at 1081.

190 *Id.*

191 *Id.*

192 *Id.*

193 *Id.* at 1081, 1092.

194 *Id.* at 1082.

195 *Id.* The three families of chip products that Clear Logic allegedly copied were: Altera's Max 7K (7000), Flex 8K (8000), and Flex 10K (10000) chip families. Matsumoto, *supra* note 180. Also, each of Altera's chip families includes a FPGA and a PLD: for instance, its Flex 10K family includes a Flex 10K PLD and a Flex 10KA FPGA. Matsumoto, *supra* note 179; *see also,* Automotive Designline, *Clear Logic Pushes Ahead with Altera-Compatible ASICs,* EE TIMES (Nov. 29, 1999), https://www.eetimes.com/document.asp?doc_id=1189033 [https://perma.cc/8L4J-T8YW] (discussing the Flex 10K PLDs and Flex 10KA FPGAs) [hereinafter *Pushes Ahead*].

of reverse engineering under the SCPA.[196] The jury in the district court rejected this defense with regard to the SCPA mask work infringement claim, and returned a verdict in favor of Altera.[197]

On appeal to the Ninth Circuit, Clear Logic surprisingly did not contest the award of damages or any of the specific terms of the injunction, but did argue that the District Court judge misinterpreted the application of the SCPA, and improperly instructed the jury concerning the defense of reverse engineering.[198] The Ninth Circuit thus began its analysis of the SCPA, which can be split into two main parts: (1) the proper "scope" of the SCPA, namely the exact parts of a chip layout protected by the SCPA, and (2) the precise definition of the statutory exception of reverse engineering that exists in the SCPA as an affirmative defense for alleged infringers of mask works.[199]

1. The Scope of the SCPA: *Altera*'s Physical Grouping versus *Clear Logic*'s "Idea"

Of course, Clear Logic and Altera were divided on the issue of the SCPA's "Scope," that is, what exact part of the chip did the SCPA protect?[200] This division was caused by a disagreement in the definition of the word "architecture."[201] According to Altera, the "architecture" is comprised of "the components and structures that are physically arranged within the chip."[202] However, Clear Logic argued that the architecture is "essentially a block diagram showing the basic arrangement of the chip. From this conceptual

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196 *Altera,* 424 F.3d at 1086–89; 17 U.S.C. § 906(a) (1984) (Reverse Engineering exception of SCPA).

197 *Altera*, 424 F.3d at 1088.

198 *Id.* at 1083. Also, even though Clear Logic did not contest the amount of damage award nor did it contest any of the specific terms of the injunction, it contested the "liability for those damages," and hence was trying to annul the district court's decision on the SCPA issue in order to throw out the entire claim. *Id.*

199 Mr. Karl J. Kramer, partner at Morrison & Foerster, indicated that the two main issues the Ninth Circuit dealt with in *Altera* were: (1) What exactly is the scope of the SCPA? (2) What exactly is the "Reverse Engineering" defense? Telephone Interview with Karl J. Kramer, Senior Partner, Morrison & Foerster, in Palo Alto, Cal. (Feb. 6, 2006).

200 *Altera,* 424 F.3d at 1084.

201 *Id*. at 1083.

202 *Id.* at 1082.

plan, the designer creates floor plans that show the arrangement of functional modules, focusing on how the designer will group major components."[203] In other words, Clear Logic argued that the floor plan and the architecture of a chip were at "higher levels of abstraction" compared to the lower levels of the actual chip and its transistors or other components[204] In contrast, Altera emphasized that the groupings of components on a chip are not "higher levels of abstraction," but concrete parts of the mask, and therefore, still expressions of the mask work.[205] Mr. Kramer persuasively analogized this to a small piece of the Da Vinci's *Mona Lisa*, which is still part of the *Mona Lisa* as far as concrete expression goes—it is not an "abstraction" of the overall painting.[206]

