THE PROTECTION OF PIONEER INNOVATIONS – LESSONS LEARNT FROM THE SEMICONDUCTOR CHIP INDUSTRY AND ITS IP LAW FRAMEWORK

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1. INTRODUCTION

In the second half of the 20th century, semiconductor technology as integrated circuits (IC), commonly known as microchips, became more and more dominating in our lives. Microchips are the control center of simple things like toasters as well as of complex high-tech machines for medical use. Of course, they also define the hearts of each computer. With the invention of semiconductor technology, a whole new economic sector began its rise and soon played a major role in the economies of the large industrial countries like the U.S., Japan and the EC.[1] Especially, it stands out for its innovational power and its readiness to invest. Microchips are a symbol for the modern industrial society.

In the following considerations, I will try to show how and why

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1. Jeffrey T. Macher, David C. Mowery & Alberto Di Minin, *Semiconductors*, in INNOVATION IN GLOBAL INDUSTRIES: U.S. FIRMS COMPETING IN A NEW WORLD (COLLECTED STUDIES) (Jeffrey T. Macher & David C. Mowery eds., 2008), http://www.nap.edu/openbook.php?record_id=12112&page=101

semiconductors became a major technical innovation (Part 1). Then, I will discuss some of the important features of the global "ecosystem" of the chip industry (Part 2). All these observations will lead to the main chapter discussing the existing sui generis protection for the layout of semiconductors (Part 3) and the economic and legal reasons for its collapse (Part 4), along with the continuing high value of the "classical" IP rights such as patents and copyright.

PART 1: SEMICONDUCTORS AS TECHNICAL INNOVATION AND ITS ECONOMIC CONTRIBUTION

TECHNICAL INNOVATION

In order to illustrate the IP legal system, a first short look at the technical devices is necessary.[2] The construction of microchips is traditionally based on silicon dies (wafers) on which the developer "prints" integrated circuits via specially created patterns (masks) in a photolithography process. The circuits control the transmission of electrical impulses, including those that control computers. The three-dimensional disposition of the pattern, which defines the structure of the circuit, is called layout design or topography.[3] Semiconductors can be found almost everywhere, i.e., PCs, laptops, servers, mobile phones or consumer electronics (TV sets, gaming consoles, and household appliances). They are also an integral part of automobiles, rail services, or military devices.

1901–1954: The Pre-Planar Period

The first period could be characterized as the period of individual researchers and entrepreneurs with strong egos. The first U.S patent on semiconductors was granted to the radio pioneer Jagadis Bose for his semiconductor rectifiers (1901). After that the research topic of the semiconductor remained an issue for single researchers around the globe who protected their semiconductor inventions by patents. In 1906 the American physicist Lee De Forest invented the vacuum tube triode, enabling the amplification and switching of electrical signals. Furthermore, Julius Lilienfeld[4] received patents for his basic idea of the solid

2. Thomas Hoeren, *Das deutsche Halbleiterschutzgesetz vom 1.11.1987*, BETRIEBS-BERATER 1904 (1988).

3. *See* STANLEY WOLF & RICHARD N. TAUBER, SILICON PROCESSING FOR THE VLSI ERA: PROCESS TECHNOLOGY (2000).

4. William F. Brinkmann, Douglas E. Haggan & William W. Troutman, *A History of the Invention of the Transistor and Where It Will Lead Us*, 32 IEEE JOURNAL OF SOLID-STATE CIRCUITS, No. 12 (1997), https://classes.soe.ucsc.edu/ee171/Winter06/notes/transistor.pdf [March 17, 2015].

state transistor (MOS field-effect transistor) in 1925[5] and 1930.[6] In 1933, the German Pohl published his technical vision that semiconductors in radio receivers might one day replace vacuum tubes, which were, in those days, too big and unreliable. In the late 1940s, large computers were built with over 10,000 vacuum tubes and occupied over 93 square meters of space.

The big boom of semiconductors started during World War II when the U.S military forces needed special radar receivers to detect and convert microwave signals.[7] After the war, Bell Telephone Labs in Holmdel, N.J., a subsidiary of AT&T, became the leading force for future developments.[8] In December 1947, three Bell employees, and later Nobel Prize winners, John Bardeen, William Shockley, and Walter Brattain published their invention of the first successful semiconductor amplifier. The transistor quickly replaced the vacuum tube due to its small size, low heat generation and high reliability.

1954: The IC Period

Around 1954, computers became increasingly equipped with microchips. In addition, the U.S military forces and space agencies expressed their great interest in the new technologies and forced the researchers to focus on the miniaturization of microchips.[9] Simultaneously, Bell engineers implemented their idea of photolithographic techniques developed for producing patterns on printed circuit boards. Precise window sections were etched chemically where unexposed resist had been washed away leaving the exposed hardened resist; in 1957, such an etching technology was granted a patent protection.[10] In September 1955, William Shockley and Arnold Beckman founded the Shockley

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5. US Patent No. 1745175: Julius Edgar Lilienfeld, *Method and Apparatus for Controlling Electric Current* (first filed in Canada on October 22, 1925).

6. US Patent No. 1745175 (issued Jan. 28, 1930).

7. C. A. Warren, B. McMillan & B. D. Holbrook, *Military Systems Engineering and Research*, in A HISTORY OF ENGINEERING AND SCIENCE IN THE BELL SYSTEM: NATIONAL SERVICE IN WAR AND PEACE, 617-48 (1925-1975) (M. D. Fagan ed., 1978); Thomas J. Misa, *Military Needs, Commercial Realities, and the Development of the Transistor, 1948-1958*, in MILITARY ENTERPRISE AND TECHNOLOGICAL CHANGE: PERSPECTIVES ON THE AMERICAN EXPERIENCE 256-64 (Merrit Roe Smith ed., 1985).

8. For the role of Bell Labs see JEREMY BERNSTEIN, THREE DEGREES ABOVE ZERO: BELL LABS IN THE INFORMATION AGE (1984); J. Hornbeck, *The Transistor*, in A HISTORY OF ENGINEERING AND SCIENCE IN THE BELL SYSTEM: ELECTRONICS TECHNOLOGY (1925-1975) 12 (F. M. Smits ed., 1985).

9. A special focus point was the US Army's Signal Engineering Laboratory at Fort Monmouth, New Jersey. *See* KENNETH FLAMM, MISMANAGED TRADE? STRATEGIC POLICY AND THE SEMICONDUCTOR INDUSTRY 30-31 (1996)[hereinafter MISMANAGED TRADE?].

10. US Patent No. 2890395: Jay W. Lathrop & James R. Nall (both US Army's Diamond Ordnance Fuze Laboratories in Maryland), *Semiconductor Construction* (June 9, 1959).

Semiconductor Laboratory as a Division of Beckman Instruments in Mountain View which is regarded as the birthplace of Silicon Valley. Shockley could use the extra cleanliness of California (which was important for producing semiconductors) and the amazing labor forces of the Californian universities for his company.[11]

Only two years later, eight of his employees, the so-called traitorous eight, left the company and founded Fairchild Semiconductor, one of the most influential companies in the semiconductor industry.[12] For instance, Jean Hoerni, from Fairchild, created the idea for a planar transistor.[13] Multiple transistors, resistors, and capacitors were fabricated on a silicon wafer, connecting them by a conducting pattern of aluminum via a silicon dioxide film, which formed over the active silicon layer and created a circuit on a silicon die in the impurity diffusion process.[14] In July 1959, Robert Noyce,[15] from Fairchild, filed a patent application for "Semiconductor Device and Lead Structure,"[16] a first model of an integrated circuit. The invention of Noyce was recorded only a few months after the key findings of Jack Kilby, an employee of Texas Instruments.[17] Kilby invented the concept of the monolithic integrated circuit by linking diodes, transistors, resistors, and capacitors with aluminum metal lines on top of the protective oxide coating.[18] This involved creating electronic circuits on a semiconductor substrate by forming multiple circuit elements, such as resistors and transistors, and it became the basic patent for ICs. This, together with the Noyce patent, became the basic patent coverage for ICs[19] and the beginning of real business in Silicon Valley. The inventions of Noyce and Kilby were made independently of each other so that Fairchild and Texas Instruments had separate

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11. PETER ROBIN MORRIS, A HISTORY OF THE WORLD SEMICONDUCTOR INDUSTRY 89 (1990).

12. *See Motorola, Inc. v. Fairchild Camera and Instrument Corp.*, 366 F. Supp. 1173 (D. Ariz. 1973).

13. *Id.*

14. *See* Semiconductor History Museum of Japan, *Trends in the Semiconductor Industry* (2011), http://www.shmj.or.jp/english/trends.html.

15. LESLIE BERLIN, THE MAN BEHIND THE MICROCHIP: ROBERT NOYCE AND THE INVENTION OF SILICON VALLEY (2005).

16. US Patent No. 2981877 (filed Jul. 30, 1959).

17. He received the Nobel Prize in 2000 for that invention. *See* CHRISTOPHE LÉCUYER, MAKING SILICON VALLEY: INNOVATION AND THE GROWTH OF HIGH TECH, 1930-1970 (2006).

18. *Id.*

19. However, the history of who invented the IC is much more controversial. *See generally* BO LOJEK, HISTORY OF SEMICONDUCTOR ENGINEERING (2007); *see generally* ARJUN N. SAXENA, INVENTION OF INTEGRATED CIRCUITS: UNTOLD IMPORTANT FACTS (2009).

patent rights in their invention.[20] That was one of the main reasons why the IC industry flourished from the beginning; it allowed young start-ups the use of existing semiconductor techniques for their own purposes.

Former employees of Fairchild and his competitor, Texas Instruments, founded a lot of small enterprises, like National Semiconductor Corp, Advanced Micro Devices Ltd. and, last but not least, Intel Corp. In 1977, the Federal Trade Commission noted:

> The fact that companies can rapidly copy each other is very important. This rapid copying is the result of the mobility of personnel from firm to firm and the unwillingness of most firms to bring trade secrets or patent infringement suits. The rapid innovation and coping can also be explained by the number of times executive and technical personnel have left large firms to set up their own small, spin-off firms.[21]

Most of the spin-offs were situated within a few square miles within the Santa Clara Valley in California.

And the Rest of the World?

Reading the existing literature on the history of semiconductors, it seems that the US was really the lone inventor for some time in this field and that other countries only entered the stage as copycats later. The chip innovation landscape was, however, more complex than the mostly US-originated research literature seems to lead on. Much of the research literature on this matter is very U.S. centered.

It is often forgotten that European and Japanese inventors paved the way of semiconductors as well. It seems like Europe was active from the outset in transistors, for instance; some European scientists were led by the idea of solid-state amplifiers.[22] In 1934, the German expert, Oskar Heil, constructed a working field transistor (Feldeffekttransistor) and received a patent for its construction.[23] When

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20. That led to a long judicial litigation, decided by the United States Court of Customs and Patent Appeals. The Court decided in favor of Noyce on the basis of too broad wording of the Kilby patent. *Noyce v. Kilby*, 416 F.2d 1391, 1397-1398 (C.C.P.A. 1969).

21. FED. TRADE COMM., BUREAU OF ECONOMICS, ECONOMIC REPORT ON THE SEMICONDUCTOR INDUSTRY: STAFF REPORT TO THE FEDERAL TRADE COMMISSION (1977).

22. *See* Michael Riordan, *How Europe Missed The Transistor*, 42 IEEE SPECTRUM, (Nov. 1, 2005), *available at* http://spectrum.ieee.org/semiconductors/devices/how-europe-missed-the-transistor.

