

# THE JOHN MARSHALL REVIEW OF INTELLECTUAL PROPERTY LAW



WHAT THE STORY OF THE INVENTION OF THE TRANSISTOR TEACHES US  
ABOUT 21ST CENTURY PATENT PRACTICE

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## ABSTRACT

In 1947, scientists at Bell Laboratories internally disclosed a remarkable new invention that would later become known as the “transistor.” Following the initial disclosure, Bell Labs methodically planned and facilitated the patenting, publication, and licensing of this new technology. The manner in which Bell Labs handled the disclosure and licensing of this pioneering invention provides a template that present-day inventors would be well-advised to emulate.

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*Cite as* Lawrence B. Ebert, *What the Story of the Invention of the Transistor Teaches Us About 21st Century Patent Practice*, 8 J. MARSHALL REV. INTELL. PROP. L. 80 (2008).

# WHAT THE STORY OF THE INVENTION OF THE TRANSISTOR TEACHES US ABOUT 21ST CENTURY PATENT PRACTICE

LAWRENCE B. EBERT \*

## INTRODUCTION

In 1956, the Nobel Prize in physics went to three individuals, William Shockley, John Bardeen, and Walter Brattain, for their work on the invention of the transistor.<sup>1</sup> Although the Nobel Prize was shared among the three, and many people to this day believe there was one invention, the underlying patents for the transistor do not reflect joint inventions.<sup>2</sup> Further, unlike the situation with the later-invented integrated circuit, there was no litigation over the fundamental transistor patents, with licenses readily granted in the underlying technology.<sup>3</sup> The manner in which Bell Labs handled the invention of the transistor more than fifty years ago can inform present day inventors of proper practice and the avoidance of pitfalls.

## I. HISTORY<sup>4</sup>

Results of the first invention, to a point contact transistor by Bardeen and Brattain, were presented to Bell Labs management on December 23, 1947.<sup>5</sup> Bell

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<sup>1</sup> JEREMY BERNSTEIN, THREE DEGREES ABOVE ZERO: BELL LABS IN THE INFORMATION AGE 78 (1984); J.A. HORNBECK, AT&T BELL LABS., A HISTORY OF ENGINEERING & SCIENCE IN THE BELL SYSTEM: ELECTRONICS TECHNOLOGY (1925–1975) 12 (1985); Larry Armstrong, *Who's the Real Mr. Chips?*, BUSINESS WEEK, June 21, 2004, at 22.

<sup>2</sup> U.S. Patent No. 2,524,035 (filed June 17, 1948) (issued Oct. 3, 1950) (naming Bardeen and Brattain as inventors and indicating an assignment to Bell Telephone Laboratories); U.S. Patent No. 2,524,034 (filed Feb. 26, 1948) (issued Oct. 3, 1950) (naming Brattain and Robert B. Gibney as inventors and indicating an assignment to Bell Telephone Laboratories); U.S. Patent No. 2,524,033 (filed Feb. 26, 1948) (issued Oct. 3, 1950) (naming Bardeen as inventor and indicating an assignment to Bell Telephone Laboratories).

<sup>3</sup> See Robert L. Risberg, Jr., Comment, *Five Years Without Infringement Litigation Under the Semiconductor Chip Protection Act: Unmasking the Spectre of Chip Piracy in an Era of Diverse and Incompatible Process Technologies*, 1990 WIS. L. REV. 241, 249 n.40 (1990) (noting that “Bell held the original transistor patent and wanted to encourage semiconductor development so it licensed its patent for a 2% royalty”); see also *Noyce v. Kilby*, 416 F.2d 1391 (C.C.P.A. 1969) (awarding priority to Noyce on a patent for the integrated circuit more than ten years after his application was filed and the relevant companies, Fairchild and Texas Instruments, had worked out a settlement before the decision by the Court of Customs and Appeals).

<sup>4</sup> See generally Lawrence B. Ebert, *Foreseeing a Not Obvious Future*, INTELL. PROP. TODAY, Sept. 2004, at 34, 34–37 (discussing the history of the transistor).

