Networking Software Copyrights and the Semiconductor Chip Protection Act: A Study of Legal Protection for Application Specific Integrated Circuit Technology

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Introduction

From life-saving medical equipment to the latest video game, electronics technology increasingly influences modern-day life. An inevitable tangent is the struggle to define legal rights in this technology. Frequently, computer programmers and electronics developers contend with techno-pirates who duplicate and distribute misappropriated technology. The high cost of technology development and the comparatively low cost of duplication intensifies the problem.[1] The resulting legal conflicts range from a video game manufacturer's misappropriation of software,[2] to a microscopic inspection of electronic chips for similarity.[3] Currently, federal copyright law is the primary means of preventing unauthorized duplication of computer software.[4] Similarly, the Semiconductor Chip Protection Act of 1984[5] (SCPA) protects integrated circuits—the mainstay of modern electronic hardware. The novelty of these protection methods and the uncertainties surrounding new technology raise interpretive issues. A paramount issue is how to legally distinguish between hardware and software.

A special family of electronic chips—Application Specific Integrated Circuits (ASICs)—epitomizes this struggle. Most integrated circuits come from the supplier fully defined and ready for immediate use in an electronic device,[6] but ASICs require the purchaser to define some func-

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1. H.R. Rep., No. 781, 98th Cong., 2d Sess. 2-3 (1984), *reprinted in* 1984 U.S.C.C.A.N. 5750, 5750-52.

2. *See* Atari Games Corp. v. Nintendo of Am. Inc., 975 F.2d 832, 841-42 (Fed. Cir. 1992), *reh'g denied*, 1992 U.S. App. LEXIS 30957.

3. *See* Brooktree Corp. v. Advanced Micro Devices, Inc., 977 F.2d 1555, 1564 (Fed. Cir. 1992), *reh'g denied*, 1993 U.S. App. LEXIS 415.

4. *See e.g.*, Apple Computer Inc. v. Franklin Computer Corp., 714 F.2d 1240, 1248 (3d Cir. 1983), *cert. denied*, 464 U.S. 1033 (1984).

5. Semiconductor Chip Protection Act of 1984, Pub. L. 98-620, 98 Stat. 3347 (codified as amended at 17 U.S.C. §§ 901-914 (1988)).

6. *See* Parag K. Lala, Digital System Design Using Programmable Logic Devices 1 (1990).

tional characteristics before using the component.[7] The undefined state of ASICs resembles a pre-printed form with unfilled blanks. To fill in the blanks, the ASIC purchaser describes custom electronic features with special software.[8] Dedicated equipment translates these software descriptions into physical changes to the ASIC chip.[9] As a result of this "personalization" process, an ASIC becomes a hybrid of hardware and software. Thus, analyzing the protection available to personalized ASICs provides unique insight into software copyright and SCPA issues.

Case law providing categorical protection to ASICs is unlikely, given the breadth and evolving membership of this class of chip.[10] Nonetheless, specific legal controversies concerning ASICs abound.[11] In addition, chip developers employ special design techniques to impede technology piracy.[12] A global market[13] in excess of eight billion dollars[14] characterizes the economic role of ASICs. Growing consumer markets for automobile navigation systems and cellular telephone networks are predicted to boost

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7. *See* Jeffrey L. Hilbert, *Introduction to ASIC Technology, in* Application Specific Integrated Circuit (ASIC) Technology 2-5 (Norman G. Einsruch & Jeffrey L. Hilbert eds., 1991).

8. Ronald Collett, *Market Dynamics of the ASIC Revolution, in* Application Specific Integrated Circuit (ASIC) Technology 22-23 (Norman G. Einsruch & Jeffrey L. Hilbert eds., 1991).

9. *Id.* at 10, 22-23.

10. *See* Lala, *supra* note 6, at 4-7, 167-68, 242-43.

11. One type of ASIC, a Read Only Memory (ROM), can be copyrighted as a software vehicle. Apple Computer Inc. v. Franklin Computer Corp., 714 F.2d 1240, 1249 (3d Cir. 1983), *cert. denied*, 464 U.S. 1033 (1984). *See* Gerard V. Curtin, Jr., Comment, *The Basics of ASICs: Protection for Semiconductor Mask Works in Japan and the United States*, 15 B.C. Int'l & Comp. L. Rev. 113 (1992) (discussing the inadequacy of international protection of ASICs offered by the SCPA and parallel legislation in Japan); Glynn S. Lunney, Jr., Note, *Copyright Protection for ASIC Gate Configurations: PLDs, Custom and Semicustom Chips*, 42 Stan. L. Rev. 163 (1989) (arguing for the extension of copyright to ASICs). *See also,* Russell Flannery, *Taiwan Fears U.S. Trade Retaliation*, Electronic News, April 27, 1992, at 10 (discussing Taiwanese chip piracy, including ASICs); *NCR Hits AT&T with Antitrust Suit*, Electronic News, January 28, 1991, at 1 (revealing NCR assertion that AT&T merger resulted in unfair control of ASIC market).

12. Intel, the manufacturer of the recently released Pentium microprocessor, requires assent to a nondisclosure agreement before users can obtain access to key programming features of the device. This approach, at least temporarily, preserves a competitive advantage. Spencer Katt, *Katt's catch of the day: Appendix H is no help when the chips are down*, PC Week, May 17, 1993, at 128. Several types of ASICs include a security feature to prevent reading the programmed pattern which defines the custom features of the device. *See* Lala, *supra* note 6, at 7.

13. Dev Chakravarty, *Marketing ASICs, in* Application Specific Integrated Circuit (ASIC) Technology 48-50 (Norman G. Einsruch & Jeffrey L. Hilbert eds., 1991).

14. *See* Ronald Collett, *Market Dynamics of the ASIC Revolution, in* Application Specific Integrated Circuit (ASIC) Technology 8 (Norman G. Einsruch & Jeffrey L. Hilbert eds., 1991).

the ASIC market to fifteen billion dollars by the mid-1990s.[15] Federally funded ASIC projects, like high-performance computers, devices to assist the disabled, medical equipment, and military systems[16] punctuate the importance of ASICs. Thus, a close examination of legal protection available for ASICs not only enhances academic insight into software copyrights and the SCPA, but also responds to the expanding social and economic impact of ASICs.

Part I of this Note explains the technology at issue. Part II provides an analysis of the federal intellectual property protection available to ASICs. To fill potential gaps in protection and promote consistent application of the Copyright Act and the SCPA, Part III recommends complementary protection of ASICs under both acts and "judicial license" to adapt intellectual property statutes to new technologies.

I. The Technology Behind Integrated Circuitry

The advent of the integrated circuit in 1959 founded modern electronics, leading to the first microcomputers in the early 1970s.[17] Rapid advances continued through the seventies and eighties, culminating in the vast software and hardware industries of the nineties. The software industry is the more novel of the two areas because it depends on a mature electronics industry. This chronology prompts a description of hardware first.

A. Hardware

Electronic hardware designs include two types of circuits—linear and digital. Linear circuits continuously respond to an input signal to provide a continuous output. For example, adjustment of a light dimmer continuously changes light intensity. In contrast, digital circuits manipulate discrete signals. For example, the flip of a light switch alternates between the discrete states of *off* and *on*.[18] ASICs depend on a digital interface to personalize the circuit. This dependance calls for a more detailed discussion of digital design.

Digital circuitry usually represents the binary states of *off* and *on* as low and high voltages, respectively. The numerals "0" and "1" symbolically represent these voltages.[19] Although a single two-state signal

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15. *See id.*

16. Search of WESTLAW, FEDRIP-AB Library (July 20, 1993) (searching for the term "ASIC").

17. H.R. Rep., No. 781, 98th Cong., 2d Sess. 2 & n.2 (1984), *reprinted in* 1984 U.S.C.C.A.N. 5750, 5752 & n.2.

18. *See* Paul Horowitz & Winfield Hill, The Art of Electronics 316-17 (1980).

19. *Id.* at 317; Wils L. Cooley, *Circuit Principles*, *in* Electronic Engineers' Handbook 3-47 to 3-50 (Donald G. Fink & Donald Christiansen eds., 1989).

or bit is rather simplistic, an alignment of many bits can encode numbers, characters, and other information. For example, an alignment of eight bits creates a byte which may represent as many as 256 numbers.[20]

Digital designs break down into logic and memory functions. As the name suggests, logic circuits provide decision-making capability. For instance, these circuits compare or manipulate encoded information and provide the result as output signals.[21] These outputs might serve as inputs to additional logic devices, creating a complex chain of circuitry. In contrast, memory cells retain the state of a bit indefinitely.[22] An arrangement of memory cells with logic circuits creates sequential logic functions.[23] One common arrangement is a Random Access Memory (RAM).[24] Another common arrangement is the electronic brain of most desktop computers, the microprocessor.[25]

Complex manufacturing processes combine microminiature electronic components on a single monolithic chip.[26] This chip, or integrated circuit, may contain as many as 200,000 components[27] on a square as small as a quarter inch per side.[28] The process builds up the integrated circuit components one layer at a time, on a base of semiconductor material such as silicon.[29] Each step adds material onto previous layers or etches away some of the previously deposited material.[30] A mask acts as stencil, defining the pattern for material deposition or removal.[31] As a result, these mask images provide key information concerning integrated circuit manufacture.[32] A typical ASIC might employ twelve or more masks.[33]

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20. *See* HOROWITZ & HILL, *supra* note 18, at 316-21.

21. *See id.* at 331-37.

22. *Id.* at 341, 454.

23. *Id.* at 362-70.

24. A RAM retains binary patterns until rewritten or power removal. PAUL HOROWITZ & WINFIELD HILL, THE ART OF ELECTRONICS 354-56 (1980).

25. *Id.* at 484.

26. H.R. REP., No. 781, 98th Cong., 2d Sess. 2-3 (1984), *reprinted in* 1984 U.S.C.C.A.N. 5750, 5750-52.

27. Alan B. Grebene et. al., *Integrated Circuits and Microprocessors, in* ELECTRONIC ENGINEERS' HANDBOOK 8-2 (Donald G. Fink & Donald Christiansen eds., 1989).

28. H.R. REP., No. 781 at 13; Richard E. Matick et. al., *Electronic Data Processing, in* ELECTRONIC ENGINEERS' HANDBOOK 23-4 (Donald G. Fink & Donald Christiansen eds., 1989).

29. H.R. REP., No. 781 at 12-14; Alan B. Grebene et. al., *Integrated Circuits and Microprocessors, in* ELECTRONIC ENGINEERS' HANDBOOK 8-3 to 8-19 (Donald G. Fink & Donald Christiansen eds., 1989).

30. *Id.*

31. Alan B. Grebene et. al., *Integrated Circuits and Microprocessors, in* ELECTRONIC ENGINEERS' HANDBOOK 8-3 to 8-19 (Donald G. Fink & Donald Christiansen eds., 1989). *See* Joseph Montalbo, *ASIC Manufacturing, in* APPLICATION SPECIFIC INTEGRATED CIRCUIT (ASIC) TECHNOLOGY 194-96 (Norman G. Einsruch & Jeffrey L. Hilbert eds., 1991).

