Journal of Gender, Social Policy & the Law

Volume 19 | Issue 3 Article 2

2011

Examining Exclusion in Woman-Inventor Patenting: A Comparison of Educational Trends and Patent Data in the Era of Computer Engineer Barbie

Annette I. Kahler

Recommended Citation

Kahler, Annette I. "Examining Exclusion in Woman-Inventor Patenting: A Comparison of Educational Trends and Patent Data in the Era of Computer Engineer Barbie." American University Journal of Gender Social Policy and Law 19, no. 3 (2011): 773-798.

EXAMINING EXCLUSION IN WOMAN-INVENTOR PATENTING: A COMPARISON OF EDUCATIONAL TRENDS AND PATENT DATA IN THE ERA OF COMPUTER ENGINEER BARBIE®

ANNETTE I. KAHLER*

I. Introduction 774
II. Women Inventors in the United States 778
A. Historical Perspectives 778
B. Recent Statistics 782
III. Data Comparisons 784
A. Educational Trends 784
B. Patent Trends 788
C. Gender Imbalance in the Patent Bar 791
IV. Barriers to Greater Participation By Women 792
A. Gender Stratification in Engineering and Computer Science 792
B. Stereotypes, Cultural Norms, and Computer Engineer Barbie® 795
C. Does it Matter? 797
V. Conclusion 798

*Exigent Innovations, Inc. and Heslin, Rothenberg, Farley & Mesiti, P.C. The opinions expressed herein are my own and do not necessarily represent the views of the organizations with which I am affiliated. I substantially completed this article while I was a Visiting Assistant Professor of Law and Director, Center for Law & Innovation, at Albany Law School. I wish to thank law student Amanda Connors and Albany Law School staff attorney Pamela Ko for their research assistance, as well as the many student researchers who assisted in data gathering. I also thank the participants in the 2010 American University College of Law 7th Annual Symposium on *IP/Gender: Mapping the Connections* for their comments on an earlier version of this Article.

"Have women made material contributions to the sum total of creative achievements? Have they designed, devised, discovered, and invented to reduce labor, to forestall danger, disease, and death, to embellish life with creative comforts, and to enrich humanity with new stores of knowledge?"[1]

I. INTRODUCTION

Patents are a big business and valuable currency in our innovation-based global economy. Worldwide, more than 6.7 million patents are in force, nearly 4 million patent applications are in backlog, and upwards of 750,000 new patents are granted each year.[2] The cumulative effect of these numbers is staggering, with the patent landscape becoming increasingly dense and complex, as inventors stake out, through patent claims, the metes and bounds of property rights in newly developed or improved technologies and seek the legal right to exclude others from making or using their inventions.[3]

The efficiency and efficacy of the U.S. patent system has been the subject of great debate in recent years. This debate stems largely from the tremendous backlog of patent applications that have amassed in the examination queue and the corresponding increase in patent application pendency.[4] The growing backlog of unexamined applications and increase in application pendency has caused patent-related data to be closely scrutinized. Statistics on patent activity published annually by organizations such as the World Intellectual Property Organization (WIPO)

1. WOMEN'S BUREAU, U.S. DEP'T OF LABOR, WOMEN'S CONTRIBUTIONS IN THE FIELD OF INVENTION: A STUDY OF THE RECORDS OF THE UNITED STATES PATENT OFFICE, 28 BULL. WOMEN'S BUREAU 1 (1923) [hereinafter WOMEN'S BUREAU], *available at* http://pds.lib.harvard.edu /pds/view/2586395?op=t&n=1&s=4 (introducing the 1923 report on women's patenting by the Women's Bureau of the U.S. Department of Labor).

2. *See* WORLD INTELLECTUAL PROP. ORG., WORLD INTELLECTUAL PROPERTY INDICATORS 9-10 (2010), *available at* http://www.wipo.int/export/sites/www/ipstats/en/statistics/patents/pdf/wipo_pub_941.pdf [hereinafter WORLD IP INDICATORS].

3. *See also* U.S. CONST. art I, § 8, cl. 8 (forming the basis for the "right to exclude," which is the cornerstone of the U.S. patent system, by granting Congress the power to protect the public disclosure and teaching of inventions that are critical to the progress of science and that promote the arts). *See generally* 35 U.S.C. § 271(a) (2006) (providing that, absent authorization or a specific exception, anyone who "makes, uses, offers to sell, or sells" a patented invention either within or outside of the United States during the patent's term has infringed on that patent).

4. *See* U.S. PATENT & TRADEMARK OFFICE, PERFORMANCE AND ACCOUNTABILITY REPORT: FISCAL YEAR 2009, at 112 tbl.1, 114 tbl.3, 115 tbl.4 (2009), *available at* http://www.uspto.gov/about/stratplan/ar/2009/2009annualreport.pdf [hereinafter PERFORMANCE AND ACCOUNTABILITY REPORT] (reporting in Table 3 that 735,961 pending patent applications are awaiting action by an examiner, and in Table 4 that average patent application pendency to first action is 25.8 months and average total pendency is 34.6 months).

and the United States Patent and Trademark Office (USPTO) are voluminous.[5] Substantial effort is invested in collecting, analyzing, and annually reporting an abundance of detailed statistics across a multitude of variables. This data is highly useful for monitoring many of the trends in intellectual property (IP) activity and in understanding the role of IP in stimulating and diffusing innovation; however, despite the plethora of patent-related data readily available for public consumption, the statistics report comparatively little about the inventors behind the patents and even less about the subcategory of female inventors.[6]

Although we count, measure, and compare data on patents, and voraciously debate patent theory and doctrine, we do not analyze, nearly to the same extent, inventor demographics in order to understand how inventor participation in the patent system is influenced by gender,[7] race, age, educational background, and other identity characteristics and, more broadly, how the composition of the inventor community impacts systemic innovation outcomes.[8]

In studying patenting by women, it is notable that the USPTO has never required inventors to self-identify their sex or requested such information be provided even on an optional basis.[9] Instead, from time to time, the USPTO issues special reports on patenting by women,[10] relying on gender

---

5. *See, e.g.*, PAT. TECH. MONITORING TEAM, U.S. PATENT & TRADEMARK OFFICE, GENERAL PATENT STATISTICS REPORTS AVAILABLE FOR VIEWING, *available at* http://www.uspto.gov/web/offices/ac/ido/oeip/taf/reports.htm; *Data Visualization Center*: *Your Window to the USPTO: Patents Dashboard*, U.S. PATENT & TRADEMARK OFFICE, http://www.uspto.gov/dashboards/patents/main.dashxml (providing a "dashboard" visualization of recent data); *see also* WORLD IP INDICATORS, *supra* note 2, at 31-132.

6. *See, e.g.*, WORLD IP INDICATORS, *supra* note 2 (offering no gender-related patent data in the 112-page report); *see also* PERFORMANCE AND ACCOUNTABILITY REPORT, *supra* note 4 (lacking indicators related to gender in its 152-page report or in its associated workload tables).

7. This Article uses the term "gender" interchangeably with "sex."

8. *Accord* Joan Scott, *Gender: A Useful Category of Historical Analysis*, 91 AM. HIST REV. 1053, 1054 (1986) (adding that the recent usage of the word "gender" is a reaction to the traditional "biological determinism" that accompanies the word "sex"). *See generally* Jane Flax, *Gender as a Social Problem: In and For Feminist Theory*, 31 AMERIKASTUDIERIEN 193 (1986) (distinguishing sex as biological and gender as subject to cultural construction).

9. *See* U.S. PATENT & TRADEMARK OFFICE, *Women Inventors*, KIDS' PAGES, http://www.uspto.gov/web/offices/ac/ahrpa/opa/kids/ponder/ponder8.htm (last visited Oct. 17, 2010) ("We will never know all the women who deserve credit for their creative labor, as the Patent and Trademark Office does not require gender, racial, or ethnic identification in patent or trademark applications. Through diligent research—and a few educated guesses—we can identify trends in patenting by women.").

10. *E.g., U.S. Patenting by Women, 1977 to 1996, in* U.S. PAT. & TRADEMARK OFF., U.S. DEP'T OF COMMERCE, BUTTONS TO BIOTECH, 1996 UPDATE REPORT WITH SUPPLEMENTAL DATA THROUGH 1998 (1999), *available at* http://www.uspto.gov/web/offices/ac/ido/oeip/taf/wom_98.pdf [hereinafter BUTTONS

identification of inventors accomplished through female name-matching.[11] There is no regular schedule for release of these publications, and no updates have been provided since 2002.[12] As a result of this irregular reporting, we do not know with certainty what has happened in the realm of woman-inventor patenting in intervening time periods, how that activity may correlate with other relevant trends, or the extent of its effect on individual attainment or systemic performance.

