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The Basics of ASICs: Protection for Semiconductor Mask Works in Japan and the United States

INTRODUCTION

During the 1970s and 1980s, industrial products changed worldwide as electric devices became electronic devices. Typewriters metamorphosed from electric typebar models to electronically-driven daisy-wheel printers.¹ Personal computers became more powerful, easier to use, and relatively inexpensive, making a mass home market feasible.² Automobile engines were designed to monitor themselves and to diagnose their own problems through repair-shop computers.³

This combination of sophistication and cost-reduction was due largely to semiconductor technology. Before the advent of semiconductors such as transistors and integrated circuits, electrical functions required soldering wires to each element of a circuit. Sophisticated functions were impractical because they required large areas and cumbersome wiring.⁴ Semiconductors, however, allowed designers to put many functions on a tiny chip, thereby reducing size, complexity, and cost through lower material and assembly costs.⁵

American manufacturers stood to make great profits from this new technology. They also realized that foreign competitors, especially from Japan, posed a threat to their market domination.⁶ As a result, the U.S. semiconductor industry sought protection for their chips. The U.S. semiconductor producers claimed that

¹ MICROELECTRONICS AND SOCIETY, FOR BETTER OR FOR WORSE: A REPORT TO THE CLUB OF ROME 5 (G. Friedrichs ed., 1982).

² *Id.* at 7, 72.

³ *Id.* at 5.

⁴ T. R. REID, THE CHIP: HOW TWO AMERICANS INVENTED THE MICROCHIP AND LAUNCHED A REVOLUTION 14 (1984).

⁵ *Id.* at 15.

⁶ H. R. REP. NO. 781, 98th Cong., 2d Sess. — (1984), reprinted in 1984 U.S.C.C.A.N. 5750, 5752 [hereinafter HOUSE REPORT]. See M. K. Fisher, *Beyond Fair Use: Reverse Engineering and the Semiconductor Chip Protection Act of 1984*, 3 COMPUTER LAW 9, 9 (Apr. 1986).

foreign competitors would circumvent the high cost of developing their own chips by photographing the layout of U.S. vendors' chips.⁷ In this way, the foreign companies would be able to make identical but vastly less expensive chips, and capture the price-sensitive U.S. market.⁸ To prevent losses of market share, the Semiconductor Industry Association petitioned Congress for legislation to protect semiconductor devices.⁹ Specifically, it sought protection for the layouts that defined the circuits and functions contained on the chips. The result of this campaign was the 1984 Semiconductor Chip Protection Act (SCPA).¹⁰

At approximately the same time, Japan passed its Act Concerning the Circuit Layout of a Semiconductor Integrated Circuit (Japanese Act).¹¹ The Japanese Act closely follows the SCPA, and several commentators believe it was passed as a result of strong urging by the U.S. Government.¹² Like the SCPA, the Japanese Act created a new form of intellectual property to cover semiconductors, distinct from patent or copyright.¹³

This Comment argues that both the SCPA and the Japanese Act are inappropriate for today's semiconductors. Although the acts do offer protection tailored to standard, off-the-shelf semiconductors, they do not cover today's most important products: application-specific integrated circuits (ASICs). Further, the SCPA leaves a large gap because it fails to cover joint development, a common ASIC design practice. Part I of this Comment contains a brief overview of semiconductor technology, integrated circuits, and ASICs. Part II discusses the SCPA and the Japanese Act. Part III covers the actual results of both acts and explains why they provide inadequate protection for ASICs. Part III also offers suggestions for amendments to the two laws. The two acts

⁷ HOUSE REPORT, *supra* note 6, at 5751.

⁸ *Id.* at 5752; Fisher, *supra* note 6, at 9.

⁹ Fisher, *supra* note 6, at 11-13.

¹⁰ Semiconductor Chip Protection Act, 17 U.S.C.A. § § 901-14 (West Supp. 1991).

¹¹ Act Concerning the Circuit Layout of a Semiconductor Integrated Circuit, Law No. 43 of 1985 [hereinafter Japanese Act].

¹² Ronald S. Laurie, *The First Year's Experience Under the Chip Protection Act or "Where are the Pirates Now That We Need Them?"*, 3 COMPUTER LAW 11, 16 (Feb. 1986). Another view suggests that Japan passed its semiconductor protection law because of the increasing threat of piracy from semiconductor manufacturers in developing countries in the Pacific Rim, such as Taiwan and Malaysia. Telephone Interview with T. Kato, Toshiba America Electronic Components, Inc., in Burlington, MA. (Apr. 2, 1991) [hereinafter Kato Interview].

¹³ HOUSE REPORT, *supra* note 6, at 5755.

should contain uniform protection and penalties in order to encourage development. Until the Japanese and U.S. governments take remedial action, however, customers and manufacturers who enter into development agreements should protect themselves by including clear ownership and licensing provisions in their contractual arrangements. Finally, this Comment's conclusion suggests that ASICs' growing importance, the problems of joint development, and the differences in protection between the Japanese Act and the SCPA merit changing these laws.

I. OVERVIEW OF TECHNOLOGY

A. *Semiconductors*

AT&T Bell Laboratories introduced the first commercially viable transistor in 1947.¹⁴ Since that time, semiconductor technology has advanced substantially, although the underlying theories of electrical circuitry have remained the same.¹⁵ An electrical circuit is an unbroken path over which electric current flows through several stages, or components.¹⁶ Originally, these functions were carried out by wiring that connected all the circuit elements. When engineers discovered silicon's unique ability to conduct electric current under some conditions and to resist it in others, they also found that the wiring's functions could be controlled by the ability of semiconductors to "semi-conduct."¹⁷ Instead of a cumbersome collection of vacuum tubes and switches regulating the current, this new product, called a transistor, could contain paths for current flow directly on the silicon.¹⁸ In addition, the transistor's entire package could be more densely packed with circuit elements, while at the same time avoiding the vacuum tube's dangerous heat-producing propensities.¹⁹

¹⁴ REID, *supra* note 4, at 16-20.

¹⁵ *Id.* at 15.

¹⁶ *Id.* at 17. A "passive component," such as a resistor or capacitor, takes the electrical current and stores it or slows down its passage through the circuit. An "active component" plays a more vital role: it acts as a "gate keeper," controlling when the current flows through its on/off action. It also can alter the signal once it has begun to flow through the circuit by amplifying or suppressing it.

¹⁷ *Id.* at 15.

¹⁸ *Id.*

¹⁹ *Id.* at 14. Large numbers of vacuum tubes in early computing systems generated vast amounts of heat, often melting wiring and causing total failure. The great number of tubes that would be required to run today's sophisticated machines would render them impractical because of the large space they would require, as well as problems associated with cooling so many heat-generating devices.

Although transistors solved some size problems associated with complicated circuits, connecting each device still posed a problem. The only practical method involved hand-soldering, but if one small part of the solder was defective, the entire circuit would fail.²⁰ The solution to this problem came in 1958, with the development of the integrated circuit (IC).²¹

B. *Integrated Circuits*

Engineers developed the first IC as a phase shift oscillator, a small collection of circuit components on a single piece of silicon, connected by gold wire.²² Later versions of ICs used channels of metal filaments set into the silicon instead of wire connectors to connect the circuit elements.²³ As the technology evolved, engineers developed a photolithographic process to etch the metal connection onto the chip.²⁴

The simplicity of the first ICs gave way to more complex designs.²⁵ As circuit components and connections grew smaller, it became possible to integrate more elements in the same space. The level of integration controls the sophistication of the tasks the IC can perform. At lower levels, the IC can perform transistor-like on/off functions.²⁶ At higher levels, the IC can perform logic functions relating to storage, processing, or manipulation of data.²⁷

²⁰ *Id.* at 20. At the time, it was believed that the only precise way to make the connections was to have women hand-solder the wires, using magnifying glasses and tweezers, because their smaller hand size would enable them to do the delicate work. In addition to the questionable reasoning behind such a policy, this meant that the labor costs for assembly were still relatively high, and if one of the minuscule connections was defective, the entire circuit would fail.

²¹ *Id.* at 65–67.

²² *Id.* at 66. The phase shift oscillator was chosen because it incorporates all elements of an electronic circuit.

