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The 1984 Semiconductor Chip Protection Act: A Comprehensive View

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The 1984 Semiconductor Chip Protection Act creates a new form of U.S. legal protection specifically aimed at eradicating chip piracy. The Act provides substantial remedies for those harmed by chip piracy. This article discusses the Act in terms of its background, its provisions, and certain of its limitations.

I. BACKGROUND

One of the technological marvels of the modern age is the electronic integrated circuit—better known as the chip.

> It seems trifling, barely the size of a newborn's thumbnail and little thicker. The puff of air that extinguishes a candle would send it flying. In bright light it shimmers, but only with the fleeting iridescence of a soap bubble. It has a backbone of silicon, an ingredient of common beach sand, yet is less durable than a fragile glass sea sponge, largely made of the same material.
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> Still, less tangible things have given their names to an age, and the silver-gray fleck of silicon called the chip has ample power to create a new one. At its simplest the chip is electronic circuitry: Patterned in and on its silicon base are

> miniscule switches, joined by "wires" etched from exquisitely thin films of metal. Under a microscope the chip's intricate terrain often looks uncannily like the streets, plazas and buildings of a great metropolis, viewed from miles up.[1]

Currently, a square piece of thin silicon, at most a half-inch on a side, can contain upwards of a million or more separate electronic components. For the past decade, entire computers have been fabricated on single chips. Such single-chip computers (commonly referred to as microprocessors) have become ubiquitous. These devices can execute an operation in less than a millionth of a second (a microsecond).

Microprocessors first appeared in many varieties of specialized industrial applications, such as process control and instrumentation.[2] Engineers quickly realized that microprocessors could be used as an "electronic brain" to accurately and quickly control many repetitive tasks to free human beings from drudgery. Consequently, over the last decade microprocessors have been used in many commonplace applications in order to add mechanized "intelligence" to a wide variety of tasks. These chips form an integral part of many products, running the gamut from consumer goods—such as personal computers, video games, stereos, microwave ovens, video cassette recorders, digital watches, compact disc players, and automobiles (for dashboard displays, fuel injection, and anti-pollution control)—to life support equipment—such as pacemakers, surgical cardiovascular and pulmonary monitoring equipment, and artificial heart pump control equipment—to applications such as real-time air, sea, land, and space navigation and emergency location systems; communication; and electronic countermeasure and surveillance equipment. New and better uses for semiconductor chips are emerging

1. A. A. Boraiko, *Electronic Mini-Marvel That is Changing Your Life—The Chip*, 162, no. 4 NATIONAL GEOGRAPHIC 420-57 (October 1982) (hereinafter referred to as NATIONAL GEOGRAPHIC), specifically page 421.
2. This is the writer's personal observation based upon his experience as an electrical development engineer who was employed by and designed industrial process control equipment for the Production Equipment Laboratories of the Aluminum Company of America (ALCOA) during 1976-1977. During that time, Intel Corporation announced its first single-chip microprocessor, the eight-bit 8748, which was designed for process control applications and shortly thereafter was so used by the writer.

daily, and society is being rewarded with a continually corresponding enhancement of the quality of life. More than perhaps with any other invention, the semiconductor chip has brought America and the world into the information age and has freed it of significant tedium and drudgery.[3]

The basic building block of an integrated circuit is the transistor. This electrical device can amplify an electrical signal and/or act as an electrical switch. Fabrication of a transistor begins with a material known as a "semiconductor," the most predominant being silicon. Semiconductors possess a rather unique physical property: they can be made to either conduct electricity or insulate depending upon their electrical state. This state can be altered by applying a voltage across the semiconductor or by adding various elements or compounds, known as "impurities," to the semiconductor material itself by a process commonly known as "doping."[4] Transistors are made by doping small adjacent regions existing on and extending slightly below a top surface of a semiconducting material (known as a "substrate") with various materials (dopants such as phosphorus or arsenic) to suitably change the electrical properties of each of these regions (*e.g.,* to increase or decrease the affinity of each of these regions to attract free electrons). A conductive, metallic pattern is situated above each region. This pattern, often referred to as "metallization," contacts each region and routes electrical current thereto.

A. Advent of the Integrated Circuit

Early electrical systems used vacuum tubes for signal switching and amplification. Unfortunately, tubes were large, electrically slow to respond, bulky, power hungry, and quite unreliable. The number of tubes used in any electrical system was limited because of the large size and power consumption of the tubes. Inasmuch as the information-processing capability of any electrical system is determined by the number of switching elements it uses, early computers, which were built using tubes, had limited processing ability.

3. Semiconductor Chip Protection Act of 1984, REPORT OF THE HOUSE OF REPRESENTATIVES, No. 98-781, 98th Cong. 2d Sess. 2 (1984) (hereinafter referred to as the HOUSE REPORT).
4. *Prepared Statement of F. Thomas Dunlap, Jr., Corporate Counsel and Secretary, Intel Corporation, Hearing before the Subcommittee on Patents, Copyrights and Trademarks of the Committee on the Judiciary United States Senate,* 98th Cong., 1st Sess. on S. 1201 68-77, specifically page 69 (1983) (hereinafter referred to as the *Senate Report*).

In 1947, the transistor was invented at Bell Telephone Laboratories as a replacement for vacuum tubes. Although the transistor was significantly smaller than a vacuum tube, it had a drawback: a set of leads, connected at one end to a semiconductor substrate which contained the transistor and soldered at the other end to a circuit board, often broke away from the circuit board.

To increase the reliability associated with transistors, Jack Kilby at Texas Instruments and Robert Noyce at Fairchild Semiconductor, in the mid-1960s, independently devised the integrated circuit (the "chip") in which the transistor and its interconnection leads were fabricated on a common semiconductor substrate.[5] The transistor occupied a portion of the substrate and the interconnection leads were implemented as an overlaying metallization pattern. Since permanent metallization patterns replaced soldered leads, the reliability of integrated circuits greatly exceeded that of non-integrated transistors.

Today, an integrated circuit containing 100,000 to a million or more separate transistors is quite common. In fact, a newly introduced chip—the "one million-bit dynamic RAM chip"—contains at least two million separate transistors on a silicon substrate less than half an inch on a side. This new technology has enabled a computer substantially more powerful than the vacuum tube models, which twenty-five years ago would have filled a whole room, to now contain one microprocessor less than a quarter of an inch on a side and containing upwards of 100,000 transistors.[6]

B. Chip Manufacture

In order to understand what is protected by the 1984 Semiconductor Chip Protection Act, one must possess a rudimentary understanding of how a semiconductor chip is manufactured.

Depending upon the size of an individual chip, generally hundreds of chips are fabricated together on a substrate. One starts with a circular wafer of silicon (the "substrate") generally three-five inches in diameter. At the end of the process, the wafer will resemble a sheet of hundreds of postage stamps with each individual chip being one of the "postage stamps."

To begin manufacture, one surface of the wafer is completely coated with a thin layer of silicon dioxide (SiO_2), usually by subjecting the wafer to a steam bath. This oxide layer is then coated with a light-sensitive, acid-resistant material commonly known as "resist."

5. National Geographic, *supra* note 1, at 429.
6. *Id.*

At this point, a mask—for example, a stencil on a glass disk—is placed over the resist. The mask has the layout pattern for one layer of the chip. This pattern is defined by the light and dark areas on the mask—much like the dark areas of a photographic negative define the light areas in a developed picture. The mask is exposed to ultraviolet light, which passes through the transparent portions of the mask and polymerizes the resist lying beneath these transparent portions. The wafer is then immersed in a solvent which removes the unpolymerized resist and leaves the polymerized resist on the wafer in the same pattern as that of the transparent portions of the mask. Thereafter, the wafer is placed in an acid bath, typically hydrofluoric acid, which removes the oxide coating on the wafer that is not covered by the remaining resist. This process leaves a hill-and-valley pattern in each chip comprising the wafer.