We are fortunate that academic scholarship has begun to fill some of the gaps; however, IP gender study is an emerging field, and one that is still sparsely populated from an empirical studies standpoint. While scholars studying patent activities of academic scientists have enriched the literature,[13] less focus has been directed toward the realm of corporate patenting and the contributions of employee-inventors within those organizations.[14] The existing body of empirical work examining woman-inventor patenting has been limited in sample sizes and to narrowly-focused communities within the innovation ecosystem. While there has been productive research into women-inventor patenting within the life sciences and in academia generally, the fruits of such research do not always generalize well. For example, as more women pursue degrees in life sciences than other areas of science, it is unclear whether trends of female patenting in life sciences necessarily implies similar patterns of female patenting in other areas of sciences. Generalizing from the sciences to engineering is particularly difficult, especially in sub-specialties of engineering that are vastly male-dominated, such as electrical and

---

TO BIOTECH]; OFFICE OF ELEC. INFO. PROD., U.S. PATENT & TRADEMARK OFFICE, U.S. PATENTING BY WOMEN: 1977-2002 (2003) (on file with author) [hereinafter U.S. PATENTING BY WOMEN].

11. *See* U.S. PATENTING BY WOMEN, *supra* note 10, at tbl.1 (explaining how women inventors are identified through their first and middle names).

12. E-mail from Paul Harrison, USPTO Patent Tech. Monitoring Team Member, to author (Feb. 17, 2010) (on file with author) (confirming that, "we haven't updated the report on women inventors since the 2002 report").

13. *See, e.g.*, LAUREL SMITH-DOERR, WOMEN'S WORK: GENDER EQUALITY VS. HIERARCHY IN THE LIFE SCIENCES (2004) (focusing on life sciences and the biotech industry) [hereinafter SMITH-DOERR, WOMEN'S WORK]; *see also* Kjersten Bunker Whittington & Laurel Smith-Doerr, *Gender and Commercial Science: Women's Patenting in the Life Sciences*, 30 J. TECH. TRANSFER, 355, 357 (2005) (suggesting that more research needs to be done on how commercial behavior may contain gender disparity); Waverly W. Ding et al., *Gender Differences in Patenting in the Academic Life Sciences*, 313 SCIENCE 665, 665 (2006); Kjersten Bunker Whittington & Laurel Smith-Doerr, *Women Inventors in Context: Disparities in Patenting Across Academia and Industry*, 22 GENDER & SOC'Y, 194, 195 (2008) [hereinafter *Disparities in Patenting*]; G. Steven McMillan, *Gender Differences in Patent Activity: An Examination of the US Biotechnology Industry*, 80 SCIENTOMETRICS 683, 684 (2009).

14. *See Disparities in Patenting*, *supra* note 13, at 194-95 (noting that scholarship focused on disparities between men and women in academic settings is a limited view).

mechanical engineering. Similarly, the existing literature on academic female patentees may or may not extrapolate well to women in business and industry.

Scholars have yet to conduct comprehensive and longitudinal empirical studies across technologies, organizations, and geography. With more than ninety percent of U.S. patents assigned to corporations at time of issuance,[15] it is important to focus more on the position of women inventors in industry, particularly in engineering and computer-related fields, where recent patent trends show the greatest rate of increase, yet educational data reveals a large degree of gender stratification.[16] The sheer volume of data, however, would make it difficult for individual researchers to tackle this work without support from national patent offices in the form of systematic tracking and reporting of inventor demographics. Moreover, in doing this, it would be important to protect the privacy interests of inventors and ensure that reporting of inventor demographics would not unintentionally introduce bias into the patent examination process.

History reveals that women have systematically been excluded from inventing, patenting, and other science and engineering-related endeavors, for a variety of legal, social, and economic reasons. Arguably, many of the more overt forms of discrimination toward women have diminished over time; however, informal barriers and subtle (albeit even unintentional and unconscious) bias persist.[17]

Contemporary analysis of gender stratification in the science and engineering workforce often focuses on variation in educational interests and choices across the sexes. It would follow that fewer number of women graduating with degrees in science and engineering fields would lead to fewer women scientists and technologists in the workforce. This in turn would lead to fewer women inventors named on patents. However, despite significant progress in recent decades toward closing the gender gap in most educational areas, even in the era of Computer Engineer Barbie,®[18] engineering and computer science remain strongly male-dominated fields.[19] We must consider why this is the case and which other factors, particularly

15. *See* U.S. PATENT TECH. MONITORING TEAM, U.S. PATENT & TRADEMARK OFFICE, PATENTING BY ORGANIZATIONS: 2009, at pt. A1-1 (2010), *available at* http://www.uspto.gov/web/offices/ac/ido/oeip/taf/topo_09.pdf (showing that of 167,349 U.S. utility patents granted in 2009, 92% were issued to U.S. and foreign corporations) (percentage calculated by author).

16. *See infra* Part II.

17. *See generally* SMITH-DOERR, WOMEN'S WORK, *supra* note 13 (discussing how female scientists are often more successful in highly internally linked biotechnology firms than in the more traditional hierarchical bureaucracies).

18. Barbie® is a registered trademark of Mattel, Inc.

19. *See infra* Part II.A.

those on the demand side of the workforce equation, may play a part in perpetuating the IP gender divide.

This Article intends to set the stage for a more meaningful and empirically-based discourse about women, IP, and invention, by bringing together the information that we know, identifying that which we do not know, and arguing that comprehensive empirical study on woman-inventor patenting is in order.

In Part I, this Article explores the history of women as inventors and patentees, examining the exclusion of women inventors through discriminatory property laws, unfavorable and stigmatizing stereotypes, barriers created by gender bias, and lack of educational opportunities. In Part II, this Article examines recent educational trends for women and compares data on woman-inventor patenting and participation by women in the patent practitioner community. In Part III, this Article discusses benefits that accrue to inventors who patent and the reasons why comparatively lower rates of patenting as compared with their male counterparts disadvantage women in science and engineering. Finally, this Article concludes in Part IV that patenting among women inventors has most likely increased only modestly since 2002. While the impact of this is most significant for women on an individual basis, there can be no doubt that there is a broader price society pays for sub-optimized outcomes across the intellectual property and innovation ecosystem.

II. WOMEN INVENTORS IN THE UNITED STATES

Throughout history, women have faced significant barriers as inventors and patentees. As detailed records on woman-inventor patents are not regularly kept, this Article relies primarily on special reports, issued from time-to-time by the USPTO,[20] in combination with a limited collection of academic research.[21] A review of these studies shows that, in the early 1900s, approximately 1.4 percent of U.S. patents named at least one woman inventor.[22] By 2002, this number had grown to 10.9 percent.[23]

A. Historical Perspectives

A review of the historical literature discloses various forms of biases and barriers that have disadvantaged women inventors since the inception of

20. *See supra* note 10 and accompanying text.

21. *See supra* note 13.

22. WOMEN'S BUREAU, *supra* note 1, at 13 tbl.II.

23. U.S. PATENTING BY WOMEN, *supra* note 11, at tbl.1-1; *see infra* notes 52-56 and accompanying text (focusing specifically on utility patents naming at least one woman inventor).

the U.S. patent system. These include restrictions on women's property rights, lack of educational opportunities, limited economic resources, unflattering stereotypes of women inventors, and gender bias even in the face of a seemingly gender-neutral patent system.[24]

An early bulletin from the Women's Bureau of the U.S. Department of Labor[25] reviewed the records of the patent office from 1790 to 1921 and reported:

> As there is no widespread belief in women's inventive abilities and in their powers of creative research, so also is there general absence of active encouragement of women to lay claim to the existing opportunities and facilities for research and experiment. This fact manifestly has direct bearing upon the relative number, range, and quality of scientific inventions and discoveries patented by women.[26]

The report describes a "vicious cycle" of limited opportunities for women to pursue inventive activity, resulting from the division of labor between the genders,[27] and the "lack of faith" and "timidity" of women.[28]

Among the pervasive barriers to early women inventors were laws that gave the legal rights to a wife's property and earnings to her husband.[29] The law considered married women to be legal nonentities, subject to the control of their husbands, unable to enter into contracts on their own or engage in trade without permission from their husbands.[30] With respect to intellectual property, a married woman could not sell her patent rights, mortgage real property to finance a business operation using a patent, or sue for patent infringement.[31] Many women did not receive credit for their

---

24. Matilda Gage, *Woman as an Inventor*, 136 N. AM. REV. 478, 488 (1883); Deborah J. Merritt, *Hypatia in the Patent Office: Women Inventors and the Law, 1865-1900*, 35 AM. J. LEGAL HIST. 235, 300-05 (1991); Carroll Pursell, *Women Inventors in America*, 22 TECH. & CULTURE 545, 545-47 (1981); ELLEN H. SHOWELL & FRED M.B. AMRAM, FROM INDIAN CORN TO OUTER SPACE: WOMEN INVENT IN AMERICA (1995); B. Zorina Khan, *Married Women's Property Laws and Female Commercial Activity: Evidence from United States Patent Records, 1790-1895*, 56 J. ECON. HIST. 356, 357 (1996) [hereinafter Khan, *Married Women's Property Laws*]; B. Zorina Khan, "*Not For Ornament": Patenting Activity by Nineteenth-Century Women Inventors*, 31 J. INTERDISC. HIST. 159, 160 (2000) [hereinafter Khan, *Not for Ornament*].