²³ *Id.* at 18–21, 65. With the connections part of the silicon itself, reliability increased. There was an added benefit, because the areas previously taken up by external connections were now free to be used for additional components.

²⁴ Kato Interview, *supra* note 12. In this process, a laser etches the microscopic channels for connections away from the chip, after which layers of metal are applied.

²⁵ ALFRED W. BARBER, PRACTICAL GUIDE TO DIGITAL INTEGRATED CIRCUITS 25 (2d ed. 1984). Engineers were eventually able to integrate thousands of components onto a single chip. As a result, the semiconductor industry has identified four main levels of integration: small-scale integration (SSI), medium-scale integration (MSI), large-scale integration (LSI), and very large-scale integration (VLSI).

²⁶ Kato Interview, *supra* note 12.

²⁷ *Id.*

C. ASICs

ASICs use very large scale integration (VLSI)²⁸ technology to achieve multiple functions on a single chip; because of the varied nature of ASIC functions, many elements must be on the chip.²⁹ Manufacturing an ASIC chip involves etching away successive layers of a thin wafer of silicon using photolithographic “masks” or patterns to control the topography of the chip.³⁰ The number of masks used depends upon the complexity of the chip to be produced, with complex chips using up to twenty-four layers.³¹ ASIC design is always directed to a customer-defined performance or function goal,³² and these customer-defined targets are the most important factors controlling an ASIC’s complexity.

The two main classes of ASICs, gate arrays and standard cells, differ mainly in their use of base layers and interconnections.³³ The design scheme chosen, however, affects the design’s complexity.³⁴ In a gate array, all the base layers are predefined, so the designer must define only the interconnections between the elements, thereby enabling the chip to perform the desired function.³⁵ Masks are customized in a standard cell, but their height is limited to control the transistor size and, thus, the chip’s complexity.³⁶ These limits restrict the designer’s choices, but they also result in a shorter time from design to production and lower costs than full custom chips.³⁷

Designing ASIC chips presents several issues which do not arise in designing standard chips. In a standard design, the goal is to design a chip that will become a part of a system made up of

²⁸ STEVEN S. LEUNG & MICHAEL A. SHANBLATT, *ASIC SYSTEM DESIGN WITH VHDL: A PARADIGM* 10 (1989). VLSI allows ASIC designs that contain up to 200,000 elements.

²⁹ *Id.* at xxi. ASICs comprise four general types of semi-custom chips: programmable logic devices (PLD), gate arrays (GA), standard cells (SC), and full custom (FC) designs. Generally, however, the term “ASIC” refers to gate array and standard cell designs; this Comment will be restricted to those meanings. *Id.* at 9–10.

³⁰ BARBER, *supra* note 25, at 22.

³¹ Telephone Interview with Kenneth Pilczak, Area Sales Manager, ATMEL Corporation, in Braintree, MA. (Feb. 19, 1991) [hereinafter Pilczak Interview]; *see also* HOUSE REPORT, *supra* note 6, at 5762.

³² Pilczak Interview, *supra* note 31.

³³ *See supra* note 29 and accompanying text.

³⁴ *See supra* note 29 and accompanying text.

³⁵ LEUNG & SHANBLATT, *supra* note 28, at 10. This is also sometimes called the “personalization layer.” *See also* Laurie, *supra* note 12, at 18.

³⁶ LEUNG & SHANBLATT, *supra* note 28, at 10.

³⁷ *Id.* at 10–11.

many chips. ASIC design, on the other hand, endeavors to put an entire customer-specified system onto a single chip.³⁸ Thus, in ASIC design, the designer must add or specify the connections between various elements of the chip itself.³⁹ As a result, these connections can take up to seventy percent of the chip area in some cases.⁴⁰ Some ASIC designs also require self-testing, or “testability” functions to be built into the chip.⁴¹ Whereas standard chips can contain nodes for testing, and can be tested easily with other chips, an ASIC’s complexity does not allow such accessibility, and requires that the chip be able to test its own performance.⁴²

D. *Joint Developments*

Most ASIC design projects involve joint developments between customers and vendors, which can cloud issues of ownership. In ASIC design situations, a customer typically will approach an ASIC vendor with specific design requirements.⁴³ Two common approaches to ASIC development are full joint development, and partial joint development. In full joint work, the customer’s engineer will work with the vendor’s design engineering staff to generate a schematic diagram of the chip layout using computer-aided engineering (CAE) software and machinery.⁴⁴ At this point, the computer scans and interprets the schematic diagram to make a “netlist,” or alphanumeric representation of the circuit.⁴⁵ This netlist can include interconnections and standard cells. Intercon-

³⁸ *Id.* at 1; Kato Interview, *supra* note 12.

³⁹ Kato Interview, *supra* note 12. The analogy here is between transistors and integrated circuits. An integrated circuit can be defined simplistically as a series of transistors grouped to perform a certain function. Using the same example, an ASIC chip could be defined as a series of integrated circuits on a single chip, designed to perform a specific function.

⁴⁰ LEUNG & SHANBLATT, *supra* note 28, at 38. There are several different design techniques, however, that are reducing this figure. The “sea of gates” channelless type of gate array uses space more efficiently so there is less need for extra space for connections. The result in such designs is that there is more space for additional circuit elements. Kato Interview, *supra* note 12.

⁴¹ LEUNG & SHANBLATT, *supra* note 28, at 38. Generally, “testability” is required when the chip is to function as part of a sophisticated system, such as a supercomputer. In such situations, this function is more critical because the system in which the chip is to be used is so complex. Kato Interview, *supra* note 12.

⁴² Kato Interview, *supra* note 12.

⁴³ Pilczak Interview, *supra* note 31; *see also* LEUNG & SHANBLATT, *supra* note 28, at 40–48.

⁴⁴ Pilczak Interview, *supra* note 31.

⁴⁵ *Id.*

nections are a customer's specifications for the circuit paths between elements of the chip. Standard cells are the vendor-specified layouts for logic and other elements of the chip.⁴⁶ The netlist will also identify the chip, its inputs, outputs, and its use.⁴⁷

Partial joint work consists of the same steps, allocated differently. In this method, the customer defines its desired functions and reduces them to computer code. The customer then brings the resulting netlist to the manufacturer for the remaining steps.⁴⁸

After the CAE system processes the netlist, it generates a "sticks" layout, which is a first-level graphic representation of the circuit.⁴⁹ The graphics blocks of the sticks layout are filled in with the correct parameters, and are then transferred to computer tape.⁵⁰ Machines in the silicon foundry run these tapes and produce masks which will determine the layout and topography of the chips.⁵¹

E. *Reverse Engineering*

Another aspect of the semiconductor design and production process is reverse engineering, which involves obtaining a copy of a competitor's chip and dissolving successive layers of silicon to discover the circuit pattern.⁵² This is an important concept, largely because of the nature of the semiconductor industry. The industry relies heavily on second-source devices that are "form, fit, and function" replacements for the original devices because manufacturers may not be able to meet demands for a certain type of chip.⁵³ Few customers are willing to rely totally on one

⁴⁶ *Id.*

⁴⁷ *Id.*

⁴⁸ Kato Interview, *supra* note 12.

⁴⁹ Pilczak Interview, *supra* note 31. The layout is called a "sticks" layout because of its similarity to stick figure drawings.

⁵⁰ *Id.*

⁵¹ *Id.*

⁵² HOUSE REPORT, *supra* note 6, at 5751.

⁵³ *Id.* at 5771. Another reason for the semiconductor industry's insistence on including reverse engineering provisions in the law involved the burgeoning personal computer (PC) market in the early 1980s. IBM, the developer of the popular DOS-based PC family, designed the machine in a way that allowed other companies to replicate the design very easily. This gave rise to a large market in "chip set" vendors, who specialized in selling copies of the IBM chips in the same configurations. The customers of these vendors became purveyors of the "clone" machines many PC users chose based on price. IBM later realized the revenue drain its open design caused, and fought back with its proprietary PS/2 series of personal computers. Kato Interview, *supra* note 12.

vendor for a device, and it is common for vendors to recommend second sources for their products.⁵⁴ This practice of easy access to second sources is well established in the industry, due mainly to the fluctuations in silicon supply.⁵⁵ While at present many industry members concede that reverse engineering of an ASIC is very difficult, the technology does exist and is capable of being enhanced.⁵⁶

With rapid advances in semiconductor technology, questions of design protection arise frequently. ASICs are poised to dominate semiconductor sales in the future, and issues of protection for them will become increasingly important. At present, however, traditional forms of intellectual property protection such as copyright and patent, as well as the SCPA, do not provide adequate protection for this valuable technology.