At this point, various impurities (dopants) may be diffused into the exposed substrate areas in order to form local regions having particular electronic properties. Alternatively, aluminum or other metallic elements may be laid down over the exposed substrate to form a metallization pattern, or an insulating layer may be formed to electronically isolate the layers of a multilayer chip.

In any event, many masking steps (often eight or more) are employed to fabricate a chip. The end product is a multilayered sandwich of doped silicon, silicon dioxide, and metallization, in which each layer has been defined by a particular mask. Once the fabrication is complete, the chips are sawed apart and packaged in ceramic or plastic carriers (*e.g.*, plastic dual-in-line packages).

Masks are often produced by a computer. Alternatively, laser or electron beams may be selectively applied over the face of a wafer to suitably etch the substrate and thereby define a particular layer.[7]

C. Extent of the Semiconductor Industry

The semiconductor industry is an essential component of the U.S. economy. This industry has maintained a high level of research and development and has been able to provide decreasingly less expensive and increasingly more powerful chips. For example, in 1982, average research and development expenditures, as a percentage of sales, amounted to 10.7 percent. During the same time, capital investment levels, as a percentage of sales, amounted to approximately 14 percent. This high level of research and development and capital expenditures has caused the density of semiconductor chips, *i.e.*, the number of transistors which

7. *Senate Report*, *supra* note 4, at 2-4.

comprise an integrated circuit, to approximately double each year since the early 1960s. Since the early 1970s, the U.S. semiconductor industry, notwithstanding sharp cyclical business fluctuations, had achieved a growth rate of approximately 20 percent per year. During the same period, U.S. high technology industries, as a whole, only grew at an annual rate of 7 percent.[8] Moreover, the U.S. chip market grew from $9.5 billion in 1981 to $12.4 billion in 1983.[9]

As a result, semiconductor chips have allowed production costs to significantly decline and quality to substantially rise, thereby permitting a vast array of American products to remain competitive in world markets. Furthermore, by using more sophisticated chips, U.S. businesses, in certain instances, have been able to relocate off-shore production facilities back in the U.S. with a subsequent increase in American employment.[10]

D. Chip Manufacturing Economics and Copying

Generally, a chip manufacturer develops a family of related chips rather than one single chip. For example, a microprocessor chip will usually be marketed along with a family of ancillary support chips—input/output (I/O) controllers, interrupt handlers, and the like—so that a customer can develop a complete electrical system around these chips.[11] A reasonably complex microprocessor may itself cost $4 million to develop.[12] The design effort alone requires thousands of hours of work by highly skilled engineers and technicians. However, the cost of developing such a family includes development of a customer base for these chips as well; the latter may often cost as much as the physical development of the chips. All totaled, the expenses for developing a complete family of chips may reach $100 million.

By contrast, a chip can be copied for relatively little work and at small expense. The technology for copying chips is highly developed. Generally, a copier removes the chip from its plastic or ceramic carrier; microscopically photographs the top metallization layer; dissolves this metallization layer away by immersing the chip in a suitable acid bath in order to expose the underlying layer; and then photographs this layer.

8. *Id.* at 4.
9. Summary of Trade and Tariff Information, Semiconductors, U.S.T.C. Pub. 841, Control No. 6-5-22 (Supp.) at 2 (1984).
10. *Senate Report*, *supra* note 4, at 5.
11. *Id. See also The Semiconductor Chip Protection Act of 1983: Hearing before the Subcommittee on Patents, Copyrights and Trademarks of the Committee on the Judiciary on S. 1201*, 98th Cong., 1st Sess. 75. (May 19, 1983) (hereinafter referred to as *Hearings*).
12. *Id.* at 76.

This underlying layer is then itself removed using the acid bath. This process is then repeated until all the layers and their accompanying metallization patterns have been separately photographed. Appropriate masks are inexpensively made from each photograph.[13]

Using this process, a pirate can produce a perfect copy of a complex chip for as little as $50,000 to $100,000—far less than the original $1-4 million development costs. Inasmuch as pirating firms have no research and development expenditures to recoup, they can set their prices for copied chips far lower than can legitimate manufacturers. Oftentimes, the price is so low that a legitimate manufacturer will lose market share and, in extreme cases, will be forced out of the market entirely.[14] A manufacturer's loss from piracy can easily reach tens of millions of dollars.[15]

Chips have become far more complex and therefore more costly to produce; however, the costs of copying have remained essentially constant. As a result, the economic incentive for chip piracy has increased substantially. This, in turn, has sharply reduced the return on investment available to legitimate chip manufacturers and has reduced the amount of available capital for new research and development and for investment in new chip manufacturing equipment. Consequently, chip innovation is being increasingly stifled by piratical activities. If left unchecked, chip piracy may shut down the flow of new capital to the American semiconductor manufacturing industry, thereby risking continued American dominance of this industry.[16]

II. INADEQUACY OF PATENT, COPYRIGHT, AND TRADE SECRET LAW TO PROTECT CHIPS

Owing to the unique nature of semiconductor chips, patents, copyrights, and trade secrets provide almost no legal protection for chips. This further encourages chip piracy to flourish.

13. *Senate Report*, *supra* note 4, at 4. *Hearings*, *supra*, note 11, at 76-77.
14. *Senate Report*, *supra* note 4, at 5.
15. *Hearings*, *supra* note 11, at 126. For example, in a recent case before the ITC, Zilog Corporation has alleged that Nippon Electric Company (NEC) copied its Z-80 microprocessor chip. Since, NEC's version of the chip has entered the market in 1979, prices for the Z-80 chip fell from $6.32 to below $2.82. During the same time, NEC's annual sales of its version of this chip reached three million units, which matched Zilog's sales level at that time. In another case, occurring in August 1982, Intersil, Inc. filed a suit against Teledyne, Inc., alleging that Intersil had suffered approximately $7 million in damages resulting from Teledyne's alleged copying of a family of relatively inexpensive analog-to-digital converter chips manufactured by Intersil. This latter suit has been settled. *Id.* at n. 2.
16. *Id.*

A. Patent Protection for Chips

Patent protection encompasses any utilitarian invention for a process, machine, manufacture, or composition of matter and any useful improvement thereof[17] as long as the invention meets various statutory conditions of novelty[18] and nonobviousness.[19] Patent protection provides a patent owner with the rights to exclude others from making, using, or selling the invention claimed in the patent anywhere within the United States for a period of seventeen years after the date the patent issues.[20]

The legal difficulty in protecting chips through patents is evident in the following testimony from Gerald Mossinghoff, who, at the time this testimony was given, was the Commissioner of Patents and Trademarks:

> Patent protection is available for the process of making the chip, for the electronic circuit embodied in the chip, or for the chip itself as an article of manufacture, provided the process or circuit or the article of manufacture meets the patentability requirements of being new, useful and non-obvious. While a patent on the circuit would protect against the manufacture, use, or sale of the circuit, the circuits in chips are usually well-known and therefore unpatentable. Patents for the process of making the chip or the chip itself, as an article of manufacture, would not ordinarily protect against a taking of the design.[21]

Although patents can protect the basic electronic circuity contained within the chip (*i.e.*, the circuitry and its architecture), masks of each layer in the chip, while often quite unique, are usually not sufficiently patentably new or nonobvious to qualify for patent protection. It is in the fabrication of these masks that substantial time, effort, and millions of dollars are expended in chip design, and these masks very seldom—if ever—qualify as being patentable.