25. WOMEN'S BUREAU, *supra* note 1.

26. *Id.* at 5-6.

27. *Id.* at 6.

28. *See id.* at 5 (noting that this lack of faith limits a woman's creative abilities and increases her hesitation to apply for patents).

29. Gage, *supra* note 24, at 488-89; Khan, *Married Women's Property Laws*, *supra* note 24, at 357; Merritt, *supra* note 24, at 290 (explaining that the common law that existed in the nineteenth century prohibited women from selling or licensing her own patent, and also restricted women's ability to file lawsuits regarding patent infringements).

30. Khan, *Married Women's Property Laws*, *supra* note 24, at 357.

31. *Cf. id.* at 357-58.

inventions, yet a woman's husband could apply for the patent, sell her invention for his profit, give it away, or not use it at all, and the woman would have no remedy at law.[32] Many believed that if wives had authority over their own affairs, it would threaten the institution of marriage and the family. It is impossible to calculate how many women did not patent their inventions or did not receive credit as inventors on patent applications filed by their husbands, fathers, and brothers. Starting in the 1830s, many states began to pass legislation revising the restrictions of property laws; however, changes did not come quickly.[33] It was not until 1900 that all of the states had enacted some version of the Married Women's Property Act.[34]

Unflattering stereotypes of women inventors were pervasive, and prevailing cultural norms reinforced them. Inventing and patenting were simply not considered appropriate activities for women, and women were not encouraged to explore opportunities in science and technology.[35] The fear of ridicule and of becoming a social outcast prevented some women from pursuing patents for their inventions.[36] Society strongly reinforced the concept that women belonged at home taking care of household duties, and inventions for household and personal use were commonly trivialized.[37]

The financial investment required to pursue patents also created an economic barrier.[38] Some scholars argue that the costs associated with the patent application process were "unreasonable" and "discouraged applications from women."[39] This was particularly problematic for married women inventors, because their husbands controlled their property and

32. Gage, *supra* note 24, at 488.

33. Merritt, *supra* note 24, at 291 ("[S]tate legislatures began to remove these common-law disabilities in 1839. A series of married women's property acts increased the power of wives to own property, control their earnings, execute contracts, and file lawsuits. Reform, however, was piecemeal and slow. By 1860, less than half of the states had granted any relief to married women.") (citation omitted).

34. *Id.*

35. SHOWELL & AMRAM, *supra* note 24, at 12.

36. *See id.* (using, as an example, Betsy Metcalf, who invented a new method of braiding straw in 1789 and wrote that "many said I ought to get a patent; but I told them I did not wish to have my name sent to Congress").

37. *But see* WOMEN'S BUREAU, *supra* note 1, at 13 ("If the steady increase in the numbers of patents granted women is accounted for merely by the increase in the number of patented hairpins, hair curlers, and such trifles in feminine equipment, it is without large significance either to civilization or as an indication of women's inventive abilities.").

38. *See* Merritt, *supra* note 24, at 298-300 (estimating that in the late 1800s the total cost of a patent application filing and related attorneys' fees could amount to one hundred dollars, more than one-fifth of an average person's annual salary).

39. *Id.* at 298.

earnings, if they were allowed to work at all. To maneuver around these barriers, women would often sell their patent rights to finance the application costs.[40] One quarter of patent assignments that were made when the patent was granted were to patent lawyers and agents; this suggests that women may have traded their patent rights for application fees and patent prosecution services.[41]

Women were further disadvantaged by a lack of knowledge and connections helpful in navigating the patent process. Whereas men could associate with attorneys and receive advice gained through their networks or from personal experience,[42] women were more likely to choose a patent attorney at random; this increased the risk that they would fall victims to unscrupulous attorneys.[43]

Limited educational opportunities for women presented yet another barrier. Society encouraged women to focus on manners and etiquette, taking care of the household and children, and gaining knowledge to discuss art and current events.[44] While men attended school to learn science, philosophy, and business, these topics were considered unseemly for women.[45] Even after women began to pursue higher levels of education, there were those who strictly scrutinized this practice, because they believed women could not physically cope with the educational demands and that such studies could threaten women's reproductive capacities.[46] Men who worked in industry worked around machines that might have influenced them to invent or discover possible improvements.

The U.S. Patent office, itself, may have served as an obstacle to women attempting to patent inventions. Patent examiners expressed "disdain" for many female inventions.[47] In some instances, patent examiners were

40. *See id.* at 298-99.

41. Khan, *Not for Ornament*, *supra* note 24, at 186-87.

42. *See* Merritt, *supra* note 24, at 299 ("Even if a woman had the money to hire a lawyer and prosecute a patent application, she might have had difficulty finding a reputable attorney. A man employed outside the house might know lawyers through his business or have colleagues who could recommend a good patent attorney.").

43. *See id*. ("[F]emale inventors often fell prey to unscrupulous attorneys who charged their clients high fees while providing inadequate representation[,]" and it was reported that "thousands of unsophisticated inventors, including numerous women[,]" were taken advantage of by John Wedderburn, who "duped" inventors, or, as he referred to them, "suckers," out of fees for useless legal services and sent them "worthless medals and citations to encourage their pursuit of frivolous applications.").

44. *See* SHOWELL & AMRAM, *supra* note 24, at 11 (explaining that America's social order made it difficult for women to work with technology).

45. *See id.* at 11-12 (portraying how men were educated differently than women).

46. *See* Merritt, *supra* note 24, at 293 ("Several respected doctors argued that college training would injure the health of female students and destroy their reproductive capacities.").

47. *See id.* at 289-90.

unwilling to give female applicants informal feedback on inventions or suggest amendments, although they did so for male applicants.[48] The rate of complaints from female applicants was disproportionately high in light of how few applications women filed. The U.S. Patent Office hired its first female patent examiner in the late 1870s, and in 1891, there was a petition calling for "the passage of more liberal laws towards women."[49] While the petition did not succeed, it arguably signaled the beginning of positive steps toward creating an environment that was more accepting of women inventors.

B. Recent Statistics

In view of the historical record, the question remains: how much have women inventors advanced over the last century? Data from the two most recent USPTO reports examining U.S.-origin patents during the period of 1977 to 2002 that include at least one woman inventor are useful in answering this question.[50]

The percentage of U.S.-origin patents that include a woman inventor increased from 2.6 percent in 1977 to 10.9 percent in 2002.[51] Notably, across all years, women inventors are named on design patents and plant patents more frequently than on utility patents.[52] Within the utility patent category, we find a marked difference in women's participation across technologies, with more women inventors named on chemical patents than electrical or mechanical patents, as shown in Figure 1.[53] The rate of growth in woman-inventor patenting in the 1977 to 2002 period was also greatest

48. *Id.* at 290.

49. *See id*. at 240; Pursell, *supra* note 24, at 548 (striving for development of inventions by women).

50. *See* BUTTONS TO BIOTECH, *supra* note 10, at i; U.S. PATENTING BY WOMEN, *supra* note 10, at 1 (focusing "exclusively on patents of U.S. origin and identifying which of those U.S. origin patents include a woman inventor").

