U.C.L.A. Law Review

Redefining Progress: The Case for Diversity in Innovation and Inventing

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ABSTRACT

This Article makes the empirical and legal case for redefining the concept of patent "progress" to include the promotion of a diversity of innovators and inventors, and not just innovation. Based on a survey of the empirical literature, it details four plausible mechanisms by which diverse innovators improve innovation: novelty, non-obviousness, (overcoming) conflict, and numerosity. It introduces the concept of the "innovator-inventor gap"—the lower rate at which underrepresented technical workers become inventors—and documents how across innovative workplaces, women are patenting at a fraction of the rate of their male counterparts, in part due to barriers placed by the law and mechanics of inventorship. This Article makes several recommendations for advancing "progress" redefined: (1) reconsider inventorship law and policy; (2) institutionalize and strengthen the Patent Office's ability to promote a diversity of innovators and inventors, and not just invention; (3) launch a public-private "innovator diversity pilots clearinghouse" to support the rigorous evaluation and refinement of relevant policies and practices; and (4) a periodic, innovator-inventor survey for informing the design of policies and practices for making progress.

71 UCLA L. Rev. 540 (2024)

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INTRODUCTION

As the U.S. Constitution states, the patent system exists "to promote the Progress of . . . useful Arts, by securing for limited Times to . . . Inventors the exclusive Right to their respective . . . Discoveries."[1] The promise of the exclusive, yet limited, right provided by a patent propels "progress" by adding "fuel . . . to the fire of genius."[2] Consistent with this utilitarian bent, scholarship about the patent system has largely focused on how to reward innovation without over-rewarding it,[3] and how to strike the right balance between promoting innovation and encouraging competition.

A focus on innovation, rather than innovators—persons or teams that devise new ways of doing things—is understandable. In invention, the introduction of a new technological idea and in patent law,[4] "does it work?" matters far more than "who made it?," which is often the defining question when it comes to copyrighted works like books and music.[5] Unlike other American institutions like voting and property ownership, taking the step from being an innovator to becoming an inventor, by successfully filing for a patent over one's idea, has never been explicitly conditional on an inventor's gender or race.[6]

But this Article calls for a shift in how we think of "progress",[7] from being solely about advancing innovation to also being about advancing innovators. It argues for this change on the basis of patent law's overlooked but longstanding commitment to promoting a broad range of creative individuals. It also does so on the basis of a new synthesis I present, based on a review of the empirical

1. U.S. CONST. art. I, § 8, cl. 8.
2. Abraham Lincoln, *"To Immancipate the Mind": Lecture on Discoveries and Inventions, 1859*, *in* THE POLITICAL THOUGHT OF ABRAHAM LINCOLN 112, 121 (Richard N. Current ed., 1967).
3. Meaning, at the expense of competition or follow-on innovation, rather than optimally incentivizing the original innovation. *See, e.g.*, WILLIAM NORDHAUS, INVENTION, GROWTH, AND WELFARE: A THEORETICAL TREATMENT OF TECHNOLOGICAL CHANGE 76 (1969) (discussing the tradeoff between incentives for innovation and harm to competition associated with the exclusive rights conferred by patents).
4. Indeed, the question of whether or not an invention "works" is addressed in patent law through the utility requirement enshrined in 35 U.S.C. § 101, which denies protection to inoperable inventions.
5. In contrast with copyright, in which the term of protection is tied to the life of the author, patent rights largely function independently of the inventor.
6. Though, it is complicated, as described *infra* Part I.B.
7. It is not the first attempt to do so; Part I summarizes important previous work.

literature, of the ways that promoting diverse innovators advances progress according to four mechanisms:

Novelty: The novel insights and motivations of diverse innovators extend the direction and reach of innovation. That is because an innovator's identity influences what the innovator is likely to focus on, leading to the development of inventions and products that cater to consumers similar to the innovator.[8] When innovators are exposed to socioeconomic diversity, they also appear to shift their innovative focus towards innovation in essential goods, like food.[9] Diversifying the pool of innovators expands the knowledge base, diversifies the types of innovations developed, and broadens the reach of this innovation.[10]