II. MARKET FORCES AND THE RESULTING GOVERNMENTAL PROTECTION OF CIRCUIT LAYOUTS

A. *Market forces*

The wide range of uses for semiconductors in both new products and redesigned existing products created a huge market for this new type of electronic components. United States manufacturers feared a concerted effort by foreign semiconductor firms, especially the Japanese, to take over the U.S. market. Thus, U.S. manufacturers began to seek protection for their chips in 1979.⁵⁷ As a first step, industry members tried to obtain protection by fitting their chips into existing categories of intellectual property.⁵⁸

⁵⁴ Pilczak Interview, *supra* note 31.

⁵⁵ Another influential factor in the semiconductor industry's acceptance of easy second-sourcing was the settlement of an AT&T antitrust suit in the early days of transistors. *United States v. Western Elec. Co.*, 1956 Trade Cas. (CCH) ¶ 68,246 (D.N.J. Jan. 24, 1956) cited in James Chesser, Note, *Semiconductor Chip Protection: Changing Roles for Copyright and Competition*, 71 VA. L. REV. 249, 264 (1985). As part of the settlement of a government antitrust claim against it, AT&T agreed to give others easy access to its transistor technology for very reasonable one-time licensing fees of \$25,000. Bell Labs also ran training programs for other companies' personnel interested in producing transistors. This decision by AT&T, the inventor of the transistor, during the semiconductor's infancy, has influenced the industry to this day, both in the form of easy second-sourcing, and in cross-licensing agreements.

⁵⁶ Kato Interview, *supra* note 12.

⁵⁷ See *supra* note 9.

⁵⁸ HOUSE REPORT, *supra* note 6, at 5752.

Several peculiarities in the semiconductor industry precluded an easy solution through then-existing patent or copyright law. Existing patent law was inadequate to protect semiconductor chips because of the Patent Act's subject matter coverage and the industry's dynamics.⁵⁹ The chips themselves and their layouts seldom reached high enough levels of novelty and non-obviousness, two requirements for patent protection under the Act.⁶⁰ The volatility of end-user markets for semiconductors also made patents inappropriate. Because technology changes rapidly, the typical two- to three-year waiting period made patent protection meaningless.⁶¹ By the time a semiconductor device was patented, the technology could have developed into a new, unprotected form.

Legislative investigators then turned to the Copyright Act, because its subject matter coverage seemed expansive enough to cover chips.⁶² Among the subject matter covered by this statute were pictorial, graphic, and sculptural works, which appeared to include drawings made of a chip's layout. Copyright law also offered a way around difficulties posed by changes in technology, because the Copyright Act explicitly addressed derivative works.⁶³ This avenue failed, however, because the Copyright Act as applied has distinguished between technical drawings and the objects produced using them. Although a technical drawing itself can be protected, the Copyright Act does not protect the objects made using the drawing.⁶⁴ Thus the Act did not address the

⁵⁹ *Id.*

⁶⁰ Patent Act, 35 U.S.C.A. § § 102-03 (West 1984 & Supp. 1991); *see also* HOUSE REPORT, *supra* note 6, at 5752.

⁶¹ Pilczak Interview, *supra* note 31. Semiconductor manufacturers estimate customer product lifespans to be from six months to three years.

⁶² Copyright Act, 17 U.S.C.A. § 101 (West 1977 & Supp. 1991).

⁶³ *Id.* The Copyright Act states in pertinent part that:

A 'derivative work' is a work based upon one or more preexisting works, such as a translation, musical arrangement . . . or any other form in which a work may be recast, transformed, or adapted. A work consisting of editorial revisions, annotations, elaborations, or other modifications which, as a whole, represent an original work of authorship, is a 'derivative work.'

Id.

⁶⁴ HOUSE REPORT, *supra* note 6, at 5757. *See also* Imperial Homes Corp. v. Lamont, 458 F.2d 895, 899 (5th Cir. 1972) (copying architectural plans to produce brochures is an infringement, but there is no prohibition against construction using details contained in the plans); Demetriades v. Kaufmann, 680 F. Supp. 658, 665 (S.D.N.Y. 1988) (unauthorized copying of architectural plans is an infringement, but an injunction against further construction of a house using the plans was denied).

semiconductor manufacturer's main concern: prohibiting others from copying its circuit layout and selling the results.

A second difficulty in using the Copyright Act to cover chips was the "useful article doctrine."⁶⁵ Under this doctrine, the Copyright Act does not give protection to utilitarian objects unless their useful functions can be separated physically or conceptually from their aesthetic aspects.⁶⁶ For example, a belt buckle that appears as a free-form metal sculpture is conceptually separable from its useful function.⁶⁷ A mask work, however, functions only as part of the manufacturing process and has no real aesthetic aspects, making it a purely useful article.⁶⁸ The Copyright Office has consistently denied protection to useful articles, and has refused to accept chips as copies of masks under the Copyright Act.⁶⁹

After determining that existing intellectual property statutes could not appropriately be applied to mask works, Congress decided that the correct answer to the problem lay in a new *sui generis* form of protection.⁷⁰ Although the new act was modeled after the Copyright Act, it created a new form of industrial intellectual property.⁷¹

B. *The Semiconductor Chip Protection Act (SCPA) of 1984*

Congress passed the SCPA in 1984 to protect semiconductor chips from piracy by competitors. Among the Act's purposes were to reward creativity; encourage innovation, research and investment in the semiconductor industry; prevent chip piracy; and to

⁶⁵ *Mazer v. Stein*, 347 U.S. 201, 218 (1954), the leading case in the "useful article" doctrine held that useful articles cannot be copyrighted unless they contain an independent artistic element. In that case, a lamp base's design as a Balinese dancer was an artistic element deserving of copyright protection, separate from its use as a lamp base.

⁶⁶ See *Carol Barnhart, Inc. v. Economy Cover Corp.*, 773 F.2d 411, 412 (2d Cir. 1985) (mannequin torso forms not protected as works of art because their form was inextricably bound to their function); *Kieselstein-Cord v. Accessories by Pearl, Inc.*, 632 F.2d 989, 993 (2d Cir. 1980) (belt buckles protected as works of art as long as buckle can be conceptually separated from its function); *Esquire, Inc. v. Ringer*, 591 F.2d 796, 803 (D.C. Cir. 1976) (shape of outdoor lighting fixture not protected because no aspect of a lighting fixture's shape is physically separable from its function).

⁶⁷ *Kieselstein*, 632 F.2d at 993.

⁶⁸ HOUSE REPORT, *supra* note 6, at 5759.

⁶⁹ *Id.* at 5755. The Copyright Act requires that copyright holders place copies of each registered work in the Library of Congress. Copyright Act, 17 U.S.C.A. § 401(a) (West 1977 & Supp. 1991).

⁷⁰ HOUSE REPORT, *supra* note 6, at 5754.

⁷¹ *Id.* at 5755.

protect the public.⁷² The SCPA defines a semiconductor chip product as having two or more layers of metallic semiconducting material etched away from a piece of semiconductor material in accordance with a predetermined pattern.⁷³ The product must also be intended to perform electronic circuitry functions.⁷⁴ The mask work, or pattern for the chip layout, is a series of three-dimensional patterns defining the layers of the chip.⁷⁵

A threshold requirement for SCPA protection is establishing ownership of the circuit layouts. The SCPA recognizes ownership of the layouts by the mask's creator, the legal representative of the creator, or the creator's employer if the work was created within the scope of employment.⁷⁶ It is notable that the SCPA does not provide specifically for joint ownership and registration, even though joint developments in ASIC designs are common.⁷⁷ The mask work owner may license some rights under the SCPA, but to transfer rights, he or she must transfer them all.⁷⁸

To obtain protection under the SCPA, there are four requirements in addition to establishing ownership. First, the mask must

⁷² *Id.* at 5750. It is unclear how the public at large was to benefit from this law; however, a threat was said to be "posed to the continued viability of the information society." *Id.* at 5752.