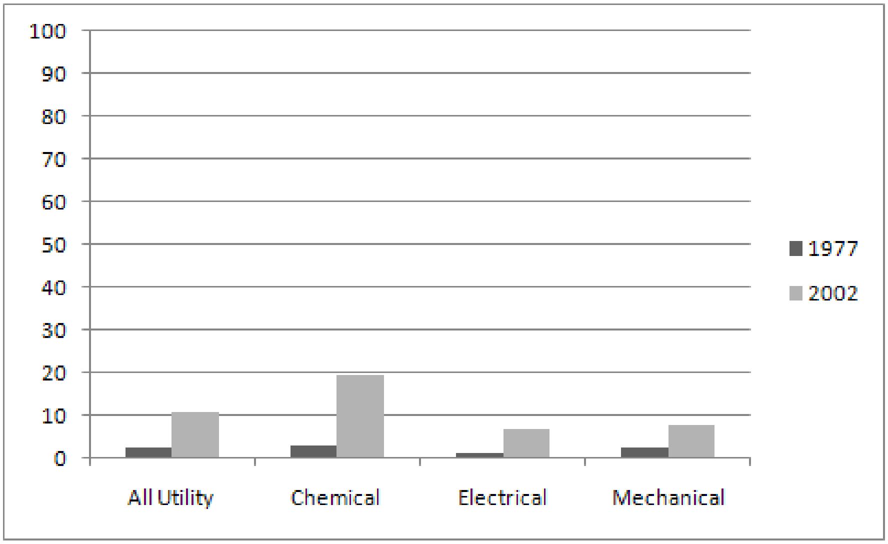
51. U.S. PATENTING BY WOMEN, *supra* note 10, at app. tbl.1-1.

52. *See id.* (showing that across the 1977 to 2002 period, on average, women were named as inventors on 7.0 percent of utility patents, 11.5 percent of design patents, and 11.5 percent of plant patents).

53. *See id.*; E-mail from Paul Harrison to author, *supra* note 12 (explaining the three broad patent technology classifications: "The Mechanical, Electrical and Chemical reports were created several years ago by looking at the US Patent Classification System (USPCS) classes/subclasses and determining which area the majority of the patents in those classes/subclasses were most closely related to. The reports are updated as new classifications are added and as the content of classes/subclasses change over time. Each issued patent is the USPCS includes one primary classification (or original classification) and may include one or more cross-reference classifications. The online Mechanical, Electrical and Chemical reports only include Utility patents and only include the patent primary classification. By including only primary classifications, each patent is counted only one time.").

in the chemical technologies.[54] While it would be logical to presume that the higher participation of women in patenting chemical inventions is directly related to educational trends for women, it remains less clear whether that is the entire explanation or other factors would be found to account for varying levels of woman-inventor participation across technology disciplines.

Figure 1: Percentage of U.S. utility patents with at least one woman inventor (1977 and 2002)—By Technology Classification



At first glance, the USPTO report appears deceptively comprehensive. In addition to providing an estimate of how many patents have issued over a twenty-five-year period with at least one woman inventor, and breaking down the data by patent-type and technology category, it also identifies the organizations[55] and states[56] that are associated with the greatest numbers of

54. *See* U.S. PATENTING BY WOMEN, *supra* note 10, at tbl.1-1 (calculation by author).

55. *See id.* at 1 ("The seven organizations receiving the most U.S.-origin woman-inventor patents cumulatively in the 1998 to 2002 period are reported to be International Business Machines Corporation (1732), Procter + Gamble Company (698), [t]he U.S. Government (610), Eastman Kodak Company (607), Motorola, Inc. (531), Kimberly-Clark Worldwide, Inc. (508), and Lucent Technologies (505).").

56. *See id.* ("For the year 2002, the top states of origin (based on residence of first-named inventor) for the most U.S. woman-inventor patents are California (2192), New York (995), Texas (591), New Jersey (575), Pennsylvania (510), Massachusetts (462),

woman-inventor patents. Upon close examination, however, gaps in the information become apparent. For example, the data does not show what percentage of the overall patent inventor population is female, as the unit of measurement tracked by the patent office is patents, not inventors. We know that in 2002, 10.9 percent of *patents* named at least one woman inventor, but that does not imply that 10.9 percent of patent *inventors* are women. Because patents frequently name multiple inventors, it is likely that women inventors account for less than 10.9 percent of the overall inventor population. Similarly, with regard to patent ownership, the USPTO reports on the organizations assigned the most patents naming a woman inventor; however, the report does not put that information into the context of the organization's overall portfolio, and as a result, the relative participation of women and men as patent inventors within the company is unknown.[57]

With regard to information about the geographic distribution of woman-inventor patents, the frame of reference is the state of residence of the first-named inventor, who is not necessarily the woman inventor.[58] Therefore, we must not assume that the states listed are where the women inventors are actually residing or working. Finally, because the last-issued USPTO report is from 2002, we do not know what has happened in the years since then. We do not know whether the landscape for women inventors has changed or remained largely the same and we do not know how that impacts systemic performance and outcomes in the innovation ecosystem.

Despite these limitations, the USPTO reports arguably remain the most comprehensive source of information about woman-inventor patents in the U.S. and are an important starting point for assessing the landscape occupied by women inventors.

III. DATA COMPARISONS

A. Educational Trends

To put in context the information regarding woman-inventor patents issued from 1977 to 2002, and to set the stage for predicting what might

---

and Ohio (455).").

57. *See id.* at tbl.6 (listing International Business Machines Corporation (IBM) as having the most woman-inventor patents in the 1998-2002 period (1732 patents)). However, as IBM received the most U.S. patents overall during this time period, it is not surprising that they would also have the most woman-inventor patents. Without putting the woman-inventor patents in context of the organization's total portfolio, the significance of the data is unclear. *Id*.

58. *See id*. at tbl.3 (highlighting states of origin in 2002 for U.S. origin women-inventor patents).

have occurred in the years since, I examined U.S. educational data from 1966 to 2006.[59] General trends for Bachelor's, Master's, and Doctorate degrees over the forty-year period were noted, and more detailed data was explored for Science and Engineering (S&E)-type degrees.[60]

As an initial baseline, in 1966 women obtained 42.6 percent of Bachelor's degrees, 33.8 percent of Master's degrees, and 11.6 percent of Doctorate degrees.[61] By the early 1980s, women had overtaken men at the Bachelor's and Master's degree levels, with female students earning more than fifty percent of the degrees in both categories and earning nearly one-third of all Doctorate degrees.[62] An upward trend continued over the next twenty-five years and, as of 2006, women earned 57.8 percent of Bachelor's degrees, 60.0 percent of Master's degrees, and 45.1 percent of Doctorate degrees.[63]

The educational data clearly demonstrates that women's academic pursuits are greater in fields other than science and engineering.[64] However, in the forty-year period from 1966 to 2006, the most significant growth for women has been in S&E fields, with biological sciences and engineering both showing particularly large percentage increases.[65] However, when the social and behavioral sciences, namely social sciences[66] and psychology, are removed from the S&E numbers, a slightly different picture emerges with women receiving a lower proportion of

59. *See generally* NAT'L SCI. FOUND., DIV. OF SCI. RES. STATISTICS, SCIENCE AND ENGINEERING DEGREES: 1966-2006 (2008) [hereinafter S&E DEGREES: 1966-2006], *available at* http://www.nsf.gov/statistics/nsf08321/content.cfm?pub_id=3785&id=2 (including data by degree field and time of award).

60. *See infra* text accompanying notes 68-72; *see also* S&E DEGREES: 1966-2006, *supra* note 59 (including fields of study categorized by NSF as "Science and Engineering" including agricultural sciences, biological sciences, computer sciences, earth, atmospheric and ocean sciences, mathematics, physical sciences, psychology, social sciences, and engineering when examining the areas of science and engineering that are most closely related to patented technologies).

61. S&E DEGREES: 1966-2006, *supra* note 59, at 5 (describing degrees awarded in all field by degree level and sex of recipient from 1966-2006).

62. *See id.* (observing that in 1981 women earned 50.3% of Master's degrees, and in 1982, women earned 50.5% of Bachelor's degrees and during the same period, women earned approximately 32% of Doctorate degrees).

63. *Id.*

64. *See id.* at 7 (showing that in 2006, women earned 61.2% of bachelor's degrees, 63.9% of master's degrees, and 57.7% of doctorate degrees fields other than science and engineering).

65. *Id.* at 14 (indicating that women received 24.8% of S&E Bachelor's degrees in 1966 and 50.5% in 2006, compared to 52.2% of Non-S&E degrees in 1966 and 61.2% in 2006).