32. *Id.*

33. Joseph Montalbo, *ASIC Manufacturing, in* APPLICATION SPECIFIC INTEGRATED

The final product resembles an aerial photograph of an urban area with a grid-like street pattern.

B. Software

An overview of software also provides background necessary to frame ASIC legal issues. The Copyright Act[34] defines software or a "computer program" as a "set of statements or instructions to be used directly or indirectly in a computer in order to bring about a certain result."[35] Usually, a programmer composes software or source code from a high-level computer language such as BASIC, FORTRAN, or PASCAL.[36] A computer language contains the instruction formats, data structures, and the rules of syntax necessary to construct a useful program. High-level languages provide the most intelligible, human-readable form of software.[37] In contrast, when the programmer needs direct control over computer processing, a computer-specific assembly language is used.[38] This low-level source code is more cryptic and tedious, but is still intelligible to one trained in the given language.[39]

In order for the computer to execute a program it requires translation into machine language.[40] Machine language, or object code, contains the sequences of "1s" and "0s" needed to trigger the computers sequential logic functions.[41] Consequently, object code is impractical for human comprehension, but is the usual form for commercial distribution. An assembler program translates an assembly program into machine language. This translation is straightforward because each assembly language instruction corresponds to a unique object code sequence.[42]

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33. Joseph Montalbo, *ASIC Manufacturing, in* APPLICATION SPECIFIC INTEGRATED CIRCUIT (ASIC) TECHNOLOGY 194-96 (Norman G. Einsruch & Jeffrey L. Hilbert eds., 1991).

34. Act of October 19, 1976, Pub. L. No. 94-553, 90 Stat. 2541 (codified as amended at 17 U.S.C. §§ 101-810 (1988)).

35. 17 U.S.C. § 101 (1988).

36. *See* Richard E. Matick Et. Al., *Electronic Data Processing, in* ELECTRONIC ENGINEERS' HANDBOOK 23-83 to 23-86 (Donald G. Fink & Donald Christiansen eds., 1989); ARTHUR B. PYSTER, COMPILER DESIGN AND CONSTRUCTION 3-4 (1980). *See also,* Apple Computer, Inc. v. Franklin Computer Corp., 714 F.2d 1240, 1243 (3d Cir. 1983), *cert. denied,* 464 U.S. 1033 (1984).

37. PYSTER, *supra* note 36, at 3-4 (1980).

38. *Id.* at 3.

39. *See* PAUL HOROWITZ & WINFIELD HILL, THE ART OF ELECTRONICS 472, 487-97 (1980). *See also, Apple,* 714 F.2d at 1243.

40. PYSTER, *supra* note 36, at 3 (1980). *See also, Apple,* 714 F.2d at 1243.

41. *Apple,* 714 F.2d at 1243. *See* PYSTER, *supra* note 36, at 3.

42. HOROWITZ & HILL, *supra* note 18, at 472.

In contrast, transformation of a high-level language requires a compiler program.[43] A compiler translates the high-level language into intermediate assembly language form.[44] This process may expand the number of instructions and optimize certain aspects of the software.[45] This enhancement may alter the structure or sequence originally contained in the high-level source code.[46] The final step assembles this intermediate form into object code.[47] Thus, the sequence and organization of an object code from a high-level language is less similar to the original code than the object code from a low-level language.

In addition to language level, the categorical purpose of programs vary. The most direct program is the application program, which performs tasks such as bookkeeping and word processing under specific directions from the operator.[48] A less direct program is an operating system program, which specifies the internal operations of the computer system.[49] DOS is a common operating system program. Typically, user control over this type of program is limited.[50] Even more remote is computer microcode. Microcode usually refers to a special code permanently embedded in a computer. This code generates one or more binary operations inside a computer microprocessor for each object code instruction received.[51]

C. The Hardware-Software Hybrid: Application Specific Integrated Circuits (ASICs)

ASICs cut across traditional hardware-software and logic-memory definitions.[52] Broadly defined, ASICs are composed of three categories: (1) full custom, (2) semi-custom, and (3) Programmable Logic Devices (PLDs).[53] These devices can be linear, digital, or both.[54] The purchaser

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43. *Id.* at 472-3.

44. *See* PYSTER, *supra* note 36, at 3.

45. *Id.* at 17-19.

46. *Id.*

47. *Id.*

48. *See e.g.,* Apple Computer, Inc. v. Franklin Computer Corp., 714 F.2d 1240, 1243-44 (3d Cir. 1983), *cert. denied*, 464 U.S. 1033 (1984).

49. *Id.*

50. *Id.*

51. *See*, Tracy L. Hurt, *NEC v. Intel: Copyright and the Mysteries of Embedded Microcode*, 29 JURIMETRICS J. 313, 314 (1989); Robert Steinberg, *NEC v. Intel: The Battle Over Copyright Protection For Microcode*, 27 JURIMETRICS J. 173, 177-79 (1987).

52. For an explanation concerning the hybrid nature of ASICs, *see supra* notes 7-9 and accompanying text.

53. *See* LALA, *supra* note 6, at 2-4.

54. *See* James Rowson, *Computer-Aided Design Tools and Systems, in* APPLICATION SPECIFIC INTEGRATED CIRCUIT (ASIC) TECHNOLOGY 161-64 (Norman G. Einsruch & Jeffrey L. Hilbert eds., 1991). *See also*, PAUL M. BROWN, A GUIDE TO ANALOG ASICS 1-6 (1992).

of a full-custom ASIC specifies the entire device design.[55] Semicustom ASICs, called gate arrays, contain vast numbers of sequential logic building blocks or *cells* which are connected according to the purchaser's specifications.[56] Another type of semicustom ASIC is a macrocell design. These are personalized by connecting pre-defined cell groups selected from an ASIC vendor's macrocell library.[57] Programming both full-custom and semicustom designs is possible using a hardware description language.[58] A computer graphic logic diagram may also serve as an input for personalization.[59] The selected source data provide direction to the dedicated equipment, creating the masks for the final personalized integrated circuit layers.[60]

The last category of ASICs are PLDs. The common arrangements of logic gates and memory cells contained in PLDs result in the highest degree of pre-definition and the simplest customization process.[61] Initially, a small fuse connects each gate and memory cell in a fuse-link interconnection chip layer. This overload of connections renders the device useless. However, equipment transforms user-specified software or graphic representations of the desired circuit into electric signals. These signals blow fuses to remove unwanted connections. The remaining fuse-link connections implement the desired electronic function.[62] Among the most common fused-link devices are programmable read only memories (PROMs or ROMs), field programmable logic arrays (FPLAs) and programmable array logic (PAL).[63]

PROM or ROM is one of the best known device types. This PLD effectively contains a memory cell corresponding to each fuse. When a fuse is blown, the cell changes its binary state (such as from a "1" to a "0").[64] Thus, a ROM retains a readable "memory" pattern of "1s"

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55. Lala, *supra* note 6, at 2.

56. *See* Jeffrey L. Hilbert, *Introduction to ASIC Technology, in* Application Specific Integrated Circuit (ASIC) Technology 2-5 (Norman G. Einsruch & Jeffrey L. Hilbert eds., 1991).

57. A cell library contains representations of desirable custom functions available for incorporation in the vendor's ASIC. *Id.* at 3; Lala, *supra* note 6, at 3.

58. Ronald Collett, *Market Dynamics of the ASIC Revolution, in* Application Specific Integrated Circuit (ASIC) Technology 22-23 (Norman G. Einsruch & Jeffrey L. Hilbert eds., 1991).

59. *Id.* at 10, 22-23.

60. *See id. See also*, James Rowson, *Computer-Aided Design Tools and Systems, in* Application Specific Integrated Circuit (ASIC) Technology 127-34, 140, 148, 154-57, 166-67, 171 (Norman G. Einsruch & Jeffrey L. Hilbert eds., 1991).

61. *See* Lala, *supra* note 6, at 2-4.

62. *Id.* at 13.

63. *Id.* at 3-10 (1990).

64. Unlike a RAM, a ROM retains the memory pattern despite power removal. Alternatively, one can model a ROM as a logic device. *Id.* at 21-25.

and "0s" corresponding to which fuses are blown. FPLA and PAL personalization also result from selected removal of fuse connections. However, FPLA and PAL connection patterns facilitate logic-memory functions other than permanent memory.[65] A custom interconnecting mask layer may serve as a substitute for the fuse-link layer. A high volume of devices with the same connection pattern economically dictates this substitution.[66]

The personalization process for most ASICs is permanent, but recent technology resulted in erasable ASICs.[67] These devices are reusable, easier to test, and save chip space by replacing fuses with smaller electronic connections.[68] Their sophistication parallels that of simple gate arrays.[69] The two types of erasable ASICs are those erased by exposure to ultraviolet light and those electrically erased. However, their utility is limited.[70] Finally, because the connections of erasable ASICs are purely electronic,[71] no corresponding mask exists.

D. How Reverse Engineering Makes Duplication by Competitors Possible

Commonly available forms of software and hardware are object code and integrated circuits. Neither form contains a directly ascertainable description of how the product works. Frequently, developers try to decompose a product into functional elements to enhance their knowledge and incorporate improvements. This reverse engineering process varies depending on the product under inspection. In software, reverse engineering breaks object code into more discernable intermediate assembly language.[72] However, because of modifications during compilation, reconstitution of a high-level language is not possible.[73] Similarly, chip

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65. *See* LALA, *supra* note 6, at 4-7, 47, 53, 116, 124.

66. *Id.* at 22.

67. *Id.* at 167-68.

68. *Id.*

69. *Id.* at 167-69, 178, 186-87, 200-01, 242-243. *See* Dave Burskey, *Denser, Faster FPGAs vie for Gate-Array Applications*, ELECTRONIC DESIGN, May 27, 1993, at 55 (discussing the growing market for electrically erasable gate arrays).

70. Ultraviolet erasure requires an expensive quartz window in the integrated circuit package. Typical electrically erasable devices can be rewritten about 10,000 times and will typically retain data for about 10 years. LALA, *supra* note 6, at 23-24.

71. *Id.* at 23-24, 167-68.

72. *See* Sega Enters. Ltd. v. Accolade, Inc., 977 F.2d 1510, 1514-15 (9th Cir. 1992); Atari Games Corp. v. Nintendo of Am., Inc., 975 F.2d 832, 843-44 (Fed. Cir. 1992); Vault Corp. v. Quaid Software Ltd., 847 F.2d 255, 268-69 (5th Cir. 1988).

73. For an explanation of the compilation process, see *supra* notes 42-45 and accompanying text.

peeling entails the dissection of an integrated circuit layer by layer, revealing the materials and patterns necessary to reproduce integrated circuit masks.[74] However, the expense and incompatibility of related processes limit the effectiveness of this method.[75]

Both methods find application in a clean-room procedure.[76] For this procedure, one group "reverse engineers" a competitor's product and records the functional aspects. A second group, isolated from the product, takes this written specification and attempts to create a compatible product from it.[77] The legality of reverse engineering and the clean-room duplication process are considered in Part III.