23. GB 439457: Oskar Heil, *Improvements in or Relating to Electrical Amplifiers and other Control Arrangements and Devices* (first filed in Germany, March 1934); see R. G. Arns, *The Other Transistor: Early History of the Metal-Oxide-Semiconductor Field-Effect Transistor*, 7 ENGINEERING SCIENCE AND EDUCATION JOURNAL, No. 5, 233, 236,

the excessive thoroughness of the German patent office delayed the examination, he translated the application into English and filed for a patent in Britain.[24] The patent was issued within nine months.[25] In 1952, the British physicist, G. W. A. Dummer, had the idea of integrating the transistors in solid blocks without any connecting wires. The functional elements should be connected directly by "cutting out areas of the various layers."[26] This vision was implemented by the UK company, Plessey, and not by Dummer. Based on Dummer's ideas, they produced the world´s first integrated circuit model, which was demonstrated at the 1957 International Symposium on Components in Malvern, England.[27] However, the project was never realized as the funding was inadequate and potential customers remained skeptical.

In August 1948, German physicists Herbert F. Mataré (1912–2011)[28] and Heinrich Welker (1912–1981),[29] employees of Compagnie des Freins et Signaux Westinghouse in Aulnay-sous-Bois (France), started an application procedure for a patent on a "transistron," which was produced on behalf of the French telephone company and the French military. More and more European governments became convinced that European R & D in this area should be supported by a European industrial policy. The national states used very high tariffs, subsidies, and other defensive strategies to build up "national champions" in the European semiconductor industry. Still, the majority of these companies were incapable of competing with US players, and were forced to leave the market to American and (later) Asian companies.

China and Korea[30] entered the stage very late, mainly as mere chip

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Oct.1998.

24. Armand Van Dormael, *The "French Transistor,"* 23, *available at* http://www.cdvandt.org/VanDormael.pdf.

25. *Id.*

26. W. A. G. Dummer, *Electronic Components in Great Britain*, SYMPOSIUM ON PROGRESS IN QUALITY ELECTRONIC COMPONENTS, IRE (1952); Mike Green, *Dummer's Vision of Solid Circuits at the UK Royal Radar Establishment*, 35 IEEE ANNALS OF THE HISTORY OF COMPUTING, No. 1, 55-56, Jan.-Mar. 2013.

27. David Manners, *50 Years of the UK Semiconductor Industry*, ELECTRONICS WEEKLY (Sep. 17, 2010), http://www.electronicsweekly.com/news/business/50-years-of-the-uk-semiconductor-industry-2010-09/.

28. John Markoff, *Herbert F. Mataré. An inventor of the transistor has his moment*, N. Y. TIMES, Feb. 24, 2003; Armand Van Dormael, *Biographies: Herbert F. Mataré*, 31 IEEE ANNALS OF THE HISTORY OF COMPUTING, No. 3, 68-73 (2009).

29. Kai Christian Handel, *Anfänge der Halbleiterforschung und -entwicklung: dargestellt an den Biographien von vier deutschen Halbleiterpionieren*, PhD Thesis RWTH Aachen (1999)(on file with author); Armand van Dormael called Mataré and Welker the real owner of the Nobel Prize for transistors; see ARMAND VAN DORMAEL, THE SILICON REVOLUTION 157 (2012); *"French Transistor," supra* note 25.

30. *See* S. Ran Kim, The Korean System of Innovation and the Semiconductor Industry: A Governance Perspective (forthcoming), http://www.oecd.org/korea/2098646.pdf;

producers. However, the situation was quite different in Japan.[31]

Early Years: Japan as Chip Producer

Japan started its semiconductor business by producing transistors on the basis of a cheap cost structure. From the beginning, US companies cooperated with Japanese companies particularly concerning the inexpensive production of microchips for consumer electronics. Hitachi, Matsuhita Electric, Toshiba, Nippon Electric, Mitsubishi Electric, and Kobe Kogyo (today part of Fujitsu) were the first and major companies to produce semiconductors.[32] They produced their chips on the basis of the Bell licensing model (see below) and sent thousands of Japanese researchers to the U.S. to visit conferences and semiconductor plants.[33]

By 1957, they were all active in producing chips for the internal Japanese market and the international market. Most of them entered the industry in the second half of the 1950s. They started their own R&D programs in the early fifties.[34] The budgets were, however, rather low in the beginning; the companies relied mostly on technical assistance agreements with foreign companies. In the middle of the sixties, R&D expenses only amounted to 2% of the semiconductor sales in Japan, compared to 6% in the U.S.[35] Few patents were awarded for the technology in Japan before 1962, and none before 1959. Japan could have used the high level of financial support of its banks and big enterprises.[36]

Japan also avoided the high labor mobility of employees and recruited experts for a lifetime.[37] Start-up companies in Japan, such as Tokyo Tsushin Kogyo, later renamed Sony, integrated the new technol-

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MORRIS, *supra* note 12; Rundong Ke, Senior Project, *Comparison of China and Japan's Economic Development in the Semiconductor Industry* (2012), http://digitalcommons.bard.edu/senproj_s2012/342.

31. For the different perspectives of US and Japanese scholars in this matter, *See* M. Uenohara, T. Sugano, J. G. Linvill & F. B. Weinstein, *Background*, in COMPETITIVE EDGE: THE SEMICONDUCTOR INDUSTRY IN THE U.S. AND JAPAN 14-15 (D. I. Okimoto, T. Sugano & F. B. Weinstein eds., 1984).

32. *See* JAPAN ELECTRONIC BUYERS GUIDE 1 (1965).

33. *See* MISMANAGED TRADE?, *supra* note 10 at 40-45; with references to a NHK documentary series.

34. C. C. Gee, *World Trends in Semiconductor Development and Production*, BRITISH COMMUNICATIONS AND ELECTRONICS 450-61, June (1959).

35. OECD, *General Report – Gaps in Technology*, tbl.B2 (1968), http://static2.orf.at/vietnam2/files/futurezone/200916/generalreportgapstechnology_65222.pdf.

36. For the surprising effect of banking, *see* ELEANOR M. HADLEY, ANTITRUST IN JAPAN, ch.11 (1970).

37. MORRIS, *supra* note 12 at 98; I. M. Mackintosh, *Dominant Trends Affecting the Future Structure of the Semiconductor Industry*, 43 RADIO AND ELECTRICAL ENGINEER 50 (1973).

ogy within small size radios, such as the famous Sony TR55 portable. Another Japanese company, NEC, used semiconductors for the new market of desktop calculators. In the early 1950s, Japanese companies started to produce semiconductor devices under license.[38] In July 1956, five Japanese firms licensed American patents to produce special radio receivers.[39] In 1959, Japan had become the largest producer of transistors so that 50% of the American market for portable radios were made in Japan. This led to the first demands in the US press for import controls.[40] The Japanese Government heavily supported the growth of the semiconductor industry especially by promoting the 1971 MITI program, which helped Japan become one of the most important semiconductor countries in the world. The semiconductors were used at this time for military purposes and later for computers in the US, while Japan was more fascinated by its potential use in portable low-cost consumer devices, such as radios, TVs, and calculators.[41]

Even when the costs for designing chips increased, American and Japanese corporations worked hand in hand based on cross-licensing agreements. But the competition between the two countries increased. The small start-up companies in the U.S. were constructed as being "fablessness" (i.e., the organizational separation of the design and fabrication stages)[42] contrary to the traditional, so-called IDMs (integrated device manufacturers). Countries like Japan and Korea started by simply acting as cheap producers of chips with low labor costs.[43] The Japanese competitors invented the vertically integrated business model where semiconductor companies not only developed, but produced and distributed chips and application products as well (Sony).

Japan as Chip Inventor

From the beginning of transistor and semiconductor developments, Japanese experts were involved.[44] The Nobel Prize winner, Leo Esaki, of Sony, noticed negative resistance characteristics in the current-

38. MORRIS, *supra* note 12 at 99.

39. The companies were Hitachi, Tokyo Tsushin Kogyo Ltd., Mitsubishi Electric Mfg., Tokyo Shibaura Electric and Kote Kogyo.

40. *See* e.g. ELECTRONICS ISSUE, January 6, 1961.

41. It is not true that semiconductors were an "American development," as Intel stated in the Copyright hearings.

42. Franco Malerba, Richard Nelson, Luigi Orsenigo & Sidney G. Winter, *Vertical Integration and Disintegration of Computer Firms: A History Friendly Model of the Co-Evolution of the Computer and Semiconductor Industries* (Econstor Working Paper No. 0619, 2006), http://www.econstor.eu/bitstream/10419/31831/1/522546056.pdf.

43. S. Ran Kim, *supra* note 31.

44. See J. Nishizawa & A. Ouchi, *Nihon no handotai kaihatsu (Semiconductor Development in Japan)*, TOKYO: THE INDUSTRIAL RESEARCH ASSOCIATION (1993).

voltage characteristics of very highly doped pn-junction in 1957 and talked about these phenomena at several international conferences. His publications were used by Shockley, the former US-inventor of the transistor. Unfortunately for Esaki, there was no clear R&D strategy developed by the Japanese government at that time (which might have to do with the peculiarity that Japan had no military forces or space program interested in these technologies as in the U.S.). Therefore, Esaki never asked for a patent for his invention but shared his ideas with other international researchers. In 1960, a Bell employee filed a patent application for a device utilizing the Esaki effect.[45]

The development of semiconductor technology was organized by two players, the Electrical Communications Laboratory (ECL) owned by NTT and the Electrotechnical Laboratory (ETL) funded by MITI. NTT was a public corporation at that time, the Nippon Telegraph and Telephone Corporation. MITI was the very powerful Ministry of International Trade and Industry. Apparently, the ETL made first transistor experiments in 1951 while ECL constructed the first properly functioning device.[46]

Later in 1960, NEC began the development of the first ICs; NEC established p-Channel MOS (Metal-Oxide Semiconductor) technologies in 1964.[47] With the increased production of Japanese MOS calculators, the U.S. semiconductor industry lost interest in supporting their Japanese colleagues.[48] They feared that they were losing their domestic customers. Furthermore, it proved more and more difficult to sell in Japan in the face of the growing "Buy Japan" attitude. Indeed, in the early 1970s, it was not allowed to import complex ICs into Japan (apart from previously specified end customers). The Japanese Government was very aware of the national deficiencies in basic research and product design but were determined to overcome these deficiencies. Japanese experts asserted that the technology transfer between the U.S. and Japan was very one-sided. The consequence was a growing reluctance on the part of some U.S. manufacturers to share their technology with the Japanese via licensing contracts. The Japanese increasingly recognized

45. US Patent No. 3058064 (filed Feb. 1, 1960).

46. See YASUZO NAKAGAWA, SEMICONDUCTOR DEVELOPMENT IN JAPAN 22-31 (1985); Makoto Watanabe, *Electrical Communications Laboratories: Recent LSI Activities*, JAPAN TELECOMMUNICATIONS REVIEW 3-8, January 1979.

47. See D. I. OKIMOTO, T. SUGANO & F. B. WEINSTEIN, COMPETITIVE EDGE: THE SEMICONDUCTOR INDUSTRY IN THE U.S. AND JAPAN 16 (1984); T. Kurosawa, *Shirikon Kotohajime (The Origin of Silicon Business)*, TOKYO: NEC CREATIVE 73-75 (1997).