66. *See id.* at 69 (defining social sciences as including anthropology, area/ethnic studies, economics, history of science, linguistics, political science, public administration, and sociology).

degrees awarded—namely, 38.6 percent of Bachelor's degrees,[67] 32.4 percent of Master's degrees,[68] and 39.1 percent of Doctorate degrees.[69] This is not an unexpected finding, as women comprise a majority of degree recipients in social sciences (53.7 percent) and psychology (77.4 percent).[70]

Gender stratification is most apparent and consistent in engineering fields, where women have historically been, and remain, in the minority. Nevertheless, engineering has been a growth area for women over the past forty years. Compared to 1966, when women earned only 0.4 percent of the undergraduate degrees in engineering, by 2006 women earned 19.5 percent of undergraduate engineering degrees.[71] The majority of growth in women's engineering occurred in the decade between the mid-1970s and mid-1980s.[72] Moderate growth continued after the mid-1980s, up until 2006,[73] before dropping slightly in 2007 and 2008.[74]

Differing levels of participation by women exist across specialized disciplines within engineering. The USPTO assigns patented inventions an original classification that corresponds with one of three broad technology categorizations–electrical, mechanical, or chemical.[75] This research examines educational data for women in these three engineering categories from 2000 to 2008. Recent data reflects that in 2008 women represented a significantly higher ratio of graduates in chemical engineering (33.3 percent), as compared with electrical engineering (11.0 percent) and mechanical engineering (11.8 percent).[76] Strikingly, although the number of women receiving undergraduate engineering degrees increased across this period from 12,206 to 12,918 (a 5.8 percent increase),[77] the percentage

67. *Id.* at 8, 12 (using 2006 data to calculate results).

68. *Id.* at 15-19 (calculated by Author from Tables 12 and 16 using 2006 data).

69. *Id.* at 22-26 (calculated by Author from Tables 19 and 23 using 2006 data).

70. *Id.* at 14.

71. *Id.* at 21-28 (showing slightly higher percentages were found in the advanced degree categories, with women earning 22.9% of engineering Master's degrees (NSF Table 18) and 20.2% of engineering Doctorate degrees (NSF Table 25) in engineering in 2006).

72. *Id*. at 14 (showing that between 1976 and 1986 the percentage of undergraduate engineering degrees earned by women increased from 3.4 percent to 14.5 percent).

73. *Id.* (showing that between 1986 and 2006 the percentage of undergraduate engineering degrees earned by women increased from 14.5 percent to 19.5 percent).

74. DIV. OF SCI. RES. STATISTICS, NAT'L SCI. FOUND, WOMEN, MINORITIES, AND PERSONS WITH DISABILITIES IN SCIENCE AND ENGINEERING tbl.C-5 (2010) [hereinafter TABLE C-5], *available at* http://www.nsf.gov/statistics/wmpd/pdf/tabc-5.pdf (illustrating that the percentage of Bachelor's degrees in engineering earned by women dropped to 18.5 percent in both 2007 and 2008).

75. *See infra* note 53. *See generally* TABLE C-5, *supra* note 74.

76. TABLE C-5, *supra* note 74.

77. *Id.* (showing that in the same time period, the number of undergraduate engineering degrees awarded to men increased from 47,281 to 56,977 (a 20.5 percent

of undergraduate engineering degrees awarded to women dropped across the board in all categories, as shown below in Figure 2.

Figure 2: Engineering Bachelor's Degrees Earned by Women 2000 and 2008[78]

	Bachelor Degrees Earned by Women – 2000		Bachelor Degrees Earned by Women – 2008	
	Number	Percent	Number	Percent
All Engineering	12206	20.5	12918	18.5
Electrical Engineering	2350	13.3	1907	11.0
Mechanical Engineering	1782	13.6	2093	11.8
Civil Engineering	2325	24.3	2751	22.5
Chemical Engineering	2203	35.4	1834	33.3
Other Engineering[79]	3546	27.4	2611	25.3

Likewise, there is a significant and growing gender divide in the field of computer science. In 2000, women earned 28.0 percent of the Bachelor's degrees in computer science, compared with 17.7 percent in 2008.[80] At the Master's degree level, the drop was from 33.4 percent in 2000 to 26.8 percent in 2008.[81] During this period, both the percentage and total number of women earning computer science degrees declined.[82]

In stark contrast to the findings in the field of computer science, women received more undergraduate degrees in biological sciences than in any other S&E field aside from social sciences and psychology.[83] The trend continued from 2000 to 2008, with women receiving 58.5 percent of the Bachelor's degrees in biological sciences in 2000 and 59.8 percent in 2008.[84] Regarding Master's degrees, women earned 55.5 percent of degrees in 2000 and 58.7 percent in 2008.[85]

---

increase)).

78. *Id*.

79. *Id*. (demonstrating that the "other" engineering category includes aerospace engineering, industrial engineering, materials engineering, and other engineering).

80. *Id.* (percentages calculated by author).

81. DIV. OF SCI. RES. STATISTICS, NAT'L SCI. FOUND., WOMEN, MINORITIES, AND PERSONS WITH DISABILITIES IN SCIENCE AND ENGINEERING tbl.E-2 (2010) [hereinafter TABLE E-2], *available at* http://www.nsf.gov/statistics/wmpd/pdf/tabe-2.pdf.

82. *Compare* TABLE C-5, *supra* note 74 (illustrating that in 2000, 10,522 women earned Bachelor's degrees in computer science, compared with 6,883 in 2008), *with* TABLE E-2, *supra* note 81 (demonstrating that in the Master's degree category, there were 5,003 women earning degrees in 2000, compared with 4,594 in 2008).

83. TABLE C-5, *supra* note 71.

84. *Id*.

85. Table E-2, *supra* note 81.

Similarly, chemistry is an area that is upward trending and approaching nearly fifty percent participation from women. In 2008, women earned 49.9 percent of the Bachelor's degrees in chemistry, up from 47.2 percent in 2000.[86] Likewise, women acquired 46.3 percent of the Master's degrees in chemistry in 2008, up from 43.1 percent in 2000.[87]

B. Patent Trends

Noting that, through 2002, women inventors have been named most frequently on chemical patents,[88] and acknowledging that this finding corresponds to educational trends, the question presented is how many woman-inventor patents we would expect to find since 2002. To consider this, I examined data on U.S. utility patents granted in the ten-year period of 1999 to 2008, with specific emphasis on the breakout of patents according to technology category.[89]

In 1999, the USPTO issued 153,485 utility patents of which 36.4 percent were mechanical, 35.5 percent were electrical, and 28.1 percent were chemical.[90] By 2008, the breakdown had changed significantly, as depicted in Figure 3 below. Of the 157,772 utility patents granted in the U.S. in 2008,[91] 27.0 percent of patents granted were mechanical patents, 53.5 percent were electrical and 19.5 percent were chemical.[92] Most notably, there was a significant increase in grants of electrical patents,[93] and a

86. Table C-5, *supra* note 74.

87. Table E-2, *supra* note 81.

88. *See supra* Figure 1.

89. PATENT TECH. MONITORING TEAM, U. S. PATENT & TRADEMARK OFFICE, CHEMICAL CLASSES (12-31-2009) (2008) [hereinafter CHEMICAL CLASSES]; PATENT TECH. MONITORING TEAM, U. S. PATENT & TRADEMARK OFFICE, ELECTRICAL CLASSES 1999-2008 (2009) [hereinafter ELECTRICAL CLASSES]; PATENT TECH. MONITORING TEAM, U. S. PATENT & TRADEMARK OFFICE, MECHANICAL CLASSES (12-31-2008) (2008) [hereinafter MECHANICAL CLASSES].

90. PATENT TECH. MONITORING TEAM, U. S. PATENT & TRADEMARK OFFICE, ALL TECHNOLOGIES (UTILITY PATENTS) REPORT (2010) [hereinafter ALL TECHNOLOGIES REPORT], *available at* http://www.uspto.gov/web/offices/ac/ido/oeip/taf/all_tech.htm; ELECTRICAL CLASSES, *supra* note 89; MECHANICAL CLASSES, *supra* note 89; CHEMICAL CLASSES, *supra* note 89 (figures calculated by author).