II. Relevant Federal Law

The congressional authority to extend intellectual property protection to hardware and software arises from the Copyright and Patent clause of the United States Constitution.[78] Software protection arguably arose with the 1976 reenactment of the Copyright Act,[79] which accounted for contemporary technological advances.[80] A 1980 amendment removed all doubt concerning the copyrightability of software by adding the definition of "computer program" and by curtailing the exclusive rights for computer program copyright owners.[81] In contrast, the SCPA protection of integrated circuits through mask works is explicit.[82] Before considering the protection these statutes offer ASICs, this Note examines the strongest form of federal intellectual property protection—patent law.[83]

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74. *See e.g., Atari*, 975 F.2d at 836.

75. John G. Rauch, *The Realities of Our Times: The Semiconductor Chip Protection Act of 1984 and the Evolution of the Semiconductor Industry*, 75 J. Pat. & Trademark Off. Soc'y 114-16 (1993).

76. *See Sega*, 977 F.2d at 1514-15, 1525-26.

77. *Id.*

78. The clause grants congress the power "[t]o promote the Progress of Science and the useful Arts, by securing for limited times to Authors and Inventors the exclusive Right to their respective writings and Discoveries." U.S. Const. art. I, § 8, cl. 8.

79. Act of October 19, 1976, Pub. L. No. 94-553, 90 Stat. 2541 (codified at 17 U.S.C. §§ 101-810 (1988)).

80. *See* Apple Computer, Inc. v. Franklin Computer Corp., 714 F.2d 1240, 1247 (3d Cir. 1983), *cert. denied*, 464 U.S. 1033 (1984).

81. Act of December 12, 1980, Pub. L. No. 96-517 §10, 94 Stat. 3015, 3028 (codified at 17 U.S.C. §§ 101, 117 (1988)). *See Apple*, 714 F.2d at 1248.

82. 17 U.S.C. § 902 (1988).

83. *See* Patent Act, 35 U.S.C. §§ 101-376 (1988). The protection offered by a patent is broader and more certain than copyright. R. Lewis Gable & J. Bradford Leaheey, *The Strength of Patent Protection for Computer Products: The Federal Circuit and the Patent Office Refine the Test for Determining which Computer-related inventions Constitute Patentable Subject Matter*, 17 Rutgers Computer & Tech. L.J. 87, 87-89 (1991).

A. *Why Patent Law Will Not Categorically Protect ASICs*

Patents for hardware and software are available for ASICs on a narrow case-by-case basis, but the high standards of novelty[84] and nonobviousness[85] make categorical patent protection of ASICs unlikely.[86] Only patents for highly innovative electronic hardware are available.[87] Software patentability arguably depends on incorporation in an invention that satisfies the requirements of the Patent Act, irrespective of the particular software involved.[88] Consequently, an ASIC is not patentable unless it embodies a patentable hardware or software invention. In contrast, the potential for uniform coverage under the Copyright Act and the SCPA is greater.

B. *Copyrights*

A copyright holder obtains the exclusive right to reproduce and distribute copies of a protected work for commercial purposes.[89] The term of a copyright is at least fifty years.[90] Despite this broad protection, coverage is thin because it only extends to the expression of a work and not the underlying idea.[91] This expression element is in tension with the largely utilitarian nature of technological works. ASICs are not immune to this tension triggered first by the questions of whether ASICs are a proper subject for copyright, and second, by the unsettled nature of the software infringement test which probes the scope of that pro-

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84. 35 U.S.C. § 102.

85. *Id.* § 103.

86. *Cf.* Brooktree Corp. v. Advanced Micro Devices, Inc., 977 F.2d 1555, 1562-63 (Fed. Cir. 1992) ("[S]ome original circuitry may be patentable . . . [but] . . . Congress sought more expeditious protection [SCPA] against copying of original circuit layouts, whether or not they met the criteria of [a] patentable invention.").

87. *See Brooktree*, 977 F.2d at 1573, 1575, 1577 (upholding three patent claims concerning a video display chip); Intel Corp. v. U.S. Int'l Trade Comm'n, 946 F.2d 821, 831 (Fed. Cir. 1991) (involving patents in EPROM circuitry); In Re Mulder, 716 F.2d 1542, 1549 (Fed. Cir. 1983) (rejecting as obvious a patent on a particular gate array layout).

88. *See* Nelson R. Capes, *Current Status of Patent Protection for Computer Software,* 74 J. Pat. & Trademark Off. Soc'y 5 (1992). *Cf.* Arrythmia Research Technology, Inc. v. Corazonix Corp., 958 F.2d 1053, 1055 (Fed. Cir. 1992) (upholding patent which incorporates an algorithmic process specified as performable by a computer program or by dedicated hardware).

89. 17 U.S.C. § 106 (1988).

90. In the case of ownership by a named author protection lasts for the life of the author plus 50 years, but for anonymous or institutional owners, the protection lasts 75 years from registration or 100 years from creation, whichever is shorter. *Id.* §§ 301-03.

91. *Id.* § 102.

tection. In addition, the question of reverse engineering as a "fair use" of a copyrighted work affects the scope of copyright for ASICs.

1. Copyright Subject Matter.—The first question is whether ASICs are a proper subject for copyright protection. The Copyright Act provides that "[c]opyright protection subsists in original works of authorship fixed in any tangible medium of expression . . . ."[92] Also, it excludes from coverage "any idea, procedure, process, system, method of operation, concept, principle or discovery . . . ."[93] Thus, the subject matter test becomes: (1) whether the work is original, (2) whether the work is fixed in a tangible medium, and (3) whether the work is excluded as utterly utilitarian. Winnowing protected expression from the unprotected idea of a work could be considered part of the subject matter test. However, because this separation is an integral part of determining infringement, the expression—idea dichotomy is considered as part of the infringement test.[94]

(a) Categorical protection.—In addition to providing the basic elements of copyrightable subject matter, the Copyright Act lists eight categories of protected works,[95] but the list is not exclusive.[96] Unlisted works arising from new technology have a good chance at protection through judicial extension, but works previously rejected probably require legislative inclusion.[97] Software remains unlisted. Nonetheless, since the 1980 amendment,[98] copyright protection of high level application programs as a literary work is well-settled.[99] There have been extensions of protection to flowcharts;[100] user interfaces;[101] screen outputs;[102] and the

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92. *Id.* § 102(a).

93. *Id.* § 102(b).

94. *See* 1 Mellville Nimmer & David Nimmer, Nimmer On Copyright § 2.03[D] (perm. ed. rev. vol. 1992) [hereinafter Nimmer & Nimmer].

95. Literary works; musical works; dramatic works; pantomimes and choreographic works; pictorial, graphic and audiovisual works; sound recordings; and architectural works are all expressly protected. 17 U.S.C.A. § 102(a).

96. H.R. Rep. No. 1476, 94th Cong., 2d Sess. 51 (1976), *reprinted in* 1976 U.S.C.C.A.N. 5659, 5664.

97. 1 Nimmer & Nimmer, *supra* note 94, § 2.03[A].

98. For a discussion of this amendment, *see supra* note 81 and accompanying text.

99. *E.g.*, Whelan Assocs., Inc. v. Jaslow Dental Lab., Inc., 797 F.2d 1222, 1233-34 (3d Cir. 1986), *cert. denied*, 479 U.S. 1031 (1987).

100. Eng'g Dynamics, Inc. v. Structural Software, Inc., 785 F. Supp. 576, 583 (E.D. La. 1991); Lotus Dev. Corp. v. Paperback Software Intern., 740 F. Supp. 37, 43 (D. Mass. 1990).

101. Lotus Dev. Corp. v. Borland Intern., Inc., 788 F. Supp. 78, 82 (D. Mass. 1992).

102. *See e.g.*, Digital Communications Assocs., Inc. v. Softklone Distrib. Corp., 659 F. Supp. 449, 462-463 (N.D. Ga. 1987).

non-literal structure, sequence, and organization of computer programs.[103] Conversely, the pervasive utility of an integrated circuit mask work can arguably lead to the conclusion that mask works are not copyrightable per se.[104] This conclusion was one of the reasons for enactment of the SCPA.[105] Thus, the ASIC copyright issue narrows to whether the device is an embodiment of protected software.

(b) A starting point: how copyright law subject-matter standards have applied to integrated circuit components.—Prior software copyright decisions concerning integrated circuits provide a springboard for application of the subject matter test to ASICs. Protection of hardware customized by software began with infringement cases involving audio-visual copyrights in video game displays.[106] In these cases, the display image resulted from object code embedded in ROMs in the video game console.[107] Relying on the video game decisions, a landmark case, *Apple Computer, Inc. v. Franklin Computer Corp.*[108] definitively protected a ROM as a vehicle for software copyrighted as a literary work.[109] In this case, Apple Computer sought a preliminary injunction to enjoin Franklin Computer's infringement of copyrighted programs. These programs included the object code version of operating system software embedded on ROMs. Franklin admitted the copying, but maintained the programs were not copyrightable. The court held that object code is copyrightable, despite the inability to readily read it, and despite the utilitarian nature of a ROM media.[110] Furthermore, the utilitarian nature of an operating system program did not defeat protection.[111] Other circuits embraced the *Apple Computer* holdings.[112] Consequently, the copyright protection of a ROM as a software media is well established.

Another heralded case is *NEC Corp. v. Intel Electronics, Inc.*[113] In this case, NEC sought a declaratory judgement regarding infringement

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103. *Whelan*, 797 F.2d at 1248.

104. *See* H. R. Rep No. 781, 98th Cong., 2d Sess. 3-6 (1984), *reprinted in* 1984 U.S.C.C.A.N. 5750, 5752-53. *But see* 3 Nimmer & Nimmer, *supra* note 94, § 18.11[B].

105. *See* H. R. Rep No. 781, at 3-4.

106. *See e.g.*, Stern Elecs., Inc. v. Kaufman, 669 F.2d 852, 855-56 (2d Cir. 1982); Williams Elec., Inc. v. Artic Int'l, Inc., 685 F.2d 870, 874 (3d Cir. 1982).

107. *Stern*, 669 F.2d at 854; *Williams*, 685 F.2d at 871-72.

108. 714 F.2d 1240, 1249 (3d Cir. 1983), *cert. denied*, 464 U.S. 1033 (1984).

109. *Id.*

110. *Id.*

111. *Id.* at 1253-54.

112. *See* Cable/Home Communication Corp., v. Network Prod., Inc., 902 F.2d 829, 843 (11th Cir. 1990); Whelan Assocs., Inc. v. Jaslow Dental Lab., Inc., 797 F.2d 1222, 1233-34 (3d Cir. 1986), *cert. denied*, 479 U.S. 1031 (1987). *But see* Data Cash Sys., Inc. v. JS & A Group, Inc., 480 F. Supp. 1063, 1066-67 (N.D. Ill. 1979), *aff'd on other grounds*, 628 F.2d 1038 (7th Cir. 1980) (holding against copyright protection of object code prior to effectivity of Copyright Act of 1976).