Labs declared the transistor work “Bell Telephone Labs confidential.”<sup>6</sup> There was an immediate political problem, in that Bardeen and Brattain had not informed their supervisor Shockley of the work.<sup>7</sup> In response, merely five days after the management presentation, on December 28, 1947, Shockley had his own ideas for a different type of transistor -- the junction transistor -- witnessed by a different scientist, Richard Haynes.<sup>8</sup> Shockley then proceeded to a meeting of the American Physical Society in Chicago, where he further worked on his ideas in the Bismarck Hotel.<sup>9</sup> In this time period, Shockley purportedly told Bardeen and Brattain, “sometimes the people who do the work don't get the credit for it.”<sup>10</sup> On February 18, 1948, the Shockley junction device was demonstrated within Bell Labs.<sup>11</sup>

Shortly after the presentation of the junction device, several patent applications were filed on February 26, 1948; these included Application Serial No. 11,165, which, through a continuation-in-part (“CIP”), would yield Bardeen and Brattain's U.S. 2,524,035; Application Serial No. 11,166, which directly yielded U.S. 2,524,033 to Bardeen; Application Serial No. 11,168, which directly yielded U.S. 2,524,034 to Brattain and Gibney; the issue date for these three patents was October 3, 1950.<sup>12</sup> An application for Shockley's device was filed on June 26, 1948, and matured into U.S. 2,569,347.<sup>13</sup> One notes that a literature search on the word “transistor” will not reveal any of these patents, because the word “transistor” was not coined, or used, until later.<sup>14</sup> Application Serial No. 64,681 filed December 10, 1948, yielded U.S. 2,530,745 to Wallace on November 21, 1950 and included the text: “The device in all

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<sup>5</sup> BERNSTEIN, *supra* note 1, at 78; HORNBECK, *supra* note 1, at 4–5; MICHAEL RIORDAN & LILLIAN HODDESON, *CRYSTAL FIRE: THE BIRTH OF THE INFORMATION AGE* 138–140 (1997).

<sup>6</sup> RIORDAN & HODDESON, *supra* note 5, at 152; *see* BERNSTEIN, *supra* note 1, at 78 (noting that the discovery of the point contact transistor “was kept secret for almost seven months”); *see also* ERNEST BRAUN & STUART MACDONALD, *REVOLUTION IN MINIATURE: THE HISTORY AND IMPACT OF SEMICONDUCTOR ELECTRONICS* 45 (2d ed. 1982) (describing how Bell Labs maintained the transistor discovery in strict secrecy in order to pursue further research prior to patenting); *cf.* HORNBECK, *supra* note 1, at 14 (describing how the transistor was disclosed to the military and designated as unclassified only two days before disclosure for purposes of scientific publication).

<sup>7</sup> *See* RIORDAN & HODDESON, *supra* note 5, at 144 (stating that Shockley was upset that his work was being overlooked in favor of Bardeen and Brattain's research). The first commercial implementation of transistors by AT&T, which was in a telephone system in New Jersey, involved point contact transistors, which were considered to have a better frequency response than junction transistors. *Id.* at 138.

<sup>8</sup> *Id.* at 143.

<sup>9</sup> *Id.* at 143–44; FREDERICK SEITZ & NORMAN G. EINSBRUCH, *ELECTRONIC GENIE: THE TANGLED HISTORY OF SILICON* 171 (1998). Soon after the discovery by Bardeen and Brattain, Shockley proposed the bipolar junction transistor. *Id.*

<sup>10</sup> RIORDAN & HODDESON, *supra* note 5, at 145.

<sup>11</sup> *Id.* at 154–155.

<sup>12</sup> U.S. Patent No. 2,524,035 (filed June 17, 1948) (issued Oct. 3, 1950); U.S. Patent No. 2,524,034 (filed Feb. 26, 1948) (issued Oct. 3, 1950); U.S. Patent No. 2,524,033 (filed Feb. 26, 1948) (issued Oct. 3, 1950).

<sup>13</sup> U.S. Patent No. 2,569,347 (filed June 26, 1948) (issued Sept. 25, 1951) (naming Shockley as the inventor and noting an assignment to Bell Telephone Laboratories).

<sup>14</sup> *See* BERNSTEIN, *supra* note 1, at 95 (detailing the conversation between J.R. Pierce and Brattain in which Pierce came up with the name “transistor”); BRAUN & MACDONALD, *supra* note 6, at 45 (noting that the name “transistor” found immediate general acceptance).

of its forms has received the appellation “Transistor” and will be so designated in the present application.”<sup>15</sup>

Although the transistor is generally considered a pioneering invention, there were concerns about prior art at the time of application.<sup>16</sup> There was a U.S. Patent issued in 1930 which disclosed the concept of what would be known as the field-effect transistor.<sup>17</sup> Bardeen himself was concerned that the Bardeen/Brattain device might not be patentable, and various Lilienfeld patents did bring rejection in November 1948 to two transistor patent applications of Bell Labs.<sup>18</sup> Patent attorneys at Bell Labs considered the Bardeen/Brattain device patentable because holes, rather than electric fields, were functioning as the grid.<sup>19</sup>