Nonobviousness: Diverse perspectives support nonobvious connections and combinations that lead to greater innovation.[11] Disciplinary and ethnic diversity on product and innovation teams has been linked to greater radical innovation and gender diversity, with improved innovation outcomes.[12] Research has also shown how intersections of cultures, disciplines, and geographies have led to breakthrough ideas that combine insights from multiple perspectives, and how diverse scholars are more likely to introduce new conceptual linkages and connections missed by others.[13]

(Overcoming) Conflict: Conflict can also be the source of innovation. Challenges to conventional wisdom and moving beyond disagreements can lead to insights marked by greater complexity and synthesis.[14] "Red teams"—internal groups assigned the role of emulating a potential adversary or attacker—enable objective criticism, the discovery of weaknesses and vulnerabilities, and improvement through iteration.[15]

8. *See, e.g.*, Rembrand Koning, Sampsa Samila & John-Paul Ferguson, *Inventor Gender and the Direction of Invention*, 110 AEA PAPERS & PROC. 250 (2020) (discussing the innovator identity phenomenon).
9. *See* Elias Einio, Josh Feng & Xavier Jaravel, *Social Push and the Direction of Innovation* 2–4 (Ctr. for Econ. Performance, Discussion Paper No. 1861, 2022), https://cep.lse.ac.uk/pubs/download/dp1861.pdf [https://perma.cc/WPS9-32FG].
10. Diversifying the innovator pool can also make it less likely that populations will be dangerously overlooked in the development of innovative products. *See* CAROLINE CRIADO PEREZ, INVISIBLE WOMEN: DATA BIAS IN A WORLD DESIGNED FOR MEN (2019).
11. As described in Part I.A.2.
12. Though not always. *See* Part I.A.2. for a review of relevant studies.
13. *See* Bas Hofstra, Vivek V. Kulkarni, Sebastian Munoz-Najar Galvez, Bryan He, Dan Jurafsky & Daniel A. McFarland, *The Diversity-Innovation Paradox in Science*, 117 PROC. NAT'L ACAD. SCIS. (PNAS) 9284, 9284 (2020).
14. *See infra* Part I.A.3.
15. MICAH ZENKO, RED TEAM: HOW TO SUCCEED BY THINKING LIKE THE ENEMY, at xi–xii (2015); *see also* discussion *infra* Part I.A.3.

Numerosity: broadened participation in innovation means reducing the risk of missing out on the star innovators that make outsized contributions to innovation, economic growth, and the course of history. Removing barriers to participation leads to the more efficient allocation of talent.[16]

Despite these benefits, participation in invention and entrepreneurship is markedly *non*diverse: men receive 87 percent of U.S. patents and 98 percent of VC funding.[17] Children from high-income (top 1 percent) families are ten times as likely to become inventors as those from below-median income families, even when controlling for aptitude.[18] Over 50 percent of new U.S. patents went to the top 1 percent of patentees, and more than 50 percent of all patents of U.S. origin were generated by just five states, all coastal.[19] In light of these disparities, it is worth critically examining the ways in which the patent system can be reoriented and reformed to ensure that diversity's contributions to innovation are captured and the significant gaps in participation in innovation and invention are narrowed.

This Article advocates for an expanded interpretation of the constitutional concept of "progress"[20] in patent law to encompass not only the advancement of innovation, but also the advancement of a diversity of innovators and inventors. Such an expansion is justified in light of the ways that diversity improves innovation, as well as the patent system's historical, but largely overlooked commitment to fostering a broad range of innovators. A more capacious understanding of progress brings into focus problems on the demand side, where

16. *See* discussion *infra* Part I.A.4.

17. U.S. PAT. & TRADEMARK OFF., PROGRESS AND POTENTIAL: 2020 UPDATE ON U.S. WOMEN INVENTOR-PATENTEES 3 (2020) [hereinafter USPTO], https://www.uspto.gov/sites/default/files/documents/OCE-DH-Progress-Potential-2020.pdf [https://perma.cc/UZ7Z-9YHZ] (reporting that approximately 12.8 percent of US inventors are women, which, assuming binary gender, translates into an approximately 87 percent male inventor rate); Kim Elsesser, *Female Entrepreneurs Funded by Female VCs Face Difficulties Obtaining Future Funds*, FORBES (June 6, 2022, 5:38 PM), https://www.forbes.com/sites/kimelsesser/2022/06/06/female-entrepreneurs-funded-by-female-vcs-face-difficulties-obtaining-future-funds/?sh=36a465cf6a7c [https://perma.cc/8U3F-BMDT]; Anthony Martinez & Cheridan Christnacht, *Women Making Gains in STEM Occupations but Still Underrepresented*, U.S. CENSUS BUREAU (Jan. 26, 2021), https://www.census.gov/library/stories/2021/01/women-making-gains-in-stem-occupations-but-still-underrepresented.html [https://perma.cc/D4L9-6Q58] (reporting that women represent 27 percent of STEM workers).