113. The initial findings were reported in NEC Corp. v. Intel Corp., 645 F. Supp.

of Intel's microcode copyright.[114] In both published and unpublished decisions, the district court found the microcode copyrightable in spite of highly utilitarian material inherent in microcode.[115] However, the unpublished decision analyzed the degree of similarity and determined that NEC did not infringe the copyright.[116] Although it lacks precedential value, this case supports the likelihood that courts will extend copyright coverage beyond ROMs to other ASICs.

Both the *Apple Computer*[117] and *NEC*[118] courts found persuasive arguments in the final report of the National Commission On New Technological Uses of copyrighted works ("CONTU report").[119] The 1980 amendment of the Copyright Act adopted the recommendations of this commission.[120] As a result, courts treat this report as a comprehensive legislative history for the amendment.[121]

(c) Originality.—The first inquiry is whether ASICs satisfy the originality requirement. Originality requires only that the author did not copy the work from another and that the work possess "some minimal degree of creativity."[122] Minimal creativity must exceed mere independent effort, but any objective amount will do.[123] The CONTU report condones this traditional approach for software.[124] Originality poses little problem

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590 (N.D. Cal. 1986). However, the judge recused himself so the initial decision was vacated as moot at 835 F.2d 1546 (9th cir. 1988). On retrial, an unpublished decision was reported in No. C-84-20799-WPG, 1989 WL 67434 (N.D. Cal. 1989). *See also*, Tracy L. Hurt, *NEC v. Intel: Copyright and the Mysteries of Embedded Microcode*, 29 Jurimetrics J. 313 (1989); Robert Steinberg, *NEC v. Intel: The Battle Over Copyright Protection For Microcode*, 27 Jurimetrics J. 173 (1987).

114. For an explanation of microcode, *see supra* note 51 and accompanying text.

115. 645 F. Supp. at 595; 1989 WL 67434, at *3. See also Intel Corp. v. Advanced Micro Devices, Inc., No. C-90-20237-WAI, 1993 WL 135953, at *1 (N.D. Cal. April 15, 1993) (implicitly acknowledging the copyrightability of microcode).

116. NEC Corp. v. Intel Corp., No. C-84-20799-WPG, 1989 WL 67434, at *17 (S.D. Cal. 1989).

117. 714 F.2d at 1247.

118. 1989 WL 67434, at *2.

119. The commission resulted from Pub. L. 93-573, § 201, 88 Stat. 1873 (1974).

120. *Compare* National Commission On New Technological Uses Of Copyrighted Works, Final Rep, 12 (1979) [hereinafter CONTU Report] *with* Act of December 12, 1980, Pub. L. 96-517, § 10, 94 Stat. 3015, 3028 (adding definition of computer program to 17 U.S.C. § 101 (1988) and modifying 17 U.S.C. § 117 (1988)).

121. *But see* Whelan Assocs., Inc. v. Jaslow Dental Lab., Inc., 797 F.2d 1222, 1241-42 (3d Cir. 1986), *cert. denied*, 479 U.S. 1031 (1987) (refuting arguments stemming from CONTU Report).

122. Feist Publications, Inc. v. Rural Tel. Serv. Co., 111 S. Ct. 1282, 1287 (1991) (citing 1 Nimmer & Nimmer § 2.01); Lin-Brook Builders Hardware v. Gertler, 352 F.2d 298, 301 (9th Cir. 1965).

123. *Feist*, 111 S. Ct. at 1289.

124. CONTU Report, *supra* note 120, at 18, 20.

in software cases including those protecting ROMs.[125] Likewise, other ASICs should satisfy the originality requirement. However, two problem areas may arise under certain circumstances.

First, short sentence fragments and phrases may fail the originality requirement.[126] The programs customizing some ASICs may involve terse and redundant statements, especially in simpler devices such as PALs and PLAs. In *NEC*, the court acknowledged the limit, but even the smallest subroutines of the microcode survived because the originality inquiry considered the work as a whole.[127] Nonetheless, one district court found that a minor variation in a binary protocol for facsimile machine communications lacked originality.[128]

Most ASICs are highly customized devices, so applications expressed in short program fragments are unlikely. If the software definition of a device is so simple that it faces a serious originality challenge, then it is unlikely to merit any attention by the industry.

A second area where originality comes into question is when the work is compiled or derived from another work. Copyright protection for a compilation[129] or derivative work[130] only extends to the author's material contributions to the work.[131] In *Feist Publications, Inc. v. Rural Telephone Service Co.*,[132] the Supreme Court held that uncopyrightable facts arranged in an original way can be copyrighted as a compilation.[133] However, the Court further held that the arrangement of names and telephone numbers in a phone book lacked the requisite originality.[134] The customization of macrocell ASICs is mainly an arrangement of selected modules from a vendor's cell library. Similarly, many specifi-

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125. M. Kramer Mfg. Co., Inc. v. Andrews, 783 F.2d 421, 438 (4th Cir. 1986); Apple Computer, Inc. v. Franklin Computer Corp., 714 F.2d 1240, 1246 (3d Cir. 1983), *cert. denied*, 464 U.S. 1033 (1984).

126. *See*, Lin-Brook Builders Hardware v. Gertler, 352 F.2d 298, 301 (9th Cir. 1965); 1 NIMMER & NIMMER, *supra* note 94, § 2.01[B].

127. NEC Corp. v. Intel Corp., No. C-84-20799-WPG, 1989 WL 67434, at *2 (N.D. Cal. 1989).

128. Secure Servs. Technology v. Time and Space Processing, 722 F. Supp. 1354, 1363 (E.D. Va. 1989).

129. "A 'compilation' is a work formed by the collection and assembling of preexisting materials or of data that are selected, coordinated, or arranged in such a way that the resulting work as a whole constitutes an original work of authorship." 17 U.S.C. § 101 (1988).

130. "A 'derivative work' is a work based upon one or more preexisting works, such as a translation . . . abridgement, condensation, or any other form in which a work may be recast, transformed, or adopted." *Id.* § 101.

131. *Id.* § 103.

132. 111 S. Ct. 1282 (1991).

133. *Id.* at 1289.

134. *Id.* at 1297.

cation programs are arrangements of preexisting material. Nonetheless, even a slight "creative spark" in the arrangement offers the necessary originality.[135] So not only ROMs, but all ASICs characterized as compilations or derivations of prior works appear to survive the originality element if some creative aspect exists.

(d) Fixation.—The second copyright element is the identification of ASICs as a tangible media in which the work is fixed. "Fixed" means a media stable enough to permit communication of the work for "more than transitory duration."[136] As a software vehicle, ROMs meet the fixation requirement, including erasable varieties.[137] Similarly, other ASICs appear to provide sufficiently fixed media for the purposes of copyright.

The tangibility aspect of a work requires it to "be perceived, reproduced or communicated, either directly or with the aid of a machine or device."[138] In considering what constitutes a software copy, the CONTU report emphasizes the one-to-one correspondence between physical representations of code on a magnetic tape and the human-readable copy.[139] This commentary implicitly suggests that some degree of correlation is necessary. Because compilation modifies the structure of a high-level source code, reconstruction of the source code through disassembly is not possible.[140] However, even in the absence of a strict correlation, some level of structure and organization is probably discernable through disassembly. The current protection of object code, including ROMs, suggests this imperfect correlation of high-level source code to object code will still satisfy the second prong of the tangible media element.

The correlation argument is made against ASICs other than ROMs.[141] Except for ROMs, disassembly of ASICs does not yield a detailed expressive code. However, chip peeling might yield some organizational features traceable to the initial source code or computer graphic diagram, revealing a limited ability to perceive, reproduce or communicate the originating ASIC software.[142] Nonetheless, the detail of any information

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135. *Id.* at 1294.

136. 17 U.S.C. § 101 (1988).

137. *See* Apple Computer, Inc. v. Franklin Computer Corp., 714 F.2d 1240, 1243 (3d Cir. 1983), *cert. denied*, 464 U.S. 1033 (1984); E. F. Johnson Co. v. Uniden Corp., 623 F. Supp. 1485, 1490 (D. Minn. 1985).

138. 17 U.S.C. § 102(a).

139. CONTU REPORT, *supra* note 120, at 22.

140. For an explanation of the compilation process, *see supra* notes 42-45 and accompanying text.

141. *See* Gerard V. Curtin, Jr., Comment, *The Basics of ASICs: Protection for Semiconductor Mask Works in Japan and the United States*, 15 B.C. INT'L & COMP. L. REV. 113, 134 (1992).

142. For an explanation of chip peeling, *see supra* notes 73-75 and accompanying text.

surviving this transformation is unlikely to reach the degree of correlation that exists between object code and assembly instructions. Ultimately, the sufficiency of the correlation depends on whether "expression" as well as "idea" survived the transformation. Thus, this determination should default to the case-by-case infringement examination below.[143] Finally, requiring a strict correlation creates friction with the current protection of object code vehicles. Upsetting this protection contravenes the original intent of the legislature.[144]

(e) Utility.—The final test is whether the utilitarian nature of ASICs prohibits protection. This problem arises when the intended use of a copyrighted work requires copying the work.[145] In *Baker v. Selden*,[146] the Supreme Court denied protection to bookkeeping forms in a copyrighted book because the application of the teachings of the book required use of the forms.[147] This "useful article" doctrine expanded to forbid protection of any form.[148] Later cases narrowed the *Baker* holding,[149] and Congress appeared to codify this narrow interpretation in the Copyright Act by only prohibiting protection of utilitarian aspects of the work.[150]

A comparison with other categories of work challenged by the utility element reveal the impact on ASICs. The first category considered is software.

In *Apple Computer*, this challenge arose with respect to the copyrightability of operating system programs. The court held that although protection does not extend to the process underlying an operating system program, the utilitarian nature of the software does not bar protection when the work otherwise satisfies subject matter requirements.[151] Similarly, the majority in the CONTU report stated that utilitarian aspects of a computer program should not bar copyright protection.[152] Thus, neither the broad interpretation of *Baker* nor the useful nature of software prevent protection. Similarly, the primary use of an ASIC as a software vessel satisfies this element.

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143. For a discussion of the role of expression in infringement inquiries, *see supra* note 94 and accompanying text.

144. CONTU REPORT, *supra* note 120, at 22.

145. *See* 1 NIMMER & NIMMER, *supra* note 94, § 2.18[A].

146. 101 U.S. 99, 103 (1879).

147. *Id.*

148. 1 NIMMER & NIMMER, *supra* note 94, § 2.18[B][1].

149. *See e.g.*, Apple Computer, Inc. v. Franklin Computer Corp., 714 F.2d 1240, 1251-52 (3d Cir. 1983), *cert. denied*, 464 U.S. 1033 (1984) (citing 1 NIMMER & NIMMER § 2.18[D] and arguing that Mazer v. Stein, 347 U.S. 201 (1954) curtailed reading of *Baker* to withdrawal of protection from the underlying idea only).

150. *See* 17 U.S.C. § 102(b) (1988).

151. *Apple Computer*, 714 F.2d at 1251-52.