Once the patent applications were squared away, Bell Labs did submit manuscripts to journals.<sup>20</sup> Nevertheless, it is significant to note that the Bardeen/Brattain science papers were submitted *before* Shockley’s patent application was filed.<sup>21</sup> Specifically, the submission date of the Bardeen and Brattain letters to *Physical Review* was June 25, 1948,<sup>22</sup> which is after the June 17, 1948 CIP filing of Bardeen/Brattain<sup>23</sup> but before the June 26, 1948 filing of Shockley’s patent application.<sup>24</sup> Shockley is acknowledged in the *Physical Review* letter, but is not an author.<sup>25</sup>

Further, after all the basic patent applications (those of Bardeen/Brattain and Shockley) were filed, Bell Labs unveiled the discovery to the public.<sup>26</sup> This presentation was held on June 30, 1948 in New York City, rather than at the Murray Hill, New Jersey location of Bell Labs.<sup>27</sup> Ralph Bown, director of research at Bell

<sup>15</sup> U.S. Patent No. 2,530,745 col.1 ll.52–54 (filed Dec. 10, 1948) (issued Nov. 21, 1950) (naming Wallace as inventor and noting an assignment to Bell Telephone Laboratories).

<sup>16</sup> RIORDAN & HODDESON, *supra* note 5, at 146, 176.

<sup>17</sup> U.S. Patent No. 1,745,175 (filed Oct. 8, 1926) (issued Jan. 28, 1930) (naming Julius Edgar Lilienfeld as inventor and disclosing principles for what would become known as the “field-effect transistor”); RIORDAN & HODDESON, *supra* note 5, at 146, 176.

<sup>18</sup> See BRAUN & MACDONALD, *supra* note 6, at 40 (rejecting Shockley field-effect principle partly due to Lilienfeld patent); RIORDAN & HODDESON, *supra* note 5, at 146, 176; ’175 Patent; see also Ebert, *supra* note 4, at 34–35.

<sup>19</sup> RIORDAN & HODDESON, *supra* note 5, at 146.

<sup>20</sup> J. Bardeen & W.H. Brattain, Letter to the Editor, *The Transistor, A Semi-Conductor Triode*, 74 PHYSICAL REV. 230 (1948); W.H. Brattain & J. Bardeen, Letter to the Editor, *Nature of Forward Current in Germanium Point Contacts*, 4 PHYSICAL REV. 231 (1948); W. Shockley & G.L. Pearson, Letter to the Editor, *Modulation of Conductance of Thin Films of Semi-Conductors by Surface Charges*, 74 PHYSICAL REV. 232 (1948); see HORNBECK, *supra* note 1, at 14–15; see also RIORDAN & HODDESON, *supra* note 5, at 147 (noting that Bell Labs policy prohibited publishing of research until after patent applications were filed).

<sup>21</sup> Compare Bardeen & Brattain, *supra* note 20, at 230 (June 25, 1948), and Brattain & Bardeen, *supra* note 20, at 231 (June 25, 1948), and Shockley & Pearson, *supra* note 20, at 232 (June 25, 1948), and HORNBECK, *supra* note 1, at 14–15 (stating that the PHYSICAL REVIEW scientific papers were submitted for publication June 25, 1948), with U.S. Patent No. 2,569,347 (filed June 26, 1948).

<sup>22</sup> Bardeen & Brattain, *supra* note 20, at 230; Brattain & Bardeen, *supra* note 20, at 231.

<sup>23</sup> U.S. Patent No. 2,524,035 (filed June 17, 1948) (issued Oct. 3, 1950).

<sup>24</sup> ’347 Patent (filed June 26, 1948) (issued Sept. 25, 1951).

<sup>25</sup> Bardeen & Brattain, *supra* note 20, at 231; see BERNSTEIN, *supra* note 1, at 78.

<sup>26</sup> ’347 Patent (filed June 26, 1948) (issued Sept. 25, 1951); HORNBECK, *supra* note 1, at 15 (stating that after the ’347 patent was filed, the transistor was demonstrated to the press).

<sup>27</sup> HORNBECK, *supra* note 1, at 15.