18. Alex Bell, Raj Chetty, Xavier Jaravel, Neviana Petkova & John Van Reenen, *Who Becomes an Inventor in America? The Importance of Exposure to Innovation*, 134 Q.J. ECON. 647, 649 (2019).

19. Colleen V. Chien, *The Inequalities of Innovation*, 72 EMORY L.J. 1, 8 (2022).

20. U.S. CONST. art. I, § 8, cl. 8.

the law of inventorship is limiting who can be credited on a patent. Progress, redefined, also highlights challenges on the supply side, where the law and mechanics of inventing—combined with issues relating to inventor identity, perfectionism, and social networks—hinder broader participation. Without acknowledging and addressing these legal, administrative, and systemic obstacles to progress, equal opportunity in invention and its attendant benefits are likely to remain elusive.

Part I considers evidence of diversity's impact on innovation and inventorship. In the absence of conclusive causal studies, it details four plausible mechanisms by which diverse innovators improve innovation: through novel perspectives and motivation, nonobvious combinations, (overcoming) conflict, and numerosity. A sense of progress that includes promotion of a diversity of innovators, and not just invention, is also supported by the doctrine and design of the patent system. This system has long paid attention not only to the products of innovation, but also who is innovating and in what settings.

Part II explores challenges to progress in the diversification of inventorship. Using the case study of gender, it defines and presents fresh empirical evidence of the "innovator-inventor gap" in the workplace, where women often patent at less than half the rate of their male counterparts.[21] It also shows how the laws and mechanics of inventorship have not only prevented many who have contributed to innovation from receiving credit on patents, but also widened the patent grant gap—the lower rate at which patents are awarded to female and minority patent applicants.

Part III proposes several steps for making progress in the promotion of a diversity of innovators. First, it calls for reconsidering inventorship law and policy to broaden who receives credit for their inventive contributions. Second, it outlines steps the U.S. Patent and Trademark Office (USPTO) should take to promote a diversity of innovators, not just innovation. Third, it proposes the rigorous testing and scaling of policy and practice interventions to overcome the challenges to participation described. Such interventions could take the form of "opt-out" idea submission framing, which communicates the expectation that all, not just those that opt into participating, have good ideas, to overcome gaps in awareness and confidence,[22] and reframing Patent Office rejections to reduce

21. *See* discussion *infra* Part II.
22. *See* Colleen V. Chien & Jillian Grennan, *Closing the Innovator-Inventor Gap: Evidence From Proactive (Opt-Out) Outreach*, AEA RCT REGISTRY (May 13, 2024, 11:58 AM), https://www.socialscienceregistry.org/trials/12897 (last visited June 19, 2024) (describing a randomized control to test such a proactive outreach, or "opt-out" intervention).

the patent grant gap. Fourth, it discusses a periodic innovator-inventor survey for informing the design of policies and practices for making progress.

I. THE CASE FOR REDEFINING PATENT PROGRESS

If the goal of the patent system, as defined by the Constitution, is the "Progress of Science and useful Arts,"[23] why should the identity of who is making this progress matter? While diversity in innovation has both utilitarian and deontological rationales that are relevant when considering progress,[24] carefully examining the empirical evidence for diverse innovation is important for several reasons. First, the perception of science and engineering as neutral, objective, and technical rather than personal has bred skepticism that innovator diversity really matters.[25] The reported failure of corporate diversity initiatives to have their intended impact[26] also serves as a reminder that achieving diversity is hard and thus it is important to examine, and not just assume, its benefits. Overstating the empirical case is dangerous—the difficulty of showing a consistent, causal link between upper management diversity and improved outcomes has felled board diversity mandates in California.[27] But a failure to articulate the specific benefits of diversity is also fraught. For example, one of the most significant points of contention between the majority and dissenting opinions in the U.S. Supreme Court case *Students for Fair Admissions, Inc. v. President & Fellows of Harvard College*[28] centers on the robustness of the link between race-conscious admission policies and the educational benefits associated with a more diverse student body.[29]