152. CONTU REPORT at 21.

Except for ROMs, the software character of a personalized ASIC is highly remote because the primary goal is a custom electronic device rather than computer instruction. Moreover, the ASIC may even become part of a machine executing software. The CONTU report suggests a limit, stating: "[t]he movement of electrons through wires and components of a computer is precisely that process over which copyright has no control. . . . [A]nyone is free to make a computer to carry out any unpatented process. . . ."[153] Thus, the unprotected functional aspects of an ASIC necessarily receive no protection, despite software origins. In contrast, the easy alternate characterization of a ROM as a logic device, instead of memory,[154] makes inconsistent legal results likely if the rules rely on technical distinctions between logic and memory.[155] Also, although the primary function of ASICs is more utilitarian than a protected ROM, the complete absence of expression does not follow. Consequently, this tenuous expression is best left to the infringement test for proper sorting.

Another analogous area concerns the protection of three-dimensional objects represented by drawings or illustrations. A copyrighted drawing does not protect the corresponding three-dimensional object.[156] In the past, a copyright of an architectural plan did not extend protection to the corresponding building with utilitarian features.[157] Similarly, copyrighted graphic or mask work representations of the three-dimensional characteristics of an ASIC may not protect it. However, the United States' accession to the international Berne Convention[158] resulted in the addition of architectural works as the eighth expressly listed work.[159] This addition broadens categorical protection and leaves room for expansion of coverage to favored areas such as new technological works.[160] Hence, this addition supports ASICs as an interstitial addition to copyright subject matter.

Copyright office regulations do not extend copyright protection to the ingredient lists of recipes.[161] An ASIC resembles a recipe because

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153. *Id.* at 22.

154. *See supra* note 64 and accompanying text.

155. *See* Mark A. Hollingsworth, *Is the Medium the Message? Extending Copyright Protection to Logic Devices*, 12 Whittier L. Rev. 383 (1991) (arguing for extension of copyright protection to computer integrated circuits); Glynn S. Lunney, Jr., Note, *Copyright Protection for ASIC Gate Configurations: PLDs, Custom and Semicustom Chips*, 42 Stan. L. Rev. 163 (1989) (arguing for extension of copyright to ASICs).

156. *See* 1 Nimmer & Nimmer, *supra* note 94, § 2.18[H][2].

157. *E.g.*, Imperial Homes Corp. v. Lamont, 458 F.2d 895, 899 (5th Cir. 1972).

158. 1 Nimmer & Nimmer, *supra* note 94, § 2.20.

159. Architectural Works Copyright Protection Act in 1990, Pub. L. 101-650, 104 Stat. 5089.

160. *See supra* notes 95-103 and accompanying text.

161. 37 C.F.R. § 202.1(a) (1991). Some cases have opposed this regulation, but these decisions are criticized. *See* 1 Nimmer & Nimmer, *supra* note 94, § 2.18[I].

personalization software provides the ingredients to make an electronic device. In contrast, a personalized ASIC involves alternate choices and complex arrangements, not just a simple list of ingredients. Thus, the recipe rule may not deny protection to ASICs.

Another comparative aspect of ASICs is the potential for overlapping protection methods. Video games often entangle two types of works embedded on a ROM: (1) computer programs as literary works and (2) video displays as audiovisual works.[162] For such dualistic works, copying of the computer program often results in infringement of both copyrights.[163] However, copying the video display does not infringe both because several different programs can result in the same audiovisual display.[164] Similarly a personalized ASIC is a transformation of an independently copyrightable computer program or graphic representation. Concurrently, an ASIC mask work warrants SCPA protection.[165] Also, like a video game ROM, the ASIC itself is an uncopyrightable mechanical device.[166] Although not directly analogous, the dual copyright protection afforded video games blazes the trail for concurrent methods of ASIC technology protection.

These subject matter comparisons do not reveal any strong challenges to ASIC copyright protection. In contrast, the low degree of correlation between ASICs and originating software, as well as the pervasive utility of the devices, persist as formidable subject matter threats. The absence of a categorical exclusion of expression under the subject matter examination weakens this threat. As a result, a case-by-case examination for infringement is likely to arise for most ASIC challenges.

2. Copyright Infringement: The Substantial Similarity Test.—An infringement action turns on whether the plaintiff owns the copyright and whether the defendant copied the work.[167] When copying is absent, no action in infringement exists—even if the independently created works are identical.[168] The software/ASIC analogy used in subject matter anal-

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162. *See e.g.*, Williams Elecs., Inc v. Artic Int'l, Inc., 685 F.2d 870, 875 (3d Cir. 1982); 1 Nimmer & Nimmer, *supra* note 94, § 2.18[H][3][b].

163. Only one registration is required for both the literary and audiovisual aspects of a computer program. 37 C.F.R. § 202.3(b)(3)-(b)(6) (codification of 53 Fed. Reg. 21,817 (1988)).

164. *See e.g.*, Stern Elecs., Inc. v. Kaufman, 669 F.2d 852, 855 (2d Cir. 1982); 1 Nimmer & Nimmer, *supra* note 94, § 2.18[H][3][b].

165. 17 U.S.C. § 902 (1988). For discussion of mask works, *see supra* notes 102-03 and accompanying text.

166. For discussion of mechanical devices *see* 1 Nimmer & Nimmer, *supra* note 94, § 2.18[F].

167. *E.g.*, Whelan Assocs., Inc. v. Jaslow Dental Lab., Inc., 797 F.2d 1222, 1231 (3d Cir 1986), *cert. denied*, 479 U.S. 1031 (1987).

168. 3 Nimmer & Nimmer, *supra* note 94, § 13.01[B].

ysis carries over to infringement inquiries. Software infringement is usually circumstantial. Consequently, the defendant's access to the plaintiff's work, plus substantial similarity to the plaintiff's work, raises an inference of copying.[169] Defendants typically concede access, so only the issue of substantial similarity remains.[170] Also, substantial similarity analysis arises from a challenge to the existence of protected expression, even when verbatim copying is admitted.[171] Thus, this test embodies the expression—idea dichotomy codified in the Copyright Act.[172]

Presently, the substantial similarity test for software copyrights is splintered across the circuits. An initial analysis of common expression—limiting doctrines enhances the subsequent analysis of this split of authority. The doctrines are (1) exclusion of borrowed expression, (2) merger, and (3) *scenes a faire*. These doctrines often straddle "subject matter" and "substantial similarity" inquiries.[173]

(a) Expression limiting doctrines: borowed expression, merger, and scenes a faire.—To the extent a work results from material or facts borrowed from the public domain, it is unprotected.[174] In addition, expression from copyrighted works is not protected if licensed for use in a compilation or derivative work.[175] Frequently, computer programmers borrow routines from public sources.[176] Thus, original software often contains public domain fragments. Similarly, ASIC programmers rely on available routines including vendor cell libraries and subroutines. The expressions in ASICs traceable to these borrowed sources is not protected.

Merger denies copyright protection to any idea capable of expression in only one way. It sets the scope of protection in direct proportion to the number of different methods available to convey an idea.[177] For software, maximum efficiency with respect to speed and size of a program

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169. *Whelan*, 797 F.2d at 1231-32.

170. *Id.* at 1232.

171. 3 Nimmer & Nimmer, *supra* note 94, § 13.01[B].

172. *Compare* "Copyright protection subsists . . . in original works of authorship fixed in any tangible medium of expression . . . ." 17 U.S.C. § 102(a) (1988), *with* "In no case does copyright protection . . . extend to any idea . . . ." *Id.* § 102(b).

173. For a discussion concerning the overlap of subject matter and infringement tests, *see supra* notes 93-94 and accompanying text.

174. *E.g.*, 3 Nimmer & Nimmer, *supra* note 94, § 13.03[F][4]. *See also, Whelan*, 797 F.2d at 1236.

175. *E.g.*, 3 Nimmer & Nimmer, *supra* note 94, § 13.03[F][4]. *See also*, 17 U.S.C. § 103 (1988).

176. 3 Nimmer & Nimmer, *supra* note 94, § 13.03[F][4].

177. Computer Assocs. Int'l, Inc. v. Altai, Inc, 982 F.2d 693, 708 (2d Cir. 1992); Apple Computer, Inc. v. Franklin Computer Corp., 714 F.2d 1240, 1253 (3d Cir. 1983), *cert. denied*, 464 U.S. 1033 (1984). *See also*, Brown Bag Software, Inc. v. Symantec, Corp., 960 F.2d 1465, 1476 (9th Cir. 1992); Whelan Assocs., Inc. v. Jaslow Dental Laboratory, Inc., 797 F.2d 1222, 1236 (3d Cir 1986), *cert. denied*, 479 U.S. 1031 (1987).

is such an expression-limiting idea.[178] In *Apple Computer*, the court confronted merger in connection with the utility and efficiency goals central to an operating system program, but held that a sufficient number of methods existed to avoid triggering the doctrine of merger.[179] In contrast, the *NEC* court found the small number of instructions needed to perform some of the simpler microcode subroutines narrowed protection to verbatim copying only.[180] ASIC creators share these efficiency concerns regarding the density of functions on a chip, power consumption and similar technical performance criteria.[181] In the case of large, full-custom and semicustom ASICs the usual code is complex, allowing alternative modes of expression, at least in terms of software organization. In contrast, short routines common to simpler PLDs result in fewer expressive modes which narrow protection.

A similar limiting doctrine is *scenes a faire*. For literary works, the doctrine "denies copyright protection to those elements that follow naturally from the work's theme rather than from the author's creativity."[182] For computer programs, this doctrine prevents copyright protection of expressive modes required by external constraints inherent in the hardware and software.[183] In *NEC*, these constraints became a key issue because object code instructions and microprocessor hardware confine the microcode tasked with translating between them.[184] For ASICs, the limitation increases with the amount of pre-definition in a given device. Consequently, a full-custom ASIC faces the least amount of hardware constraint, but a PLD with a limited number of usable fuse-patterns is likely to impose severe limitations on the methods of expression. Electronic interface requirements dictated by the circuitry incorporating the ASIC might also impose additional limitations irrespective of ASIC type.

(b) A comparison with the infringement inquiry in software cases.— Software language and associated practices result in similar limitations. For example, a given software language may only allow certain data structures or command types.[185] ASICs are closely tied to the flexibility of the given device and available programming methods.[186] Also, ASIC and software programmers adhere to industry standards and academic

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178. *Computer Associates*, 982 F.2d at 708; 3 Nimmer & Nimmer § 13.03[F][2].

179. *Apple Computer*, 714 F.2d at 1253.

180. NEC Corp. v. Intel Corp., No. C-84-20799-WPG, 1989 WL 67434, at 16 (N.D. Cal. 1989).

181. *See* Lala, *supra* note 6, at 1-4.

182. 3 Nimmer & Nimmer, *supra* note 94, § 13.03[F][3].

183. *Computer Associates*, 982 F.2d at 709 (citing 3 Nimmer & Nimmer § 13.03[F][3]). *See also*, *Brown Bag Software*, 960 F.2d at 1475; *Whelan*, 797 F.2d 1236.

184. *NEC*, 1989 WL 67434, at 16.

185. *See* 3 Nimmer & Nimmer, *supra* note 94, § 13.03[F][3][b].

186. *See* Lala, *supra* note 6, *passim*.

guidelines which remove some expressive modes from consideration. Thus, public domain exclusion, merger, and *scenes a faire* doctrine carve out bits of expression, sometimes leaving little to protect. The functional utility of ASICs amplifies these constraints, cutting deeper gouges into expression than for traditional software.