However, despite this disagreement over the term "architecture," both Clear Logic and Altera agreed that "chip design starts with a high-level idea and moves toward the placement of individual transistors on a chip in several layers."[207] This is relevant because it tracks the logic of how chip engineers view, and ultimately build, their designs, just as how other copyrights are approached from the point of view of artists that create them. Before trial for the district court case, Altera filed a motion for summary judgment regarding the scope of the SCPA.[208] The motion essentially argued that the scope of the SCPA extends to the "placement of the components and their interconnection lines on the actual chip."[209] The district court granted Altera's

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203 *Id.*

204 *Id.* "The designer next creates an electrical schematic, which is a two-dimensional abstract drawing. After this, a layout designer creates a three-dimensional layout design which includes the specific placement of all of the elements of the chip and is used to make the glass marks that are printed onto the chip." *Id.*

205 Kramer, *supra* note 199.

206 *Id.*

207 *Altera,* 424 F.3d at 1083. "Ultimately, the schematics and floor plans are used to develop the specific placement of every transistor that will eventually go on the chip." *Id.* Mask works were defined by the Ninth Circuit as "glass disks" etched "with the pattern for each layer of the chip," and the patterns from these mask works are printed "onto the semiconductor chip, one layer at a time, by photolithography." *Id.* (citing S. REP. NO.98-425, at 2–3). This definition of a mask work may be clearer: "Generally, there are eight to twelve layers to the chip, each of which requires a separate mask. The series of all these masks is the mask work." *Id.*

208 *Id.* at 1084.

209 *Id.*; Kramer, *supra* note 199.

motion, ruling that the placement of the components were physical embodiments of the layout design chosen by Altera engineers and that the layout design was more than a mere idea.[210]

The district court reasoned that Altera's layout design was more than an abstract "idea," it was a physical, concrete blueprint for the layout of the semiconductor chip.[211] The district court also left for the jury the factual question of whether Altera had proven infringement.[212] The Ninth Circuit approved of this by first, reiterating the *Brooktree* holding: A mask work can be infringed if the "finder of fact" may properly find "substantially similarity" between the accused mask work, even though other portions of the chip were not copied.[213] Secondly, the Ninth Circuit agreed that the district court "appropriately allowed the jury to determine whether the copying of the layout of the cell within the chip was infringement."[214] The district court then determined that the SCPA was "broad enough to cover the type of claims made by Altera" referencing a line from the *Brooktree* Federal Circuit decision: "copying groupings of transistors and interconnection lines may constitute a violation of [the SCPA]."[215] The Ninth Circuit reviewed the granting of the motion de novo and attempted to provide a well-reasoned definition of the "scope" of the SCPA.[216]

The two conflicting definitions of scope were as follows: Altera asserted that the scope of the SCPA extends to the physical "placement of groupings of transistors on the chip." Clear Logic, on the other hand, argued that the "placement of the groupings of transistors" is an *idea*, and hence falls outside of the scope of the

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210 *Altera,* 424 F.3d at 1084.
211 *Id.* at 1084–85.
212 *Id.* at 1085.
213 Brooktree Corp. v. Advanced Micro Devices, Inc., 977 F.2d 1555, 1564 (Fed. Cir. 1992).
214 *Id.* at 1565; *Altera,* 424 F.3d at 1085.
215 *Altera,* F.3d at 1085 (quoting *Brooktree III*)
216 *Altera,* 424 F.3d at 1085*; see also Brooktree III,* 977 F.2d 1555 (Fed. Cir. 1992). Interestingly enough, it was mentioned that *Brooktree* was a case that originated in a federal district court in the Ninth Circuit, but because it involved patent law matters, the Federal Circuit had jurisdiction over the case. However, because of origin jurisdiction, the Federal Circuit stated that it applied Ninth Circuit law in addressing the SCPA claim. *Altera,* 424 F.3d at 1085, n.4.