Labs, demonstrated the transistor in applications with a telephone handset, a radio, and a television.<sup>28</sup> The next day, the *New York Times* had a small mention of this in "News of the Radio" on page 46.<sup>29</sup>

To enhance implementation of the technology, a Transistor Technology Symposium was held in April 1952,<sup>30</sup> and Bell Labs began licensing its new invention to interested companies for a fee of \$25,000; among the first licensees were General Electric, IBM, Raytheon, Texas Instruments, and a small Japanese company, Tokyo Tsushin Kogyo, that eventually became Sony Electronics.<sup>31</sup> Bell Labs was not interested in integrating the transistor into consumer products, but Sony literally created the consumer electronics industry with a \$25,000 license from Bell Labs and without patent litigation.<sup>32</sup>

## II. PATENTS AND PUBLICATIONS AS REPOSITORIES OF VALUABLE INFORMATION

The primary benefit to the public of the patent system is the public disclosure of useful information.<sup>33</sup> In the case of the invention of the transistor, Bell Labs scientists promptly and accurately disclosed their information, both through patenting and through scientific publication, so that other scientists could build upon their work.<sup>34</sup>

Bruce Alberts wrote in the September 5, 2008 issue of *Science* on the importance of having an accurate repository of science articles, which comments apply equally to the importance of having an accurate repository of issued patents:

The publication of a scientific article is less a way for scientists to earn recognition and advance their careers than it is an engine of scientific progress. Science continually advances only because many cycles of

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<sup>28</sup> *Id.*; see also BRAUN & MACDONALD, *supra* note 6, at 46 (demonstrating the substitution of transistors for valves in a radio and a television set).

<sup>29</sup> *The News of Radio*, N.Y. TIMES, July 1, 1948, at 46, available at <http://people.msoe.edu/reyer/regency/NYTimes.jpg>. The text mentions the demonstration of the transistor in a radio receiver, a telephone system, and a television unit. *Id.* The text also mentions that the transistor can be employed as an oscillator. *Id.* However, the text does not mention anything about using the transistor in an application for a hearing aid. *Id.*

<sup>30</sup> BERNSTEIN, *supra* note 1, at 96 (suggesting that Bell Labs hosted the symposium on transistors in April, 1952 in an attempt to stave off an antitrust consent decree); RIORDAN & HODDESON, *supra* note 5, at 197 (responding to requests for additional information about manufacturing processes, Bell Labs organized the Transistor Technology Symposium attended by over one hundred participants).

<sup>31</sup> BERNSTEIN, *supra* note 1, at 96 (noting that Bell Labs licensed its transistor technology to Raytheon and Texas Instruments); see also SEITZ & EINSBRUCH, *supra* note 9, at 176 (licensing transistor technology to Texas Instruments and International Business Machines, among others).

<sup>32</sup> RIORDAN & HODDESON, *supra* note 5, at 215–217 (stating how Sony first used its license to launch its transistor radio).

<sup>33</sup> JANICE M. MUELLER, AN INTRODUCTION TO PATENT LAW, 26, 28 (2d ed. 2006) (disclosing how to make and use the invention enables others to practice the invention once the patent expires).

<sup>34</sup> U.S. Patent No. 2,524,035 (filed June 17, 1948); Bardeen & Brattain, *supra* note 20, at 230; Brattain & Bardeen, *supra* note 20, at 231; Shockley & Pearson, *supra* note 20, at 232; see also HORNBECK, *supra* note 1, at 14–15 (filing of '035 patent application on June 17, 1948, and publishing of first scientific publication on July 15, 1948).

independent testing by different scientists allow new knowledge to be built with confidence upon old knowledge, thereby creating a repository of reliable understandings about the world.<sup>35</sup>

Patents are an engine of scientific progress, just as publications are.<sup>36</sup> We want the information in both patents and publications to be accurate, and we want people to read them, so that wasteful, duplicative work is avoided.<sup>37</sup> The prompt and proper documentation of the research effort by Bell Labs gave timely information to scientific peers, and enhanced advancement, rather than duplication, of an important discovery.<sup>38</sup>

### III. PATENTS AS AN ENTRY INTO THE FREE MARKET

Bell Labs/AT&T was a large entity at the time of the issuance of the patents, but had no particular business interest in developing certain applications of the transistor.<sup>39</sup> Defining the invention through a patent, and licensing those well-defined rights, allowed market participants (both large and small) interested in developing applications of the technology uncomplicated entry.<sup>40</sup>

In the 21<sup>st</sup> century, we have many smaller entities who need assistance in developing their technology.<sup>41</sup> To facilitate their market entry, such entities need to know they can enter the marketplace and negotiate without fear that their technology will be stolen.<sup>42</sup> Defining the invention through a patent facilitates the entry of such smaller players into the market.<sup>43</sup>

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<sup>35</sup> Bruce Alberts, Editorial, *Scientific Publishing Standards*, 321 SCIENCE 1271 (2008).