With these doctrines in mind, the first software "substantial similarity" test arises from *Whelan Associates v. Jaslow Dental Laboratory.*[187] In *Whelan*, the defendant attempted to author a computer program to assist in administration of a dental lab, but eventually entered an agreement with the plaintiff to create the desired program. Later the defendant tried to write a comparable program in a different language for use on smaller personal computers. Once again, another programmer finished the project. The defendant advertised this program as a new version of the prior program. Despite different programming languages and host computers, the court held that the new program infringed the prior program.[188] The court applied a broad "substantial similarity" standard, holding that expression was any aspect not essential to the single idea of performing administrative tasks for a dental laboratory.[189]

The single idea approach of *Whelan* offers broad infringement protection for software. Although the court discusses the limiting doctrines, it seems to favor policy concerns over detailed application of these doctrines.[190] Under this standard, the same broad protection is likely for ASICs. The single idea underlying an ASIC program is the particular purpose of the personalized device. Hence, under *Whelan*, the literal and non-literal features of a given ASIC are protected for this purpose.

The "total concept and feel test" arose to determine substantial similarity of works created for children,[191] and eventually spread to video game cases.[192] Critics of the test point out vagueness and contradiction of copyright goals.[193] The highly technical character of ASICs emphasizes uncertainties under this standard. A derivative of this test survives in *Brown Bag Software, Inc. v. Symantec Corp.*[194] In that case, a freelance programmer participated in the development of both the plaintiff's and defendant's outlining programs. After examining seventeen similar fea-

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187. 797 F.2d 1222 (3d Cir 1986).

188. *Id.* at 1248.

189. *Id.* at 1238-39.

190. *Id.* at 1235-37.

191. 3 NIMMER & NIMMER, *supra* note 94, § 13.03[A][1][c].

192. *E.g.*, Atari, Inc. v. North Am. Philips Consumer Elec. Corp., 672 F.2d 607, 619-20 (7th Cir. 1982), *cert. denied*, 459 U.S. 880 (1982).

193. E.F. Johnson Co. v. Uniden Corp., 623 F. Supp. 1485, 1492-93 (D. Minn. 1985) (finding test unfortunate for computer copyrights); 3 NIMMER & NIMMER § 13.03[A][1][c] (concluding the test contradicts non-protection of ideas).

194. 960 F.2d 1465 (9th Cir. 1992).

tures grouped in five categories, the district court granted a summary judgment for the defendant. The groupings concentrated on computer user interfaces such as outline editing, printing, and display colorization schemes. The summary judgment was affirmed.[195]

The *Brown Bag Software* court applied two tests: an extrinsic objective test and an intrinsic subjective test.[196] The extrinsic test invites expert opinion and applies the expression-limiting copyright doctrines of merger and scenes a fair to "analytically dissect" the scope of protection for the work.[197] The comparison of remaining expression occurs under the intrinsic test. This second prong turns on the subjective response or "overall look and feel" from the perspective of an ordinary and reasonable person.[198] This subjective prong lies in wait to unpredictably deny protection. Exaggeration of this unpredictability is likely for ASICs, given the complex technical concepts involved. Furthermore, recent deemphasis of the intrinsic prong of the test adds new dimensions of uncertainty.[199]

The court in *Computer Associates International, Inc. v. Altai, Inc.*[200] rejected the *Whelan* holding, adopting the "successive filtering method."[201] In *Computer Associates*, an employee went to work for a competitor, Altai, taking copies of source code for an operating system subroutine in violation of employment agreements. At Altai, the employee developed an operating system interface which used about 30% of the stolen code. Upon learning of this infringement, Altai developed a replacement interface program using a procedure similar to clean-room duplication,[202] which excluded the new employee entirely. The trial court found the first program infringed Computer Associates' copyright, but that the

195. *Id.* at 1478.

196. *Id.* at 1475.

197. *Id.* at 1475-76.

198. *Id.* at 1476. *See also*, Data East U.S.A., Inc. v. EPYX, Inc., 862 F.2d 204, 208 (9th Cir. 1988).

199. Recent decisions of the Ninth Circuit avoided reaching the intrinsic prong of the test for software. *Brown Bag Software*, 960 F.2d at 1476; *Data East*, 862 F.2d at 208.

200. 982 F.2d 693, 705 (2d Cir. 1992). *See* Daniel A. Crowe, *The Scope of Copyright Protection for Non-literal Design Elements of Computer Software: Computer Associates International, Inc. v. Altai, Inc.*, 37 St. Louis U. L.J. 207 (1992) (generally favoring the *Computer Associates* Test). *See also*, Recent Case Note, *Copyright Law—Scope of Protection of Non-literal elements of Computer Programs—Second Circuit Applies an "Abstraction-Filtration-Comparison Test,"* 106 Harv. L. Rev. 510 (1992) (criticizing the narrowing of non-literal protection of computer programs by *Computer Associates*).

201. *Computer Associates*, 982 F.2d at 706 (incorporating the three-step test endorsed in 3 Nimmer & Nimmer § 13.03[F]).

202. For discussion of clean-room procedures, *see supra* note 76 and accompanying text.

second program did not. On appeal, despite Computer Associates' challenge, the decision with respect to the second program was affirmed.[203]

The *Computer Associates* test contains three steps. First, the abstraction step decomposes the detailed code of a program into increasingly general patterns, taking out more and more of the expressive "incident" until only ideas are left.[204] The process "resembles reverse engineering on a theoretical plane . . . ."[205] For example, it might start with examination of individual instructions, then organize low-level modules, then examine high-level modules, and finally end at the ultimate purpose of the work. For ROMs, the process is the same as for software, but for other ASICs the outcome depends on the device development process and complexity. Therefore, complex sequential logic devices have many levels, but simpler PLDs have only a few levels.

The second step of the *Computer Associates* substantial similarity test is filtration.[206] This step applies the limiting doctrines of merger, *scenes a faire*, and exclusion of public domain material to filter the unprotected features from the protected expression at each level extracted from the work.[207] This filtration is likely to reveal a significant amount of protected matter for sophisticated devices such as gate arrays, but hardware and software constraints leave little expression for simpler ASICs.

The final step is comparison. This "inquiry focuses on whether the defendant copied any aspect of this protected expression [surviving filtration], as well as an assessment of the copied portion's relative importance with respect to the plaintiff's overall program."[208] This comparison follows the pattern favoring complex ASICs. However, the "comparative importance" consideration provides a glimmer of hope for simple devices which contain minute, but important, expressive aspects.[209] Copying of these important features in an otherwise dissimilar work might yield broader ASIC protection in specific cases. Furthermore, the recognition of even a small amount of protected expression still mandates protection against verbatim copying.

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203. *Computer Associates*, 982 F.2d at 715. The abstraction test originated with Judge Learned Hand in Nichols v. Universal Picture Corp. 45 F.2d 119, 121 (2d Cir. 1930), *cert. denied*, 282 U.S. 902 (1931).

204. *Computer Associates*, 982 F.2d at 707.

205. *Id.*

206. *Id.*

207. *Id.* at 707-08.

208. *Id.* at 710.

209. *See* Sega Enters. Ltd. v. Accolade, Inc., 977 F.2d 1510, 1515-16 (9th Cir. 1992) (indicating the importance of a 25 byte segment to assure compatibility of programs totaling up to 1.5 million bytes).

The unsettled nature of "substantial similarity" for computer programs is no less prominent when considering ASICs. Although embracing the extension of protection to non-literal software features, judicial and scholarly criticism of the *Whelan* "substantial similarity" test[210] and the uncertainty of the *Brown Bag Software* test support the *Computer Associates* standard.[211] This standard offers a clear, objective, and systematic approach to substantial similarity determinations. Furthermore, the abstraction and filtration steps break down complex technical concepts into manageable fundamental units. Finally, these factors combine to enhance judicial efficiency, fairness, and consistency.

3. Fair Use Defense.—One final area of the Copyright Act germane to ASICs is the defense of fair use.[212] Recently, two cases, *Atari Games Corp. v. Nintendo of America, Inc.*[213] and *Sega Enterprise Ltd. v. Accolade, Inc.*[214] considered whether reverse engineering of a computer program constitutes fair use. Both cases involved competing video game companies that sell plug-in cartridge games. The object code form of these games resides in integrated circuits inside the cartridge. To play the game, one inserts the cartridge in a electronic console connected to a television. In each case, a manufacturer disassembled the object code of a competing manufacturer to produce games compatible with the console of the competing manufacturer. In *Sega*, the manufacturer wired into the circuitry of the competitor's game console to obtain the object code. In *Atari*, the manufacturer disassembled object code by chip peeling the competitor's ROMs.[215] In *Sega*, the United States Court of Appeals for the Ninth Circuit held "where disassembly is the only way to gain access to the ideas and functional elements embodied in a copyrighted computer program . . . disassembly is a fair use of the copyrighted work, as a matter of law."[216] This result confirms the earlier interpretation of Ninth Circuit law by the federal circuit court in *Atari*, where the court held that reverse engineering by chip peeling and disassembly of object code was a fair use for discovery of processes and ideas,[217] including intermediate copying steps.[218]

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210. *See Computer Associates*, 982 F.2d at 705-06; 3 Nimmer & Nimmer § 13.03[F].

211. The *Brown Bag Software* court recently endorsed the *Computer Associates* "substantial similarity" standard which confuses the matter further. Sega Enters. Ltd. v. Accolade, Inc., 977 F.2d at 1525. Also, the United States Court of Appeals for the Federal Circuit endorses this test. Atari Games Corp. v. Nintendo of Am. Inc., 975 F.2d 832, 839-40 (Fed. Cir. 1992).

212. 17 U.S.C. § 107 (1988). *See* 3 Nimmer & Nimmer § 13.05.

213. 975 F.2d at 835 (exercising pendent jurisdiction on copyright issues and consequently applying Ninth Circuit law).

214. 977 F.2d 1510.

215. *See supra* notes 72-74 and accompanying text.

216. *Sega*, 977 F.2d at 1527-28.

217. *Atari*, 975 F.2d at 843-44.

The reverse engineering holding in *Sega* resulted from an analysis of fair use factors provided in the Copyright Act.[219] First, commercial exploitation of information obtained by copying disfavors fair use.[220] Like the video game compatibility in *Sega*, the commercial purposes attendant to reverse engineering of ASICs is likely to raise a presumption against fair use. Even so, reverse engineering of ASICs overcomes this factor by seeking only functional equivalency.[221] Second, the nature of the work supports fair use when copying is needed to access unprotected aspects of the work.[222] Copying to discern functional aspects of video game object code or to discover functional features of an ASIC supports reverse engineering as a fair use. Third, the larger the amount of copying, the more it militates against fair use.[223] The disassembly of the entire program cuts against fair use in *Sega*, as would peeling an entire ASIC chip. However, this factor alone is not fatal to the defense.[224] Finally, the fourth factor concerns the market impact of allowing fair use.[225] It favors ASICs when the effects of reverse engineering are indirect and provide a potential for market growth.