⁷³ Semiconductor Chip Protection Act, 17 U.S.C.A. § 901(a)(1)(A) (West Supp. 1991). The semiconductor chip product [has] "two or more layers of metallic, insulating, or semiconductor material, deposited or otherwise placed on, or etched away or otherwise removed from, a piece of semiconductor material in accordance with a predetermined pattern." *Id.*

⁷⁴ *Id.* at § 901(a)(1)(A).

⁷⁵ *Id.* at § 901(a)(2)(A). The Act states in pertinent part that:

[A] 'mask work' is a series of related images, however fixed or encoded—(A) having represented the predetermined, three-dimensional pattern or metallic, insulating, or semiconductor material present or removed from the layers of a semiconductor chip product; and (B) in which series of the relation of images to one another is that each image has the pattern of the surface of one form of the semiconductor chip product.

Id.

⁷⁶ *Id.* at § 901(a)(6). The Act states in pertinent part that:

[T]he 'owner' of a mask work is the person who created the mask work, the legal representative of that person if that person is deceased or under a legal incapacity, or a party to whom all the rights under this chapter of such person or representatives are transferred in accordance with section 903(b); except that, in the case of a work made within the scope of a person's employment, the owner is the employer for whom the person created the mask work or a party to whom all the rights under this chapter of the employer are transferred in accordance with section 903(b).

Id.

⁷⁷ Compare Semiconductor Chip Protection Act, 17 U.S.C.A. § 901(a)(6) (West Supp. 1991) with Copyright Act, 17 U.S.C.A. § 201(a) (West 1977 & Supp. 1991).

⁷⁸ Semiconductor Chip Protection Act, 17 U.S.C.A. § 903(b) (West Supp. 1991).

be fixed on a semiconductor chip.⁷⁹ Second, the layout must be original.⁸⁰ Third, its owner must meet citizenship or domicile requirements.⁸¹ Fourth, the owner must register the mask at the Copyright Office within two years.⁸²

The first requirement for obtaining protection under the SCPA is that the mask be fixed on a chip.⁸³ Once the mask is fixed on a chip, it must meet the second requirement, that it be original, or an original combination of existing designs.⁸⁴ The SCPA does not define "original," rather, it takes its meaning from the Copyright Act, which equates originality with independent creation.⁸⁵

If the mask is original and fixed on a chip, protection is given based on the third requirement, the owner's domicile, as it relates to commercial exploitation of the chip.⁸⁶ If a chip is first exploited outside the United States, it is protected if its creator is a national or domiciliary of the United States, or of a foreign nation that affords treaty-based mask protection to U.S. nationals. The chip is also protected if its creator is a stateless person.⁸⁷ In the absence of a treaty, if the foreign nation offers protection for masks similar to protection under the SCPA, the President may issue a proclamation protecting that nation's masks in the United States.⁸⁸

The owner of the mask work must also register the work with the Register of Copyrights to obtain protection.⁸⁹ If the owner of a mask does not register the mask within two years after it is first commercially exploited anywhere in the world, SCPA protection

⁷⁹ *Id.* at § 902(a)(1).

⁸⁰ *Id.* at § 902(b).

⁸¹ *Id.* at § 902(a)(1)(A)-(B).

⁸² *Id.* at § 908(a).

⁸³ *Id.* at § 902(a)(1). The SCPA holds that a mask is "fixed" on a chip when its pattern is contained in the chip in a permanent or stable form which can be perceived or reproduced from the other product for more than a short time. *Id.* at § 901(a)(3).

⁸⁴ *Id.* at § 902(b)(1)-(2). The masks will not be protected if they are "(1) not original; or (2) consist of designs that are staple, commonplace, or familiar in the semiconductor industry, or variations of such designs, combined in such a way that, considered as a whole, is not original." *Id.*

⁸⁵ Neil Boorstyn, *The Semiconductor Chip Protection Act of 1984*, COPYRIGHT L.J. 2 (1985).

⁸⁶ Semiconductor Chip Protection Act, 17 U.S.C.A. § 901(a)(1)(B) (West Supp. 1991).

⁸⁷ *Id.* at § 902(a)(1)(A).

⁸⁸ *Id.* at § 902(a)(2). The interim orders protecting Japanese masks in the U.S. expired on July 31, 1991. An extension of existing orders was issued under section 914 of the SCPA, 54 Fed. Reg. 50,793 (1989). Orders are also in place for Sweden, Australia, Austria, Belgium, and France.

⁸⁹ Semiconductor Chip Protection Act, 17 U.S.C.A. § 904(a) (West Supp. 1991).

is lost.⁹⁰ Once the mask work is registered, SCPA protection lasts for ten years from either the date of registration or the first exploitation, whichever comes first.⁹¹

Under the SCPA, the owner of the mask work has exclusive rights to reproduce it, and to import and distribute works that contain it.⁹² The mask owner may also authorize others to reproduce, import, and distribute the work.⁹³ These exclusive rights, however, do not include the right to make derivative works based on the original, as the Copyright Act provides.⁹⁴

The SCPA limits the owner's rights by a "fair use" provision analogous to, but much broader than, the fair use concept in copyright. This concept allows public use of copyrighted material when the public interest so warrants.⁹⁵ The SCPA allows traditional fair uses such as analysis and research intended to expand knowledge and encourage research. Recognizing the common practices in the semiconductor industry, however, the SCPA also allows reverse engineering.⁹⁶

The reverse engineering provisions of the SCPA prohibit only the complete stripping down of a chip to determine its makeup

⁹⁰ *Id.* at § 908(a). The Copyright Act, however, makes registration permissive rather than mandatory. Copyright Act, 17 U.S.C.A. § 408 (West 1977 & Supp. 1991).

⁹¹ Semiconductor Chip Protection Act, 17 U.S.C.A. § 904(b) (West Supp. 1991).

⁹² *Id.* at § 905. The Act states in pertinent part that:

The owner of a mask work provided protection under this chapter has exclusive rights to do and authorize any of the following: (1) to reproduce the mask work by optical, electronic, or any other means; (2) to import or distribute a semiconductor chip product in which the mask work is embodied; and (3) to induce or knowingly cause another person to do any of the acts described in paragraphs (1) and (2).

Id.

⁹³ *Id.*

⁹⁴ Copyright Act, 17 U.S.C.A. § 106(2) (West 1977 & Supp. 1991). The Copyright Act gives a copyright holder the exclusive right to prepare derivative works.

⁹⁵ Compare Semiconductor Chip Protection Act, 17 U.S.C.A. § 906 (West Supp. 1991) with Copyright Act, 17 U.S.C.A. § 107 (West 1977 & Supp. 1991). The Copyright Act allows for fair use which includes purposes such as criticism, comment, news reporting, teaching, scholarship, or research.

⁹⁶ Semiconductor Chip Protection Act, 17 U.S.C.A. § 906 (West Supp. 1991). The Act states in pertinent part that:

(a) Notwithstanding the provisions of section 905, it is not an infringement of the exclusive rights of the owner of a mask work for—(1) a person to reproduce the mask work solely for the purpose of teaching, analyzing, or evaluating the concepts or techniques embodied in the mask work or the circuitry, logic flow, or organization of components used in the mask work; or (2) 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 made to be distributed.

Id.

for the purpose of replicating the findings in an identical chip.⁹⁷ Thus, the SCPA allows a chip designer to analyze a chip and incorporate the results of the analysis into a new mask work. The second designer is then free to copy, import, or distribute this new device, receiving essentially the same rights for the copy as the creator received for the original mask.⁹⁸ The SCPA allows this "quasi-copying" through reverse engineering because of the tight market in semiconductors.⁹⁹

Mask owners who have registered a work, may enforce their exclusive rights under the SCPA. Under the terms of the act, owners are entitled to bring a civil action for infringement in any U.S. district court within three years after the claim accrues.¹⁰⁰ Upon a finding of infringement, owners may receive actual damages, or total statutory damages of \$250,000 for each instance of infringement in a cause of action.¹⁰¹ The court may also order the destruction of any infringing products or the masks with which they were produced.¹⁰²

C. *The Japanese Act Concerning the Circuit Layout of a Semiconductor Integrated Circuit*

Due in large part to pressure from the U.S. government and fear of losing protection for its nationals' mask works, the Japanese government enacted the Japanese Act in 1985.¹⁰³ The Japanese Act was directed at the reciprocity provision of the SCPA, which gives foreign mask works protection if their governments offer protection similar to the SCPA to U.S. nationals.¹⁰⁴ The Japanese Act is largely modeled after the SCPA, although there are some significant differences in penalty and procedure.