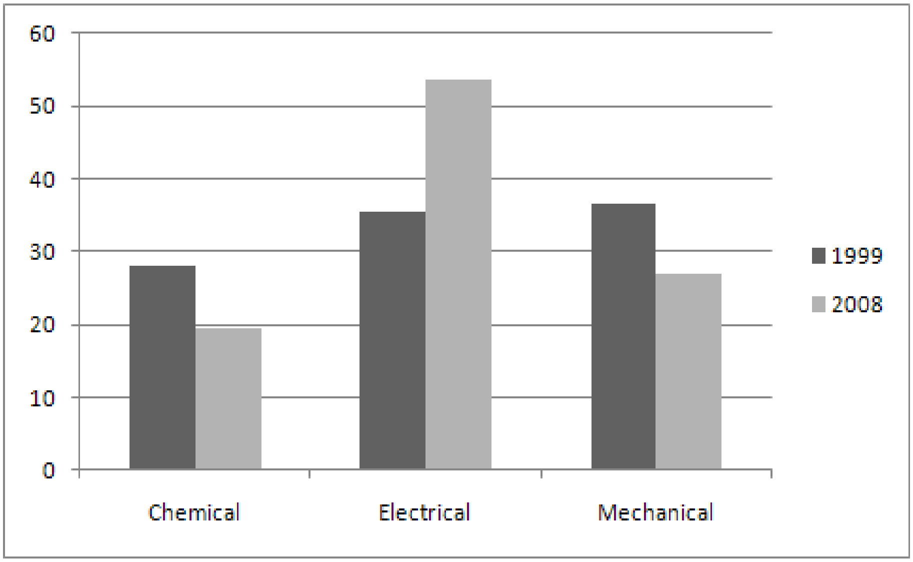
91. ALL TECHNOLOGIES REPORT, *supra* note 90.

92. *Id.;* ELECTRICAL CLASSES, *supra* note 89; MECHANICAL CLASSES, *supra* note 89; CHEMICAL CLASSES, *supra* note 89 (figures calculated by author).

93. Significant growth over the 1999 to 2008 period can be seen in patent technology classifications associated with the electrical field, including multiplex communications (U.S. Class 370), active solid-state devices (U.S. Class 257), telecommunications (U.S. Class 455), electrical computers and digital processing systems (U.S. Class 709), image analysis (U.S. Class 382), computer graphics processing and selective visual display systems (U.S. Class 345), pulse or digital communications (U.S. Class 375), radiant energy (U.S. Class 250), and electrical systems and devices (U.S. Class 361). *See* PATENT TECH. MONITORING TEAM, U. S. PATENT & TRADEMARK OFFICE, PATENT COUNTS BY CLASS BY YEAR (2010),

downward trend in chemical patents, clearly demonstrating that patent trends in the U.S. are moving in one direction, while technical training for women is moving in an opposite direction.

Figure 3: Percentage of U.S. Utility Patents Granted in Chemical, Electrical, and Mechanical Patent Classifications, 1999 and 2008

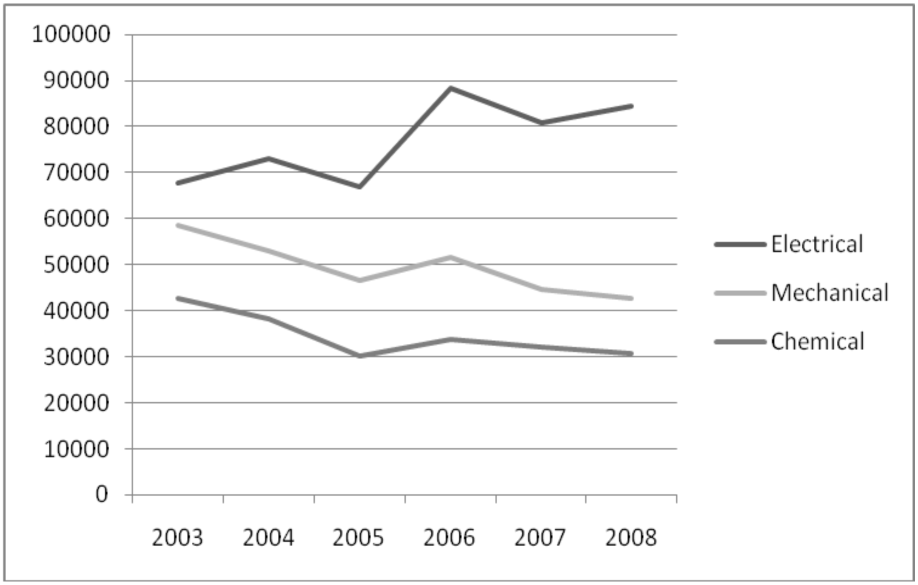


This finding, on its own, does not suggest a likelihood of much increase in patenting by women since 2002.[94] Examining more closely the U.S. patent data from 2003 to 2008, the total number of U.S. utility patents issued decreased by 6.7 percent overall in this period; however, the change was not distributed evenly across technology categories, as shown in Figure 4. A significant increase occurred in the electrical category (+24.4 percent), while decreases were seen in both mechanical arts and chemical arts (-27.4 percent and -27.7 percent respectively).

http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cbcby.htm (rates of growth calculated by author based on number of patents granted combined with percentage increases during the period from 1999 to 2008).

94. KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 417 (2007) (emphasizing that "[i]f a person of ordinary skill in the art can implement a predictable variation" the law likely prohibits its patentability).

Figure 4: U.S. Utility Patents Granted by Technology Classification, 2003-2008



Assuming that the rate of change in woman-inventor patenting in the 2003 to 2008 period across these categories continued at the same pace as in the prior five-year period (1998 to 2002),[95] there should have been approximately 10.8 percent of utility patents issued with at least one woman inventor in 2003, growing to 11.5 percent in 2008.[96] As the total number of patents issued to all inventors declined during this period, the number of woman-inventor patents likely declined, even if there were a slight increase in the ratio of women inventors as compared to men.

This prediction assumes that the rate of change for woman-inventor patenting in the 2003 to 2008 period would mirror the previous five year period. While this rate of change cannot be confirmed, the educational trends alone do not direct us to a different conclusion. Other factors could possibly influence productivity and increase the number and ratio of woman-inventor patents—even without changing the gender composition of the field. Without more comprehensive empirical research on women inventors as a baseline from which to measure, it is challenging to identify the factors that influence patent productivity across technological and organizational contexts.

---

95. The average annual increase in woman-inventor patents from 1998 to 2002 was 3.0% for chemical patents, 4.4% for mechanical patents, and 1.8% for electrical patents. *See* U.S. PATENTING BY WOMEN, *supra* note 10 (figures calculated by author).

96. *Id.* (compared with 10.7% in 2002).

C. Gender Imbalance in the Patent Bar

Women inventors are not the only group that remains a mystery in the IP system. There is little data on women patent attorneys and patent agents as well.[97] In the same way that the USPTO does not collect gender information for inventors, it also does not attempt to gather such information from patent practitioners, and has not issued any special reports on the subject.[98] Individuals applying to take the patent bar examination are not asked to self-identify their gender, even on a voluntary basis, when submitting the required application form,[99] or after they successfully pass the patent bar examination and are admitted to practice before the USPTO, or when the USPTO performs periodic audits of the roster of patent practitioners. Because gender data is not initially collected, there is no way to track this data over time and identify trends, such as how many women, as compared to men, apply to take the patent bar examination, successfully pass the exam, or receive admission on an annual basis. Requiring patent practitioners to disclose their gender would allow researchers to calculate how educational backgrounds of the women may be the same or different from their male counterparts, how long women actively practice in the field as compared to men, and why women exit the profession.

I have conducted a separate but related study addressing the lack of quantitative data about female participation in patent law. In this study, I have gender-identified the USPTO roster of registered patent practitioners

97. Collectively, "patent practitioners." Regulations governing the recognition of individuals to practice before the United States Patent and Trademark Office in patent cases are set forth in the Code of Federal Regulations. *See* 37 C.F.R. §§ 11.5-11.9 (2010). The term "practitioner" in this Article conforms with the CFR definition: "Practitioner means (1) an attorney or agent registered to practice before the Office in patent cases or (2) an individual authorized under *5 U.S.C. 500(b)* or otherwise as provided by this subchapter, to practice before the Office in trademark cases or other non-patent cases." 37 C.F.R. § 10.1(r) (2010). For purposes of this Article, the definition of patent practitioners is limited to those individuals registered to practice before the USPTO, and does not include non-USPTO-registered attorneys performing patent-related work, such as patent litigation, licensing, and patent or intellectual property counseling.

98. Telephone interview with USPTO Office of Enrollment & Discipline (inquiring to confirm that the Office does not collect gender information from patent bar examination applicants or registered patent practitioners) (on file with author). As the government agency that administers the U.S. patent system and has the sole authority to register individuals to practice before its office, the USPTO would be in the best position to collect gender information from prospective and actively registered patent practitioners, in a manner similar to that used by state bar associations.