48. Rundong Ke, Senior Project, *Comparison of China and Japan's Economic Development in the Semiconductor Industry* (2012), http://digitalcommons.bard.edu/senproj_s2012/342.

that fruitful access to U.S. research would depend on them offering enough to the U.S. side to make a fair exchange.[49]

So a research wave started in Japan in the late 1960s.[50]Japanese semiconductor producers such as NEC, Toshiba, and Hitachi developed microprocessors on the large scale, beginning with 4-bit devices and then upgrading to 8-bit and 16-bit products. The microprocessors were first utilized for industrial aims, but then applied to home electronics, computers, and cars. In 1972, Japan presented the world´s first calculator with a CMOS LSI (Complementary Metal-Oxide Semiconductor Large Scale Integration) circuit, produced jointly by Toshiba and Sharp. Using low-cost domestic production and being supported by MITI and the local banks, Japan developed high quality chips, which, in 1980, caused Hewlett-Packard to announce "that the Japanese 16K DRAMs were of far higher quality than those made in the United States."[51]

PART 2: SEMICONDUCTORS – THE UNDERLYING ECOSYSTEM[52]

From the beginning, the U.S. military-industrial complex was confronted with a Japanese bureaucracy-business–banking infrastructure.[53]

THE ECOSYSTEM IN THE U.S.

The ecosystem in the U.S. was very different from the one in Japan. The starting points in the U.S. were the military forces[54] and space agencies, especially the Navy, the Army, NASA, and the AEC/DOE (Atomic Energy Commission and the Department of Energy).[55] The tradition started during the Second World War when semiconductor research was used for improving radar systems.[56] In 1949, the Govern-

49. *Id.*

50. For the increasing number of US patents granted to Japanese companies starting in 1962, *see* JOHN E. TILTON, INTERNATIONAL DIFFUSION OF TECHNOLOGY: THE CASE OF SEMICONDUCTORS 141 tbl.6-2 (1971).

51. ALFRED D. CHANDLER, INVENTING THE ELECTRONIC CENTURY 130 (2005).

52. Werner Ballhaus, Alessandro Pagella, Constantin Vogel & Christoph Wilmsmeier, *Faster, Greener, Smarter – Reaching Beyond the Horizon in the World of Semiconductors* (2012), http://www.pwc.com/en_GX/gx/technology/publications/assets/semiconductor-industry-analysis-and-projections.pdf.

53. COMPETITIVE EDGE, *supra* note 48 at 16.

54. CHANDLER, *supra* note 52 at 130.

55. *See generally* MISMANAGED TRADE?, *supra* note 10.

56. Richard C. Levin, *The Semiconductor Industry*, in GOVERNMENT AND TECHNICAL PROGRESS: A CROSS INDUSTRY ANALYSIS 67 (Richard R. Nelson ed., 1982).

ment granted big research funds to Bell for the first time.[57] More money was given to the new Silicon Valley start-ups from 1956.[58] Between 1952 and 1964, Signal Corps spent about $50 million for semiconductor engineering.[59] The Government responded to new developments very quickly and flexibly.[60] Therefore, the key factor for the start of the U.S. semiconductor industry was government research.[61]

The Government not only funded research in that area, but was also responsible for the public procurement of semiconductor devices. For instance, in 1952, all of the Western Electric′s sales and virtually all of the rest went to the military.[62] To a certain degree, non-military uses of ICs were caused mainly as a kind of spill-over from military research[63].

The government backing was linked to an aggressive funding and development policy in favor of Californian universities, such as Stanford, Berkeley, and Caltech. These universities managed to oversize the traditional predominance of the Boston research centers, such as MIT, quite rapidly. They could trust the intelligence of young researchers educated by Ivy League universities and the Government was ready to support fresh research in small university expert groups or start-ups. At the end of the 1960s, participants in the industry, including universities, changed their strategies to align with the companies more interested in mass-production of microchips, and with universities interested in organic microchips and other "exotic visions."[64]

From a business perspective, the driving force at the early times was only one company, AT&T, with Bell Laboratories as its research unit and Western Electric as its manufacturing arm. This company was responsible for one of the striking features in the early semiconductor industry, its cross-licensing strategies and the high mobility[65] of scientists and engineers. A unique situation arose when AT&T was forced by the antitrust Decree of 1956[66] to refrain from selling semiconductors

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57. J. Kraus, *An Economic Study of the US Semiconductor Industry*, PhD thesis, New York (1973).

58. Levin, *supra* note 57.

59. ERNEST BRAUN & STUART MACDONALD, REVOLUTION IN MINIATURE: THE HISTORY AND IMPACT OF SEMICONDUCTOR ELECTRONICS 71 (1978).

60. Levin, *supra* note 57 at 68.

61. This result is supported by the new publication of MARIANA MAZZUCATO, THE ENTREPRENEURIAL STATE: DEBUNKING PUBLIC VS. PRIVATE SECTOR MYTHS (2013).

62. Levin, *supra* note 57 at 59 tbl.2.16 (citing J. KRAUS, AN ECONOMIC STUDY OF THE US SEMICONDUCTOR INDUSTRY, PhD thesis, New York (1973)).

63. Levin, *supra* note 57 at 64.

64. *Id.* at 47.

65. For this specific feature *see* Neus Palomeras, *Markets for Inventors: Examining Mobility Patterns of Engineers in the Semiconductor Industry*, 1-10 (2004), *available at* http://ssrn.com/abstract=875284.

66. *United States v. Western Elec. Co.*, 1956 Trade Cas. (CCH) ¶ 68, 246 (D.N.J. Jan.

commercially. All these U.S. particularities led to the existence of a combination of several receiving tube firms cooperating with start-ups. The start-ups consisted of companies that had not produced vacuum tubes in the past and could therefore start manufacturing semiconductors. These companies included Motorola, Transitron, established in 1952, or Texas Instruments, a former geophysical company.[67] A unique start-up situation was caused by Shockley who quickly erected and changed the company structure for the promotion of his invention of the transistor (from Bell to Shockley Laboratories to Beckman Instrument with eight of his employees establishing Fairchild Camera and Instruments).[68] Regarding the industry, Bell Labs and the old receiving-tube suppliers were predominant in the early days.[69] However, small start-ups were very important, as they had a substantial impact on advancing mainstream semiconductor technology along its dominant miniaturization trajectory.[70] At the end of the 1950s, the former start-up companies Motorola, TI, and Fairchild Semiconductor were the world leading producers in transistors in terms of revenue.[71]

In the beginning, the chip industry in the U.S. was not organized and represented by a single lobbyist association. Since 1977, the Semiconductor Industry Association (SIA) has been the voice of the U.S. semiconductor industry.[72] The SIA was established by five microelectronics pioneers, representing over 80% of the U.S. semiconductor production. In 1988, the SIA helped found the National Advisory Committee on Semiconductors (NACS), a presidential committee with eight private CEOs and eight Officials. Between 1989 and 1992, the NACS edited various recommendations for strengthening the U.S. semiconductor industry. In 1994, six CEOs of fabless companies established the Fabless Semiconductor Association (FSA) to promote the fabless business-model globally. In December 2007, the FSA altered its business model to become the GSA, the Global Semiconductor Alliance.

The U.S. Government organized further projects, for example the Semiconductor Research Corporation (SRC) in 1982 and SEMATECH in 1987. SEMATECH received its funding from the public research agency DARPA that financed almost 50% of the consortium's budget and

24, 1956).

67. TILTON, *supra* note 51 at 50.

68. *Id.* at 51.

69. Levin, *supra* note 57 at 49.

70. *Id.* at 56.

71. CHANDLER, *supra* note 52 at 124.

72. *See also* Richard N. Langlois & W. Edward Steinmueller, *Strategy and Circumstances: The Response of American Firms to Japanese Competition in Semiconductors, 1980-1995* (1999), *available at* http://papers.ssrn.com/abstract=204093.

thereby gained access to all rights and trade secrets involved.[73] With a budget of $ 500 million, Sematech was sponsoring the development and production of U.S.-made ultra-thin circuity chips in response to the Japanese DRAM success story. The sponsoring was finished in 1996 as foreign companies like Hyundai, Infineon or ST Microelectronics joined the project. Today these corporations are not funded or organized by national states anymore. Due to the specialties of the semiconductor industry, the Industry came back to its self-regulation roots. "New alliances were also formed, such as the Common Platform Consortium composed of IBM and Samsung and partnering with Infineon, Freescale, STMicroelectronics and Toshiba."[74] The success of SEMATECH has been discussed controversially in literature[75] although most authors regard SEMATECH as a success story.[76]

AND JAPAN?

The situation was different in Japan.[77] Military procurement had no impact in Japan as Japan was not allowed to have an army after the Second World War. The country was relatively poor and had a lot of cheap labor forces (such as in China today). Therefore, the country was attractive as a place for producing chips. There were, however, no wholly owned foreign subsidiaries at this time.[78] As mentioned above, the producers of receiving tubes which started producing chips in 1957 consisted of Hitachi, Toshiba, Matsushita Electric, Nippon Electric, Mitsubishi Electronic, and Kobe Kogyo (part of Fujitsu).[79] However, the pioneer of producing commercial transistors was not one of these eight companies, but a new firm called Sony. Start-ups also did not have any impact of the semiconductor development.[80] The development of semi-

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73. *See* Memorandum of Understanding between SEMATECH, Inc. and the U.S. Department of Defense (1998)(on file with author).

74. Sacha Wunsch-Vincent, *OECD Information Technology Outlook* 168 (2008), http://uploadi.www.ris.org/editor/12338245519308041E.pdf.

75. *See* the critical remarks in Robert M. Byron, *SEMATECH – A Case Study: Analysis of a Government-Industry Partnership* (1993), http://www.dtic.mil/dtic/tr/fulltext/u2/a273166.pdf; Advisory Council on Federal Participation in SEMATECH, *SEMATCH – Progress and Prospects* (1989), http://www.dod.mil/pubs/foi/Science_and_Technology/DARPA/10_F_0709Report_of_theAdvisoryCouncil_onFederalParticipation_inSEMATECH_1989.pdf.

76. *See* for example Dan W. Holladay, *Testimony before the Senate Committee in Energy and Natural Resources* (June 2012), http://www.energy.senate.gov/public/index.cfm/files/serve?File_id=aa4e2db1-2ae9-42a7-87be-7c4f21134524.

77. D. I. OKIMOTO, BETWEEN MITI AND THE MARKET. JAPANESE INDUSTRIAL POLICY FOR HIGH TECHNOLOGY (1989)[hereinafter MITI AND THE MARKET].

78. TILTON, *supra* note 51 at 136.

79. ELECTRONIC BUYERS, *supra* note 33.

80. *See* the figures of US patents granted to Japanese companies starting in 1962 in

conductors was mainly focused on commercial applications such as calculators or radios.

Yet, the U.S. and Japanese governments increasingly interfered in the industry by forcing preferential treatment for their national firms. In military procurement cases, foreign bids were increased by 50% since 1962.[81] From the beginning, the Japanese government tried to use its powers to prohibit the formation of semiconductor firms controlled by foreign stakeholders. The government, however, also controlled the licensing agreements between Japanese and U.S. companies which needed to get an official state permission. Furthermore, Texas Instruments was not allowed to establish a wholly owned subsidiary in the early 1960s. Furthermore, the examination of a patent application by TI was delayed for decades. In 1968, after five years of negotiation, TI agreed to a joint venture with Sony, with each firm holding 50% of the equity. Furthermore, TI agreed to license its IC patents to all Japanese companies. This strategy gave the Japanese industry an opportunity to build up economies of scale.[82]

The Japanese success model was also based on the idea of life-time employment.[83] As a kind of tradition, Japanese workers did not change their jobs so often; they were more interested in building a career within the same company during their lifetime. The company thus had a guarantee that knowledge is not disseminated and lost in the case of an acquittal. The know-how would remain within the company and only used internally.[84]

Another feature of the Japanese model was the national banking sector that actively supported the semiconductors "made in Japan."[85] Financial power was abundantly available for investment in new technologies. Japanese banks were allowed to acquire equity shares in companies to which they lend, dissimilar to U.S. banks which were refrained from doing so according to the Glass-Steagall Act of 1933.[86] Therefore, the banks could support Sony & Co. even in times when

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TILTON, *supra* note 51 at 141 tbl.6-2 (showing that the patents were granted to the receiving tube firms.)