⁹⁷ *Id.* at § 906. See also Fisher, *supra* note 6, at 9.

⁹⁸ Semiconductor Chip Protection Act, 17 U.S.C.A. § 906(a)(2) (West Supp. 1991).

⁹⁹ See *supra* notes 59–61 and accompanying text.

¹⁰⁰ Semiconductor Chip Protection Act, 17 U.S.C.A. § 910(b)(1), § 911(a), (d) (West Supp. 1991). The SCPA does not, however, provide for criminal sanctions against infringers.

¹⁰¹ *Id.* at § 911(c).

¹⁰² *Id.* at § 911(c)(2).

¹⁰³ Japanese Act, *supra* note 11; see also Laurie, *supra* note 12, at 16; 12 INT'L EXECUTIVE REP., Feb. 15, 1990, available in LEXIS, Country Reports Library, Asia File. There are, however, other schools of thought which hold that a more compelling reason for enactment of the Japanese Act was Japan's fear of large scale infringement from companies based in the newly-expanding Pacific Rim countries. See *supra* note 12 and accompanying text.

¹⁰⁴ Semiconductor Chip Protection Act, 17 U.S.C.A. § 902 (West Supp. 1991).

The Japanese Act is intended to promote the development of semiconductor integrated circuits and, thus, contribute to a healthy economy.¹⁰⁵ The Ministry of International Trade and Industry (MITI) oversees the registration of masks.¹⁰⁶ MITI is the governmental body charged with taking a special interest in nurturing key industries, such as the semiconductor industry.¹⁰⁷

Under the Japanese Act, a semiconductor integrated circuit is a product which has transistors or other circuitry elements inseparably formed on a semiconducting material and which is designed to perform an electronic circuitry function.¹⁰⁸ The mask's creator or the creator's successor may register it,¹⁰⁹ but if the layout is created during the course of employment, the employer owns the mask.¹¹⁰ The Japanese Act also provides for joint ownership of the mask work by two or more creators.¹¹¹ If the owner of the mask has transferred, leased, or imported semiconductor products using the mask within two or more years prior to applying for registration, the application will be denied.¹¹² MITI may also deny an application if the applicant is not the creator, the work was jointly created but not all parties have sought registration, or the cabinet has prohibited such registration by special order.¹¹³ MITI may also cancel an exist-

¹⁰⁵ Japanese Act, *supra* note 11, at art. 1. The Act specifically says that "the purpose of this Act is to promote the development of semiconductor integrated circuits by establishing a system for ensuring the adequate use of the circuit layout of a semiconductor integrated circuit, and thereby contribute to the healthy development of the national economy." *Id.*

¹⁰⁶ *Id.* at art. 8(1).

¹⁰⁷ EDWIN O. REISCHAUER, *JAPAN: THE STORY OF A NATION* 274 (3d ed. 1986). See also REID, *supra* note 4, at 172-73; KAREL VANWOLFEREN, *THE ENIGMA OF JAPANESE POWER: PEOPLE AND POLITICS IN A STATELESS NATION* 124-25 (1989). Although the Japanese government maintains that the Ministry of International Trade and Industry (MITI) is merely an advisory agency, many Westerners still believe that the Ministry targets certain industries for strategic infusions of government money and assistance.

¹⁰⁸ Japanese Act, *supra* note 11, at art. 2(1).

¹⁰⁹ *Id.* at art. 3(1).

¹¹⁰ *Id.*

¹¹¹ *Id.*

¹¹² *Id.* at art. 6.

¹¹³ *Id.* at art. 8. The Japanese Act states in pertinent part that:

The Minister of International Trade and Industry shall dismiss an application for registration for establishment if it is evident from the application form . . . that the application for registration for establishment falls within any of the following items: (1) where the applicant is not the creator, etc.; (2) where there are two or more creators, etc., and they have not jointly applied for registration for establishment; (3) where the applied-for circuit layout is not eligible for registration for establishment under the provisions of Article 6; or (4) where the

ing registration based on a later finding of any of the previous factors.¹¹⁴

Unlike the SCPA, the Japanese Act covers anyone who registers a mask, regardless of where the work was first exploited or the nationality of its creator.¹¹⁵ Additionally, the Japanese Act does not provide for continuous government control over the registration process. When the Japanese Act was first passed, MITI handled the initial steps. MITI was, however, empowered by the Japanese Act to designate an outside authority to handle the process. MITI assigned this process to a private body, the Industrial Property Cooperation Center (IPCC),¹¹⁶ after which MITI became an overseer in the system.¹¹⁷

Rights under the Japanese Act vest in the mask owner upon registration and continue for ten years from that date.¹¹⁸ The registrant obtains exclusive rights to use the layout for business purposes, but has no rights against others using the same layout if created independently by someone else.¹¹⁹ The Japanese Act also contains reverse engineering provisions similar to those in the SCPA. As a result, a holder of a circuit layout right cannot prevent the manufacture of another chip produced by using and analyzing the registered mask.¹²⁰

Rights under the Japanese Act may be transferred either as sole use rights or ordinary use rights.¹²¹ Sole use rights operate similarly to U.S. transferral of rights; ordinary use rights are similar to licenses. In each case, any grantee of a right may transfer that right only if it is transferred along with the business that uses the circuit layout, if the circuit layout owner has ap-

application form does not comply with the formal requirements, or there are other grounds provided for by Cabinet order.

Id.

¹¹⁴ *Id.* at art. 9(1).

¹¹⁵ *Id.* at art. 47.

¹¹⁶ Under the Japanese Act, however, MITI may examine the Industrial Property Cooperation Center's (IPCC) performance and terminate its management of the registration process. Japanese Act, *supra* note 11, at art. 41. MITI Ordinance No. 81, Dec. 24, 1985, *cited in* 53 Fed. Reg. 16,308 (1988). There is some concern about the role of the IPCC in Japan's mask registration system because many U.S. semiconductor manufacturers believe that the body is closely tied to that nation's domestic semiconductor industry. See 12 INT'L EXECUTIVE REP. Feb. 15, 1990, *available in* LEXIS, Country Reports Library, Asia File; 12 INT'L EXECUTIVE REP. Jan. 15, 1990, *available in* LEXIS, Country Reports Library, Asia File.

¹¹⁷ Japanese Act, *supra* note 11, at art. 28(1).

¹¹⁸ *Id.* at art. 10.

¹¹⁹ *Id.* at art. 11.

¹²⁰ *Id.* at art. 12(2).

¹²¹ *Id.* at arts. 16 (sole use rights), 17 (ordinary use rights).

proved the transfer, or if inheritance or other general succession has taken place.¹²²

Infringement under the Japanese Act is defined as use of the circuit for business purposes, primarily for imitation of the mask.¹²³ The holder of the registration may demand that a wrongdoer cease the activity, and may also demand that one likely to infringe take steps to avoid it.¹²⁴ The mask owner may further demand that any infringing products be destroyed and that other steps be taken to avoid future infringement.¹²⁵ If the violation is detected after the fact, the wrongdoer will be liable for royalties to the creator equal to the normal rate for such use.¹²⁶ The creator must, however, register the mask before demanding compensation for the alleged infringement.¹²⁷

Penalties for infringement under the Japanese Act are limited to prison terms or fines. Upon complaint to the authorities, anyone who infringes on a circuit layout right shall be punished with penal servitude not exceeding three years or a fine not exceeding one million yen.¹²⁸ Similarly, anyone who registers a layout by fraud may be punished with a prison term of up to one year, or a fine of up to 300,000 yen.¹²⁹ Anyone in the registration office who reveals secrets disclosed in the registration process may also be punished with a prison term of up to one year or a fine of up to 300,000 yen.¹³⁰ Finally, if an agent of an individual or a juridical person, such as a corporation, infringes on a layout or obtains a registration by fraud, then the principal shall be liable for the fine in each case, while the violator will receive either the fine or the prison term.¹³¹

III. THE EFFECTS OF THE ACTS, AND THE PROBLEM OF ASICs

A. *The SCPA and the Japanese Acts in Practice*

After passage of the SCPA in the United States, there was a flurry of mask registrations, but subsequently there has been a

¹²² *Id.* at arts. 16(3), 17(3).