The acceptability of reverse engineering shrinks any available copyright protection for ASICs. The extension of fair use to chip peeling by the *Atari* court reinforces this conclusion.[226] Specifically, the exemption of intermediate copying to discover functionality permits the free transmission of technical ASIC information. Furthermore, because ASICs other than ROMs contain only a remote functional derivative of the source code, reverse engineering encounters a lower expression barrier when compared to more traditional software vehicles. The protection of software, ASICs, or any utilitarian work creates perception problems when compared to the role of copyright law as a guardian of expression.[227] Even if ASICs pass the requisite subject matter tests, only the most prominent expressive features of ASIC source code are likely to survive substantial similarity and reverse engineering challenges. Therefore, practical copyright protection of ASICs extends only to situations involving identical or nearly identical copying of prominent expressive features.

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218. *Id.* However, the court held that Atari infringed Nintendo's copyright because of misuse of access to Nintendo's source code through the federal Registrar of Copyrights Office. *Id.* at 841-42.

219. *Sega*, 977 F.2d at 1521-28.

220. *Id.* at 1522-23.

221. *Id.*

222. *Id.* at 1524-26.

223. *Id.* at 1526.

224. *Id.*

225. *Id.* at 1522.

226. *Atari*, 975 F.2d at 836.

227. *Id.* at 843.

C. *Semiconductor Chip Protection Act (SCPA)*

ASIC protection is not exhausted by the Copyright Act. In 1984, Congress enacted the Semiconductor Chip Protection Act (SCPA) aimed at the protection of integrated circuits.[228] The SCPA picks up where the Copyright Act left off by providing protection for mask works images.[229] The rights of the mask works registrant include the right to exclusively reproduce, distribute, and import the mask work and semiconductor products embodying it.[230] The SCPA protection lasts for ten years.[231] Similar to copyrights, SCPA issues include whether ASICs are proper subjects for protection. Although SCPA mask work infringement involves substantial similarity,[232] it does not suffer from a split of authority. However, potential conflicts between the SCPA and the Copyright Act pose issues other than subject matter. For example, one question is whether ASIC protection under the SCPA precludes copyright protection. Also at issue is how the relationship of the reverse engineering defense of each act might impact ASIC protection.

Uncertainty also stems from a dearth of litigation under the SCPA. The dominant explanation is that modern chip complexity and incompatible manufacturing processes render chip mask piracy uneconomical in comparison to the piracy of simpler devices which initially spawned the SCPA.[233] However, these factors are driven by unpredictable market and technology factors.[234] Also, more than 9,000 mask work registrations suggest continued interest in SCPA protection.[235] In fact, the relative ease of duplicating a few personalization layers, fuse-link pattern, or

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228. Semiconductor Chip Protection Act of 1984, Pub. L. 98-620, 98 Stat. 3347 (codified as amended at 17 U.S.C. §§ 901-914 (1988)).

229. 17 U.S.C. §§ 902 (1988).

230. *Id.* § 905.

231. *Id.* § 904(b).

232. *See* Brooktree Corp. v. Advanced Micro Devices, Inc., 977 F.2d 1555, 1564-65 (Fed. Cir. 1992).

233. *See*, John G. Rauch, *The Realities of Our Times: The Semiconductor Chip Protection Act of 1984 and the Evolution of the Semiconductor Industry*, 75 J. PAT. & TRADEMARK OFF. SOC'Y 93, 114-16 (1993); Robert J. Risberg, Jr., *Five Years Without Infringement Litigation Under the Semiconductor Chip Protection Act: Unmasking the Spectre of Chip Piracy in an Era of Diverse and Incompatible Process Technologies*, 1990 WIS. L. REV. 241, 244-45.

234. Gerard V. Curtin, Jr., Comment, *The Basics of ASICs: Protection for Semiconductor Mask Works in Japan and the United States*, 15 B.C. INT'L & COMP. L. REV. 113, 120 (1992).

235. At least 9020 mask work registrations exist; Search of WESTLAW, COPYRIGHT Library, (July 20, 1993) (search for records with mask works class designator, "CL(MW)"). *See also, supra* note 12 and accompanying text (describing alterative protection methods sought by integrated circuit manufacturers).

the program corresponding to erasable ASIC connections might breathe new life into the act.

1. SCPA Subject Matter.—The subject matter protected under the SCPA is "a mask work fixed in a semiconductor chip product."[236] "However, protection shall not be available for unoriginal mask works or mask work designs which are "staple, commonplace, or familiar in the semiconductor industry . . . ."[237] Similar to the Copyright Act, the SCPA expressly withholds protection from an "idea, procedure, process, system, method of operation, concept, principle or discovery."[238] Consequently, the following tests exit for SCPA subject matter: (1) whether a mask work exists, (2) whether the mask work is fixed in a semiconductor product, (3) whether the mask work is original and not staple or commonplace, and (4) whether the mask work is excluded as an idea, process, or method of operation.

(a) Does a mask work exist?—The SCPA definition of mask work is "a series of related images . . . having a three-dimensional pattern of metallic, insulating, or semiconductor material present or removed from the layers of a semiconductor product . . . ."[239] The statute requires each image to correlate to "the pattern of the surface of one form of the semiconductor chip product . . . ."[240] This designation includes any ASICs with mask layers. In fact, the Register of Copyrights states "semiconductor chip products that are produced by adding metal-connection layers to unpersonalized gate arrays may separately register the entire unpersonalized gate array and the custom metallization layers."[241] An "unpersonalized gate array" is defined as "an intermediate form chip product that includes a plurality of circuit elements that are adaptable to be personalized into a plurality of different final form chip products in which some of the circuit elements are or will be, connected as gates."[242] Although administrative regulations are not conclusive, they are often given deference.[243] At least one commentator suggests the SCPA is an exclusive means of protecting some ASICs.[244]

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236. 17 U.S.C. § 902(a) (1988).

237. *Id.* § 902(b).

238. *Id.* § 902(c).

239. *Id.* § 901(a)(2).

240. *Id.* § 901(a)(2)(B).

241. 37 C.F.R. § 211.4(c) (1991) (codification of 56 Fed. Reg. 7,816 (1991)).

242. *Id.*

243. *See, e.g.*, Marascalco v. Fantasy, Inc., 953 F.2d 469, 473 (9th Cir. 1991), *cert. denied*, 112 S. Ct. 1997 (1992) (giving judicial deference to Register of copyright interpretation); Eltra Corp. v. Ringer, 579 F.2d 294, 297 (4th Cir. 1978) (recognizing Register of copyrights can issue rules and regulations as an executive officer).

244. Gerard V. Curtin, Jr., Comment, *The Basics of ASICs: Protection for Semiconductor Mask Works in Japan and the United States*, 15 B.C. Int'l & Comp. L. Rev. 113, 115 (1992).

Thus, ASIC personalization masks for full-custom and semicustom gate arrays satisfy this requirement. In contrast, fuse-based ASICs are not as easily protected because a custom mask is not the usual result. However, just as dedicated equipment converts the source code into an ASIC fuse pattern, it may also produce a mask work corresponding to the fuse pattern. Although not necessary to the manufacturing process, this artificial fuse-link mask work still appears to comply with the SCPA definition. Because SCPA protection apparently extends to software representations of mask layers, a fairly complete protection of fuse-link ASICs seems possible.[245] In contrast, the absence of a related image for the personalization layers of erasable ASICs reveals that SCPA protection for these devices is less likely.[246]

(b) Is the mask work fixed?—The questionable status of erasable devices also breeds uncertainty under the fixation element. Specifically, "a mask work is 'fixed' in a semiconductor chip product when its embodiment in the product is sufficiently permanent or stable to permit the mask work to be perceived or reproduced from the product for a period of more than transitory duration."[247] Furthermore, legislative history reveals that although a computer program representation of a mask work is protected,[248] such a representation does not satisfy the fixation requirement.[249] Reading the programmed pattern from an erasable device is possible using both personalization equipment and less direct techniques. However, the information perceived is not likely to be a "mask work" as defined by the statute. Consequently, the "mask work" definition is likely limited to a visually related image and probably excludes erasable ASICs from protection under the SCPA. In contrast, mask-based and fuse-link ASICs appear to comply with the fixation requirement.

(c) Is the mask work original?—The SCPA originality requirement incorporates the same meaning used in the Copyright Act.[250] However, the "staple or commonplace" requirement is not as clear.[251] These terms arguably add to the copyright originality requirement. One view holds that this requirement lies between copyright originality and the more rigorous novelty requirement for patents.[252] Another argument suggests

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245. H.R. Rep., No. 781, 98th Cong., 2d Sess. 17 (1984), *reprinted in,* 1984 U.S.C.C.A.N. 5750, 5766.

246. For an explanation of erasable ASICs, *see supra* notes 67-71 and accompanying text.

247. 17 U.S.C. § 910(a)(3) (1988).

248. H.R. Rep., No. 781, at 20 (1984).

249. *Id.* at 17 (1984).

250. *Id.*

251. 3 Nimmer & Nimmer, *supra* note 94, § 18.03[B].

252. 35 U.S.C. § 102 (1988).

the addition of a type of nonobviousness reminiscent of patent law.[253] Nonetheless, the legislative history indicates these additional statements only codify "some minimum of creativity" and prohibit protection for works in the public domain.[254] Also, the legislative history contrasts this element with patent law elements, implying that the more stringent patent requirements do not apply.[255] A higher standard jeopardizes categorical protection of not only ASICs, but also other integrated circuits. This result contradicts the intent of the SCPA.[256]

(d) Is the mask work excluded as an idea, process, or method of operation?—The final element is that SCPA protection not extend to "idea, process, system, method of operation, concept, principle, or discovery . . . ."[257] This does not appear to present a problem for mask-based ASICs. The legislative history refutes the "useful article" doctrine encountered under the Copyright Act.[258] Also, legislative history of the SCPA suggests the provision is only meant to distinguish protection reserved for patent law.[259]

On the other hand, simpler fuse-link ASICs such as PLAs and PALs might encounter a problem in connection with this element. The personalization of these devices depends on programming one of a finite number of fuse patterns for a given device. If the SCPA protects the first registrant for a given pattern, but refuses to protect identical patterns independently developed later, then the registration effectively removes the pattern as an option for other developers. Consequently, the idea underlying the pattern would obtain protection in opposition to the subject matter element,[260] and exclusion of simpler finite pattern devices from SCPA protection follows.[261] However, if the SCPA adopts the copyright rule that independent authors of identical works deserve equal protection,[262] the problem is avoided. Still, the absence of express statutory guidance is troubling. In contrast, the legislative history discusses reproduction of semiconductor chip products along the lines of copying under the Copyright Act.[263] Also, in the only SCPA case reaching the

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253. *Id.* § 103.

254. H.R. Rep., No. 781, 98th Cong., 2d Sess. 19 (1984), *reprinted in,* 1984 U.S.C.C.A.N. 5750, 5768.

255. *Id.*

256. *Id.* at 3.

257. 17 U.S.C. § 902(c) (1988).

258. H.R. Rep., No. 781, at 10, 16.

259. *Id.* at 19.