TILTON, *supra* note 51 at 36; Robert Skole, *Government Electronic: Federal Outlets Tough for Foreigner*, 41 ELECTRONICS 119-24, December 1968.

82. Marie Anchordoguy, *Mastering the Market: Japanese Government Targeting of the Computer Industry*, 42 INTERNATIONAL ORGANIZATION, No. 3 (1988).

83. See JAMES C. ABEGGLEN, MANAGEMENT AND WORKER – THE JAPANESE SOLUTION (1973).

84. COMPETITIVE EDGE, *supra* note 48 at 5.

85. *See id.* at 151-53.

86. *Id.* at 7.

there was no return of investment. This cooperation was based on the old corporate models in Japanese society, called keiretsus, informally linking Sony with the Mitsui Bank.[87]

One of the striking actors in this area was, and still is, MITI, the Japanese Ministry of International Trade and Industry.[88] From 1949 to 2001, the ministry promoted the interests of Japanese industry together with the Bank of Japan and various others regulatory bodies. MITI was the central motor for the semiconductor industrial policy in Japan. In 1957, the Electronics Industry Promotion Law was established, inaugurating MITI as "genyoku", the central leader of electronics industry.[89] It has to be taken into account that until 1964, imports of foreign technologies were regulated by the Act on Foreign Capital and had to be individually reviewed by the Foreign Investment Council before approval. The amount of foreign currency reserves in Japan was low at the time; and MITI published guidelines to control technology imports.[90] The ministry had the advantage that the Japanese antitrust control system was rather lax at these times. The responsible FTC had problems in regulating the cooperation between state and industry and almost never complained about activities of MITI.[91] The power of MITI was increased by the fact that the Japanese state is highly centralized. Furthermore, the Japanese regulatory control is not achieved through unilateral decree (as in the U.S.), by but by voluntary compliance.[92] From the beginning, MITI supported public-private research partnerships, a pioneering concept for corporations in other ICT areas. They put in a lot of effort (especially by funding) in the 1970s to get domestic semiconductor manufacturers to pool R&D resources.[93] In 1976, they established a kind of supercomputer cooperation, the so-called Very Large-Scale Integration (VLSI) Consortium including Fujitsu, NEC, Hitachi, Mitsubishi, and Toshiba.[94]

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87. *See* however the critical remarks of Yoshira Miwa & J. Mark Ramseyer, *The Fable of the Keiretsu* (2001), http://www.law.harvard.edu/programs/olin_center/papers/pdf/316.pdf [March 17, 2015].

88. MITI AND THE MARKET, *supra* note 78; CHALMERS JOHNSON, MITI AND THE JAPANESE MIRACLE – THE GROWTH OF THE INDUSTRIAL POLICY, 1925-1975 (1982) (In my view, who is underestimating the importance of MITI).

89. MISMANAGED TRADE?, *supra* note 10 at 53.

90. Y. Wakumoto & K. Nakano, *License as Management Strategy, Akamon Management Review* 1-44 (2005), retrieved from: http://www.gbrc.jp/.

91. MITI AND THE MARKET, *supra* note 78 at 13.

92. *Id.* at 15.

93. KENNETH FLAMM, CREATING THE COMPUTER: GOVERNMENT, INDUSTRY, AND HIGH TECHNOLOGY 184-92 (1988).

94. The effect of this consortium is disputed; see SCOTT GALLON, DIVIDED SUN: MITI AND THE BREAKDOWN OF JAPANESE HIGH-TECH INDUSTRIAL POLICY, 1975-1993 (1995).

PART 3: SEMICONDUCTORS AND THE IP SYSTEM

Although thousands of patents were granted for the semiconductor processes and functions, the layout of semiconductors have historically been held as incapable of traditional IP protection.[95] The inadequacy of patent or copyright law systems to cope with microchips was the official reason for the U.S. government to force the IP world into a new sui generis protection regime for semiconductors, which proved to be unsuitable at the end (see below). Several causes for the inadequacy of the traditional IP system were discussed in literature. Patent protection was considered to last too long considering the integrated circuit's useful commercial life of less than one year.[96] In addition, patent protection was considered useless as most layouts of IC were seen as obvious variations of prior layouts.[97] Furthermore, another criticism[98] was that the circuit layout could not be described in the form of a valid patent, i.e. verbally. But this approach is dubious. Of course, a drawing is not patentable and can only be used in the patent application for illustration. But, this is not an inadequacy of the patent system. It is an inherent element of patent law that the design and layout are not patentable (unless it contains an invention). However, Patent law is capable of protecting the whole physical range of semiconductor devices, from the methods of fabrication to new application of semiconductors in final electronic products.

Protection regimes for industrial designs, such as the Australian Designs Act and the British Registered Designs Act 1949, are incapable of being applied to tiny designs, i.e. microscopic engravings or designs within sealed containment. In addition, these regulations can only be used for ornamental and aesthetic aspects of designs, excluding functional aspects. The same applies for copyright law. In general, the design of a microchip is itself not a suitable object of copyright law due to its utilitarian nature.[99] It is, in fact, dubious whether such designs em-

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95. John G. Rauch, *The Realities of Our Times: The Semiconductor Chip Protection Act of 1984 and the Evolution of the Semiconductor Industry*, 3 FORDHAM INTELL. PROP. MEDIA & ENT. L. J. 403, 408 (1993).

96. Robert L. Risberg, Jr., *Five Years Without Infringement Litigation Under The Semiconductor Chip Protection Act: Unmasking the Specter of Chip Piracy in an Era of Diverse and Incompatible Technologies*, 1990 WIS. L. REV. 241, 252 (1990); see also Jonathan H. Lemberg, *Semiconductor Protection: Foreign Responses to a U.S. Initiative*, 25 COLUM. J. TRANSNAT'L L. 345, 348 (1987).

97. Carl A. Kukkonen, III, *The Need to Abolish Registration for Integrated Circuit Topographies Under TRIPS*, 38 IDEA 105, 107 (1997).

98. Levin, *supra* note 57 at 80.

99. *Universal Furniture Int'l, Inc. v. Collezione Europa USA, Inc.*, 196 F. App'x 166, 171 (4th Cir. 2006) (finding that furniture design is not copyrightable when the design aspects serve a mainly functional purpose); *see also Brandir Int'l, Inc. v. Cascade Pac. Lumber Co.*, 834 F.2d 1142, 1143, 1148 (2d Cir. 1987) (holding that a squiggle-designed "ribbon" bicycle rack was a useful article and thus not copyrightable); *ConWest Res., Inc.*

body artistic merits or reflect a certain degree of individual and personal creativity. Moreover, U.S. experts[100] expressed the view (however unjustified) that the European concept of droit moral might cause problems in the chip industry.

Astonishingly, almost no one discussed the protection of semiconductors as trade secrets or the general application of rules of unfair competition law.[101] As patent law did not preempt state trade secrets law,[102] many U.S. states adopted the Uniform Trade Secrets Act (UTSA). The UTSA prohibits the disclosure or use of a trade secret if the infringer uses improper means to get knowledge of the trade secret. But, due to the high mobility of the semiconductor experts, there was a constant flow of experts from one company to another which undermined a possible trade secret protection (see above). Finally, trade secret protection is not very helpful against reverse engineering of goods sold on the open market. As a consequence, trade secret laws seemed inadequate as the high mobility of experts and networking structure of the semiconductor industry undermined any chance to enforce trade secret rules (see below). Surprisingly, undiscussed was the fact that many states could have offered a protection against slavish copying under competition law.[103] The U.S. however seems to fear that this protection regime would overly restrict the use of reverse engineering in the chip industry and hinted to the fact that the duration of protection under these rules might be inappropriate.[104] Therefore, the chip industry was struggling hard to find any protection tool. Consequentially, the story of

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v. Playtime novelties, Inc., 84 U.S.P.Q.2d 101, 1023-24 (N.D. Cal. 2006) (determining that design aspects of body part sculptures were not separable from their utilitarian functions). See Steven P. Kasch, *The Semiconductor Chip Protection Act: Past, Present, and Future*, 7 BERKELEY TECH. L. J. 79-80 (1992), http://scholarship.law.berkeley.edu/cgi/viewcontent.cgi?article=1100&context=btlj [March 17, 2015]; James Chesser, *Semiconductor Chip Protection: Changing Roles for Copyright and Competition*, 71 VA. L. REV. 249, March 1985. However, there are court decisions in the UK which held that mask works are protectable under copyright law in that chips may be considered "copies" of the technical drawings for the chips (L. B. (Plastics) Ltd. v. Swish Products Ltd. (1979)). The Swish doctrine is very controversial even in the UK; see *Green Paper on Reform of the Law Relating to Copyright, Design and Performers Protection* (Cmnd 8302); R. J. Hart, *Legally Protecting Semiconductor Chips in the U. K.*, 9 EUR. INTELL. PROP. REV. 260 (1985).

100. Richard H. Stern, *The Semiconductor Chip Protection Act of 1984: The International Comity of Industrial Property*, 3 BERKELEY J. INT'L LAW 273, 297 (Winter 1986).

101. See *International News Service v. Associated Press*, 39 S. CT. 68 (1918); Levin, *supra* note 57 at 82.

102. *Kewanee Oil Co. v. Bicron Corp.*, 94 S. CT. 1879, 1882 (1974).

103. CHRISTINE FELLNER, THE FUTURE OF LEGAL PROTECTION FOR INDUSTRIAL DESIGN 101-04 (1985).

104. Richard H. Stern, *The Semiconductor Chip Protection Act of 1984: The International Comity of Industrial Property*, 3 BERKELEY J. INT'L LAW 30, 296 (Winter 1986).

IP and microchips is a long story, with several regulatory phases.

PHASE 1: CROSS-LICENSING (1950–1980)

Until 1939, independent university centres combining the knowledge of physicists, mathematicians, and chemists organized research on semiconductors. During these early days of "lone inventors," research was conducted to advance fundamental knowledge, with little thought of practical use. This academic approach was used in Europe even after the Second World War so that Mataré and others were talking about new concepts at conferences without seeking patent protection beforehand.

In the U.S., the situation changed during the Second World War when U.S. military forces stressed the use of patent protection for these new technologies.[105] While the Europeans were talking at conferences, the U.S. experts were applying for patents. Nevertheless, the semiconductor industry was still characterized by its openness and transparency after the Second World War.[106] The technological features were created by U.S. engineers who asked for patent protection for the basics of their inventions, but also opened their "books" for other researchers throughout the world. For instance, Bell had the vision of sharing the new technology with other experts around the globe in order to support innovation. Therefore, Bell organized three meetings for international scientists to inform them about the new semiconductor technology first hand. In April 1952, Bell welcomed over 100 representatives from 40 companies (including GE, Sony, Texas Instruments, etc.) at the last Bell conference.[107] People interested in that conference had to pay a $25,000 patent-licensing fee upfront, deductible against future royalties and were allowed to visit the nine-day Transistor Technology Symposium, including a tour through Western Electric's transistor factory in Allen-

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105. *See generally "French Transistor," supra* note 25.