SCPA.[217] The Ninth Circuit rejected Clear Logic's argument, stating that the "groupings [were] more than conceptual," and hence properly fell under SCPA's scope.[218] After reviewing an interesting assortment of cases and legal sources, the Ninth Circuit came to the conclusion that the schematics and floor plans of an IC convey "more concrete ideas" by designating how a chip may be structured or organized, and that the "mask work" contained ideas that are concretely and "physically expressed," and are thus subject to protection under the SCPA.[219] Hence, the Ninth Circuit found that "organization of groupings" were physically part of the mask work, and not abstract concepts.[220]

Agreeing with Altera and the district court, the Ninth Circuit held that the "placement of logic groupings in a mask work is not an abstract concept; it is embodied in the chip and affects the chip's performance, efficiency, and timing."[221] Therefore, the Ninth Circuit defined the scope of the SCPA as protecting "the organization of groupings of logic functions on Altera's mask works, and the interconnections between them."[222]

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217 *Altera,* 424 F.3d at 1085.

218 *Id.*

219 *Id.* at 1086. In considering the "abstraction" argument advanced by Clear Logic, the Ninth Circuit discusses a variety of legal sources, including 4 MELVILLE B. NIMMER & DAVID NIMMER, NIMMER ON COPYRIGHT § 13.03 (2005) (comparing the analysis of broad ideas, plot structures, dialogue or a sequence of events in a novel or play to the levels of abstraction in creating a computer program), H.R. 1028, *supra* note 92, at 316–32 (letter and article submitted by Eric W. Petraske, patent attorney) (identifying ideas from electrical data, geometric information about component placement, size, shape, circuit design within the mask level), Data East USA, Inc. v. Epyx, Inc., 826 F.3d 204, 207–09 (9th Cir. 1988) (finding a broad idea behind the design and assessing each successive step in the design process until one identifies the point at which the idea becomes protectable expression), Computer Assocs. Int'l, Inc. v. Altai, Inc*.,* 982 F.2d 693, 706–12 (2d Cir. 1992) (as amended) (explaining the abstraction-filtration-comparison test for different levels of abstraction in computer programs).

220 *Altera,* 424 F.3d at 1086.

221 *Id.* "Unlike the outline of an article or the chapters in a book, these groupings physically dictate where certain functions will occur on a chip and describe the interaction of parts of the chip." *Id.*

222 *Id.*

2. The Reverse Engineering Issue

The SCPA reverse engineering exception allows a person to: (1) "reproduce [a] mask work solely for the purpose of teaching, analyzing, or evaluating the concepts or techniques embodied in the mask work or circuitry, logic flow, or organization of components used in the mask work; or…(2) to incorporate the results of such an analysis [as described in (1)] into an original mask work which is made to be distributed."[223] The policy behind the reverse engineering doctrine is to encourage innovation.[224] However, due to the thin line between reverse engineering and forbidden copying, the definition of the reverse engineering exception must be clear and exact to be effective. A reproduced mask work, or second mask work, must not be "substantially identical to the original," and as long as there exists evidence of "substantial toil and investment" in creating the second mask work—rather than "mere plagiarism," the second chip will not "infringe the original chip, even if the layout of the two chips is, in substantial part, similar."[225] The *Brooktree* case has implicitly established a "paper trail" requirement for a legitimate reverse engineering defense. A firm that simply copied another's mask work would have no evidence of its own investment and labor, whereas a legitimate reverse engineering job would involve a "trail of paperwork documenting the analysis of the original chip as well as the development of an independent design."[226]

On appeal to the Ninth Circuit, Clear Logic challenged the district court's jury instruction regarding reverse engineering.[227] Upon analyzing the instructions as a whole, the Ninth Circuit

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223 17 U.S.C. § 906(a).

224 *Altera,* 424 F.3d at 1086. Reverse engineering has long been an accepted practice in the semiconductor chip industry. *Id.* at 1083. By photographing and chemically dissolving each layer of the chip, a second company can recreate the entire mask work for any chip. This process allows legitimate analysis of chips to spur innovation and improvement on existing designs, but also makes direct copying of chips feasible. *Id.* at 1083–84.

225 Brooktree Corp. v. Advanced Micro Devices, Inc., 977 F.2d 1555, 1566 (Fed. Cir. 1992).

226 *Id.*; *see also Altera,* 424 F.3d at 1087. Yet, the *Brooktree* "paper-trail" requirement is a bit more nuanced. In *Brooktree III*, the Federal Circuit held that the "sheer volume of paper" was not dispositive. 977 F.2d at 1569.