¹²³ *Id.* at art. 23.

¹²⁴ *Id.* at art. 22(1).

¹²⁵ *Id.* at art. 22(2).

¹²⁶ *Id.* at art. 25(2).

¹²⁷ *Id.* at art. 27(2).

¹²⁸ *Id.* at art. 51. At the current rate of exchange (129.95 yen = \$1.00), this is approximately \$7,695.00. WALL ST. J., Oct. 7, 1991, at 1.

¹²⁹ Japanese Act, *supra* note 11, at art. 52.

¹³⁰ *Id.* at art. 54.

¹³¹ *Id.* at art. 56.

slowdown in applications.¹³² There are two theories for this slowdown. The first proposes that the SCPA has fulfilled its objective of showing clearly that the masks are protected, which has in turn stopped pirating. The second, more widely held view, is that registrations are down because the SCPA is an ineffective piece of legislation that does not address the advances in semiconductor technology which have occurred since 1984.¹³³ Evidence points in favor of the latter view because of the difficulties in copying a highly-integrated circuit.¹³⁴ The copyist must not only replicate the topography of the chip, but must also ensure that the silicon used in the copies is identical to the original.¹³⁵

The lack of litigation under both the SCPA and the Japanese Act also points to their irrelevance. To date, no cases have been brought under the Japanese Act, and only one has been brought under the SCPA: the *Brooktree* case.¹³⁶ The *Brooktree* case presented an opportunity to clear up some of the ambiguities of terms in the SCPA, because, as *sui generis* legislation, there was no controlling precedent. *Brooktree*, however, dealt only with standard, off-the-shelf products and offered little general guidance with regard to the SCPA and ASICs. It did, however, offer some clues to judicial standards for applying the reverse engineering provisions of the SCPA.

In the case, Brooktree sought a judgment against Advance Micro Devices, Inc. (AMD) for copying its video chip layouts.¹³⁷

¹³² Curiously, half the registrations at the end of 1985, the first year registrations were available, went to foreign mask work owners. Laurie, *supra* note 12, at 11. Yearly tallies of registrations have been 1263 (1985), 859 (1986), 1122 (1987), and 1047 (1988). Robert J. Risberg, Jr., Comment, *Five Years Without Infringement Litigation Under the Semiconductor Chip Protection Act: Unmasking the Spectre of Chip Piracy in an Era of Diverse and Incompatible Process Technologies*, 1990 Wis. L. Rev. 241, 265 n.120. More recent tallies have been: 1162 (1989) and 1093 (1990). Letter from Melissa Dadant, Supervisor, Mask Work Unit, Copyright Office (Apr. 18, 1991) [hereinafter Dadant letter]. Interestingly, registrations by Japanese parties have exceeded those of U.S. parties: 585 versus 530 (1989), and 759 versus 309 (1990).

¹³³ Risberg, Comment, *supra* note 132, at 276.

¹³⁴ Kato Interview, *supra* note 12.

¹³⁵ Risberg, Comment, *supra* note 132, at 256; Pilczak Interview, *supra* note 31.

¹³⁶ *Brooktree v. AMD*, 705 F. Supp. 491, 491 (S.D. Cal. 1988), memorandum decision, No. CIV 88-1750-E (CM), 1990 WL 23618 at * 1, 1990 WL 23619 at * 1 (S.D. Cal. Dec. 11, 1990).

¹³⁷ *Id.* Brooktree Corporation is a semiconductor manufacturer engaged in designing, producing, and selling semiconductor chips for high-resolution computer graphics displays. *Brooktree*, 705 F. Supp. at 493. Advanced Micro Devices, Inc. (AMD) is one of the largest U.S. chip manufacturers, which competes with Brooktree. *Id.* In its suit, Brooktree alleged that AMD had pirated Brooktree's Bt451 and Bt458 IC chips by direct copying,

AMD raised the reverse engineering defense, claiming that even if it took parts of Brooktree's layouts, it added its own work, resulting in a new product.¹³⁸ Although the reverse engineering defense was thought "fail-safe" if a defendant proved additional work through a "paper trail," examination of the *Brooktree* result demonstrates that proving reverse engineering alone is not enough to avoid infringement penalties under the SCPA.¹³⁹

In ruling on a motion for a temporary restraining order against AMD, the judge set out the standards for reverse engineering.¹⁴⁰ He noted that if a chip is reverse engineered, there is an infringement only if the new chip is substantially identical to the original chip.¹⁴¹ In addition, if a defendant accused of infringing on an SCPA-registered chip can produce a detailed "paper trail" showing both analysis of the original chip, as well as significant independent work, the plaintiff has the burden of proving the identical nature of the chips.¹⁴² In denying Brooktree's motion, the judge noted that the purpose of the SCPA was to prevent wholesale copying.¹⁴³ Implicit in his ruling was approval of the sort of research and development work accomplished by AMD's work.¹⁴⁴

which then allowed it to introduce the AMD replicas at a significantly lower cost. *Id.* Specifically, Brooktree alleged that AMD had copied active areas in some cells of the Bt chips and also had copied the location and paths of connectors between the cells. *Id.* at 494.

¹³⁸ *Brooktree*, 705 F. Supp. at 495. In its defense to the SCPA infringement charges, AMD claimed legitimate reverse engineering.

¹³⁹ *Id.*

¹⁴⁰ *Id.*

¹⁴¹ *Id.*

¹⁴² *Id.*

¹⁴³ *Id.* The judge also noted that Brooktree had proved neither the likelihood of success on the merits, nor irreparable harm. *Id.* at 496.

¹⁴⁴ The jury in *Brooktree* returned a verdict in favor of Brooktree, with damages in the amount of \$25 million. *Brooktree v. AMD*, 1990 WL 23618, at * . Despite AMD's having raised the reverse engineering defense, thought to be fail-safe if accompanied by a paper trail, the jury rejected the claim. An important element in the decision was that although AMD used a small portion of the Brooktree layouts, the portions it took were critical operating parts. The jury found that AMD used only about 30 percent of Brooktree's layouts, but the parts it took were 80 percent of the transistors, the critical operating parts of the circuits. *Brooktree*, 705 F. Supp. at 495.

In a memorandum decision after the verdict, the judge in the U.S. District Court for the Southern District of California stated that a plaintiff need not prove that every layer, circuit, and cell of the defendant's work are the same as the original, but only that the defendant misappropriated a material portion of the chip. *Brooktree*, 1990 WL 23618, at * 4. The court upheld the jury's award of \$25 million to Brooktree, and issued a permanent injunction prohibiting AMD from making, using, or selling any chips containing the mask work layout found to infringe Brooktree's mask work rights. *Brooktree*, 1990 WL 23619, at * 1, * 5.

Once the case was presented to the jury, however, the panel did not accept the reverse engineering defense. One reason for this verdict favoring Brooktree was that although AMD was able to show a paper trail, the portions of its design identical to the Brooktree design were also the most critical elements of the Brooktree chips.¹⁴⁵

B. *The Problem of ASICs*

Even with the *Brooktree* decision, there is still very little guidance for future litigants under the SCPA. The case offers little judicial analysis of a reverse engineering claim, and is limited to its facts. Significantly, the *Brooktree* case fails to comment on ASICs or custom chips, which are predicted to dominate integrated circuit sales in the future.¹⁴⁶ Under the current legislation in both Japan and the United States, predictable ASIC protection is difficult because of the acts' limited subject matter coverage, incomplete treatment of ownership issues, and differing penalty provisions.

ASICs defy categorization under either the Japanese Act or the SCPA. Neither act addresses custom chips or their elements, such as connectors or cells.¹⁴⁷ This omission in itself would not cause a problem if the elements of ASICs, standard cells and connectors,¹⁴⁸ fit squarely within the definitions contained in either act. The Japanese Act seems to cover collections of unconnected circuit elements like gate arrays.¹⁴⁹ The SCPA's requirement, however, that a mask be fixed on a chip intended to perform electronic circuitry functions causes some difficulty.¹⁵⁰

In its pure form, a gate array can be fixed onto a semiconductor chip without any connections between the various circuit ele-

¹⁴⁵ *Brooktree*, 705 F. Supp. at 495.