106. It is misleading to state that the inventors of the Bell transistor did not recognize the potential of their ideas as especially Mark A. Lemley did in *The Economics of Improvement in Intellectual Property Law*, 75 TEX. L. REV. 989 (1997) or in Mark A. Lemley & R. Anthony Reese, *Reducing Digital Copyright Infringement Without Restricting Innovation*, 56 STAN. L. REV. 1345, 1345-54, 1373-1426 (2004). Bell had a clear patent application strategy, but did not enforce the patents via litigation. Furthermore, the bell "cookbook" demonstrates that Bell has clearly foreseen the usability of the transistors in radio, phone and TV.

107. CHANDLER, *supra* note 52 at 122. The three symposia were attended by representatives of universities and delegates of European and US companies. Japanese experts were however not present. As a matter of fact, official lists of attendees did not exist, only a group of conference photos. For an analysis of the people attending the conferences see F. M. SMITS, A HISTORY OF ENGINEERING AND SCIENCE IN THE BELL SYSTEM: ELECTRONICS TECHNOLOGY (1925-1975) 28-29 (1985); MISMANAGED TRADE?, *supra* note 10 at 41 n.7.

town, PA.[108] The proceedings of these conferences (*The Transistor*) were named "Ma Bell's Cookbook" and became the leading directory for global semiconductor research in the 1950s. Starting from that point, a lot of U.S. and international companies asked for licenses from Bell.[109]

The famous patents of Bell, licensed according to the Bell cookbook, were licensed on the condition that the licensee makes his own patents available at a fair price.[110] The IP system was considered slow and too complicated to cope with the necessities of the quick growing, young semiconductor industry where small start-up companies need a mentality of a free exchange of ideas to improve their ICs. Thus, the semiconductor industry extensively relied on the cross-licensing model.[111] However, in 1998, the system was heavily under attack by the Federal Trade Commission, which held that the enforcement of a cross-licensing system by Intel was anti-competitive and a misuse of monopoly power.[112]

Bell used open strategies because of the antitrust policy problem. In January 1949, the Department of Justice opened an antitrust case against Western Electric and its parent company AT & T due to the fact AT & T and three other companies established a patent pool in 1932.[113] The case was settled by a consent decree in January 1956.[114] AT & T agreed in this decree to grant royalty-free licenses on any patent issued before the time of the decree to any applicant. All future Bell patents

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108. The attendants were however to a certain extent disappointed about the information policy of Bell. For instance, John Saby, inventor of the alloy junction transistor at General Electric, stated that, "In crystal growing, for example, Gordon Teal wrote papers on crystal growing, but never disclosed a lot of the details of the process to get the crystals to grow. People who grew crystals generally had to discover themselves, and people in academia were teed off by this because Bell would print all these things, but they didn't really tell you how to make crystals that you could perform independent research on, unless you got down on your knees and ask them for a piece of crystal." *Oral-History: John Saby*, ENGINEERING AND TECHNOLOGY HISTORY WIKI, ethw.org/Oral-History:John_Saby (last visited Feb. 5, 2016).

109. See Hyungsub Choi, *The Boundaries of Industrial Research: Making Transistors at RCA, 1948-1960*, 48 TECHNOLOGY AND CULTURE 758-82 (2007).

110. Levin, *supra* note 57 at 80.

111. See Carl Shapiro, *Navigating the Patent Thicket: Cross-Licenses, Patent Pools, and Standard Setting*, in 1 INNOVATION POLICY AND THE ECONOMY 119 (Adam B. Jaffe, Josh Lerner & Scott Stern eds., 2001); CARL SHAPIRO, TECHNOLOGY CROSS-LICENSING PRACTICES: FTC V. INTEL (1999); Albert Galasso, *Cross-License Agreements in the Semiconductor Industry: Waiting to Persuade*? (2006), *available at* http://www.inno-tec.bwl.uni-muenchen.de/files/service/links/epip/alberto_galasso.pdf.

112. The case was also part of a civil law litigation: *Intergraph Corp. v. Intel Corp.*, 195 F.3d 1346, 1349 (Fed. Cir. 1999).

113. Levin, *supra* note 57 at 75.

114. *Id.*

would be available with reasonable royalties on any of its patents sought by the Bell system. In addition, the decree barred AT & T from "engaging in any business other than the furnishing of common carrier communications services."[115] In literature,[116] it was argued that this consent decree did little more than ratify the existing corporate policy. In fact, Bell employees already published articles in 1949 that Bell was willing "to make available on reasonable terms to all who desire them non-exclusive licenses under its patents for any use."[117] Bell traditionally asked for cross-licensing agreements.[118] The company had the fear that the invention of the transistor and its consequences were so big that "we couldn´t keep it to ourselves and we couldn´t make all the technical contributions."[119] Therefore, Bell opened its laboratories by organizing conferences and publishing handbooks thereby transferring knowledge to its competitors. Due to the consent decrees with U.S. antitrust authorities signed in the 1950s, the "technological giants" in semiconductor production, largely IBM and AT&T, were effectively curtailed from enforcing patent rights against rival firms throughout the 1960s and 1970s.[120] Insofar, the antitrust regulation incentivized innovation at least on the long run.

Existing patents were thus either cross-licensed or to a certain degree ignored.[121] The problem with patents in the European semiconductor business was that nobody really knew who the inventor of which element was. For instance, the name, Shockley, was left off the patent application after lawyers of Bell found that Shockley´s writings on tran-

115. *Id.*

116. *Id.*

117. K. S. McHugh, *Bell System Patents and Patent Licensing*, BELL TELEPHONE MAGAZINE, 1-4 (1949).

118. A. M. Golding, *The Semiconductor Industry in Britain and the United States: A case study in Innovation, Growth, and Diffusion of Technology*, PhD thesis University of Sussex (1971).

119. Morton/Bell cited in TILTON, *supra* note 51.

120. Levin, *supra* note 57; Bronwyn H. Rosemarie Ham Ziedonis, *An Empirical Analysis of Patent Litigation in the Semiconductor Industry* 7 (Jan. 2007), http://eml.berkeley.edu/~bhhall/papers/HallZiedonis07_PatentLitigation_AEA.pdf (last visited Mar. 17, 2015)(hereinafter Hall & Ziedonis I). AT&T applied this open strategy even in the 1970. *See* Robert E. Kerwin & Richard A. DeFelice, *Silicon for the Masses: How AT&T Licensed its IP in the 1970s to Facilitate the Development of a Worldwide Semiconductor Industry*, in INTERNATIONAL ECONOMIC NEGOTIATION: MODEL VERSUS REALITY 229 (Viktor Aleksandrovich Kremeniũk & Gunnar Sjöstedt eds., 2002).

121. Eric von Hippel, *Appropriability of Innovation Benefit as a Predictor of the Source of Innovation*, RESEARCH POLICY 95-116 (1982). Bigger Japanese companies were also fond of cross-licensing models. *See* Kazuyuki Motohashi, *Licensing or Not licensing? An Empirical Analysis of the Strategic Use of Patents by Japanese Firms*, 37 RESEARCH POLICY 1548-55 (2008); Melissa M. Appleyard, *How Does Knowledge Flow? Interfirm Patterns in the Semiconductor Industry*, 17 STRATEGIC MANAGEMENT 137-54 (1996).

sistors were "highly influenced" by an earlier 1925 patent granted to Lilienfeld.[122] Furthermore, the big players, Fairchild and Texas Instruments, sued each other for patent infringement; in a 1966 settlement, each party dropped its opposition and agreed not to dispute its rival's patents for a period of ten years.[123] These companies closed cross-licensing agreements and invited others to join in the distribution and enhancement of their results. Arguments about trade secrets were unknown.[124] One of the big symbols of this spirit was the instrument of reverse engineering that allowed all semiconductor companies to check the interiors of circuits produced by competitors.[125] Years later, we call this practice of knowledge sharing the "industry norm of competition." "The industry spokespersons, while seeking protection from piracy as they perceived it, were insistent on preserving and encouraging the industry practices of creative copying, a practice known to them as reverse engineering."[126]

Throughout the whole discussion on the SCPA all experts held that the examination of the technical details of a competing chip is important and should be legal in order to obtain improved chip designs. As a result, many semiconductor companies avoided the process of enforcing or licensing existing patents.[127] As statistics show, patent court proceedings started in 1973 on a very low level and highly increased only from 1983.[128]

PHASE 2: THE JAPANESE – U.S. CHIP-WAR AND THE SEARCH FOR EFFECTIVE PROTECTIVE MEASURES (1980–1984)

More and more, the press noted that semiconductors were "America´s most promising growth industry."[129] Indeed, the situation changed in the 1980s, especially with the substantial investment required for

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122. WILLIAM SHOCKLEY, ELECTRONS AND HOLES IN SEMICONDUCTORS: WITH APPLICATIONS TO TRANSISTOR ELECTRONICS (1956).

123. W. F. Finance, *The International Transfer of Semiconductor Technology through US Based Firms*, NBER (NATIONAL BUREAU OF ECONOMIC RESEARCH) WORKING PAPER NO. 118 (1975).

124. However, companies like Bell Labs had a clear sense for the importance of secrecy requirements prior to a patent application; see MICHAEL RIORDAN & LILLIAN HODDESON, CRYSTAL FIRE: THE BIRTH OF THE INFORMATION AGE 150 (1997).

125. For technical details on Reverse Engineering, *see* FLORIAN SCHWEYER, DIE RECHTLICHE BEWERTUNG DES REVERSE ENGINEERING IN DEUTSCHLAND UND DEN USA 18 (2012).

126. Leo J. Raskind, *Reverse Engineering, Unfair Competition, and Fair Use*, 70 MINN. L. REV. 385, 391 (1985).

127. Levin, *supra* note 57, at 81.

128. Hall & Ziedonis I, *supra* note 121.

129. H.R. 1007, 96th Cong. (1979).

VLSI chips.

At this time, there were restrictive trade barriers erected in the U.S. against European and Asian semiconductor products. The U.S. government used a "Buy American" policy that required foreign corporations to bid 6% under the lowest bid by an American firm. In military procurement cases, foreign bids have increased by 50% since 1962.[130] The Japanese Government answered quickly to this preferential treatment for U.S. companies. In 1960, American and Japanese companies started a patent war over semiconductors that lasted for a decade. The MITI restricted Fairchild and Texas Instruments from investing in their IC plants that they built in Japan.[131] Subsequently, the period of free use was over although it took more than thirty years until the Japanese Patent Office in 1989 granted patent rights in ICs to Texas Instruments.[132] This explains why the U.S. industry really fought for a *sui generis* protection semiconductor. It is not that the existing IPs were ineffective but a new *sui generis* right would help in a trade war especially due to the fact that a new right could only be enforced internationally on the basis of reciprocity.

The Semiconductor *sui generis* protection right was an invention of Intel and its counsel Roger Borovoy. After a first attempt of the U.S. Senate to extend copyright protection to integrated circuits failed,[133] the lobbyists who represented the interests of the Californian semiconductor industry fought together with the U.S. House of Representatives[134]

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130. TILTON, *supra* note 51, at 36.; Skole, *supra* note 82, at 119-24.

131. MISMANAGED TRADE?, *supra* note 10, at 56-59. Further details can be found in the US based report of MARK MASON, AMERICAN MULTINATIONALS IN JAPAN: THE POLITICAL ECONOMY OF JAPANESE CAPITAL CONTROLS 1899-1980 176-87 (1992); for the Japanese perspective see NAKAGAWA, *supra* note 47, at 154-66.