23. U.S. CONST. art. I, § 8, cl. 8.
24. *See infra* Part I.B.
25. *See, e.g.*, Leanne Son Hing, *The Myth of Meritocracy in Scientific Institutions*, 377 SCIENCE 824, 824 (2022).
26. *See* Frank Dobbin & Alexandra Kalev, *Why Diversity Programs Fail*, HARV. BUS. REV., July–Aug. 2016, at 52 (concluding, based on an analysis of data from 800 firms over three decades, that diversity measures like training, hiring tests, performance ratings, and grievance systems actually decrease the proportion of women and minorities in management); Crest v. Padilla, No. 19STCV27561, slip op. at 6–7 (Cal. Super. Ct. May 13, 2022) (citing studies that find scant proof that board diversity mandates have resulted in benefits beyond diverse boards).
27. *See Crest*, slip op. at 6 (striking down a California law, requiring corporate boards to include women, as inconsistent with the state constitution's Equal Protection Clause because the relevant studies "failed to sufficiently show a causal connection between women on corporate boards and corporate governance [outcomes]").
28. 600 U.S. 181 (2023).
29. *Compare id.* at 214–16 (describing the lack of "meaningful connection" between the educational goals of affirmative action and the admission programs' reliance on racially "overbroad" categories to accomplish them, as well as the lack of metrics to gauge whether the

To make the case for redefining progress, this Part begins by reviewing studies that consider the link between innovator diversity[30] and innovation outcomes, identifying four plausible mechanisms by which the presence of diverse innovators enhances innovation. Diversity does not *always* produce these positive outcomes—the available studies[31] are largely correlational, not causal.[32] In addition, care must be taken not to overgeneralize, not only because of the varying forms of diversity and outcomes studied, but also because our

educational benefits stemming from diversity have indeed been realized), *with id.* at 341, 371 (Sotomayor, J., dissenting) (stressing the "well-documented benefits of racial integration in education" and the value of diverse, multidimensional viewpoints to all students—including students that are not underrepresented—as well as the "instrumental" link between increasing minority enrollment and achieving educational benefits, and citing testimonial evidence of same).

30. Sources of diversity include traits that are observable (gender, race, class, or age), unobservable (derived from personality, experience, or values), or functional (based on knowledge, former training, or organizational standing). Diversity can further be assessed at the individual, team, or organizational level. *See, e.g.*, Fidan Ana Kurtulus, *What Types of Diversity Benefit Workers? Empirical Evidence on the Effects of Co-worker Dissimilarity on the Performance of Employees*, 50 INDUS. RELS. 678, 683 (2011); John Qin, Nuttawuth Muenjohn & Prem Chhetri, *A Review of Diversity Conceptualizations: Variety, Trends, and a Framework*, 13 HUM. RES. DEV. REV. 133, 139 (2014); Yves R.F. Guillaume, Jeremy F. Dawson, Lilian Otaye-Ebede, Stephen A. Woods & Michael A. West, *Harnessing Demographic Differences in Organizations: What Moderates the Effects of Workplace Diversity?*, 38 J. ORG. BEHAV. 276, 278 (2017); Cedric Herring, *Does Diversity Pay?: Race, Gender, and the Business Case for Diversity*, 74 AM. SOCIO. REV. 208, 209–10 (2009). The National Science Foundation (NSF) is committed to expanding opportunities in STEM among people of "all racial, ethnic, geographic and socioeconomic backgrounds, sexual orientations, gender identities and to persons with disabilities." *Broadening Participation in STEM*, NAT'L SCI. FOUND., https://beta.nsf.gov/funding/initiatives/broadening-participation [https://perma.cc/46WG-T589].