17. *See* 35 U.S.C. 101, which provides "Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor. . . ."
18. *See* 35 U.S.C. 102 (1975).
19. *See* 35 U.S.C. 103 (1984) which provides "A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains."
20. *See* 35 U.S.C. 154 (1980).
21. *Hearings, supra* note 11, at 66.

Furthermore, patent protection, where it is available, does not automatically follow from the filing of a patent application. *Ex parte* prosecution must occur, which may significantly delay issuance of a patent. It is not uncommon for a patent application in the electrical art area (in which semiconductor chips reside) to remain an application for at least four years until a final resolution is made as to patentability.

Anyone can make, use, and sell (which includes copying) an inventive chip, with impunity, before a patent issues.

Since the semiconductor chip technology evolves quickly, the useful life of most semiconductor chips is very short—often a year or two at best. Consequently, the relatively long time required to obtain an issued patent substantially depreciates its value.[22]

B. Copyright Protection for Chips

Numerous questions existed, prior to the enactment of the 1984 Semiconductor Chip Protection Act, as to whether copyrights could actually protect semiconductor chips, and if so, what the scope of actual protection was. Generally, the Copyright Office took the position that semiconductor chips were utilitarian articles which highly restricted their copyrightability. This view is evident in legislative testimony given by the General Counsel of the Copyright Office before the Senate:

> Arguments in favor of protection for chips or chip design under the current [1976 Copyright Act] must confront the barriers of at least four fundamental principles of traditional copyright law: copyright does not protect useful articles per se; copyright protects the design of a useful article only to the extent that it can be identified separately from, and is capable of existing independently of, the utilitarian aspects of the article; copyright in a drawing or other representation of a useful article does not protect against unauthorized duplication of the useful article; and copyright protects only expression, not ideas, plans, or processes.

Consequently, in accordance with the views of its General Counsel, the Copyright Office "historically has refused, and presently does refuse to

22. *Senate Report, supra* note 4, at 8.

register claims to copyright in. . .the design or 'topology' of, or imprinted patterns in, semiconductor chips, and the. . .chips themselves."[23]

A question arose as to whether the recent decision of the Third Circuit in *Apple Computer, Inc. v. Franklin Computer Corp.*[24] addressed the copyrightability of chip layouts. The Third Circuit noted: "Apple does not seek to protect the ROM's architecture, but only the program encoded within it."[25] Consequently, this decision did not address the basic question as to whether chip layouts were copyrightable in spite of their high degree of functionality, but instead limited itself to considering that computer programs—which were held to be copyrightable—do not lose their copyrightable status merely because they are stored in object code in a ROM chip. Hence, under *Apple,* if one ROM manufacturer copied the layout of a second manufacturer's ROM chip, the former would not be liable; however, if a copyrighted program stored in a ROM chip were copied, even into an entirely different ROM chip, this latter act would constitute actionable copyright infringement. Any chip which does not include embedded program code, such as analog circuit chips and dedicated nonprogrammed hardware logic, would not come within *Apple.*

Thus, owing to the uncertainty in obtaining copyright and patent protection for chips, semiconductor manufacturers—prior to the enactment of the 1984 Semiconductor Chip Protection Act—have been unable to possess any degree of confidence that they will be able to prevent, or at least recoup, damages they expect to suffer for unauthorized copying of their chips.[26]

C. Trade Secret Protection for Chips

Trade secret law provides wholly inadequate protection for semiconductor chips. In particular, a protectible trade secret can reside in any formula, pattern, device, or compilation of information which is used in a person's business, and which gives him/her an opportunity to obtain an advantage over competitors who do not know or use it. However, it is not enough that information fall within this broad range of protectible information. To be protectible, a trade secret must be kept secret. Matters of public or general knowledge in an industry cannot be appropriated by someone as his secret; nor can a secret completely disclosed by the goods

23. *Id.* at 7.
24. Apple Computer, Inc. v. Franklin Computer Corp., 174 F. 2d 1240 (3d Cir. 1983), *cert. denied,* 104 S. Ct. 690 (1984).
25. *Id.* at 1249 n. 7.
26. *Senate Report, supra* note 4, at 7.

which one markets be enforced as one's secret against another who "reverse engineers" the goods to discover the secret.[27]

Unfortunately, due to the ease, as discussed previously, with which semiconductor chips can be reverse-engineered to discover the exact layouts which comprise any individual chip, trade secret protection for any semiconductor chip is completely dissipated once that chip is placed on public sale. As noted during Senate testimony on the 1984 Semiconductor Chip Protection Act, "the integrated circuit is one of the few products. . .where the blueprint [i]s imprinted on the product itself."

III. LEGISLATIVE APPROACHES TO CHIP PROTECTION

Congress considered two different legislative approaches for protecting semiconductor chips: amending the 1976 Copyright Act to encompass semiconductor chips, or enacting a new *(sui generis)* form of protection specially tailored to chips. The former approach was favored by the Senate, while the latter approach was favored by the House and, as discussed below, was finally enacted.

A. Senate Approach—Copyrights

The Senate Judiciary Committee favored the copyright approach. It reasoned that although semiconductor chips, and particularly the three-dimensional topological layouts embodied in chips, were functional and hence somewhat removed from being expression, copyrights nonetheless protected "a vast array of works, some of which have value almost exclusively as utilitarian objects" and would protect these layouts. This sentiment is evident in the following testimony:

> [C]opyright protection extends far beyond works that only convey ideas or have artistic or intellectual merit. That point becomes graphic when one considers the virtually endless list of purely commercial and highly functional items that are now accepted by the Copyright Office and the federal courts as copyrightable, including belt bucklets, telephone books, ashtrays, eyeshades, door knockers, pill boxes, and advertisements. Today, it simply must be accepted that American copyright law extends protection to works of a highly—indeed, in some cases—entirely commercial character.[29]

27. R. Milgrim, Trade Secrets §§ 2.01 and 2.05 [2] (1980).
28. *Senate Report, supra* note 4, at 9.
29. Testimony of Professor Arthur Miller at *Senate Report, supra* note 4, at 12-13.

and in the following comment also made during Senate testimony:

> Well, today, just looking at our environment, we recognize that we are literally bombarded by useful work copyrights, whether they are belt buckles or lunch pails or piggy banks. A nation that awards a 75-year copyright monopoly to an E.T. piggy bank or an E.T. cushion or an E.T. lunch pail, and then gets itself bollixed up in a conceptual debate as to whether a mask work is too utilitarian, has got its priorities fouled up.[30]

The Senate Judiciary Committee noted that there are many similarities between mask works and many copyrightable forms of expression:

> Masks are akin both in function and appearance, to maps and technical drawings, which have long been accepted as subjects of copyright. Mask works are also like film images in many ways; the latter are covered under Title 17 as "audiovisual works." The patterns etched or deposited on semiconductor material, and the masks used as stencils for the manufacture of these chips, are not visually dissimilar to pictorial and graphic works that are clearly copyrightable. In light of all these similarities, it is not surprising that the existing framework of copyright protection would suffice, with "a minimum amount of distortion" to provide protection against chip piracy.[31]

Furthermore, the Senate Judiciary Committee believed that, inasmuch as a substantial body of case law exists interpreting both the language of the 1976 Copyright Act and the scope of protection accorded by copyrights, use of copyrights would protect chips with certainty and stability. A new statute, based upon a *sui generis* approach would, by contrast, contain many new concepts and terms, which could only be defined and the scope of protection they accord parameterized through costly litigation.