<sup>36</sup> See Paul C. Craane, Comment, *At The Boundaries Of Law And Equity: The Court Of Appeals For The Federal Circuit And The Doctrine Of Equivalents*, 13 N. ILL. U. L. REV. 105, 107–09 (1992) (discussing the value of disclosure to the public because others will be stimulated to add to the lessons learned by the patentee by creating other inventions).

<sup>37</sup> See *id.* at 109.

<sup>38</sup> See HORNBECK, *supra* note 1, at 14 (disclosing transistor invention within six months after its discovery); SEITZ & EINSRUCH, *supra* note 9, at 176. In order to further promote ideas, Bell provided a set of instructions to those that licensed the technology to best advance discoveries. *Id.*

<sup>39</sup> BRAUN & MACDONALD, *supra* note 6, at 48. Bell produced few transistors and instead encouraged other firms to engage in their own development. *Id.*

<sup>40</sup> SEITZ & EINSRUCH, *supra* note 9, at 176 (identifying the granting of a license to a small company with limited background in Texas Instruments).

<sup>41</sup> See, e.g., PA. SMALL BUS. DEV. CTR., TECHNOLOGY COMMERCIALIZATION ASSISTANCE, <http://www.pasbdc.org/what/consulting/dev/techcomm.asp> (last visited Nov. 17, 2008) (“SBDC technology consultants assist high growth and technology firms with sophisticated business management issues including alternative financing, human resources, patents and trade marking, intellectual property, and product commercialization.”); N. TEX. SMALL BUS. DEV. CTR., TECHNOLOGY ASSISTANCE, [http://www.ntsbdc.org/tech\\_asst.shtml](http://www.ntsbdc.org/tech_asst.shtml) (last visited Nov. 17, 2008) (noting that the Center counsels small businesses on technology transfer, product development, the patent process, licensing, trademarks, copyrights, and trade secrets).

<sup>42</sup> See, e.g., IPBIZ, <http://ipbiz.blogspot.com/> (Apr. 5, 2008, 12:40 EST) (quoting CHARLOTTE GRAY, RELUCTANT GENIUS: ALEXANDER GRAHAM BELL AND THE PASSION FOR INVENTION 184 (2006)), available at <http://ipbiz.blogspot.com/2008/04/is-lemley-right-about-bell-and-gray.html>. Although perhaps not fully appreciated in the 21st century, the forerunner to AT&T and Bell Labs (American Bell Telephone Company, the company of Alexander Graham Bell) once was a smaller entity who used its patent to fend off the likes of the larger Western Union, working in concert with

## IV. GUIDANCE FOR PROTECTING CONFIDENTIAL INFORMATION

Although the Bell Labs of the 1950's and 1960's had a reputation as an open, academic-like research center,<sup>44</sup> one can see that Bell Labs in 1947–1948 was very protective of its work on the transistor.<sup>45</sup> When Bell Labs had a pioneering invention, Bell Labs protected it.<sup>46</sup> There was a news blackout until June 30, 1948, and when the press was invited in, it was to a controlled site in New York City, not to the lab facility in Murray Hill.<sup>47</sup>

Smaller companies with valuable work in the 21st century would be wise to emulate the approach of Bell Labs. Patent rights should be secured first. Exposure to the press should be under carefully controlled circumstances. One should recall the message of the classic case *Egbert v. Lippman*<sup>48</sup> that “public use” does not require public view.<sup>49</sup>

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Thomas Edison. GRAY, *supra*, at 184. Bell was the David in that battle. *Id.* *But cf.* SETH SHULMAN, *THE TELEPHONE GAMBIT: CHASING ALEXANDER GRAHAM BELL'S SECRET* 35 (2008) (providing evidence that Bell may have copied part of Elisha Gray's patent filing).

<sup>43</sup> EUR. PATENT OFFICE, *THE ECONOMIC IMPORTANCE OF PATENTS*, <http://www.epo.org/topics/innovation-and-economy/economic-impact.html> (last updated Aug. 18, 2008) (“A patent or patent family can be the launching pad for a start-up firm. Using their patents, small firms may be able to . . . assert their rights in front of larger companies. . . . [P]atents are vital in securing market share for small companies . . .”).

<sup>44</sup> *See, e.g., In re Certain Ion Trap Mass Spectrometers and Components Thereof*, USITC Inv. No. 337-TA-393 (Dep't Commerce Apr. 21, 1998) at 76–78, *available at* <http://edisweb.usitc.gov/edisweb/337-393/Violation/167188/167188/91a/498E99.pdf>; *see also* Richard Corrigan, *Changing Chimes at Bell*, 41 NAT'L J. 2072 (1983). With de-regulation, a change in policy at Bell Labs in the 1980's was noted in the text:

[Vice president and general counsel of Bell Labs, William L.] Keefauver also said that Bell Labs would try to continue its traditional open-door policy of making available its own findings through research papers and patent licenses. The open-door policy has helped Bell Labs recruit top talent, he said, and “you don't get that caliber of people in a closed society.” However, he added, the labs will be more guarded than in the past with research findings of short-term commercial potential.