31. For two correlational survey articles, *see* Adam D. Galinsky et al., *Maximizing the Gains and Minimizing the Pains of Diversity: A Policy Perspective*, 10 PERSPS. ON PSYCH. SCI. 742 (2015), for a description of positive associations between diverse personal experiences and creativity outcomes, and Mathias Wullum Nielsen et al., *Gender Diversity Leads to Better Science*, 114 PNAS 1740, 1740 (2017), for a description of correlational and experimental evidence of the positive impacts of gender diversity on science. But in many cases, the evidence is mixed, as in the realm of patenting. *Compare* G. Steven McMillan, *Gender Differences in Patenting Activity: An Examination of the US Biotechnology Industry*, 80 SCIENTOMETRICS 683, 690 (2009) (concluding that "while women may patent much less than men, the quality of their patents is higher"), *with* Cassidy R. Sugimoto, Chaoqun Ni, Jevin D. West & Vincent Larivière, *The Academic Advantage: Gender Disparities in Patenting*, 10 PUB. LIBR. OF SCIS (PLoS) ONE, no. 5, May 27, 2015, at 1, 1 (concluding that women's patents have a lower technological impact than that of men).

32. Causal studies also have their limitations, including internal validity (whether the study was conducted free of bias) and external validity (whether the results generalize). *See* JOSHUA D. ANGRIST & JÖRN-STEFFEN PISCHKE, MASTERING 'METRICS: THE PATH FROM CAUSE TO EFFECT 114–15 (2015).

understanding of diversity's impact on innovation is evolving.[33] Nevertheless, the balance of available evidence strongly suggests multiple ways in which diversity contributes positively to innovation. Following this analysis, the discussion then shifts to other utilitarian and deontological rationales for diversity in innovation. The Article then turns to the legal case for redefining progress in the patent system to promote a diversity of innovators and inventors, not just innovation and invention.

Before doing so, it is important to address the threshold question: if diversity in innovation is beneficial, won't the market adequately supply it? There are a few answers. On the demand side, the failure of the market to produce certain types of innovations is well documented;[34] indeed, the intellectual property system itself is a policy response to the public goods nature of knowledge creation and its appropriability by rivals.[35] On the supply side, factors like discrimination have discouraged participation in ways that are hard to compensate for.[36] Employment decisions are also often dictated by nonmarket factors. For example, women disproportionately shoulder childbearing and care burdens,[37] which impacts their

33. Note, for example, the number of studies cited in Part I.A describing the mechanisms by which diversity improves innovation that are, at the time of this publication, published recently or are under development.

34. For instance, innovation often leads to positive externalities such as spillovers that others can learn from, or public health benefits which cannot be fully appropriated by the innovators. In a purely market-driven system, these externalities typically result in less innovation than would be socially beneficial. *See, e.g.*, Nicholas Bloom, Mark Schankerman & John Van Reenen,. *Identifying Technology Spillovers and Product Market Rivalry*, 81 ECONOMETRICA 1347, 1347 (2013) (estimating the gross social returns to R&D to be "at least twice as high" as the private returns). Further, conditions that exclusively afflict poor populations like tropical diseases tend to be neglected, in the same way that diseases with long commercialization lags that exceed the fixed term of patents are also disfavored by investors. *See* Chien, *supra* note 19, at 15–16; Claire Brunel, *Do Fixed Patent Terms Distort Innovation?*, NAT'L BUREAU OF ECON. RSCH. (Feb. 1, 2014), https://www.nber.org/digest/feb14/do-fixed-patent-terms-distort-innovation [https://perma.cc/M4M3-6H9Z] (summarizing Eric Budish, Benjamin N. Roin & Heidi Williams, *Do Firms Underinvest in Long-Term Research? Evidence From Cancer Clinical Trials* (Nat'l Bureau of Econ. Rsch. (NBER), Working Paper No. 19430, 2013), http://www.nber.org/papers/w19430 [https://perma.cc/KBU6-BMV8]).

35. Budish et al., *supra* note 34 (describing the goal of intellectual property law as overcoming market failures associated with the public goods nature of creative works).

36. ALLISON SCOTT, FREADA KAPOR KLEIN & URIRIDIAKOGHENE ONOVAKPURI, KAPOR CTR. FOR SOC. IMPACT, TECH LEAVERS STUDY 1, 12–14 (2017), https://www.kaporcenter.org/wp-content/uploads/2017/08/TechLeavers2017.pdf [https://perma.cc/2JS7-FHVA] (documenting the primary reason cited by Black, Latinx, and female tech workers for leaving tech jobs as "unfair treatment," including stereotyping, bullying, public humiliation, and embarrassment).