Moreover, the Senate Judiciary Committee believed that, inasmuch as mask works are copyrightable in the U.S., foreign nations would, as a matter of comity under existing copyright treaties, such as the Universal Copyright Convention (UCC), extend their copyright laws to protect

30. Testimony of Professor Arthur Miller, *Hearings, supra* note 11, at 89.
31. *Senate Report, supra* note 4, at 13.

American mask works even if nonAmerican mask works were not copyrightable in these nations. However, the Committee believed that international protection under a *sui generis* approach, due to the absence of governing treaties, would be quite uncertain.[32]

Furthermore, the Senate Judiciary Committee believed that since copyright protection is simple and economical to obtain, any form of *sui generis* protection would, of necessity, borrow heavily from the Copyright Act. The Committee opined that making the "necessary adjustments" to the Copyright Act would be far easier and simpler than "reinventing the wheel" by enacting a new statute that would reiterate a substantial number of standard copyright provisions.[33]

Lastly, the Senate Judiciary Committee believed that minimal damage would be done to the scope of protection accorded existing copyrights if the 1976 Copyright Act were amended to encompass mask works. As one witness stated: "[O]ur concern. . .is one of certainty, precision, predictability, and of not eroding the rights in our existing works."[34] The committee noted that its amendments to the Copyright Act would not create any "realistic threat to the integrity or efficacy of existing copyrights, or of future copyrights in the kinds of works for which copyright protection is already available."[35]

B. House Approach—*Sui Generis* Protection

The House Judiciary Committee took the opposite position. It believed that several fundamental problems would be posed if the 1976 Copyright Act were amended to protect semiconductor chips using copyrights, as suggested by the Senate.

Specifically, the House Committee recognized that three-dimensional, topological designs embodied in the layered structure of a semiconductor chip are completely functional and contain no protectible (copyrightable) expression apart from their functional characteristics. As such, the House committee believed that these layouts present an entirely different class of articles than those which contain copyrightable expression having severable functional attributes.

> [C]opyright has expanded to encompass new forms of protection, many of which have commercial applications. The commercial application or character of a given

32. *Id.*
33. *Id.*
34. Testimony of Jon Baumgarten, *Senate Report*, *supra* note 4, at 14.
35. *Id.*

> copyrighted work, however, presents a far different case from that of mask works, which are intended to be and are used as part of an integral part of a manufacturing process.[36]

In fact, the House Committee noted that if the 1976 Copyright Act were to be amended, then a substantial inconsistency would result: articles having inseparable expression and functional attributes would not be copyrightable; however, topological layouts which have no expression and are completely functional would be.

Furthermore, concerns were raised that if the 1976 Copyright Act were amended to permit reverse engineering of chips, this would adversely impact other copyrighted works. Specifically, in the semiconductor industry, reverse engineering is generally carried out purely for commercial reasons—to save engineering time and thereby minimize the financial outlays required to develop new chip designs. The fair use exception as it exists in the 1976 Copyright Act (*see* 17 U.S.C. 107) only permits a copyrighted work to be copied without permission of the copyright owner if that copying occurs for essentially noncommercial purposes (education, criticism, news reporting, and the like). Inasmuch as reverse engineering often results in a copied chip design finding its way into a new, commercially available chip, the "fair use" provision would not insulate reverse engineering efforts from illegality. To do so, the fair use provision would need to be broadened to encompass reverse engineering. Concerns were raised before the House that if such a broadening occurred, it would allow more copying than that already sanctioned by the 1976 Copyright Act and would thereby weaken traditional copyright protection in any work that is presently copyrightable, such as computer programs, databases, audiovisual works, and even books.[37]

On the international side, the House recognized that foreign protection for American semiconductor layouts, under the provisions of the UCC, would be essentially nonexistant. In particular, the UCC mandates that any contracting country must accord copyright status on an equal and reciprocal basis to copyrighted works which exist in that country regardless of whether those works originate domestically in that country or overseas in another contracting country. However, each country is permitted to determine, under its own national laws, whether a work is copyrightable in the first instance. If so, then equal reciprocal treatment

36. House Report, *supra* note 3, at 6.
37. D. Wilson *et al.*, *The Semiconductor Chip Protection Act of 1984: A Preliminary Analysis*, 67, no. 2 Journal of the Patent and Trademark Office Society 57–92 (February 1985), specifically pp. 66–68.

under the UCC must be accorded.[38] The House Committee reported that, to date, no foreign country had determined that semiconductor chip topological layouts are protectible under its national copyright law. Consequently, if the U.S. followed a copyright approach, then under the UCC, the U.S. would be forced to protect foreign semiconductor chip layouts emanating from other countries and entering the U.S. without receiving any reciprocal protection for U.S. semiconductor chips entering that country.[39] Such a result would not have provided U.S. manufacturers with sufficient power to completely and effectively retaliate against foreign chip piracy. For example, even if a U.S. court order could be obtained prohibiting pirated chips emanating from a foreign pirate from entering the U.S., a U.S. manufacturer could not cure the problem at its source. There are, as yet, no foreign laws which could be utilized to shut down the foreign plant and totally eliminate the chip piracy. Moreover, the lack of applicable foreign laws would render the U.S. manufacturer totally impotent in protecting its foreign market from piracy.

IV. PROVISIONS OF THE 1984 SEMICONDUCTOR CHIP PROTECTION ACT

Given the drawbacks inherent in amending the 1976 Copyright Act to accord copyright protection to semiconductor chip topological layouts and permit reverse engineering, and in obtaining equivalent reciprocal international protection under the UCC, Congress decided that a *sui generis* approach would best protect semiconductor chip layouts.

With this in mind, Congress decided that the best way to protect semiconductor chips would be to protect the layers themselves that together comprise a chip rather than the masks used to fabricate the chip. Congress believed that masks will eventually become obsolete, probably over the next few years, due to advanced, maskless technology. Hence, if masks were to be protected, this protection would be useful only as long as masks were being used, probably only for the next few years. However, any semiconductor chip, whether made using a mask or through a maskless-based process, would possess a layered structure. By protecting the topological arrangement of the layers which form the chip rather than the masks used to produce these layers, this protection would be immune

38. Article II (sections 1 and 2) of the Universal Copyright Convention, as revised at Paris, 1971.
39. House Report, *supra* note 3, at 7.

from the evolving technology of chip manufacture and thereby quite useful.[40]

A. Protectible Mask Works

Consequently, the 1984 Semiconductor Chip Protection Act focuses on a "mask work" as being the protectible element in an integrated circuit. In section 901, a mask work is defined 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 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.

In the same section, a "semiconductor chip product" is defined as:

> the final or intermediate form of any product
> (A) having 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; and
> (B) intended to perform electronic circuitry functions.

As such, a mask work encompasses a chip that was fabricated using either a conventional mask—*e.g.*, tape on mylar, photolithographic masks—or advanced maskless integrated circuit fabrication technologies, such as laser and/or electron beam etching.

However, not all mask works are protectible under the 1984 Act. To be eligible under this act, a mask work and its owner must first meet certain threshold requirements, as specified in section 902, of nationality, first commercial exploitation, and/or international reciprocity. Specifically, section 902 (a) states, in pertinent part:

40. A short article dealing with the substantive provisions of the 1984 Act is I. Ostroff, *The 1984 Semiconductor Chip Protection Act*, 1985 IEEE INTERNATIONAL SOLID-STATE CIRCUITS CONFERENCE, DIGEST OF TECHNICAL PAPERS 291-93 (1985).