99. *See generally* PATENT TECH. MONITORING TEAM, U. S. PATENT & TRADEMARK OFFICE, GENERAL REQUIREMENTS BULLETIN FOR ADMISSION TO THE EXAMINATION FOR REGISTRATION TO PRACTICE IN PATENT CASES BEFORE THE UNITED STATES PATENT AND TRADEMARK OFFICE (2008) (explaining patent bar application requirements and making no mention of gender identification).

with attorney or agent status and examined in greater detail a subset of the roster representing patent practitioners employed at IP law firms.[100] The preliminary results indicate that 18.0 percent of registered patent attorneys are women, compared with approximately 26.1 percent of patent agents. Variation in gender distribution exists across geography, with more women patent attorneys and agents in the Northeast and Western regions of the U.S., as compared to the Southern and Midwestern regions.[101] In a law firm sample, differences appear across firm types; for example, a higher percentage of female patent practitioners work in general practice law firms with IP departments than in boutique law firms practicing exclusively in the IP field. Finally, and not surprisingly, the educational trends previously noted carry through to the patent bar. Two-thirds of male patent practitioners in the law firm sample had an engineering degree, as compared with less than one-third of the women.

Relating these findings to the deficiency of women inventors, it is unclear what connection might exist between gender disparity in the patent bar and gender disparity in the adjacent inventor community. It spurs the question of whether a larger pool of female inventors would drive demand for a greater number of female patent practitioners, and, similarly, whether a larger pool of female patent practitioners would encourage more women to become inventors or influence more activity within the pool of existing female inventors. More generally, this line of questioning relates to how actors within the innovation and IP ecosystem impact and influence behavior and outcomes in adjacent and interrelated communities.

IV. BARRIERS TO GREATER PARTICIPATION BY WOMEN

In light of the data reported in this Article, the question remains why more women are not participating in the inventor community. Although there are undoubtedly many reasons, I limit my focus here to stalled progress in attracting women into engineering and computer science in the face of persistent stereotypes that make these fields particularly unappealing to young women.

A. Gender Stratification in Engineering and Computer Science

In recent decades, there has been a great deal of emphasis on

100. Data sheets from study are on file with author. Approximately 95% of the active USPTO roster was gender-identified with data current through 12/31/2008. Law firm data was collected for 84 law firms across the U.S. throughout 2008.

101. Regions correspond to *Census Regions and Divisions of the United States*, U.S. CENSUS BUREAU, http://www.census.gov/geo/www/us_regdiv.pdf (last visited Nov. 12, 2010).

encouraging women to enter S&E fields, and a myriad of studies have studies have explored why women still do not enter these fields in higher numbers.[102] Social and environmental factors may play a large role in the persistent gender gap.[103] Negative stereotypes and continuing workplace biases may create an uninviting environment that women are disinclined to enter or from which they may prematurely exit.[104] From a workforce readiness standpoint, this creates a significant problem as workplace projections for the next decade show that the fastest growing careers requiring at least a Bachelor's degree will call for considerable scientific or mathematical training.[105] As demonstrated by the educational data presented in Section II, gender disparity is not evenly distributed across all S&E fields—it is more pronounced in engineering and computer science. As these two fields have steep upward trends in patent activity, the exclusion of women in the inventor community is a vexing problem that has a direct effect on IP outcomes.

Why does gender disparity persist in these fields? At least one theory on the scarcity of women in engineering focuses on messaging deemed to be ineffective in attracting young women to the field.[106] Highlights from a recent study indicate that most adults and teens believe that engineering is not "for everyone," especially not for young women.[107] Specifically, the public emphasizes mathematics and science skills as important to the engineering field, while failing to also recognize the importance of other fundamental aspects, such as teamwork, communication, and creativity.[108] Effective messaging will require different messages for different target

---

102. *See, e.g.*, COMM. ON PUB. UNDERSTANDING OF ENG'G MESSAGES, NAT'L ACAD. OF ENG'G, CHANGING THE CONVERSATION: MESSAGES FOR IMPROVING PUBLIC UNDERSTANDING OF ENGINEERING 100 (2008) [hereinafter NAE], *available at* http://www.nap.edu/catalog/12187.html (recommending that marketing messages highlight the difference that engineering can make in the world); CATHERINE HILL ET AL., AM. ASS'N OF UNI. WOMEN, WHY SO FEW?: WOMEN IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (2010).

103. *See* HILL ET AL., *supra* note 102, at xiv (noting that the gap exists in science and engineering).

104. *See* Valerie Strauss, *Why Aren't There More Women in STEM*?, WASH. POST (March 23, 2010), http://voices.washingtonpost.com/answer-sheet/science/why-arent-there-more-women-in.html (recognizing that universities fail to create comfortable environment for women).

105. *See id.* (stating that the greatest increases will be in the computer and engineering fields).

106. *See* NAE, *supra* note 102, at 98 (suggesting that messaging efforts consider how the specific audience thinks about the idea of engineering).

107. *See id.* (discovering however, that the sample population respect engineers and think their work is important and rewarding).

108. *See id*. (understanding that the public generally does not know what engineers do on a day-to-day basis).

audiences.[109] To be successful, messaging must consider the makeup of the target populations—including teens, females, and minorities.[110] In continuing to emphasize math and science in marketing or branding engineering, it is likely that students will experience alienation from rather than attraction to engineering.[111] Similarly, messages should not focus on the practical benefits of being an engineer but rather should demonstrate the inspirational and optimistic aspects of engineering.[112]

In the field of computer science, the gender gap has recently widened. Whereas in 1966 women received one-third of Bachelor's degrees in computer science and math,[113] in 2006 it was closer to one-fourth.[114] Separating the fields of math and computer science reveals a greater decline in computer science alone. More recently, between 2000 and 2008, the number of women receiving Bachelor's degrees in computer science fell from 10,522 to 6,883, and the ratio of women, as compared to men, receiving computer science Bachelor's degrees decreased from 28.0 percent to 17.7 percent.[115]

Misconceptions and negative images of computer science may be significant factors contributing to the low interest in the field.[116] "As long as teenagers believe that computer science is boring, difficult, antisocial, or does not have much impact on solving the world's problems, they are unlikely to choose it for their future."[117] Significant differences exist in the way that high school boys and girls perceive computer science.[118] When asked about their level of interest in selecting computer science as a college major, forty-five percent of boys, but only ten percent of girls, responded that it would be a "very good" choice.[119] Thirty-five percent of girls responded that it would be a "bad" choice for a college major, as compared

---

109. *See id.* (realizing that messages should be adapted to take into account gender as girls have different perspectives on and connections to engineering).

110. *See id.* at 99 (claiming that few engineering organizations procured profession market-research firms' services).

111. *Id.*

112. *Id.*

113. S&E DEGREES: 1966-2006, *supra* note 59, at 14.

114. *Id.*

115. TABLE C-5, *supra* note 74.

116. *See* WGBH EDUC. FOUND. & THE ASS'N FOR COMPUTING MACH., NEW IMAGE FOR COMPUTING: REPORT ON MARKET RESEARCH 3 (2009), *available at* http://women.acm.org/participate/nic.pdf (claiming that as long as teens consider computer science boring or non-impactful, they will overlook it in the future).

117. *Id.* at 3.

118. *Id.* at 5.

119. *Id.*

with ten percent of boys.[120] Similarly, thirty-eight percent of boys said that computer science would be a "very good" career choice, while only nine percent of girls gave it the top rating.[121] Forty-seven percent of girls answered that it would be a "bad" career choice.[122] When the students answered questions about the career characteristics that were most important to them, girls and boys agreed on many of the criteria; however, boys attributed more importance than girls to "earning a high salary" and "having the power to create and discover new things."[123] Girls attributed greater importance than boys to "being passionate about your job," "having the power to do good and doing work that makes a difference," and "working with people in an interconnected, social and innovative way."[124] When asked about their comfort level with technology, the girls self-rated themselves higher than the boys as "communicators," while boys self-rated themselves higher than the girls as "techies" and "creators."[125] Overall, while college-bound males tend to have a positive opinion of computer science as a possible major and career choice, college-bound females are significantly less interested in computer science,[126] a trend that does not bode well for developing the next generation of women inventors in the computer industry.