132. Thomas C. Hayes, *Japan Grip Still Seen On Patents*, N. Y. TIMES, Nov. 24, 1989, http://www.nytimes.com/1989/11/24/business/japan-grip-still-seen-on-patents.html (last visited Mar. 17, 2015). But even then, TI failed to enforce its patent rights in Japan. For instance in 1994, a Japanese court ruled that Fujitsu Ltd. had not violated the Kilby patent, because the patent described particular technical details that Fujitsu did not use in two of its recent computer chips, see Edmund L. Andrews, *Company News: Texas Instruments Loses in Japanese Ruling*, N. Y. TIMES, Sep. 1, 1994, http://www.nytimes.com/1994/09/01/business/company-news-texas-instruments-loses-in-japanese-ruling.html (last visited Mar. 17, 2015).

133. H.R. 1007, 96th Cong. (1979) adding to § 101 Copyright Act: "Such pictorial, graphic and sculptural works shall also include the photographic masks used to imprint patterns on integrated circuit chips and include the imprinted patterns themselves even though they are used in connection with the manufacture of, or, incorporated in a useful article."

134. In a note to the author, Richard Stern (n.1) tracked back the opposition of the House against the copyright approach to Congressman Robert Kastenmeier, chairman of the House Judiciary Committee's IP subcommittee. *See* R. Kastenmeier & M. J. Reming-

for a separate protection regime. The lobbyists used several arguments for that approach: The development of an IC involves around 500 process steps which take more than two years and includes the know-how from thousands of engineers. So the lobbyists argued that this exposed them to an increasing number of copyists. Furthermore, the lobbyists claimed that existing national patent laws failed to give sufficient protection to this economic sector, because they required a high standard of inventiveness. Patent protection seemed too complex and bureaucratic, especially the requirement of a full verbal description of the circuit layout.[135] As they argued in Congress, companies needed to register thousands of semiconductor devices for patent protection in order to get protection for a single IC. The copyright system was inefficient in cases of copying the pattern on the chip itself if the Copyright Office deemed the pattern was inseparable from the utilitarian function of the chip.[136] In addition and in fact, the final chip configuration is only the result of a lot of drawings; unauthorized duplication usually came from the finished chip and not from drawings or masks.[137]

The most striking argument was the "Japanese threat."[138] Japanese corporations had a strong interest in the technology and cooperated very early with Silicon Valley. U.S. and Japanese producers cooperated via cross-licensing agreements. But then the open exchange of ideas changed dramatically when the Americans noticed the increasing economic success of Japanese silicon companies. At the parliamentary hearing, the president of Intel presented photos of a Toshiba chip that was an exact copy of the Intel chip 2147 according to his statement.[139] The Toshiba chip remained the main evidence for Japanese piracy for

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ton, *The Semiconductor Chip Protection Act of 1984: A Swamp or Firm Ground?*, 70 MINNESOTA LAW REVIEW 417 (1985).

135. Levin, *supra* note 57, at 79.

136. As a matter of fact, the Copyright Office had refused to register patterns on printed circuit boards and semiconductor chips because no separate artistic aspects had been demonstrated. COPYRIGHT PROTECTION FOR SEMICONDUCTOR CHIPS: HEARINGS BEFORE THE SUBCOMMITTEE ON COURTS, CIVIL LIBERTIES, AND THE ADMINISTRATION OF JUSTICE OF THE COMMITTEE ON THE JUDICIARY HOUSE OF REPRESENTATIVES, 98TH CONG., 1ST SESS., ON H. R: 1028 77 (1983), http://www.ipmall.info/hosted_resources/lipa/trademarks/Copyright%20Protection%20for%20Semiconductor%20Chips,%20Subcomm.%20%28Aug.%203%20AND%20Dec.%201,%201983%29.pdf (last visited Mar. 17, 2015) [hereinafter COPYRIGHT HEARINGS].

137. *Id.*

138. Rauch, *supra* 96, at 407; Daniel E. Tierney, *The United States – Japan Semiconductor Controversy: A Strategic Guide to the Use of U.S. Trade Laws as a Legal and Political Instrument*, 52. ALB. L. REV. 363 (1987-1988); Eugene Volokh, *The Semiconductor Industry and Foreign Competition*, CATO POLICY ANALYSIS NO. 99, (Jan. 1988), http://www.cato.org/pubs/pas/pa099.html (last visited Mar. 17, 2015).

139. COPYRIGHT HEARINGS, *supra* note 137.

decades.[140] Nobody, however, checked the evidence. Actually, the chips were very different. Toshiba produced a smaller chip in a double metal process which organized the transistor patterns in vertical columns. The Intel chip was bigger with horizontally organized transistors produced in a single metal process.[141]

Eventually, the term "chip piracy" was invented and is entirely useless. If there is no protection for chips, the "pirate" is not a pirate. Nevertheless, there was a very big discussion between the House and the Senate how to structure an effective system for fighting chip piracy. The Senate opted for an extension of the copyright act.[142] The House was in favor of a new system of industrial property protection.[143] The concept of the House (based on the ideas of Intel) was mainly justified by the idea that a new system of protection allowed the United States to force foreign nations to integrate this new protection system in their national legislation.[144] The copyright solution was a problem as the Universal Copyright Convention mainly relates to works of applied art and allows no other industrial products to be protected.[145] Finally, the Congress favored the idea of *sui generis* protection for its own semiconductor industry which claimed at that time to be leading worldwide.

PHASE 3: THE *SUI-GENERIS*-REGIME OF THE SCPA

The Semiconductor Chip Protection Act of 1984 (SCPA),[146] created a

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140. Years later, a second case was argued in the US press where NEC was held to have copied the famous INTEL 8086 and 8088 microprocessor in their V20 and V30; see Dan Morgan, *Battling to Innovate and Emulate: Intel versus Nippon Electric*, WASHINGTON POST, May 2, 1983. In 1986, Intel sued NEC for copyright infringement regarding their microcode. In September 1986, Judge Ingram ruled that the electronic instructions known as microcode are eligible for protection under the copyright laws; see Robert Hinckley, *NEC v. Intel: Will Hardware Be Drawn into the Black Hole of Copyright Editors*, 3 SANTA CLARA HIGH TECH. L. J. 23 (1987). This case however only dealt with software piracy, not with the layout of ICs.

141. Kasch, *supra* note 100, at 79-80.

142. This approach was taken in S. 1201, 98th Cong., 1st Sess., 130 CONG. REC. S5833-38 (daily ed. May 16, 1984).

143. This model was used in H. R. 5525, 130 CONG. REC. H5524-25 (daily ed. June 11, 1984).

144. H. R. REP Number 781, 7-8.

145. *Id.*

146. Tide III of Public Law 98-620 of November 8, 1984, now 17. U.S.C. Section 901 et. seq. Enthusiastic descriptions of this Act can be found in Jay Erstling, *The Semiconductor Chip Protection Act and its Impact on the International Protection of Chip Designs*, 15 RUTGERS UNIVERSITY COMPUTER & TECHNOLOGY LAW JOURNAL (1989), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1710225; Steven Benz, *The Semiconductor Chip Protection Act of 1984 – Experience in the Utilization of the Law and Current International Developments*, 8 EUR. INTELL. PROP. REV. 229, 229 (1986).

new kind of industrial property containing elements of patent, copyright, and competition law.[147] The Act sought to protect the "mask-work." The "mask" is the pattern that utilizes the circuits on the silicon-wafer in order to create the integrated circuit. The term "mask-work" demonstrates the traces of new sui generis right to copyright law.[148] The Act uses typical copyright terms when it requires the mask work to be "original." The reference to mask works does not fit the SCPA's intention of protecting against illegal photos of the chip itself.[149]

Additionally, the SCPA provides a new way of imposing international pressure. All nations must adopt the main elements of the SCPA. Otherwise, topographies and mask works of a foreign chip producer would not be protected in the United States.

In Europe, member states tried to establish harmonized chip protection legislation to conform with the SCPA. Other European states however resisted the pressure of the United States and created their own way to protect chips.[150]

This resistance eventually lead to the rapid preparation of a new Directive for chip protection by EC authorities after the United States granted interim for nationals and European domiciles. Soon the Directive on the Legal Protection of Semiconductor Products was adopted by the EC Council on December 16, 1986[151] in order to harmonise the composition of legal protection for semiconductor technology. In the Direc-

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147. Richard H. Stern, *The Semiconductor Chip Protection Act of 1984: The International Comity of Industrial Property*, 3 BERKELEY JOURNAL OF INTERNATIONAL LAW, Winter 1986; DAVID LADD, DAVID E. LEIBOWITZ & BRUCE G. JOSEPH, PROTECTION FOR SEMICONDUCTOR CHIP MASKS IN THE UNITED STATES (1986); Charles N. Quinn, *Protecting Semiconductor Chips in U. S.*, LA NOUVELLES 95, September (1987); Wade Woodson & Douglas C. Safreno, *The Semiconductor Chip Protection Act of 1984*, COMPUTER & HIGH TECHNOLOGY LAW JOURNAL 7 (1985).

148. Stern, *supra* note 148 at n.1. The mask work concept had nothing to do with sui generis. It was an attempt to assimilate the chip protection sought to the copyright pattern of literary works, pictorial works, musical works, etc. But once in the Senate bill it stayed in and was carried over to the subsequent House bill.

149. COPYRIGHT HEARINGS, *supra* note 137.

150. Such as the United Kingdom; *see* Thomas Hoeren, *Chip Protection in Europe*, in THE LAW OF INFORMATION TECHNOLOGY IN EUROPE (Corien Prin & Alfred P. Meijboom eds., 1992), http://www.uni-muenster.de/Jura.itm/hoeren/veroeffentlichungen/036.pdf. Several states like the Netherlands, UK and Australia informed the US that they will simply apply their existing copyright legislation to microchips. Australia advised the United States of such intention in a communication described in 50 FED. REG. 24, 665 (1985); see also 50 FED. REG. 26, 818 (1985). The Netherlands advised the United States in a communication reprinted in 50 FED. REG. 24, 795, 796-800 (1985). The United Kingdom advised the United States in a communication described in 50 FED. REG. 24, 666-68 (1985).

151. *See* Thomas Hoeren, *Chip Protection in Europe*, in THE LAW OF INFORMATION TECHNOLOGY IN EUROPE, (MAR. 17, 2015), *available at* http://www.uni-muenster.de/Jura.itm/hoeren/veroeffentlichungen/036.pdf.

tive, member states must achieve certain guidelines in order to benefit from the Directive's protection in Europe which include:

(1) The protection of the "topography" is essential, not the microchip itself, i.e. "the three-dimensional pattern of the layers of which a semiconductor product is composed."[152] Unlike the SCPA, this definition does not use the term "mask-work" to describe the object of chip protection although the term is substantively the same.

(2) The right holder must be a national of an EC member state or has to start the commercial exploitation within the EC. Otherwise, the protection depends on special declarations of the member states in agreement with the Commission (Article 3).

(3) Article 5 provides the right-holder with the exclusive right to authorize or prohibit the reproduction and commercial exploitation of the product.

The EC member states had to implement this Directive into national law by November 7, 1987.[153] For example, the Federal Republic of Germany issued the "Halbleiterschutzgesetz"[154] (Semiconductor Protection Act) on 1st November 1987. Essentially, most of these national acts mirror the wording of the Directive.