*Id.*

<sup>45</sup> *See generally* HORNBECK, *supra* note 1, at 4–15 (describing the experimentation and development of the transistor from late 1947 to mid 1948).

<sup>46</sup> *See, e.g., id.* at 14 (explaining that public announcement of the transistor was deferred, in part, so that patent applications could be filed to protect the interests of shareholders).

<sup>47</sup> *See id.*

<sup>48</sup> 104 U.S. 333 (1881).

<sup>49</sup> *Id.* at 336 (determining inventor's unobservable prior use was a “public use”); *see* *Woodland Trust v. Flowertree Nursery, Inc.*, 148 F.3d 1368, 1370 (Fed. Cir. 1998) (“Thus an inventor's own prior commercial use, albeit kept secret, may constitute a public use or sale under [35 U.S.C.] § 102(b), barring him from obtaining a patent.”); *TP Labs., Inc. v. Prof'l Positioners, Inc.*, 724 F.2d 965, 972 (Fed. Cir. 1984) (noting that “public use” may bar patent “if the inventor is making commercial use of the invention under circumstances which preserve its secrecy”); *see also* *Lockwood v. Am. Airlines, Inc.*, 107 F.3d 1565, 1570 (Fed. Cir. 1997) (holding that airline's public use of a reservation system was sufficient to place it “in public use” despite the fact that the complex algorithms on which it was based were not available to the public).

## V. INVENTORS CAN APPRECIATE THE LARGE SCOPE OF INVENTIONS

Curiously, although the intense secrecy of Bell Labs in guarding the invention of the transistor and in controlling its news release suggests that Bell Labs was well aware of the significance of the invention of the transistor, certain law reviews have taken the transistor as an example of a situation wherein the inventors did not foresee the full scope of their invention.<sup>50</sup> For example, a footnote in a 1997 law review stated that “the transistor was expected to be used primarily in hearing aids for the deaf.”<sup>51</sup> This assertion was repeated in other law reviews.<sup>52</sup> The general point is that inventors don’t understand what they have invented: “They frequently misunderstand the significance of their own invention and the uses to which it can be put.”<sup>53</sup>

The article relied upon for this proposition is by Carol Haber and is titled “Electronic Breakthroughs: Big Picture Eludes Many.”<sup>54</sup> The facts of the Haber article were obtained by Haber from Nathan Rosenberg, an economist at Stanford University, who noted of the transistor:

The invention of the transistor was not front-page news but a tiny item in a weekly column on “News of Radio” buried inside a 1947 edition of *The New York Times*. The device, the article predicted, “might be used to develop better hearing aids for the deaf.”<sup>55</sup>

In fact, there was no discussion of the transistor in the *New York Times* in 1947, because there was a news blackout at that time and the name transistor did not exist in 1947.<sup>56</sup>

The example of the transistor was used to advance a theory of Rosenberg: “Mr. Rosenberg listed at least five constraints on the human ability to predict the value of new technological developments” including “[t]he initial primitive understanding of innovations” and “[t]he specialized use to which many are initially applied.”<sup>57</sup>

In reality, the inventors of the transistor fully appreciated its potential as an amplifier, demonstrating that application in three devices (radio, phone, television)

<sup>50</sup> See, e.g., Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 TEX. L. REV. 989 (1997).

<sup>51</sup> *Id.* at 1050 n.281.

<sup>52</sup> See Mark A. Lemley & R. Anthony Reese, *Reducing Digital Copyright Infringement Without Restricting Innovation*, 56 STAN. L. REV. 1345, 1387 n.160 (2004) (counting “the inventors of the transistor, who anticipated its use in hearing aids” among “the inventors who did not recognize the potential of their ideas”); Mark A. Lemley, *Ex Ante Versus Ex Post Justifications for Intellectual Property*, 71 U. CHI. L. REV. 129, 137 n.29 (2004) (same).

<sup>53</sup> Lemley, *supra* note 52, at 137.

<sup>54</sup> Carol Haber, *Electronic Breakthroughs: Big Picture Eludes Many*, ELECTRONIC NEWS, June 13, 1994, at 46.