227 *Altera,* 424 F.3d. at 1087.

determined that the jury instructions were clear and concise, and correctly stated the law.[228] In its analysis, the Ninth Circuit revealed: the SCPA's reverse engineering provision "allows copying the entire mask work: [i]t does not distinguish between the protectable and non-protectable elements of the chip as long as the copying is for the purpose of teaching, evaluating or analyzing the chip."[229] Although the product created as a result of that analysis must be original, as defined by the statutory language of 17 U.S.C. § 906(a), the process of studying the chip is not limited to copying ideas or concepts.[230] As counsel for *Altera* emphasized, the reverse engineering exemption allows you to make an *absolute* copy of the mask work.[231] The Ninth Circuit thus stated that Clear Logic had failed to establish a valid reverse engineering defense because the reverse engineering was not limited to just "ideas."[232]

Another subtle nuance in the reverse engineering issue, not mentioned in the opinion, concerns the "merger doctrine" in copyright law.[233] Essentially, the merger doctrine states that if there is only one or very few ways to express an idea, then that expression is essentially merged with the idea. Because the idea and the ways to express that idea are so inextricably intertwined, the means of expression have little variation. Hence, no copyright infringement will occur if the expression is infringed, because the copyright owners would otherwise be preventing others from expressing an idea, which is impermissible.[234] The reverse

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[228] Following established precedent, the Ninth Circuit looked to the instructions as a whole to determine whether they had fairly and accurately covered the substance of the law. Swinton v. Potomac Corp., 270 F.3d 794, 802 (9th Cir. 2001); *see also* Tritchler v. County of Lake, 358 F.3d 1150, 1154 (9th Cir. 2004) (stating that a judgment is not reversed if the alleged error in the jury instructions are harmless).

[229] *Altera,* 424 F.3d at 1088.

[230] *Id.*

[231] Kramer, *supra* note 199.

[232] *Altera,* 424 F.3d at 1089.

[233] Lewis R. Clayton, *The Merger Doctrine,* THE NAT'L L. J., (2005), https://www.paulweiss.com/media/1851041/mergerdoct.pdf [https://perma.cc/99QS-QDVX].

[234] *Id.* This is impermissible because of the "idea-expression divide": one can hold a copyright in an expression, but not an idea. *Merger Doctrine*, US LEGAL, https://definitions.uslegal.com/m/merger-doctrine/ [https://perma.cc/CG6X-S8B5] (last visited Oct. 10, 2018) ("Merger Doctrine is a principle of copyright law which says when there is only one or limited number of ways to express an idea, copyright law will not protect

engineering concept boils down to a merger doctrine issue. There is really only one way to express a particularly complex mask work in a semiconductor chip product. If you photocopy it, in order to reverse engineer it, then you are infringing the expression and impermissibly "copying."[235]

Essentially, due to this merger doctrine issue, companies like Clear Logic can continue using the reverse engineering defense. Eventually, overuse of this defense will make the exception swallow the rule.[236] As a matter of policy, this should be discouraged, and therefore, the definition of the "reverse engineering" exception must be made clear and unambiguous.

D. Brief Reflections on Altera

The aftermath of *Altera* has inevitably damaged the business model that Clear Logic has attempted to capitalize on. Not only is Clear Logic's business model now illegal, but investors also believe it to be unprofitable. It is unlikely that in the future other Silicon Valley companies will follow this business model by attempting to "piggyback" on the designs of a competitor.[237] However, these specialty niche markets are harder to find in the high-tech industry and are relatively rare.[238] Hence, the effect on Silicon Valley's economy is tenuous at most. Smaller companies may tend to stray from this business model, and overall there may be more of an emphasis on developing individually innovative technologies as opposed to technologies that are compatible with more popular semiconductor products. It will likely make it more

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the expression because it has "merged" with the idea. When the idea and expression are very difficult to separate, they are said to merge. The rationale arose in the case *Baker v. Selden,* 101 U.S. 99 (U.S. 1880). It was later applied to *Morrissey v. Procter & Gamble Co.,* 379 F.2d 675 (1st Cir. Mass. 1967), wherein it came to be known as the Merger Doctrine.").