The semiconductor protection acts of the USA and the EC in the 1980s, create a new type of intellectual property right. These acts have a material reciprocity in common. This is a new way to force other nations not only to accept, but also into adopt this new right in their own legislation to protect their own semiconductor industries as well. This new system of material reciprocity was harshly criticized in the succeeding publications.[155] It was said to contradict the principles of industrial property law. For centuries, the national treatment principle had been regarded as the corner stone of international patent and copyright law.[156] Inventions and copyright works had been protected irrespective

152. 1986 O.J. (L24) 36.

153. There were however several mistakes in the implementation of this directive. The Commission for instance forgot to deal with the problem of the Isle of Man where most European semiconductor corporations had their seat at this time. The Isle of Man is not part of the EU. Therefore, the companies seated at the Isle of Man did not enjoy the sui-generis protection. This gap was closed only ten years later. EUR. CONSULT. ASS. DEB. 96th Sess. 644 (Nov. 11, 1996).

154. *Halbleiterschutzgesetz*, Bundesgesetzblatt, Part I, 2294 (1987), http://www.bgbl.de/banzxaver/bgbl/start.xav?startbk=Bundesanzeiger_BGBl&start=//*%255B@attr_id=%27bgbl187s2294.pdf%27%255D#__bgbl__%2F%2F*[%40attr_id%3D%27bgbl187s2294.pdf%27]__1427108083407.

155. *Das* deutsche, *supra* note 2.

156. Thomas Dreier, *National Treatment, Reciprocity and Retorsion - The Case of Computer Programs and Integrated Circuits*, in GATT OR WIPO? NEW WAYS IN THE INTERNATIONAL PROPERTY OF INTELLECTUAL PROPERTY 63, 70 (Friedrich-Karl Beier & Gerhard Schricker eds., 1989).

of the nationality of their creators or inventors.

The principle of reciprocity was integrated for the first time in industrial property laws.[157] Even in the U.S., experts feared that most other countries might refuse to adopt the U.S. system. The real reason for the reciprocity was that it created a win-win-situation for the United States. If a country like Japan adopts the structure of the SCPA, U.S. companies would obtain a protection for their mask-works within that country. On the contrary, although unrealistic, if a country like Japan refuses to grant the protection, the U.S. companies could use the foreign-mask works for free, which would allow for a high transfer of knowledge. The U.S. Government now had a very useful weapon in the trade wars against Japan and its increasingly powerful semiconductor industry.

Additionally, it is beneficial to consider how the U.S. reacted when other states used the reciprocity "weapon" in IP law. In 1996, the European Union enacted its Directive on the legal protection of databases.[158] To a certain degree, this Directive imitates the U.S. Semiconductor Protection Act's approach. The Directive establishes a new sui generis right for databases and combined that approach with the reciprocity rule established in the SCPA (Art. 11).[159] The EU's attempt to push the U.S. to integrate a sui generis protection for databases in its legislation was ultimately unsuccessful. Instead, the U.S. Copyright Office complained that U.S. database producers might get "a competitive disadvantage in Europe" due to the following rule:

> The directive's failure to provide national treatment may be challenged as an impermissible trade practice, inconsistent with existing treaty obligations, or as an inappropriate approach to intellectual property in a global marketplace.[160]

The attempted implementation of a sui generis right for databases in the U.S. was not successful. Today, courts are struggling to implement the rather complex and vague criteria for this protection regime.[161]

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157. *Id.* As Richard Stern explained, after the House´s decision to implement a sui generis right, "it became necessary to put in provisions about international comity. At a late stage, Janice Teisberg suggested this reciprocity approach instead of the copyright "universality" approach, as a way to "encourage" foreign countries to give US chip companies protection for chip layouts. Sui generis came first; this was an afterthought."

158. 1996 O.J. (L96) 9.

159. Silke von Lewinski, *Kommentar zur Datenbank-Richtlinie, Artikel 11*, in EUROPÄISCHES URHEBERRECHT (M. Walter et. al. eds., 1999).

160. U.S. Copyright Office, *Report on Legal Protection for Databases* (1997), http://www.copyright.gov/reports/dbase.html.

161. *See* Commission of the European Communities, *DG Internal Market and Ser-*

Primarily due to the pressure from the new reciprocity rule, an international agreement on the minimum standards for semiconductor protection became more and more necessary. As a result, the "Treaty on the Protection of Intellectual Property in Respect of Integrated Circuits" (IPIC) was passed in 1989 at the diplomatic conference of the WIPO in Washington.[162] Although the treaty was accepted by the majority of participating countries, it was never ratified. The failure to ratify the Treaty was directly attributable to the protest of the USA and Japan, who were the leading countries in the production of microchips at the time.[163] The U.S.'s major criticism was the Treaty's eight year protection limitation. The U.S. maintains that important semiconductors, like computer chips (Intel), have a longer lifespan than eight years. An additional argument of both Japan and the U.S. was strong criticism against the rules on compulsory licensing in Article 6 (3) IPIC. After the failure of IPIC, Article 35 to Article 38 of the Trade-Related Aspects of Intellectual Property Rights ("TRIPS") Agreement in 1994 began to regulate and protect semiconductor technology. TRIPS integrates exemptions for "private purposes," reverse engineering and innocent infringements.[164] But Article 35 TRIPS Agreement explicitly excludes the controversial Article 6 (3) IPIC which defines compulsory licensing. According to TRIPS, each member state is free to decide about the implementation in their own legal system either as a sui generis law or in existent copyright or patent law.[165]

As a matter of fact, the structure of all these sui generis regulations was not very convincing.[166] As Article 35 TRIPS Agreement states, it is

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vices Working Paper (Dec. 12, 2005), http://ec.europa.eu/internal_market/copyright/docs/databases/evaluation_report_en.pdf (discussing some of the critical features of this approach)[hereinafter Commission of the European Communities].

162. Thomas Dreier, *National Treatment, Reciprocity and Retorsion - The Case of Computer Programs and Integrated Circuits*, in GATT OR WIPO? NEW WAYS IN THE INTERNATIONAL PROPERTY OF INTELLECTUAL PROPERTY 63, 70 (Friedrich-Karl Beier & Gerhard Schricker eds., 1989).

163. ALESCH STAEHELIN, DAS TRIPS-ABKOMMEN: IMMATERIALGÜTERRECHTE IM LICHT DER GLOBALISIERTEN HANDELSPOLITIK 100 (1997).

164. Treaty on Intellectual Property in Respect of Integrated Circuits art. 6(2), May 26, 1989, 6 World Intell. Prop. Org., Copyright and Related Rights Laws and Treaties, Multilateral Treaties, Text 1-011. [hereinafter Multilateral Treaties].

165. *Id.*

165. Thomas Hoeren, *Das Washingtoner Abkommen zum Schutz des geistigen Eigentums an integrierten Schaltkreisen*, NJW 2605, 2606 (1989).

166. That might be one of the reasons why Japan and the United States have not even modified their semiconductor chip protection since the TRIPS Agreement came into effect, ten and eleven years after their initial semiconductor legislation.

not the semiconductor product itself, which is the object of protection.[167] Rather, the member states of TRIPS have to provide protection "to the layout-designs (topographies) of integrated circuits."[168] This is slightly different from the wording of the American SCPA, which protects the "mask-work." Within TRIPS, other methods in setting the circuits on the wafer apart from "masks" are protected as well.

The sui-generis protection is a combination of a copyright-like standard of "originality" and a patent law test of newness. The layout-designs are original "in the sense that they are the result of their creators´ own intellectual effort and are not commonplace among creators of layout-designs (topographies) and manufactures of integrated circuits at the time of their creation."[169] So, the topography firstly has to show minimal creativity in its design. Here the regulation uses the typical copyright standard of "intellectual effort." It further combines that standard with the additional requirements of not being "commonplace." This criterion resembles the patent law question of novelty although the negative test of being not commonplace is a lower standard than the criterion of inventiveness. The requirement is more similar to those traditionally used in utility patent law. Insofar as the sui generis approach tries to combine copyright and patent law standards, making this regime neither fish nor fowl.

Another unsuccessful provisions are those on reverse engineering.[170] "Reverse engineering" means to create a new topography by analyzing an existing one. This principle is taken from the U.S. SCPA.[171] According to Article 6 (2) lit. b IPIC, "reverse engineering" means that:

> the third party [...], on the basis of evaluation or analysis of the protected layout-design (topography) [...] creates a layout design (topography) complying with the requirement of originality [...], that third party may incorporate the second layout-design in an integrated circuit [...].[172]

Thus, a third person is allowed to analyze the existing topography of a microchip from another producer in order to create their own, new one. The other way around, simply rebuilding the same chip is not "re-

167. Agreement on Trade-Related Aspects of Intellectual Property Rights, art. 35, Apr. 15, 1994, 1869 U.N.T.S. 299 [hereinafter TRIPS].

168. *Id.*

169. Multilateral Treaties, *supra* note 165.

170. See for technical details on Reverse Engineering FLORIAN SCHWEYER, DIE RECHTLICHE BEWERTUNG DES REVERSE ENGINEERING IN DEUTSCHLAND UND DEN USA 24 (2012).

171. 17 U.S.C. § 906(a)(2).

172. Multilateral Treaties, *supra* note 165.

verse engineering." The topography of the new chip has to fulfill the requirement of originality, in the sense of Article 3 (2) IPIC mentioned above. Nevertheless, the principle of "reverse engineering" seems to be defined imprecisely, so that even mere copyists might refer to this principle in order to defend themselves against the right holder if they could show a "paper trail" to disprove plagiarism.[173]

As seen above, the term of protection was a major point of criticism to the IPIC Treaty on part of the USA and Japan. The term of protection in Article 8 IPIC was constituted to at least eight years. The criticism is only partly acceptable. Indeed, the lifespan of some microchips might last longer than eight years. But the majority of microchips are far from being used longer than eight years. This is because of the fast moving chip industry and the fast development of new layouts.

Nevertheless, the term of protection in Article 38 TRIPS Agreement was extended to ten years. Here, the same formula is used as in patent regulation.[174] The earliest date on which the protection may begin is either "the date of filing an application for registration" or, "from the first commercial exploitation wherever in the world it occurs." Noticeably, in contrast to Article 8 IPIC, the date of creation of the layout would not be taken into account.

PART 4: AND THE FUTURE?

In 1985, Intel applied for a patent for the circuit design 27C256, a programmable read-only chip with 256k memory. Other companies followed. Since the semiconductor protection has been included into TRIPS, the topic "protection of chips" seems to have disappeared almost entirely. There is hardly any publication on the protection of semiconductor technology, except for reviews in standard works, e.g. textbooks. Furthermore, only a few decisions are known dealing with the sui generis regime. The *Brooktree* case[175] became the only published U.S. case on that matter where a jury ultimately issued a $26 million verdict against a chip rights infringer which was upheld by a federal court of appeals. Years later, the Ninth Circuit decided the case *Altera v. Clear Logic*.[176]

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173. Pamela Samuelson, Suzanne Scotchmer, *The Law and Economics for Reverse Engineering*, 111 YALE L. J. 1575 (2001); Lee Hsu, *Reverse Engineering Under the Semiconductor Chip Protection Act – Complications for Standard of Infringement*, 5 ALB. L. J. SCI. & TECH. 249 (1996); Harold R. Brown, *Fear and Loathing of the Paper Trail: Originality in Products of Reverse Engineering Under the Semiconductor Chip Protection Act as Analogized to the Fair Use of Nonfiction ,Literary Works*, 41 SYRACUSE L. REV. 985 (1990); Richard H. Stern, *Determining Liability for Infringement of Mask Work. Rights Under the Semiconductor Chip Protection Act*, 70 MINNESOTA LAW REVIEW 271 (1985).