260. *See id.* at 8-9.

261. *Id.* at 9.

262. For discussion of this rule in the context of copyright infringement, *see supra* note 168 and accompanying text.

263. H.R. Rep., No. 781, at 20.

appellate level, the district court concluded that the independent development rule of copyright applies.[264] In summary, full-custom and semicustom mask-based ASICs seem to stand on firm ground with the SCPA, but fuse-based devices are less reliably protected. Protection of erasable ASICs is the most questionable.

2. Copyright and the SCPA.—The first issue under this comparison is whether the SCPA excludes any aspect of copyright protection for ASICs. The SCPA states that it does not alter rights obtained by copyright or patent.[265] As a result, the SCPA does not affect copyrights in computer programs.[266] However, even if a mask work copyright becomes possible, then the SCPA probably supersedes the copyright.[267] Surely ASIC software, in isolation from an integrated circuit specification role, deserves copyright protection as much as any other computer program. However, the copyright protection of an ASIC as a software-bearing device is less clear given its close association with chip masks. If exclusive protection did arise, then incongruent results follow for mask-based ROMs,[268] currently protected as a software vehicle under the Copyright Act.[269] To avoid this conflict with well-established law, the best result is to strictly limit any exclusion to redundant mask work protection.

In addition to the issue of concurrent protection, the role of reverse engineering in the SCPA and in copyright law generates controversy. The only SCPA case reaching the United States Court of Appeals, *Brooktree Corp. v. Advanced Micro Devices, Inc.*,[270] focused on the reverse engineering defense. In this case, Brooktree obtained two mask work registrations for a color video display integrated circuit which replaced thirty-six discrete integrated circuits. The mask works litigation focused on a ten transistor memory cell configuration which was repeated over 6,000 times, consuming 80% of the chip area. At trial, Advanced Micro Devices ("AMD") raised the reverse engineering defense, claiming that $3 million and two and one half years was spent to develop the chip. In reply, Brooktree asserted the costs resulted from AMD efforts to reproduce the cell using eight instead of ten transistors because of a mistaken count during an initial inspection of the Brooktree chip.

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264. Brooktree Corp. v. Advanced Micro Devices, Inc., 705 F. Supp. 491, 494 (S.D. Cal. 1988).

265. 17 U.S.C. § 912(a).

266. *See* 3 NIMMER & NIMMER, *supra* note 94, § 18.11[A].

267. *See* 3 NIMMER & NIMMER, *supra* note 94, § 18.11[B], n.16.

268. For a discussion of a mask as a substitute for fuse-links, *see supra* note 66 and accompanying text.

269. *E.g.*, Apple Computer, Inc., v. Franklin Computer Corp., 714 F.2d 1240, 1249 (3d Cir. 1983), *cert. denied*, 464 U.S. 1033 (1984).

270. 977 F.2d 1555, 1569-70 (fed. cir. 1992). SCPA claims were pendant to patent claims. Federal circuit jurisdiction over patent claims is exclusive. *Id.* at 1561.

Also, Brooktree buttressed the argument by pointing out AMD's completion of the design within one week after realizing the mistake. Furthermore, the AMD design used similar transistor groupings. However, AMD's and Brooktree's designs differed because the AMD transistors lacked forty-five degree angles, used smaller transistors, and diverse interconnection patterns. Yet Brooktree claimed these differences were essentially irrelevant to the function of the chip. The jury awarded $25 million to Brooktree on SCPA and related patent infringement claims. The award withstood appeal.[271]

The SCPA expressly authorizes a reverse engineering defense.[272] This defense requires "a person who performs the analysis or evaluation . . . to incorporate the results of such conduct in an original mask work which is made to be distributed."[273] The primary means of establishing the defense is by showing a significant paper trail documenting the reverse engineering.[274] If a paper trail is established the substantial similarity standard collapses into whether the "resulting semiconductor chip product is not substantially identical to the protected mask work and its design involved significant toil and investment so that it is not mere plagiarism, it does not infringe the original chip, even if the layout of the two chips is, in substantial part, similar."[275] The *Brooktree* jury found the reverse engineering defense did not survive this test, despite distinct differences and arguable improvements in the product developed by AMD.[276]

The existence of an express SCPA reverse engineering defense arguably implies the absence of such a defense under fair use provisions of the Copyright Act.[277] In contrast, the extensive reverse engineering in *Atari* and *Sega* avoided infringement to support pursuit of compatibility with existing products. Moreover, the *Sega* court insists the SCPA reverse engineering defense "says nothing about its intent with respect to the lawfulness of disassembly of computer programs under the Copyright Act."[278] Although different product types and different types of works distinguish the reverse engineering defenses of the two acts, the standards collide when a device is covered by both acts, such as a mask-based

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271. *Id.* at 1583.

272. 17 U.S.C. § 906(a) (1988).

273. 17 U.S.C. § 906(a)(2).

274. *Brooktree*, 977 F.2d at 1565-66 (citing several sources of legislative intent).

275. *Id.*

276. The AMD chip dropped the forty-five degree angle configuration and used a smaller 1.5 micron transistor technology in lieu of the slower 2.0 micron Brooktree technology. *Brooktree*, 977 F.2d at 1568-70. *See* John G. Rauch, *supra* note 233, at 122 for criticism of the *Brooktree* result.

277. 3 Nimmer & Nimmer, *supra* note 94, § 13.03[F], n.271.

278. Sega Enters. Ltd. v. Accolade, Inc., 977 F.2d at 1522.

ROM. Despite the unlikelihood of this confrontation, the possibility suggests a marriage of the standards at least in the case of ASICs.

III. Engineering Better Protection

The intellectual property statutes create a continuum of protection. At one extreme, copyright law shelters expression.[279] At the other extreme, patent law covers technological innovation.[280] In between, the SCPA provides a refuge for mask works displaying characteristics of both extremes.[281] The courts emphasize this continuum when considering expansion of intellectual property protection.[282] In addition, the CONTU report condones a limited judicial power to handle new technology needs.[283] Furthermore, legislative history for the SCPA recognizes areas requiring judicial solutions.[284] The rapid pace of technology requires a flexible form of protection that can keep pace. Hence, a judicial license to adapt existing protection to new technology is suggested—particularly for ASICs.

A. Holistic ASIC Protection

The exercise of a judicial license already resulted in solid copyright protection for ROMs as a software vessel. Although not yet judicially endorsed, SCPA protection for full-custom and semicustom ASICs seems certain. However, copyright coverage of ASICs is suspect, particularly for simpler devices. Also, simpler devices encounter problems with SCPA protection. The protection of erasable ASICs under the SCPA is unlikely because of the absence of a fixed mask work. Although neither act is capable of bringing complete protection, some minor adjustments could provide complete protection through both acts.

Several factors support better ASIC protection. One factor is the intellectual property policy to promote progress rather than reward authors.[285] Although categorical protection rewards ASIC investments, it also motivates technological improvements. One commentator finds the balance favors categorical ASIC protection.[286] The computer program

279. Computer Assocs. Int'l, Inc. v. Altai, Inc, 982 F.2d at 703.

280. H.R. Rep., No. 781, 98th Cong., 2d Sess. 3 (1984), *reprinted in* 1984 U.S.C.C.A.N. 5750, 5752. *See also, Brooktree*, 977 F.2d at 1562-63.

281. *Brooktree*, 977 F.2d at 1562-63.

282. *See* Atari Games Corp. v. Nintendo of Am. Inc., 975 F.2d at 842-43.

283. CONTU Report, *supra* note 120, at 22-23.

284. H.R. Rep., No. 781, at 26-27.

285. Twentieth Century Music Corp. v. Aiken, 422 U.S. 151, 156 (1975); Mazer v. Stein, 347 U.S. 21, 219 (1954); *Atari*, 975 F.2d at 842-43.

286. *See*, Glynn S. Lunney, Jr., Note, *Copyright Protection for ASIC Gate Configurations: PLDs, Custom and Semicustom Chips*, 42 Stan. L. Rev. 163 (1989).

amendment to the Copyright Act and the creation of mask work protection under the SCPA indicate legislative preference to extend categorical protection for similar new technologies. As a software-hardware hybrid, the same intent applies to ASICs. A contrary result discourages the application of more innovative products such as erasable ASICs. Also, to let the current partial protection prevail is to base legal rules on subtle technological distinctions. This threatens to destabilize legal protection without a guiding rationale. Comprehensive ASIC protection avoids the inconsistencies inherent in partial protection. Moreover, creation of a comprehensive scheme resolves several uncertainties plaguing the SCPA and Copyright Act.

First, despite the "staple or commonplace" language in the SCPA, unification with the copyright originality standard resolves doubts in favor of ASICs. It also supports a broader protection consistent with legislative intent and incorporates the mature copyright originality standard into the SCPA, increasing consistency.

Second, courts should avoid engrafting the one-to-one correlation requirement from the CONTU Report onto the fixation requirement of either act. This approach clarifies ASIC protection and avoids the inconsistency of protecting object code without correlation to the source code. Similarly, the interpretation of mask works to include fuse-pattern devices is consistent with the SCPA. However, software cannot substitute for a properly fixed mask work in the device.[287] Unfortunately, the definition of mask work to include erasable ASICs requires legislative action in order to preserve certainty.

Third, the three-step substantial similarity test from *Computer Associates* provides a meaningful standard with which to tailor protection for ASICs under the Copyright Act. The enhanced expression in complex ASICs warrants broader protection than that for simpler devices. Moreover, the standard recognizes the importance of small, but critical segments which are important for devices used in sophisticated systems.[288] A similar approach should frame the infant SCPA infringement standard under the same rationale. Also, the *Computer Associates* standard dovetails with legislative intent to treat SCPA substantial similarity in terms of compilation and derivative works.[289] The current migration of the circuits toward this standard assists the application to ASICs.[290] Finally, importation of the copyright standard that forbids protection of inde-

287. H.R. Rep., No. 781, at 17.

288. For example, copying of 25 bytes out of video game code comprising at least 500,000 bytes is the deciding compatibility factor. Sega Enters. Ltd. v. Accolade, Inc., 977 F.2d at 1516.

289. H.R. Rep., No. 781, at 26.

290. *See supra* note 211.

pendently created identical works assures simpler ASICs will not become undeserving of SCPA protection as an idea or method of operation.

Construing the acts together with the purpose of protecting ASICs avoids potential conflicts. As a consequence, mask work images should remain the exclusive domain of the SCPA, with parallel copyright protection for ASIC software expression. Furthermore, avoiding future reverse engineering conflicts suggests that the copyright standard include the explicit improvement showing for ASICs. Copyright fair use factors provide an avenue to account for the additional standard in proportion to the hybrid nature of the work. The *Sega* and *Atari* decisions have begun to clear a path toward this result.

B. Conclusion

The hybrid nature of ASICs calls for integrated interpretation of the Copyright Act and SCPA. Although the resulting dual protection might muddle the already complex distinctions between the two acts, it is the best compromise in light of legislative, judicial, and social policies. Moreover, the process reconciles several issues confronting the protection methods. Finally, this approach provides a systematic method to carry forward copyright and SCPA protection principles for future technological advancements.