235 Kramer, *supra* note 199. A side-note: Mr. Kramer believes that the "bridge connecting copyright and patent law" is misleading because that is actually not what the SCPA does. The SCPA is only an extension of copyright law, and really has nothing to do with patent law at all.

236 *Id.*

237 This is the process by which Clear Logic based its main products off of Altera's chip families.

238 Kramer, *supra* note 199.

difficult for those striving to be a "second source" to replicate an original work of innovative designers.[239]

However, there is one encouraging shift that *Altera* brought to the Silicon Valley economy. Following the *Altera* decision, the SCPA now exists as a viable litigation tool that many companies are just beginning to realize.[240] It may provide a tool for emerging high-tech companies to protect their architectures quickly and inexpensively. In light of *Altera*'s "physical grouping" ruling, the SCPA now encourages designers to protect groupings at a higher, more architectural level—not as abstract "ideas" but as concrete embodiments of the mask—beyond a lower transistor level.[241]

V. Contemporary Applications of the SCPA

There exists a wide array of untapped SCPA usages that have not been realized before. Former German Court of Appeals Judge, Law Professor and IP Scholar, Thomas Hoeren, suggests that the *sui generis* protection extended to semiconductor mask works via the SCPA collapsed for various economic and legal reasons, and was replaced by the modern prioritization of "classic" IP rights, such as patents and copyright, to protect integrated circuit innovations.[242] However, as this Article argues, there exists untapped potential for asserting the *sui generis* rights of semiconductor mask works, because the SCPA protects a unique area that is untouched by classic forms of IP. Moreover, it is up to contemporary high-tech companies to realize the sheer power inherent in the language of the SCPA in order to protect their architectures and designs, and benefit from leading the charge in evolving the landscape of SCPA law.

In this Part, a brief cost-benefit analysis approach is applied to the economics of today's semiconductor industry, with a focus on Silicon Valley and various factors such as (a) chip piracy, (b)

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239 *See* Heit, *supra* note 34.

240 *Id.*

241 *Id.*

242 Thomas Hoeren, *The Protection of Pioneer Innovations – Lessons Learnt from the Semiconductor Chip Industry and its IP Law Framework*, 32 J. MARSHALL J. INFO. TECH. & PRIVACY L. 151, 152 (2016).

modern reverse engineering, and (c) IC research and production costs.

A. *Chip Piracy*

It seems the concerns of chip piracy prevalent in the early 1980s are less prevalent today.[243] Previously, there were many industry leaders clamoring to have the SCPA passed because of an acute, and likely unfounded, fear of overseas chip piracy.[244] Steven P. Kasch attributes this partly to the U.S. rivalry with Japan in the electronics field at the time.[245] Leaders in the semiconductor industry worked hard to convince Congress to pass the bill. However, after its passage, the SCPA lay dormant, like Justice Jackson's proverbial "loaded weapon," unused and virtually ignored by the proponents that brought it to power.[246] In a contemporary high-tech economy, foreign chip piracy is less of a threat. Admittedly, the context of the 1979–1980 hearings involved semiconductor industry leaders accusing each other of unfounded chip piracy acts.[247] However, the market today is too complex to police. If such subtle "second-sourcing" niches exist, as seen in *Altera*, the practice would be an arguably classic path to success that can provide advantages to both the innovative producers and the customers that consume such innovation and would become increasingly difficult to parse out the legitimate industry practices from illegitimate ones. Furthermore, attempting to sift out chip piracy is complicated by an additional factor in today's high-tech economy: reverse engineering.

B. *Modern Reverse Engineering*

Although *Altera* defined the boundaries of the reverse engineering statutory exception,[248] it seems as if that will not stop reverse engineering from becoming a valid, and widespread, industry practice. As Karl Kramer discussed, companies such as Clear Logic continue to use the reverse engineering exception

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243 Radomsky, *supra* note 84, at 1057 n.29.

244 *Id.*

245 Kasch, *supra* note 25, at 97.

246 *See* Korematsu v. United States, 323 U.S. 214, 246 (1944) (Jackson, J., dissenting).