¹⁴⁶ Samuel Weber, *The Chip Business Has a Worried Look*, ELECTRONICS 70 (Jan. 1991). The semiconductor industry is estimated at sales of \$50 billion worldwide. Despite declines in sales for semiconductors last year, the industry expects ASIC revenues to increase by 11 percent in 1991, largely due to gate array and standard cell designs. Because many electronic functions are still carried out by using discrete components on printed circuit boards, many in the industry feel that there is substantial room for growth in ASICs as these circuit board designs are miniaturized using ASICs.

¹⁴⁷ Compare Semiconductor Chip Protection Act, 17 U.S.C.A. § 107 (West Supp. 1991) with Japanese Act, *supra* note 11, at art. 4.

¹⁴⁸ See *supra* notes 26-49 and accompanying text.

¹⁴⁹ Japanese Act, *supra* note 11, at art. 2(2).

¹⁵⁰ Semiconductor Chip Protection Act, 17 U.S.C.A. § 902(a)(1) (West Supp. 1991). See also Laurie, *supra* note 12, at 18.

ments.¹⁵¹ Thus, the gate array on a chip is incapable of performing electronic circuitry functions, because no complete paths exist. It could be possible to register each individual element of the gate array, but the sheer volume of such elements would make individual registrations time-consuming and prohibitively expensive.¹⁵² In addition, the Copyright Office's regulation requiring a mask to be fixed on a chip in its most complete form would seem to preclude gate arrays by definition, because they are incomplete before the customer adds the connections.¹⁵³

1. Cell Libraries

The more difficult problem of subject matter coverage for ASICs is the cell library. A cell library is a vendor's collection of standard circuit elements which a customer/designer can combine to create a desired circuit.¹⁵⁴ Typically, cell libraries are stored on magnetic tape or computer memory, and because they are not fixed on a semiconductor chip, they are ineligible for SCPA protection.¹⁵⁵ The Japanese Act, on the other hand, does not specifically require fixation in order to obtain protection, although definitions in article 2 suggest that the layout be on a chip before registration.¹⁵⁶ As a key element of ASIC design which the manufacturer wants to use repeatedly, the cell library should be protected.¹⁵⁷

¹⁵¹ Laurie, *supra* note 12, at 18.

¹⁵² *Id.*

¹⁵³ *Id.* Because of the confusion over whether even a gate array with connectors could be registered, the Copyright Office stated that both personalized (connected) and unpersonalized (unconnected) gate arrays can now be registered. 255 PRACTISING L. INST./PAT. 247. In 56 Fed. Reg. 7,816 (No. 38, 1991), the Copyright Office formalized this position, permitting separate registrations of unpersonalized gate arrays and the customized metallization [connection] layers. The problem, however, of the cost of registering each individual array remains.

¹⁵⁴ See *supra* notes 28–51 and accompanying text.

¹⁵⁵ Semiconductor Chip Protection Act, 17 U.S.C.A. § 902(a)(1) (West Supp. 1991). The Copyright Office has also held that the masks be fixed on silicon or other semiconducting material in order to be protected under the SCPA, and that fixation on computer tape is not sufficient for the purposes of the Act. PRACTISING L. INST./PAT., *supra* note 153, at 358.

¹⁵⁶ Japanese Act, *supra* note 11, at art. 2.

¹⁵⁷ Kato Interview, *supra* note 12. The cell library itself has value to the manufacturer as a selling point of its technology. Many semiconductor producers actively market the completeness of their cell libraries as inducements to customers. It is also becoming common for major vendors to cooperate in sharing their libraries with others in order to offer the customer security in second sourcing. In such agreements, however, the vendors

Commentators have suggested that masks for ASICs, especially cell libraries, are analogous to computer programs,¹⁵⁸ which receive copyright protection.¹⁵⁹ This analogy fails primarily because of the nature of a computer program itself. In the case of an operating system program stored on a chip, the chip is merely the medium on which a protected form of creation is stored, similar to writing on paper. The important distinction here is that a computer program can be divorced from the medium on which it is stored. It is possible, through sophisticated programming techniques, to have the operating system generate a hard copy printout of itself.¹⁶⁰ In the case of masks for ASICs, the mask and chip are inseparable. The mask is more correctly regarded as a step in the process of creating a chip, rather than an end in itself.¹⁶¹ In either case, it is ineligible for copyright protection, because copyright does not extend to useful articles or processes.¹⁶²

Further complications arise when the ownership provisions in the acts combine with common practices in ASIC design projects. There are two main problems of ownership, depending on whether one considers the ASIC a work-for-hire, or a jointly-owned product. A typical situation involves a customer-designed chip based on elements from the vendor's cell library, connected by paths the customer specifies.¹⁶³ Under the SCPA, the cell library is not protected until it is fixed on a chip,¹⁶⁴ but fixation does not occur until the customer has designed the connections.¹⁶⁵ At that time, under both acts, the creator, or the employer in the

carefully include restrictions on disclosure and use so that their proprietary information remains controllable.

¹⁵⁸ See generally Glynn S. Lunney, Jr., Note, *Copyright Protection for ASIC Gate Configurations: PLDs, Custom and Semicustom*, 42 STAN. L. REV. 163 (1989).

¹⁵⁹ *Apple Computer, Inc. v. Franklin Computer Corp.*, 714 F.2d 1240, 1249 (3d Cir. 1983). In *Apple Computer*, the court held that fixing a computer program onto a ROM chip satisfied the requirements of the Copyright Act for protection, and denied the defendant's argument that the ROM chip itself was a useful article not eligible for protection.

¹⁶⁰ Kato Interview, *supra* note 12. It is also conceivable that one could perform the same operation to determine the microcode instructions on an ASIC chip. This operation, however, is very difficult and time-consuming.

¹⁶¹ Laurie, *supra* note 12, at 18.

¹⁶² See *supra* notes 65-69 and accompanying text.

¹⁶³ See *supra* notes 43-51 and accompanying text.

¹⁶⁴ Semiconductor Chip Protection Act, 17 U.S.C.A. § 901(a)(1) (West Supp. 1991).

¹⁶⁵ See *supra* notes 43-51 and accompanying text.

case of works created during employment, owns the layout.¹⁶⁶ This reading would suggest that in cases where standard cells are used, the original vendor cannot protect the cell, but a customer can protect a design which incorporates the cells. The real damage, however, would occur downstream, because that layout would later be susceptible to reverse engineering. Given that the courts have not indicated clearly how they will interpret the reverse engineering rules in the future, a vendor could ultimately lose a very valuable asset: the cells in its library. A vendor who faces the prospect of losing cell libraries may severely restrict access and, effectively, discourage future technological developments. Given that both acts profess interest in promoting development, this result is clearly harmful.

2. Joint Ownership

The question of joint ownership poses an even greater problem in an industry where most advances result from close vendor and customer cooperation. The Japanese Act clearly allows joint ownership of a mask,¹⁶⁷ but the SCPA remains silent.¹⁶⁸ It is reasonable to conclude, however, that Congress chose not to include such a provision because the SCPA was modeled after the Copyright Act, which explicitly allows joint ownership.¹⁶⁹ Difficulty arises when a customer insists upon owning all the masks, while the vendor wishes to retain rights in the base layer and cell libraries.

The lines in ASIC design blur between creator and producer. In some projects, the customer specifies all the logic functions, but the manufacturer actually executes them.¹⁷⁰ This situation would seem to give both sides claim to the title of "creator." In

¹⁶⁶ Semiconductor Chip Protection Act, 17 U.S.C.A. § 901(a)(6) (West Supp. 1991); Japanese Act, *supra* note 11, at art. 5.

¹⁶⁷ Japanese Act, *supra* note 11, at art. 3.