<sup>55</sup> *Id.*

<sup>56</sup> See BERNSTEIN, *supra* note 1, at 95 (detailing the conversation between J.R. Pierce and Brattain in which Pierce came up with the name “transistor”); BRAUN & MACDONALD, *supra* note 6, at 45 (noting that the name “transistor” found immediate general acceptance).

<sup>57</sup> Haber, *supra* note 54, at 47. The three other constraints are: “The complementary and competitive relationships among technologies; The limited capacity for humans to envision entirely new technological systems, rather than simply improvements to existing systems; The need for technologies to pass economic as well as technological tests of their value.” *Id.*

in the news conference on June 30, 1948, which took place slightly more than six months after the first demonstration of the transistor to the management of Bell Labs on December 23, 1947.<sup>58</sup> In 1954, Bell Labs built the Transistorized Airbone Digital Computer (“TRADIC”), demonstrating understanding of the use of the transistor as a switch.<sup>59</sup>

Although the misunderstanding<sup>60</sup> in the law reviews appears to arise from a misunderstanding of the contents of a small article in the *New York Times*, it is worthwhile to consider other viewpoints on the transistor story.

The following is text from Professor Nick Holonyak, Jr., who was John Bardeen’s first graduate student at the University of Illinois:

I heard the question asked many times of Bardeen: “Did you see at the beginning that with the transistor you were on the path to the integrated circuit?” Bardeen always slowly shook his head, no! He always pointed-out, however, that they knew that their transistor research was important, and that it pointed at a new form of electronics but with a long way to go to become fully developed. (. . .) The point is, Bardeen knew (from the beginning, “the early days,” and beyond) the importance of the transistor, and its ongoing study, but in his great modesty and truthfulness was not about to usurp and claim knowledge of all that would happen—and that needed the contributions of many people. Shockley, on the other hand, pretended to see it “all”, [sic] but simply made too many mistakes for anyone to take seriously his claims. Furthermore, if you want to claim everything that ultimately worked, would you be as quick to claim also all the wrong guesses (guesses!) that did not work, which are much, much more numerous? (. . .) I don’t know of anything, including some very successful inventions, where it was clear from the very beginning how everything would develop.<sup>61</sup>

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<sup>58</sup> See *The News of Radio*, *supra* note 29, at 46 (reporting that a device called a transistor was first demonstrated on June 30, 1948 in a radio receiver, a telephone system, and a television unit); see also HORNBECK, *supra* note 1, at 4–5 (discussing the first demonstration of the transistor to management at Bell Labs).

<sup>59</sup> Ebert, *supra* note 4, at 36. The TRADIC was the first all-transistor computer, containing approximately eight-hundred point contact transistors. *Id.*

<sup>60</sup> Cf. IPBIZ, <http://ipbiz.blogspot.com/> (Oct. 2, 2007, 3:21 EST) (citing SETH SHULMAN, UNLOCKING THE SKY 43–45 (2002)), available at <http://ipbiz.blogspot.com/2007/10/unlocking-sky-missing-few-facts.html> (providing an unflattering depiction of the Wright Brothers’ role in developing the airplane).

<sup>61</sup> Lawrence B. Ebert, *Foreseeability and the Transistor*, INTELL. PROP. TODAY, Oct. 2004, at 41 (omissions in original). Of the hearing aid story in the law reviews, Professor Holonyak wrote:

It is “untrue” (not the least correct) that the originators of the transistor foresaw only hearing-aid applications. That is a totally naive thought-wrong to even contemplate that scientists so ingenious as to devise a totally new amplifying and switching element in a semiconductor, uncover an entirely new idea and device (in a solid substance!) and then would be so limited and think it might have only one application, only hearing aids. What a naive, ridiculous view! No first rate scientist, or patent attorney drawing up claims, is that one dimensional.

## VI. LEARNING FROM THE NEWER BELL LABS

Although the Bell Labs of the 1940's did not collaborate with many other private entities, the Bell Labs of the 1980's did collaborate, and therein gave us a lesson about joint development agreements ("JDA") from the case *Lucent Technologies, Inc. v. Gateway, Inc.*<sup>62</sup> In 1988, AT&T/Bell Labs entered into a JDA with Fraunhofer Gesellschaft in the area of digital compression, a technology later used in mp3 technology.<sup>63</sup> One scientist of Fraunhofer, Karlheinz Brandenburg, went to work at AT&T, a situation not uncommon in JDAs.<sup>64</sup> There was later litigation between Lucent and Microsoft, to whom Fraunhofer (but not Lucent) had granted a license.<sup>65</sup>