247 Kasch, *supra* note 25, at 94–95.

248 Altera Corp. v. Clear Logic Inc., 424 F.3d 1079, 1086–89 (9th Cir. 2005).

without restraint.[249] Due to the merger doctrine and other issues that complicate the policy principles behind reverse engineering, smaller second-sourcing firms may overuse the defense until the exception overtakes the rule. In older times, when it was standard practice to photograph a chip and to work backwards, reverse engineering may have seemed laborious and cost-intensive. However, with the advent of software— such as CAD tools and bitstreams that instantaneously convert complicated FPGA/PLD designs into a series of ones and zeros—reverse engineering today is a much more attainable reality. The Clear Logic example should be added to the reverse engineering literature, and these outdated methods should be discarded. Accordingly, changes in federal court jurisprudence should be implemented in order to address these "updated" rules for modern times.

C. IC Research and Production Costs

With the semiconductor industry reaching worldwide sales of over $300 billion, the costs of semiconductor research, production, and marketing have dramatically skyrocketed.[250] The largest semiconductor companies own micro-fabrication facilities in the United States and also abroad in Asian countries such as Taiwan and China.[251] Each of these facilities employs state-of-the-art manufacturing equipment that costs more than one million dollars apiece; such expensive equipment is handled by equally expensive talent.[252] As can be discerned, the overhead costs for the entire IC industry is rather high, making returns vital.[253]

A high return-to-investment ratio is crucial not only to the survival of companies, but also to the general well-being of a

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249 Kramer, *supra* note 199; *Altera,* 424 F.3d at 1083–89.

250 SIA Forecast, *supra* note 4.

251 Ralph Jennings, *China Looks to Chip Away at Taiwan's Semiconductor Dominance*, FORBES (Nov. 9, 2017, 5:00 PM), https://www.forbes.com/sites/ralphjennings/2017/11/09/an-upstart-upstream-high-tech-sector-in-china-threatens-now-dominant-taiwan [https://perma.cc/8DKY-HYJR].

252 Jim Turley, *The Business of Making Semiconductors*, INFORMIT (Mar. 28, 2003), http://www.informit.com/articles/article.aspx?p=31338&seqNum=4 [https://perma.cc/N7KJ-FWMS].

253 *Semiconductor Fabrication Plant*, ANYSILICON (June 21, 2015), http://anysilicon.com/semipedia/semiconductor-fabrication-plant [https://perma.cc/G2RX-F3SW].

competitive marketplace.[254] As the market develops and becomes increasingly advanced, competitors need more advanced faculties at their disposal: better methods of protection and better methods of growth. Participants must follow in stride or else they will perish. Semiconductor companies must learn not only how to utilize patent law to protect their novel, useful, and nonobvious innovations, but also how to employ the great advantages of the SCPA.

Semiconductor companies must realize that a viable legal tool exists to protect their coveted and highly valuable IC designs under some type of intellection property ("IP") portfolio.[255] Arguably, no other copyrightable medium, perhaps with the exception of films or books, serves as the very basis of a thriving multi-billion-dollar industry.[256] Chip and IC designs should have the same standing as other valuable forms of IP, and as seen in *Altera,* individual mask works have the potential to make or break an entire company.[257]

Furthermore, when compared to patent protection, the SCPA is potentially a better choice. Although it lacks the weighty demeanor, the tradition, and the hefty legal accouterments of patent law, SCPA copyright protection provides the same amount, if not greater, of intellectual property protection.[258]

Due partly to the inactivity of SCPA litigation and how the SCPA is a rather "new" application of a relatively "old" statute, the SCPA may take some getting used to. However, one strong advantage that the SCPA has over patent law is the lower costs

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[254] Chrisinte Fujiki, *The U.S. Semiconductor Industry is One of the Most Competitive Manufacturing Industries in the United States*, SEMICONDUCTOR INDUSTRY ASS'N (Aug. 2015), https://www.semiconductors.org/wp-content/uploads/2018/06/U.S.-Semiconductor-Industry-Competitiveness-White-Paper-Final-for-posting-08042015.pdf [https://perma.cc/NCY3-NCYN].

[255] Greguras, *supra* note 19.