¹⁶⁸ Recently, however, the Copyright Office has stated that it "could easily conceive of joint ownership resulting either from joint creation or from an assignment or contractual division of rights. There would be no impediment to registering a claim to mask work protection in the names of two or more joint owners." Dadant letter, *supra* note 132. The difficulty with this proposition, however, is that it is not well known, and is only the Copyright Office's interpretation of existing, unclear statutory language. Given that the SCPA is modeled after the Copyright Act, it suggests that if Congress intended to allow for joint registrations, it would have done so explicitly, as in the Copyright Act.

¹⁶⁹ Copyright Act, 17 U.S.C.A. § 201(a) (West 1977 & Supp. 1991).

¹⁷⁰ See *supra* notes 43-51 and accompanying text.

other projects, the customer merely specifies the interconnections between circuit elements, and the vendor designs and produces them.¹⁷¹ In such a case, the vendor appears to have a strong claim as a creator of the entire circuit. Absent joint ownership provisions in the SCPA, the vendor and customer must painstakingly negotiate each point, consuming large amounts of time and money.¹⁷² Consequently, the development is stalled. This result contravenes the purpose of promoting semiconductor development stated in both the SCPA and the Japanese Act.

The most obvious concerns of a vendor are that it retain rights to its cell libraries and mask rights in the base layers. The customer should receive mask rights in the netlists and connections it adds to the design. Because a great deal of copying is done in order to serve as a second source to an original vendor's device, provisions should be made for the vendor to allow such activity, while retaining maximum control over its cell libraries and other proprietary data. A possible solution would be for the vendor to grant a license to the customer, allowing it to procure devices using the vendor's cells in the event that the vendor is unable to fulfill its supply or price obligations. In this way, the vendor protects its proprietary rights, and the customer would be able to obtain exact copies of the chips under a license, should the primary source fail.

3. Penalty Provisions

The final problem with the Japanese Act and the SCPA are their markedly different penalty provisions.¹⁷³ For the same act of infringement, a defendant could face either a prison sentence in Japan, or a civil lawsuit in the United States. Given that much ASIC development is done by U.S. and Japanese companies operating in both countries, such unequal treatment could cause hesitation on the part of developers. The penalty provisions should be coordinated in the acts, either by making them identical, or by inserting a clause into each act guaranteeing that an infringer will face the penalties of his own nation.

¹⁷¹ *Id.*

¹⁷² Kato Interview, *supra* note 12. Negotiations over the specifics of ownership can add additional months to a development plan. *Id.*

¹⁷³ Compare *supra* notes 128–31 and accompanying text with *supra* notes 100–02 and accompanying text.

The strong growth projected for ASICs in the future suggests that immediate action is necessary to prevent future problems.¹⁷⁴ Countries such as Japan and the United States, whose high technology companies will take the lead in the industry, should be especially interested in amending their chip protection acts to cover ASICs. Any amendment should include clear definitions of ownership in vendor-client design situations. It should also include provisions for such things as standard cells and gate arrays. Further, in order to make the world marketplace more predictable, the penalty provisions of both acts should be coordinated. Given that U.S. sources predict Japan as a fertile market for U.S.-produced ASICs,¹⁷⁵ the danger of imprisonment for the infringer in Japan, but not in the United States, should be addressed.

If the countries' legislative bodies do not see fit to make such changes in their laws, parties to ASIC developments may still take steps to safeguard themselves. The complexity of an ASIC design is usually such that third-party usurpation of the masks is unlikely without other tortious behavior.¹⁷⁶ However, when the issue is one of ownership between customer and vendor, the parties should look to contractual remedies. Contract law should prove flexible enough to cover the parties' current and anticipated needs.¹⁷⁷

C. *Proposed Amendments to the SCPA and the Japanese Act*

The semiconductor industry is an important one for both Japan and the United States, and technology advances should be protected in both nations. The two acts as they stand, however, should be modified to protect ASICs as well as standard parts. Given that much ASIC work is done between Japanese and U.S. firms, coverage under these acts should be coordinated to offer standard protection to firms operating in both countries. Specifically, changes should be made in the following areas: subject matter coverage, ownership, and penalties for infringement.

¹⁷⁴ Risberg, *supra* note 132, at 256.

¹⁷⁵ NAT'L TRADE DATA BANK MKT. REP. 1, 7 (Aug. 1989).

¹⁷⁶ Kato Interview, *supra* note 12. Under tight security systems, it would be difficult for a third party to obtain a design unless it resorts to fraud or other illegal activity.

¹⁷⁷ See Dadant letter, *supra* note 132.

1. Subject Matter Coverage

The definitions sections of the two acts¹⁷⁸ should be revised to include elements of ASICs, such as cell libraries. The current requirement in the U.S. act that the mask be fixed on a chip¹⁷⁹ should also be altered to cover designs capable of being fixed on chips, as well as those actually fixed.¹⁸⁰ Finally, provisions should be made for "personalization" layers, or the customer-defined connectors in a gate array.¹⁸¹

2. Ownership

Ownership is the second area in which the acts should be amended. The SCPA should be updated to reflect the prevalence of joint development in ASICs, and should allow for joint registration as does the Japanese Act.¹⁸² Once joint registration is allowed, the acts should clearly define ownership during the various stages of ASIC design.¹⁸³ The ideal approach would be to canvass customers and vendors in the semiconductor industry in both nations to determine where lines should be drawn. It appears that today's customers are concerned about losing rights if they do not claim all their rights under the acts.¹⁸⁴ To avoid confusion, the acts should split ownership rights in joint development situations.¹⁸⁵ The change should stipulate that each party retains ownership of circuit components it creates independently. Thus, the customer would retain rights to its interconnections, and any other modifications it makes to the vendor's base layers. The customer would also hold rights to the final, complete ASIC design. The vendor, however, would hold rights to the base layers themselves, as well as to the cell libraries. In each case, the party would receive protection for the fruits of its labors, but not more.

¹⁷⁸ Semiconductor Chip Protection Act, 17 U.S.C.A. § 901 (West Supp. 1991); Japanese Act, *supra* note 11, at art. 2.

¹⁷⁹ Semiconductor Chip Protection Act, 17 U.S.C.A. § 902 (West Supp. 1991).

¹⁸⁰ In this way, the valuable cell libraries and other circuit elements owned by the semiconductor vendors could be protected before they are actually used in a customer-driven design.

¹⁸¹ See *supra* notes 33–37 and accompanying text.

¹⁸² Japanese Act, *supra* note 11, at art. 3(1).

¹⁸³ See *supra* notes 38–51 and accompanying text.

¹⁸⁴ Kato Interview, *supra* note 12.

¹⁸⁵ See *supra* notes 43–51 and accompanying text. Although there are instances where large semiconductor manufacturers do develop their own ASIC designs in-house, the bulk of ASIC design work is done through joint development projects.

In the event that the parties to the development want a different sort of arrangement, the amended acts should also allow them to contractually override these ownership provisions.

3. Penalty Provisions

Finally, legislators should make alterations in the penalty provisions sections of the acts. Currently, the Japanese Act provides solely for criminal penalties, while the SCPA provides only for civil remedies. These differences reflect fundamental differences in each country's legal system.¹⁸⁶ Nevertheless, such disparate punishment for infringement could cause a corporation in one nation to hesitate to undertake development in the other. To remove this impediment, the penalty sections of each act should contain a provision that subjects an infringer in a foreign country to the penalties of its home country's law. In this way, each nation would be able to use its laws to deal with infringers, while holding its nationals operating overseas liable to the same penalties they would face for infringement at home. The beneficial result would be that a party operating overseas would always know what to expect if it infringed either country's law.

CONCLUSION

The SCPA and Japanese Act are two pieces of legislation that were appropriate at the time of their passage, but which have only limited utility in a changed marketplace. Contractual provisions can provide some protection for the parties against each other, and should be used today. With the pace of technological change, however, it is wise to amend the acts to include clear provisions on ASICs that will also cover third parties. Unless the laws are revised to keep pace with technology, protection afforded semiconductors will be imprecise and confusing to vendors and customers, which could cause unnecessary delays in developments in this vital area of technology.

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¹⁸⁶ See VANWOLFEREN, *supra* note 107, at 212-18. Because of the fundamentally different nature of the two legal systems, imposing the same penalties in both nations would be problematic. A criminal penalty is much more serious in Japan, where few disputes result in litigation. Similarly, the threat of civil litigation is more powerful in the United States, where access to courts is easier and the criminal system is heavily burdened.