The application for the relevant '938 patent was filed in 1994.<sup>66</sup> Claims 2 and 4 of the relevant '938 patent involved contributions from Fraunhofer during the period of the JDA.<sup>67</sup> In 2006, there was a reissue leading to the '080 patent; claim 2 of the '938 was canceled.<sup>68</sup> In 2007, there was a jury trial, and later JMOL, wherein the trial judge found that Lucent lacked standing to sue for infringement of the '080 patent because Fraunhofer had not been joined.<sup>69</sup> An important lesson from the appellate case (which affirmed the district court's decision on the point) is found in the Federal Circuit's statement that the earlier case of *Israel Bio-Engineering Project v. Amgen Inc.*,<sup>70</sup> over a jointly-invented/owned patent, holds that an inventor of one or more claims of the patent is an owner of all claims of the patent.<sup>71</sup> If one enters into a JDA with another entity, and an employee of the other entity contributes to one claim but not others, the employee/other entity owns all the claims, barring some contractual agreement to the contrary.<sup>72</sup>

As one related point, at the time of the invention of the transistor the quantum of publication (the least publishable unit) was somewhat higher than today.<sup>73</sup> The patenting and journal publication of the transistor story happened about the same

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*Id.* at 41 n.2. Holonyak himself foresaw applications long before they materialized, predicting the use of light emitting diodes as useful light sources in the February 1963 issue of Reader's Digest. Harland Manchester, *Light of Hope—Or Terror?*, READER'S DIG., Feb. 1963, at 97, 100.

<sup>62</sup> 543 F.3d 710 (Fed. Cir. 2008) (listing Gateway, Cowabunga, Dell, and Microsoft as defendants).

<sup>63</sup> *Id.* at 714.

<sup>64</sup> *Id.*

<sup>65</sup> *Id.* at 715–16.

<sup>66</sup> U.S. Patent No. 5,627,938 (filed Sept. 22, 1994) (issued May 6, 1997).

<sup>67</sup> See *Lucent Techs.*, 543 F.3d at 716 (noting that the district court determined that the subject matter of claims 2 and 4 were jointly developed, and thus jointly owned, by AT&T and Fraunhofer).

<sup>68</sup> *Id.* at 714.

<sup>69</sup> *Id.* at 715–16.

<sup>70</sup> 475 F.3d 1256 (Fed. Cir. 2007).

<sup>71</sup> *Lucent*, 543 F.3d at 721.

<sup>72</sup> See 35 U.S.C. § 116 (2006). "When an invention is made by two or more persons jointly, they shall apply for patent jointly . . ." *Id.* "Inventors may apply for a patent jointly even though . . . each did not make a contribution to the subject matter of every claim of the patent." *Id.*

<sup>73</sup> See, e.g., Joseph A. Mikus, Comparative Approaches to the Theory of International Law: Discussion, 80 AM. SOC'Y INT'L L. PROC. 172, 174 (1986) (quoting Giorgio Sacerdotti, "[t]here is an increasing abundance of material and scholarly writing" nowadays, and that "it is extremely difficult to keep track of the legal literature, given the ever-increasing number of professional law journals and student law reviews").

time because publications tended to occur only when a full story was completed.<sup>74</sup> Although patents require an invention which meets statutory requirements including utility,<sup>75</sup> novelty,<sup>76</sup> nonobviousness,<sup>77</sup> and enablement,<sup>78</sup> journal publications do not. In collaborations with academic labs, private entities need to understand that universities have few restrictions on the publication of academic work, and that some understanding has to be reached on what the least publishable unit is, and when that unit will be submitted to a journal.

The story of the invention of the transistor illustrates a case in which journal publication and patenting worked hand-in-hand. Society promptly got the benefits of the knowledge of the inventors, which impacted upon a number of areas.<sup>79</sup> These areas were readily developed by other researchers and by patent licensees.

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<sup>74</sup> Bardeen & Brattain, *supra* note 20, at 230; Brattain and Bardeen, *supra* note 20, at 231; Shockley & Pearson, *supra* note 20, at 232; *see* HORNBECK, *supra* note 1, at 14–15; *see also* RIORDAN & HODDESON, *supra* note 5, at 147 (noting that Bell Labs policy prohibited publishing of research until after patent applications were filed).

<sup>75</sup> 35 U.S.C. § 101 (2006).

<sup>76</sup> *Id.* § 102.

<sup>77</sup> *Id.* § 103.

<sup>78</sup> *Id.* § 112.

<sup>79</sup> *See, e.g.*, RIORDAN & HODDESON, *supra* note 5, at ix (stating that technology “affects virtually every aspect of the human endeavor: private and public institutions, economic systems, communication networks, political structures, international affiliations, the organization of societies, and the condition of human lives”).