> [A] mask work fixed in a semiconductor chip product, by or under the authority of the owner of the mask work, is eligible for protection. . . if
>
> (A) on the date on which the mask work is registered. . .or is first commercially exploited anywhere in the world, whichever occurs first, the owner of the mask work is (i) a national or domiciliary* of the United States, (ii) a national, domiciliary or sovereign authority of a foreign nation that is a party to a treaty affording protection to mask works to which the United States is also a party, or (iii) a stateless person, wherever that person may be domiciled;
>
> (B) the mask work is first commercially exploited in the United States; or
>
> (C) the mask work comes within the scope of a Presidential proclamation issued under paragraph (2).

Thus, if a mask work has been first commercially exploited in the United States (*e.g.*, incorporated into a chip that has first been sold in the U.S.), this work is eligible for protection. Moreover, Congress manifested a substantial concern that many foreign nations would not protect U.S. mask works. Consequently, Congress, in section 902 (a) (1) (A), conditioned mask work protection for foreigners on reciprocal protection being accorded to U.S. nationals. Here, a foreigner (national or sovereign authority) can only obtain mask work protection under the 1984 Act if his home country is a party to an international treaty to which the United States is also a party and which provides reciprocal protection on an equivalent basis to mask works owned by Americans and mask works owned by its own nationals. Lastly, the President may proclaim a foreign mask work protectible under the 1984 Act if the foreign nation provides equivalent reciprocal mask work protection to both its own nationals and to those of the United States but has not yet entered into a treaty with the United States. Section 902 (a) (2) provides:

> Whenever the President finds that a foreign nation extends to mask works of owners who are nationals or domiciliaries of the United States protection (A) on *substantially the same basis as that on which the foreign nation extends protection to mask works of its own nationals and domiciliaries* and mask works first commercially exploited in that

* *Sic.* "Domiciliary" is misused throughout the wording of the Act.

> nation, or (B) on substantially the same basis as provided in this chapter, the President may by proclamation extend protection under this chapter to mask works (i) of owners who are, on the date on which the mask works are registered. . .or on the date on which the mask works are first commercially exploited anywhere in the world, whichever comes first, or (ii) which are first commercially exploited in that nation by nationals, domiciliaries or sovereign authorities of that nation. [emphasis added]

Notwithstanding the nationality, first commercial exploitation, and/or international reciprocity requirements of section 902 (a), some mask works still do not qualify for protection. These works are those which are simply not sufficiently original. Specifically, section 902 (b) states:

> Protection. . .shall not be available for a mask work that
> (1) is not original; or
> (2) consists of designs that are staple, commonplace, or familiar in the semiconductor industry, or variations of such designs, combined in a way that, considered as a whole, is not original.

To prevent mask work protection from adversely impacting the scope of patent protection, section 902 (c) states:

> In no case does protection. . .for a mask work extend to any idea, procedure, process, system, method of operation, concept, principle, or discovery, regardless of the form in which it is described, explained, illustrated, or embodied in such work.

B. Grant and Duration of Protection

Section 905 accords the owner of a protectable mask work several exclusive rights:

> (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 to cause another person to do any of the acts described in paragraphs (1) and (2).

As specified in section 904 (b), the exclusivity accorded a mask work owner lasts for at least ten years.[41] As specified in section 904 (a), this exclusivity provided by section 905 commences on the date that the earlier of two events occurs: the date on which the mask work is registered or on the date on which the mask work is first commercially exploited anywhere in the world.

C. Registration of Mask Works and Transfers of Ownership

Section 908 grants authority to the Copyright Office to handle mask work registration applications and to grant mask work registration certificates. Presently, the Copyright Office has instituted, by adopting suitable regulations, a mechanism for handling mask work applications and granting registration certificates.[42]

Under section 908 (a), a two-year registration window exists within which applications to register previously commercialized mask works must be made. Specifically, once a mask work is commercially exploited anywhere in the world, the mask work owner must file an application for mask work registration within two years thereafter or this protection will cease.

The Copyright Office regulations mandate that masks be deposited as part of the application process. However, the Copyright Office has recognized that trade secrets may be contained in mask work deposits. To prevent public access to these secrets, the Copyright Office has allowed limited "identifying" deposits to be made. These deposits often comprise a portion of the mask (*i.e.,* certain layouts) rather than the entire mask itself. Alternatively, the Copyright Office permits that sensitive material may be blocked out or stripped from the deposited material.[43]

Section 903 provides that all the exclusive rights belong to the owner of the mask work; it also provides that these rights may be transferred, by assignment or other legal means, and lastly provides that any document of transfer may be recorded in the Copyright Office and, once recorded, constitutes constructive notice of the transfer to the public.

41. Although section 904 provides a ten-year term for mask works, this term, under section 904 (c), runs to the end of the calendar year in which it would otherwise expire. Inasmuch as the period of protection for a mask work could commence on January 1 of any year, mask work protection would run to the end of the tenth successive year, in effect providing one day less than eleven full years of protection.
42. See Circular 100, "Federal Statutory Protection for Mask Works," Copyright Office, and accompanying mask work registration form "MW."
43. *Id.*

D. Permissive Notice

The owner of a mask work may, but is not required to, apply a notice to the mask work indicating that this work is protected under the Act. However, if the notice (typically the words "mask work" or the symbol "M" enclosed in a circle or alternatively the symbol "M" followed by the names of the mask work owner or a common abbreviation thereof) is affixed to the work, then this notice constitutes *prima facie* evidence of notice that the work is so protected.

E. Reverse Engineering

In enacting the 1984 Chip Act, Congress recognized that legitimate "reverse engineering" plays an important role in the continual evolution of semiconductor technology. Reverse engineering disseminates design information and thereby conserves time and expenditures by eliminating the need to reinvent standard chip designs. This, in turn, frees design resources to be consumed primarily on formulating new chip designs. However, Congress recognized that a very fine line occurs between legitimate reverse engineering efforts and piratical copying. To differentiate one from the other, Congress noted that reverse engineering is usually evidenced by a "paper trail," which consists of notebooks of engineering and technical information discovered through reverse engineering. Piratical efforts, on the other hand, leave no such "paper trail."

To encourage reverse engineering to continue, Congress enacted section 906 of the Act. Under this provision, reverse engineering any mask work and use of the teachings obtained therethrough are not an infringement of the exclusive rights accorded by section 905. In fact, an original mask work containing the efforts of a previously registered mask work that has been legitimately reverse engineered can itself be registered as a new mask work and will not infringe any of the exclusive rights accruing to the earlier registered work. Specifically, section 906 (a) recites:

> 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 to be made to be distributed.

Clearly, the existence of legitimate reverse engineering efforts that falls within section 906 (a) will depend upon the existence of a satisfactory paper trail documenting these efforts and the information gained thereby.

F. Reciprocity

To assure that an adequate international remedy will be available to Americans to combat chip piracy, the 1984 Act predicates protection for mask works that are foreign owned and first commercially exploited in a foreign country based on the existence of equivalent reciprocal rights provided in that country for U.S. mask works. Such reciprocal requirements are entirely new to U.S. intellectual property law. The purpose of this requirement is simple: to force other countries, notably those in the Far East, to enact similar laws which would provide a remedy to Americans harmed by piratical activities being conducted there and from pirated chips emanating from these countries. Unless the Secretary of Commerce finds, within three years after the enactment of the 1984 Chip Act, that a foreign country, as required under section 914, has enacted such a law, or is making good faith efforts and reasonable progress towards enacting such a law and/or entering into a suitable treaty with the United States and is not engaging in piracy of United States mask works, mask work protection is denied to the nationals or sovereign authorities of that foreign country. Specifically, section 914, in pertinent part, states:

> (a) . . .[T]he Secretary of Commerce may, upon the petition of any person, or upon the secretary's own motion, issue an order extending protection under this chapter to such foreign nationals, domiciliaries, and sovereign authorities if the Secretary finds—
>
> (1) that the foreign nation is making good faith efforts and reasonable progress toward—
>
> (A) entering into a treaty described in section 902 (a) (1) (A); or
>
> (B) enacting legislation that would be in compliance with subparagraphs (A) or (B) of section 902 (a) (2); and
>
> (2) that the nationals, domiciliaries, and sovereign authorities of the foreign nation, and persons controlled by

them, are not engaged in the misappropriation, or unauthorized distribution or commercial exploitation, of mask works; and

(3) that issuing the order would promote the purposes of this chapter and international comity with respect to the protection of mask works. . . .