B. Stereotypes, Cultural Norms, and Computer Engineer Barbie®

This was an exciting year for women computer engineers and Barbie® fans alike. Through the Barbie® "I Can Be . . ." line of dolls and accessories, which "empower[] girls to play out different roles and 'try on' fabulous careers,"[127] Mattel, Inc. launched "Computer Engineer Barbie®" as the 2010 winner of its annual "Popular Vote" competition.[128]

Mattel describes Computer Engineer Barbie® as "a reflection of the times," and a "digital diva" having the perfect "geek-chic look, with hot pink accessories and sleek gadgets to match."[129] Dressed in a funky tee

120. *Id.*

121. *Id.* at 7.

122. *Id.*

123. *Id.* at 11.

124. *Id.*

125. *Id.* at 14.

126. *Id.* at 17.

127. *Barbie I Can Be . . . Engineer Doll*, MATTEL, http://shop.mattel.com/product/index.jsp?productId=4032107 (last visited Oct. 17, 2010).

128. *See You Voted! We Listened!*, MATTEL, http://www.barbie.com/vote/ (last visited Oct. 17, 2010) (demonstrating that "News Anchor Barbie®" won the "Girls' Vote"; therefore, Mattel, Inc. introduced two new "I Can Be . . ." Barbie dolls in 2010).

129. *Id.*; *see also The Vote is In: Barbie Doll's 126th Career-Computer Engineer*,

with binary code design, she comes with cell phone headset, laptop bag, and pink laptop.[130] With over 120 careers under her belt before breaking into the world of computer engineering, Barbie® has been showing girls how to break through the "plastic ceiling" for five decades.[131]

The announcement of Barbie's new cool and creative career tore through the internet, Facebook, and Twitter with lightning speed. Computerworld pronounced, "[l]ook who's become a nerd."[132] PC World chimed in, "Ladies and gentlemen, I'd like to introduce the newest member of our IT department: Computer Engineer Barbie. She's hip, stylish, and a real whiz when it comes to fixing faulty motherboards . . . . This chick's qualified, man – and, just between us, I think she might have a thing for me."[133]

As Computer Engineer Barbie® and her companion News Anchor Barbie®, (winner of the 2010 "Girl's Vote") have only recently become available in stores, we have yet to see sales results that would demonstrate whether those popular votes will translate into consumer demand. Will girls be asking for, and will parents be buying, the geek-chic gadget girl? Or will News Anchor Barbie® come out on top? Is Computer Engineer Barbie® the first step in a new direction? Will she impact the social and cultural lens through which people view women in science and engineering? Is this a sign that Inventor Barbie® or Patent Attorney Barbie® may yet be in our future? Stay tuned.

In some sense, the existence of Computer Engineer Barbie® does seem like forward progress, particularly in light of the direct involvement of and the Society of Women Engineers and the National Academy of Engineering.[134] On the other hand, her appearance, outfitting, and marketing messages seem to reinforce the stereotype of women engineers

---

BARBIE MEDIA, http://www.barbiemedia.com/admin/uploads/ComputerEngineerBarbie.pdf (last visited Oct. 17, 2010) (recognizing that Computer Engineer Barbie® can inspire girls become a part of this growing profession, and noting that the doll's designers worked with the Society of Women Engineers and the National Academy of Engineering to ensure that the doll and her accessories realistically represent a computer engineer).

130. *The Vote is In: Barbie Doll's 126th Career-Computer Engineer*, *supra* note 129.

131. *See* Press Release, The White House Project, Barbie® Celebrates 125th Career with Global Initiative to Inspire Girls (Jan. 21, 2010), *available at* http://thewhitehouseproject.org/newsroom/releases/2010/2010BarbieICanBe.php (indicating that Barbie® has served as role model and motivating force of change for girls).

132. *See, e.g.*, Sharon Gaudin, *Look Who's A Nerd: Barbie Becomes Computer Engineer*, COMPUTERWORLD (Feb. 17, 2010), http://www.computerworld.com/s/article/9158118/Look_who_s_a_nerd_Barbie_becomes_computer_engineer.

133. JR Raphael, *Watch Out, Computer Engineers: Barbie Wants Your Job*, PCWORLD, (Feb. 12, 2010), http://www.pcworld.com/article/189241/watch_out_computer_engineers_barbie_wants_your_job.html.

134. *See supra* note 129 and accompanying text.

as geeks, albeit perhaps a more attractive version. Maybe if a girly-girl like Barbie® can wear glasses, pants, and a Bluetooth, then the rest of us will find it more acceptable? But, is there really any connection between computer engineering and visual impairment? Do we want to reinforce the idea that this connection exists? No matter where you come out on this particular issue, it is clear that stereotypes about women in science and engineering fields persist and are deeply rooted in culture and society. Although incremental progress exists, there is still far to go.

C. Does it Matter?

Having established that women inventors are few in number (although it is unclear precisely how few), the recipients of patents less frequently than their male counterparts, and in good company with women underrepresented elsewhere in the IP system, how is this significant?

Both pecuniary and non-pecuniary benefits accrue to inventors; women disproportionately are not inventors in most fields, and therefore fewer women than men experience these benefits.[135] In industry, inventors may receive rewards through enhanced positions and prestige within their corporations, and in some cases monetarily through cash bonuses disbursed under inventor reward programs. Prolific inventors, whose credentials are more favorable due to patent-inventor status, find it easier to obtain competitive positions in the job market in their field of invention.

In the academic arena, as commercial activity has increased in universities, patents have become valuable for career advancement. Scholars examine intangible benefits such as the "implicit exit option," whereby an inventor can leave a position before an inventive concept has a tangible form (where the benefit that accrues to the inventor provides increased bargaining leverage with an employer/prospective employer).[136] Additionally, this option allows exceptional inventors to satisfy their personal motivations by applying their abilities in different ways and to prove themselves in new specialties.[137] In general, inventors across organizations benefit from better research opportunities, more funding, preferential access to equipment for laboratories, greater knowledge

---

135. *See* Joseph Rossman, *The Motives of Inventors,* 45 Q.J. ECON 522, 522-24 (1931) (indicating that individuals have a "love of inventing" and a "desire to improve existing devices," as well as a desire for prestige and monetary returns).

136. *See* Robert P. Merges, *The Law and Economics of Employee Inventions*, 13 HARV. J.L. & TECH. 1, 3 (1999) (suggesting that an employee-inventor's ability to leave an inchoate concept unfinished is an important counterbalance to an employer's rights).

137. *See generally* Nicola Baldini et al., *Motivations and Incentives for Patenting within Universities: A Survey of Italian Inventors* (Acad. Of Mgmt. Meeting, Submission No. 10754, 2005), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=718481.

exchange, increases in personal earnings, and enhanced professional visibility and reputation. It is clear that women's individual attainment suffers due to their comparative lack of access to these benefits.

Less frequently discussed is the impact of gender imbalance in the inventor community on systemic innovation outcomes. From an outcomes perspective, I suggest that the issue is not so much about gender diversity, or any form of identity diversity, as it is about cognitive diversity—the ability to see and interpret problems differently, such that we envision a broader set of possible outcomes and solutions.[138] Opportunities are being missed or sub-optimized in the innovation ecosystem, because the ideas, inventions, perspectives, and proposed solutions of women are missed or sub-optimized. We can approach this question from a theoretical perspective, but the lack of empirical study on the subject creates an acute disadvantage.

V. CONCLUSION

Assumptions that women are catching up in S&E fields and will eventually occupy more slots in the inventor community are out of step with education data and recent patent trends. As women are most greatly outnumbered in engineering and computer science, attention must focus on those particular fields and pierce the corporate veil to discover the position of women inventors in industry, which generates more than ninety percent of U.S. patents. USPTO data indicates that women were inventors on 10.7 percent of utility patents in 2002. By 2008, I predict this number would have grown only modestly to 11.5 percent. This results largely from the sharp uptick in electrical patenting and a decrease in chemical patenting, trends running directly counter to educational trends for women. Gender disparity in the inventor community disadvantages women at the individual level and likely sub-optimizes systemic outcomes. I suggest comprehensive and longitudinal empirical studies of woman-inventor patenting across technologies, organizations, and geography, and the subsequent mapping of such findings to innovation outcomes.

---

138. *See generally* SCOTT E. PAGE, THE DIFFERENCE: HOW THE POWER OF DIVERSITY CREATES BETTER GROUPS, FIRMS, SCHOOLS, AND SOCIETIES (2007) (finding that diverse problem solvers with different tools consistently outperformed the groups consisting of the best and brightest).