[256] NIMMER & NIMMER, *supra* note 219, at § 13.03; *SIA Forecast*, *supra* note 4.

[257] Altera Corp. v. Clear Logic Inc., 424 F.3d 1079, 1082 (9th Cir. 2005).

[258] It may take time for the SCPA laws to develop, but it is likely that the SCPA will soon reach the status of software copyright laws protecting code. There have also been arguments to compare SCPA copyright protection to software copyright protection, because both are similar intellectual property regimes. *See* Wesley M. Lang, *The Semiconductor Chi Protection Act: A New Weapon in the War Against Computer Software Piracy,* 1986 UTAH L. REV. 417, 421 (1986); John A. Kidwell, *Software and Semiconductors: Why are we Confused?*, 70 MINN. L. REV. 533, 540 (1985).

associated with its administration. The inexpensive nature of SCPA Copyright protection—a low fee with the U.S. Copyright Office to register a mask work as opposed to the exorbitant fee associated with a registering a patent—is incentive alone to pursue a more copyright-centered IP protection strategy. Another advantage the SCPA has over patent law is speed. Whereas an inventor or company may linger in the pipeline for a long time for an examiner to approve a patent,[259] which may not even get approved, copyright registration is relatively quick and painless.[260] With the increased speed, efficiency and lower cost, may come losses in persuasion or market leverage, but it is only a matter of time before the high-tech industry afford the SCPA the weight it deserves.[261] Compared to alternative means of IP protection, namely patent law, the SCPA undoubtedly allows emerging, as well as established, semiconductor companies to protect their valuable IC architectures quickly, inexpensively, and efficiently.

CONCLUSION

The SCPA, passed as a result of industry demand in the early 1980s, has had a long and interesting legislative history, replete with diverse reviews from a variety of industry leaders. However, after the SCPA was passed in 1984, fear of rampant chip piracy proved to be the result of paranoia, with only one published case—*Brooktree v. AMD*—issued four years later.[262] Following that case, the relative uncertainty of particular SCPA provisions prevented high-tech companies from using the SPCA as a viable litigation tool. Perhaps the intellectual property bar was waiting for adjudication on various issues that were left unresolved.

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[259] John W. Schoen, *U.S. Patent Office Swamped By Backlog,* NBC NEWS (Apr. 27, 2004, 6:15 PM), http://www.nbcnews.com/id/4788834/ns/technology_and_science-tech_and_gadgets/t/us-patent-office-swamped-backlog/ [https://perma.cc/PBU5-Q5W7].

[260] United States Copyright Office, *Get It Quick Over the Net,* Guide to the Copyright Office, SL-10 (2014) https://www.copyright.gov/fls/sl10.pdf [https://perma.cc/8XYU-2LS9].

[261] Also, SCPA mask works get protected for less time (ten years from issuance) than a patent (twenty years from issuance). *See* 17 U.S.C. § 904 and 35 U.S.C. § 154 (a)(2).

[262] 977 F.2d 1555 (Fed. Cir. 1992).

In the *Altera v. Clear Logic*[263] decision in 2005, the SCPA made an encouraging comeback, undoubtedly altering the landscape of high-stakes intellectual property litigation. Not only does *Altera* clarify certain issues that were left ambiguous by the *Brooktree III* court, it also presents broader definitions of the SCPA's scope to a burgeoning high-tech industry, effectively encouraging semiconductor companies to apply the act in a wider array of situations. The SCPA protects both low-level transistor designs as well as higher, architectural "groupings,"[264] giving companies more flexibility in defending original mask work designs.

The result of *Altera* should open the eyes of high-tech companies to the existence of the SCPA as a viable and powerful legal tool. As an instrument for litigation, it rivals the market-shifting capabilities of patent law. As a form of intellectual property protection, it is quick, inexpensive, and highly efficient. The SCPA does not just exceed the regimes of copyright and patent law as a form of IP protection, but effectively joins the beneficial aspects of both legal areas. Essentially, the SCPA forms a bridge that not only connects the two disciplines, but also connects the present to the future.

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[263] 424 F.3d 1079 (9th Cir. 2005).

[264] *Id.* at 1086.