(d) (1) Any order issued under this section shall terminate if—

(A) the Secretary of Commerce finds that any of the conditions set forth in paragraphs (1), (2), and (3) of subsection (a) no longer exist; or

(B) mask works of nationals, domiciliaries, and sovereign authorities of that foreign nation or mask works first commercially exploited in that foreign nation become eligible for protection under subparagraphs (A) or (C) of section 902 (a) (1) . . . .

(e) The authority of the Secretary of Commerce under this section shall commence on the date of enactment of this chapter, and shall terminate three years after such date of enactment.[44]

44. On October 22, 1984, prior to the November 8, 1984, effective date of the 1984 Semiconductor Chip Protection Act, the Electronics Association of Japan (EIAJ) filed a petition with the Secretary of Commerce under section 914 which, if granted, would accord interim protection for mask works of Japanese origin under the 1984 Act. The petition is predicated on proposed Japanese mask work legislation, as well as on an exchange of letters between various U.S. government officials and various officials of the Japanese Ministry of International Trade and Industry (MITI). The petition was supplemented with a statement of an official of MITI. *See* letter to Donald Quigg, Acting Commissioner of Patents and Trademarks, from Yuji Tanahashi, Deputy Director-General Machinery and Information Industries Bureau of MITI, reprinted in 29 PTCJ No. 724, April 4, 1985, at pages 590-94. Section 914 (a) (1) requires a showing based, in part, that a "foreign nation" is making good faith efforts and reasonable progress toward entering into a treaty or enacting appropriate legislation. The Secretary of Commerce has delegated his authority to grant section 914 petitions to the Commissioner of Patents and Trademarks. The Commissioner interprets the "foreign nation" language in section 914 (a) (1) to require a statement from a governmental official—here an appropriate person authorized to speak for the Japanese government—that the government involved is itself "making good faith efforts and reasonable progress." *Id.* In an interim order dated June 6, 1985, Donald J. Quigg, Acting Commissioner of Patents and Trademarks, granted Japanese nationals the right to obtain protection under the Act for a one-year period of time. The U.S. Patent and Trademark Office (PTO) has concluded that the Japanese government is making "good faith efforts and reasonable progress towards" enacting reciprocal legislation and the one-year period will permit the U.S. PTO "to review the manner in which the [Japanese] law is being implemented and how the Japanese law will function in a manner that

G. Remedies

The 1984 Act provides a variety of civil remedies. At present, there are no criminal penalties for mask work infringement. As a threshold matter, section 910 (b) (1) restricts the class of persons who can utilize these remedies to: mask work owners or their exclusive licensees of *all* the rights provided by section 905 of the Act, all of whom will be collectively referred to hereinafter as mask work owners—nonexclusive licensees or exclusive licensees of only some of the rights are powerless under the Act.

To obtain access to the U.S. district courts, a mask work owner must either have a mask work registration certificate or have an application for mask work registration pending before the Copyright Office, even if the Copyright Office has refused to register the mask work. Should the latter occur, the applicant, under section 908 (g), can bring an action in an appropriate U.S. district court, within sixty days after the refusal, to keep the application alive and to seek judicial review of the decision of the Copyright Office.

To combat infringement, a mask work act plaintiff possesses an arsenal of judicial weapons. As specified in section 911, a court is empowered to order: injunctive relief in the form of temporary restraining orders, preliminary injunctions and permanent injunctions (section 911 (a)) along with actual damages resulting from the infringement *plus* the defendant's profits attributable and not taken into account in calculating these damages (section 911 (b)), or alternatively, statutory damages up to

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provides protection equivalent to that under U.S. law." *See* 30 PTCJ No. 734, (June 13, 1985), at pp. 158–59.

Acting Commissioner Quigg has recently signed similar section 914 orders granting interim protection under the Act to nationals of Sweden (*see* 30 PCTJ No. 735, June 20, 1985, at p. 171); and those of the Netherlands, Canada, Great Britain and Northern Ireland, and Australia (*see* 30 PTCJ No. 737, July 4, 1985, at p. 231). A petition was filed in the PTO which sought interim protection under the Act for nationals of all member states of the European Economic Community (EEC), namely the United Kingdom, Netherlands, Federal Republic of Germany, Belgium, Luxembourg, Denmark, Republic of Ireland, France, Italy, and Greece. *See* 30 PTCJ No. 737, July 4, 1985, at p. 232, and 30 PTCJ No. 739, July 25, 1985. Individual orders were signed by Acting Commissioner Quigg on September 12, 1985, granting such protection to all EEC countries with the exception of the United Kingdom and the Netherlands. Interim protection previously accorded to the Netherlands was extended to expire on the same date as that accorded to other member states of the EEC. See 50 Fed. Reg. 37892, Sept. 18, 1985.

In a telephone conversation on October 16, 1985 between the author and Michael Keplinger, Attorney Advisor with the Office of Legislation and International Affairs in the PTO, Mr. Keplinger reported that as of that date, there were no section 914 petitions pending before the PTO.

a maximum of $250,000 (section 911 (c)). To establish the infringer's profits, under section 911 (b), a plaintiff is only required to offer proof as to the defendant's gross revenues. Thereafter, the burden shifts to the defendant to prove both its deductible expenses and those profits not attributible to its mask work infringement. The 1984 Act contains a three-year statute of limitations (section 911 (d)) which parallels that applicable to copyrights (17 U.S.C. 507).

The financial penalties under the 1984 Act are intentionally substantial. The imposition of substantial "disincentives" to infringe are premised, in the words of the House, on the

> very substantial front-end costs of chip creation and the severe adverse economic impacts of mis-appropriation on incentives to creation of new technology. I[t] also counterbalances the absence of criminal sanctions. Unlawful chip copying, an activity designed primarily for commercial gain, is best controlled through substantial economic sanctions.[45]

Moreover, a court can order that infringing semiconductor chip products be seized, impounded, and/or destroyed (section 911 (e) (1)). The Act provides that an order may be obtained from the International Trade Commission (ITC) excluding future importation of semiconductor chip products containing infringing mask works as well as providing for seizure and forfeiture of previously imported infringing products (sections 901 (c) (1) and (2)).

Hence, the remedies under the 1984 Act are severe and should serve to cause even the most ardent infringers to think twice before infringing a protected mask work.

Innocent infringers—individuals who have no notice that they are importing and/or distributing semiconductor chips that contain infringing mask works—are insulated from liability. Under section 907 (a) (1), innocent infringers have no liability whatsoever until they receive notice of infringement, and thereafter they are only liable, under section 907 (a) (2), for a reasonable royalty on semiconductor chip products that they purchased before receiving notice and distributed and/or imported (resold) after receiving notice. The amount of this royalty is to be determined by: voluntary negotiation between the parties, mediation, binding arbitration, or, if all nonlitigous efforts fail, resort to an infringement action. Anyone who purchases an infringing semiconductor

45. House Report, *supra* note 3, at 27.

chip product from an innocent infringer is shielded from liability to the same extent as an innocent infringer (section 907 (c)). Clearly, once an innocent infringer or purchaser therefrom receives notice of infringement, he loses his "innocent" status as to all infringing semiconductor chip products which he has not yet obtained or purchased. As to those chips, he is subject to the full panoply of harsh remedies available under the 1984 Act.