174. "[...] shall not end before the expiration of a period of [...]." TRIPS, *supra* note 168 at Art. 33.

175. *Brooktree Corp. v. Advanced Micro Devices, Inc.*, 977 F.2d 155 (Fed. Cir. 1992).

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

Clear Logic was sentenced to pay $30 million USD to Altera for violating the SCPA.[177] The argument of Clear Logic that they only copied abstract features, not protectable mask work was dismissed finding that "groupings" shown in the mask were "physically a part of the mask work" and were as such protectable.[178] In the *Nintendo Co. Ltd. v. Centronics Systems Pty. Ltd.* case, the Australian Court decided in 1991[179] in favor of Nintendo and a Taiwanese chip producer. The judge held that the visible differences of the layouts were insignificant design changes and that no evaluation or analysis had been carried out by the defendant.[180]

Apparently, the original interest in the protection on part of the semiconductor industries has ceased. Already, some authors talk about chip protection as a dead subject.[181] Today the sui generis right is an example of the creation of special IP rights at the request of a limited number of countries, which in the end is not used at all. Today the sui-generis rules for semiconductors are really "dead."[182] Industry is relying on patents.[183] This led to a strange patent paradox in the semiconductor sector. In general, there are some voices in research which hint to the mixed effects and the dysfunctional nature of patent protection in semiconductor R&D.[184] In 1982, after the creation of a "pro-patent" Central Appellate Court for the Federal Circuit (CAFC),[185] the number of patents filed by semiconductor producers visibly increased. In an industry that previously has been among the least reliant on patents to protect

177. *Id.* at 1081.

178. *See also Avel Pty Limited v. Wells, FCA 590* (1991); 105 ALR 635 (1991).

179. (1991) FCA 791; (1992) AIPC 90-854; 23 IPR 119.

180. *Id.*

181. *See* Gunnar W. G. Karnell, *Protection of Layout Designs (Topographies) of Integrated Circuits – R.I.P.?*, IIC 648 (2001)(stating that the protection is "not only a 'lame' but rather "dead duck."

182. See the former economist for the Semiconductor Industry Association Benz (n.1) in an email to the author: "As an antitrust litigator, I have been disappointed that there have not been more litigation to enforce mask work designs. The wave of SCPA litigation we predicted never materialized."

183. Bronwyn H. Hall & Rose Marie Ham Ziedonis, *Patent Paradox Revisited: Determinants of Patenting in the US Semiconductor Industry, 1980-1994*, NBER WORKING PAPER NO. 7062 (1999)(hereinafter Hall & Ziedonis II). That has the consequence that the courts are now dealing with the patent rights of semiconductor producers, for instance the applicability of the first sale doctrine to chips see the US Supreme Court decision Quanta Computer, Inc. v. LG Electronics., Inc., No. 06-937, 2008 U.S. LEXIS 4702 (U.S. June 9, 2008).

184. Edwin Mansfield et al., *Imitation Costs and Patents: An Empirical study*, 91 ECON J. 907 (1981); Benjamin N. Roin, *The Case for Tailoring Patent Awards Based on the Time-to-Market of Inventions*, 61 UCLA L. REV. 36-37 (2014).

185. See the leading case on this issue, *South Corp. v. United States*, 690 F.2d 1368 (Fed. Cir. 1982).

technological advantages, there was an upsurge in patents relative to R&D expenditure after the 1980s.[186]

While companies relied more and more on patents, they were also considered to be the most ineffective tools for protecting the knowledge in that sector.[187] This paradox seems to have been caused by the fear of a race to the patent and existence of wider thicket of prior art in the silicon business.[188] As a consequence, competitors in semiconductors came back to the old times of the 1950s (see above) and the model of cross-licensing patent rights[189] or covenants not to sue. These contracts are linked with strong, extended trade secrets and confidentiality provisions.[190] In this open cross-licensing system, the patent itself changes its importance. It helps to avoid the risk of being sued for patent infringement; it is the source for the return on investment via licensing agreements. This defensive patent strategy is also helpful to guarantee internal incentives to the employees and to monitor the engineering process. Furthermore, the IP system seems to have been the key to lubricating the orderly development of the semiconductor gy.[191] The publication of the patent applications especially alerted researchers to the work being already done by others and supported an ecosystem where the inventors/researchers had respect for each other's work. The fact that cross licensing was and is the normal approach is a great credit to the patent system - the balancing payments enabled those doing the most research and invention to partly fund their efforts.

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186. Hall & Ziedonis II, *supra* note 184 at 1-128.

187. Wesley Cohen et al., *R & D Spillovers, Patents and the Incentives to Innovate in Japan and the United States* (2001), http://www.druid.dk/uploads/tx_picturedb/ds2001-161.pdf [March 17, 2015]; Wesley Cohen, Richard R. Nelson & John P. Walsh, *Protecting Their Intellectual Assets: Appropriatability Conditions and Why U.S. Manufacturing Firms Patent (or Not)* (2000), http://www.nber.org/papers/w7552 [March 17, 2015].

188. Hall & Ziedonis I, *supra* note 121; R. P. Merges, R. R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUMBIA LAW REVIEW 839 (1990).

189. Leon Radomsky, *Sixteen Years after the Passage of the U.S. Semiconductor Chip Protection Act: Is International Protection Working*, 15 BERKELEY TECHNOLOGY L. J. 1049 (2000); T. G. Lewis, *Comment: Semiconductor Chip Process Protection*, 32 HOUSTON LAW REVIEW 555, 605-06 (1995); Mehdi Ansari, *LG Electronics, Inc. v. Bizcom Electronics, Inc.: Solving the Foundry Problem in the Semiconductor Industry*, 22 BERKELEY TECHNOLOGY LAW JOURNAL 137, 138 (2007) (who states that leading semiconductor manufacturers have used broad cross-licensing agreements to provide "patent peace and allow development of parallel technology"); Dan Callaway, *Note, Patent Incentives in the Semiconductor Industry*, 4 HASTINGS BUSINESS LAW JOURNAL 135, 137 (2008) ("[L]arge semiconductor companies encourage their rivals to enter cross-licensing agreements.").

190. See Terry Ludlow, *Sign of the Times: Trends in Technology IP Licensing*, INTELLECTUAL ASSET MANAGEMENT, No. 66, 31-38, July-August 2014 describing that trend as "mega-licensing."

191. Special thanks to Roger J. Burt, former IBM patent attorney, for co-reading my study and giving me some very valuable advice as the future of semiconductor industry especially concerning the importance of the IP system in the semiconductor business.

As Roger Burt (former IBM patent attorney) stated, the "IP system, and the patent in particular, is the lubricant that enable the engine of research and development to run smoothly."[192]

As to the sui-generis right, it is problematic that only the layout-design (topography) of microchips is the object of protection. For the industry, the function of an integrated circuit is more valuable to protect than the design.[193] Furthermore, layout-designs are easily variable without loss of functionality. Topographies are therefore no longer protected once the design is altered ("reverse-engineering"). It is a condition of semiconductor protection that the layout-designs are based upon intellectual effort.

In addition, microchips, i.e. their layout-designs, are highly complex, miniature entities which are rarely copied.[194] This fact makes the protection against forgers superfluous. Consequently, the protection of semiconductor topography is uninteresting from an economic point of view. Because of a fast developing technological sector,[195] microchips have a short lifespan while the process getting to legal protection is rather time-consuming. Furthermore, it appears there is little point in protecting semiconductor topography against the "danger" of reverse-engineering. As previously mentioned, microchips with different topographies can accomplish the same function. Finally, the high costs of producing microchips today including the necessity of manufacturer´s support and the trend to tailor-made chip architecture makes chip piracy unaffordable. Topographies are also more and more influenced by technical standards and norms which leave almost no place for variations of the layout. Today, the complexity semiconductor development design cannot be controlled by a single country.[196] With the new and huge Chinese chip market, the times of the old fight between Japan and

192. Roger Burt has been co-reading this paper; the wording above has been used in an email to the author of February 25, 2015.

193. Gunnar W. G. Karnell, *Protection of Layout Designs (Topographies) of Integrated Circuits – R.I.P.?*, IIC 652 (2001).

194. *Id.*; Leon Radomsky, *Sixteen Years after the Passage of the U.S. Semiconductor Chip Protection Act: Is International Protection Working*, 15 BERKELEY TECHNOLOGY L. J. 1049 (2000).

195. *See* Rahul Kapoor, Barney Silver & Eric Larson, *Managing Complexity and Change in the Semiconductor Ecosystem* 5 (2012), http://www.arena-international.com/Journals/Company/4651/WhartonATREGIDMresearchreportNov.2012FINAL.pdf("The average time-to-market, defined as the period from design art to mass production, is about 11 months for a revision of an existing product design. It increases to about 17 months for a new product design.")

196. See IKKA TUOMI, THE FUTURE OF SEMICONDUCTOR INTELLECTUAL PROPERTY ARCHITECTURAL BLOCKS IN EUROPE (2009).

the U.S. are definitely over. Future competition is not based on a single technology but on a product variety combining pre-designed and pre-tested subcomponents. As a consequence, the increasing use of open source models for such components is already discussed in literature.[197]

The business infrastructure has changed as well. The integrated designing and manufacturing of chips was the old business model. Today, the fabless companies have won the game, companies which are only designing chips especially for specialized purposes. The money-consuming production of these chips is organized via a few big plants ("foundries" like TSMC or Globalfoundries).[198] The so-called netlists given by the fabless chip designing companies to the foundries are protected by copyright law (i.e. as text, software, or database) insofar as they include highly valuable and creative text-format converted chip designs.[199]

Astonishingly, an economic analysis of the factors which caused the death of the SCPA sui generis right has never been made. The situation is similar to other new rights which were installed to the high lobbyist pressure of industry.[200] For instance, the Commission only evaluated the sui generis right for the production of databases.[201] When the results were published showing that the new sui generis right had no effect on the database industry at all, the EU Commission remained silent. New rights were often invented in IP law, but nobody dares to abolish them again. The beginning of the semiconductor industry showed that sometimes regulatory interventions are perhaps not too necessary to promote innovation and that nations should respect the self-regulatory forces within the business sector using cross-licensing or codes of conduct instead of new sui generis rights.

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197. Eli Greenbaum, *Open Source Semiconductor Core Licensing*, 25 HARVARD JOURNAL OF LAW & TECHNOLOGY 131-57 (2011).

198. See figures on IC Insights, *Top 13 Foundries Account for 91 % of Total Foundry Sales in 2013* (2014), http://www.icinsights.com/news/bulletins/Top-13-Foundries-Account-For-91-Of-Total-Foundry-Sales-In-2013/ [March 17, 2015].

199. They can as well be protected via encryption and watermarking. *See* Moritz Schmid, Daniel Ziener & Jürgen Teich, *Netlist-Level IP Protection by Watermarking for LUT-Based FPGAs*, http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.161.3876, (last visited March 17, 2015).

200. The SCPA was the starting point of similar sui generis regulations in the United States. For instance, there is clear evidence that it is the model behind the Vessel Hulls Protection Design Act.

It is thus amazing that the most recent article on the semiconductor protection (after a long silence of 30 years) held that the US Act might be a model for regulating the protection of stem cells; see Simone A. Rose, *Semiconductor Chips, Genes and Stem Cells: New Wine for New Bottles?*, 38 AMERICAN JOURNAL OF LAW & MEDICINE 113-57 (2012).

201. Commission of the European Communities, *supra* note 162.