H. Effect of 1984 Act on Patent and Copyright Protection

Section 912 (a) specifically states:

> Nothing in this chapter [The Semiconductor Chip Protection Act of 1984—Chapter 900 of the 1976 Copyright Act] shall affect any right or remedy held by any person under chapters 1 through 8 of this title [copyrights], or under title 35 [patents].

As such, this Act does not affect the availability of patent and copyright protection. Chip designs, as discussed above, were never viewed by the Copyright Office as being copyrightable. The 1984 Act provides protection where no protection existed before—for the chips themselves. However, questions have arisen as to whether provisions of the 1984 Act will affect the copyrightability of software stored within chips. The answer is no. Software stored within a chip does not lose its copyrightability or any of the protection accorded by copyright. This view is in accord with the holding of the Third Circuit in *Apple v. Franklin,* discussed previously.

Patents cover far more than just a particular structure, and if they contain broad claims, they reach out and embrace a fundamental idea as long as it is embodied in any structure. The Chip Act does not protect any idea, only a particular structure—the three-dimensional, layered structure which forms an integrated circuit chip.

Consequently, separate aspects of an integrated circuit chip can be protected with patents and mask work registrations, and the software stored therein can be protected through copyrights. All these avenues should be used to their fullest extent to protect commercially important chips.

I. Issues Awaiting Judicial Resolution

Congress, in drafting the 1984 Act, intentionally failed to address certain issues and accorded only passing mention to others, such as: what constitutes legitimate reverse engineering, the standard to measure originality, and the standard to measure infringement and appellate review.

1. *Reverse Engineering*

In section 906 (a), which sanctions reverse engineering, Congress effectuated its intent that legitimate reverse engineering serves a valuable function in the semiconductor industry and should be encouraged to continue. However, Congress also provided means to stop chip piracy through infringement actions and other harsh remedies available under the Act.

Congress recognized that differentiating legitimate reverse engineering from chip piracy can be handled by looking for a suitable "paper trail." In particular, Congress believed that pirates look to spend as little money as possible and copy a protected mask work on a wholesale basis. Pirates leave no "paper trail" documenting their efforts. Reverse engineers, by contrast, often spend considerable money in analyzing a protected chip and, as a result of their efforts, only incorporate a portion of the reverse engineered mask work into a new chip. However, the knowledge gained by the reverse engineer is fully documented for later use and study. Therefore, owing to the economies of chip piracy and the existence of a "paper trail," Congress believes that very few, if any, situations should arise where doubt exists as to whether reverse engineering or piracy has occurred. In particular, the Senate Report states:

> There are two reasons for this. First, it will ordinarily not be economical for the pirate to copy only part of an original chip and contribute his own engineering designs for the rest. As a practical matter, the costs involved deprive the pirate of much of the benefit he seeks through his piracy. Second, the various parts of a chip are usually so integrated and inter-related that copying only part will not result in a useable end product—at least, again, not without significant economic investment in R & D on the part of the pirate, an investment unlikely to be made. Hence, cases will rarely arise that are in a gray zone between clear copying and clearly legitimate reverse engineering, since most factual situations in this field are either at one end or the other of the spectrum.
>
> Additionally, this gray zone will be further reduced by use of this kind of evidence that courts should rely on to

distinguish legitimate reverse engineering from piratical copying. As one expert pointed out, reverse engineering leaves a "paper trail" not found in the files of pirates:

> 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 that 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. . . .

The [Senate] committee agrees with and adopts that view as a guide to its intent.[46]

While this "paper trail" makes sense in theory, it is simply not clear just what types of material this "paper trail" should comprise in any given factual situation and the level of detail it should contain. Inasmuch as engineers are quite averse to producing documentation of any sort, particularly at the detail mentioned above, this author expects that many true reverse engineering efforts will only be scantily recorded, if at all. Thus, the results of legitimate reverse engineering may often resemble the shabby records of pirates. While many hours and significant financial expenditures may have been spent in reverse engineering a protected mask work with the result that a major portion of the work has been included in a subsequent work—as encouraged by the 1984 Act—an adequate "paper trail" documenting these efforts might not exist. Hence, these efforts might likely be branded as piratical. Although testimony adduced through discovery would counteract an assessment of undocumented or sparingly documented reverse engineering as being piratical, the manner and effect of such testimony needed in any given situation is left to an *ad hoc*

46. *Senate Report*, *supra* note 4, at 21-22.

determination. Therefore reverse engineers must thoroughly document their efforts or risk losing their protection under the Act. Moreover, plaintiffs must be on guard for any "paper trail" that was constructed after the fact in an effort to camouflage piratical efforts and make them appear as legitimate reverse engineering.

The determination of what constitutes legitimate reverse engineering in any situation is now left to the courts.

2. *Originality*

Under section 902 (b), the 1984 Act provides no protection for mask works that are not "original." In addition, reverse engineering efforts which result in inclusion of a protected mask work into a new chip are insulated from liability as infringing activities, provided the new chip is "original."

Section 902 (b) (2) states that a design that is staple, commonplace, or familiar in the semiconductor industry would be nonoriginal. In addition, well-known variations of these designs, when considered as a whole, would also be viewed as being nonoriginal. Clearly, this is a rather loose definition of originality.

The standard of originality consists of two parts: a novelty type test and an obviousness type test—although neither is as rigorous as for patents. As to the first, the requirement of "staple, commonplace, or familiar" designs raises questions of novelty, *i.e.,* is the design known in the art, either published or part of the knowledge possessed by those of presumably ordinary skill in the art. Whether a variation of such a design, when considered as a whole, is nonoriginal raises questions akin to nonobviousness , *i.e.,* would one of again presumably ordinary skill in the art have combined staple, commonplace, or familiar designs in the manner contained in the mask work under consideration.

The House bill incorporated a provision which limited the inquiry of mask work originality to the mask work owner, *i.e.,* the mask work (particularly the owner's contribution) was said to be original if the owner developed it independently and did not copy it from another source (the customary copyright definition of originality).[47] This provision was deleted from the 1984 Act. One can only speculate if courts will limit originality to a consideration of the mask work owner himself (a subjective standard) or take an expansive view by considering the knowledge present in the art (an objective standard).

If originality is limited to the mask work owner and his activities, piracy can be easily insulated under the reverse engineering provision. In

47. House Report, *supra* note 3, at 17. See section 901 (4) in H.R. 5525.

particular, pirates need only prove that they combined a protected mask work with what are to them original additions, such that when the entire mask work is viewed as a whole and considered in view of their subjective knowledge at the time, the entire new pirated mask work is "original" to them.

Alternatively, reliance on an objective standard of originality, *i.e.,* evaluating designs with respect to what one of ordinary skill in the art would know, places a much heavier burden on a pirate to counter a charge of infringement. Hence, this author submits that Congress, aware that a subjective view of originality would open an avenue to legitimize what is otherwise piracy, chose, by eliminating the House definition from the Act, to utilize an objective standard.

Moreover, will the existence of a "paper trail" affect the amount of originality required for a mask work to be protectible? For example, if an extensive "paper trail" exists to document reverse engineering, should the amount of originality be as great as it would be in the absence of such a trail? Clearly, to encourage reverse engineering—which the 1984 Act purports to do, it would seem that the degree of originality should vary inversely to the extent of the "paper trail." The greater the "paper trail," the more effort was spent reverse engineering the mask work and analyzing the knowledge embodied therein, and the less originality should be needed.

However, under the Act, originality alone and not the extent of a "paper trail" is the key element. Why, then, should an engineer be liable, if, after going through all this effort, he concludes that the design embodied in the mask work is optimum for his use, *i.e.,* he cannot improve it, and thereby he decides to utilize it with minor, if any, modifications? At first glance, he should not be liable. However upon deeper examination, the resulting mask work is not likely to be original, and, even though the engineer has a proper "paper trail" documenting his efforts, he is not shielded from liability as an infringer.

Since the goal of reverse engineering is to disseminate knowledge and minimize design time needed to find an optimal chip design, this goal can best be met by allowing the engineer the latitude he needs to pick suitable designs, after sufficient analysis, and then incorporate these designs into new chips. The question of liability should primarily turn on the extent of the "paper trail" rather than on any originality—inasmuch as the former may be significant and the latter minimal, as the result of legitimate reverse engineering efforts.

Inasmuch as "originality" appears to be a linchpin in the Act, prompt judicial articulation of the proper standard is imperative.

3. *Proof of Infringement*

Now, for the moment, assume that two chip designs exist, one incorporating a protected mask work and the second being an alleged copy. Furthermore, assume reverse engineering cannot be shown either by reference to a sufficient "paper trail" and/or to the copy being sufficiently "original." How does one determine whether the copy infringes the protected mask work? No one knows for sure. The 1984 Act is totally silent. However, legislative history provides a clue:

> It is the intent of the [House] Committee to permit, under the reverse engineering limitation, the "unauthorized" creation of a second mask work whose layout, in substantial part, is similar to the layout of the protected mask work—if the second mask work was the product of substantial study and analysis, and not the mere result of plagiarism accomplished without such study or analysis.[48]

Thus, this passage indicates that in the absence of substantial study and analysis, infringement becomes actionable whenever the copied mask work is "substantially similar" to the protected mask work—the copyright standard of infringement.

Using the substantial similarity test for mask work infringement raises its own special problem: for mask works, how similar is "substantially similar"? The Senate noted that there is no "rule of thumb" to determine how much copying qualifies as being substantial. For copyrights, the degree of similarity depends on the subject matter of the works and the inherent creativity in the work that was copied. For a highly creative work, less similarity is needed than for a less creative work. Hence, a play might require far less similarity, when compared against an alleged copy, for infringement to be found than for a standard commercial document. The same may be said of mask works: mask works that embody significant creativity (*e.g.*, unique microprocessors or memory chips) may require far less similarity when compared against a pirated work than those mask works (*e.g.*, standard circuit chips, such as gates, registers, and the like) that embody less creativity before actionable infringement is found.

In any event, the amount of required similarity remains to be decided on a case-by-case determination.

48. *Id.* at 22.

4. *Appellate Review*

Although not mentioned in the 1984 Act, appeals from mask work infringement and registrability decisions of the U.S. district courts would likely rise up through the normal appellate route, *i.e.*, through the various circuits, rather than through a single, specialized federal appellate court, such as the Court of Appeals for the Federal Circuit (CAFC). Consequently, with many standards in the 1984 Act now awaiting judicial clarification, conflicting decisions between circuits with varying resulting judicial standards are likely to occur until finally resolved by the Supreme Court. Unfortunately, the product life of most chips is very short. Hence, it is very unlikely that many mask work owners will want to wait the four-five years necessary to obtain a Supreme Court decision, assuming, of course, that the Supreme Court grants *certiorari* in order to hear such a case.

Even if a mask work owner contemplates filing an infringement action, forum shopping will be the rule. Jurisdiction will be sought in those forums exhibiting the least judicial hostility to mask works—much like that which occurred with patents prior to the inception of the CAFC, which now has sole nationwide jurisdiction over patent appeals. Possibly, if mask work suits become sufficiently numerous and conflicts increase in number and divergency, then appellate jurisdiction over mask works suits might, in time, be given over to a single, specialized federal court of appeals, *e.g.*, CAFC.

J. A Few Thoughts

1. *International Aspects*

The United States has taken a bold initiative in enacting the 1984 Semiconductor Chip Protection Act. Through it, the United States strongly recognizes that piracy, particularly of chips, has reached epidemic levels, and existent intellectual property treaties, and all foreign national laws, provide inadequate and, in most instances, no effective legal methods to deter this piracy. Congress has clearly indicated that U.S. protection of intellectual property emanating from a foreign country (here, mask works) is strictly conditioned on the availability of protection for U.S. intellectual property in that country on the same basis as that country affords to its own nationals. If a country is unwilling to protect U.S. mask works, then the U.S. will deny reciprocal protection.

Owing to the ever-growing importance of the semiconductor industry and the position of the United States as the dominant market, few industrialized, technologically sophisticated countries (particularly Japan) will willingly jeopardize their share of the U.S. semiconductor market. Hence, if for no other reason than to safeguard their market share, this author expects most, if not all, of these countries will provide some form of reciprocal mask work to Americans and its own nationals. Hence, international mask work protection, either through treaty and/or a collection of national laws, is likely to emerge in the near future.

Nonetheless, when foreign mask work protection arises, it is very likely to occur only in the highly industrialized Western countries (*e.g.*, United States, Japan, France, West Germany, United Kingdom, Italy, Canada, and the like). By contrast, Third World countries, which are generally devoid of technologically driven industry, are far more likely to expropriate (through, for example, compulsory licensing) any integrated circuit technology that crosses its borders rather than to protect it. As a result, mask work infringers, over time, will shift their operations to Third World countries and still continue to pirate chip designs and smuggle pirated chips into the industrialized marketplace. Third World countries will likely harbor and protect rather than inhibit infringers, as their plants may be some of the few technical facilities willing to operate in these countries and provide sorely needed foreign capital, employment, and technical training to a largely unskilled, often illiterate, native work force.

While the 1984 Chip Act provides new, potent remedies to stifle infringement, the Act does not diminish the need for American semiconductor manufacturers to exercise continued vigilance against piracy.

2. *Technology Limitations Inherent in the 1984 Act*

In sections 901 (a) (1) and (3), a semiconductor chip product is defined as having "two or more layers" in which a mask work is fixed. Clearly, as technology evolves, new classes of integrated circuitry (*e.g.*, magnetic bubble technology which presently exists) will emerge that, in fact, utilize only one layer. At present, these new single-layer technologies are unprotected under the 1984 Act. If single- and multiple-layer technologies were combined in one device (*e.g.*, a magnetic bubble integrated memory circuit), would the 1984 Act be expansively read to fully protect these devices, or would protection be accorded only to the multiple-layered portion? At present, probably only the latter would be protected. Would this result change if production realities were such that to make such a device, multiple masks were, in fact, used to fabricate the device (although portions of, for example, a photolithographic mask were totally transparent or opaque) in order to implement the single-layered portion—although the use of a second mask situated over the single-layered portion during its manufacture would not be evident from reverse engineering?

In any event, as technology evolves, this writer fully expects the 1984 Act to change in step with technology inasmuch as the commercial realities, which mandated that the Act be passed in the first instance, will mandate the manner in which the Act should be amended in the future.

V. CONCLUSION

Although the 1984 Semiconductor Chip Protection Act is not without its limitations, the Act provides a new class of protection and a highly potent arsenal of remedies. With this Act, Congress has now provided the tools for legitimate chip manufacturers to inflict heavy damage on chip pirates. The time has now come for the semiconductor industry to take up the challenge.