37. *See, e.g.*, CAROLINE SIMARD, ANITA BORG INST. FOR WOMEN & TECH., OBSTACLES AND SOLUTIONS FOR UNDERREPRESENTED MINORITIES IN TECHNOLOGY 10–14 (2009) [hereinafter

ability to take certain jobs. Moreover, it appears female entrepreneurs value autonomy and fulfillment to a greater degree than do their male counterparts.[38] Even if raw talent is equally distributed, the instruments of technical human capital formation—including access to trained STEM educators, parental effort, and role models—are not.[39] The "misallocation of talent" literature recognizes the impact of all of these factors on occupational outcomes.[40] Just as the share of doctors and lawyers that were white men declined from 94 percent in 1960 to 62 percent in 2010 due to greater civil rights and the removal of obstacles to human capital accumulation and labor market discrimination,[41] there is no reason to believe that the current composition of innovators reflects the optimal allocation of talent.

A. How Diversity Can Improve Innovation: Four Plausible Mechanisms

While the value of diversity is widely acknowledged across numerous domains, this Subpart specifically explores its contributions to the innovative process. Not every type of diversity, however, is equally relevant for each mechanism of innovation. For example, differences in physical conditions or environments—shaped by, say, one's gender, disability status, or geography—might be more important than diverse political viewpoints for the goal of fostering innovation through the introduction of novel ideas. Diversity in skills, culture, race, and gender have proven to be crucial to the discovery of nonobvious

OBSTACLES AND SOLUTIONS], https://www.exponentialtalent.com/uploads/1/6/8/4/16841408/abi-obstacles-solutions-for-underrepresented-in-tech.pdf [https://perma.cc/Z6GA-W92J]; *see also* CAROLINE SIMARD, ANDREA DAVIES HENDERSON, SHANNON K. GILMARTIN, LONDA SCHIEBINGER & TELLE WHITNEY, ANITA BORG INST. FOR WOMEN & TECH., CLIMBING THE TECHNICAL LADDER: OBSTACLES AND SOLUTIONS FOR MID-LEVEL WOMEN IN TECHNOLOGY 29–30 (2008) [hereinafter CLIMBING THE TECHNICAL LADDER], https://anitab.org/wp-content/uploads/2020/08/Climbing_the_Technical_Ladder.pdf [https://perma.cc/DJ3D-F7VN] (finding, among survey respondents, technical women to be twice as likely as technical men to have a partner that worked full-time, and only a quarter as likely to have a partner with primary children and household responsibilities.)

38. *See* MINN. LEGIS. OFF. ON THE ECON. STATUS OF WOMEN, WHY ARE WOMEN-OWNED BUSINESSES OVERALL SMALLER THAN MEN-OWNED BUSINESSES? (2016), https://www.lrl.mn.gov/docs/2016/other/160709.pdf [https://perma.cc/E7V9-MZYP].

39. *See* Chang-Tai Hsieh, Erik Hurst, Charles I. Jones & Peter J. Klenow, *The Allocation of Talent and U.S. Economic Growth*, 87 ECONOMETRICA 1439 (2019).

40. *See id.* at 1440. For a review of this literature, *see* Murat Alp Celik, *Does the Cream Always Rise to the Top? The Misallocation of Talent in Innovation*, 133 J. MONETARY ECON. 105 (2023).

41. Hsieh et al., *supra* note 39, at 1439–40.

combinations.[42] Dissenting but ultimately reconciled viewpoints can come from any number of types of differences within a team. When it comes to the fourth diversity mechanism, numerosity, the broader participation of talented individuals in innovation can accelerate its pace and improve its reach.

1. Through Novel and Different Knowledge, Experiences, and Motivations

Ideas can only be patented if they are new. Patent law's novelty standard, encoded in 35 U.S.C. § 102, requires consideration of the timing, nature, and subject matter of earlier relevant disclosures and disclosers.[43] Novel ideas, in turn, spring from novel experiences, viewpoints, and skills, which breed new problems, approaches, and solutions. "Problem finding," an essential step in the process of problem solving,[44] requires a deep understanding of the circumstances, settings, and dynamics of a situation. Just as necessity breeds invention, novel experiences lead to novel understandings of problems—but also, and perhaps just as importantly, the motivation to solve these problems.

A number of innovations have been the result of people solving their own particular problems,[45] and by doing so, solving them for others, too.[46] One such person was a visually impaired boy who found reading books with raised letters tedious and difficult. At fifteen, Louis Braille came up with an alternative system of raised dots and lines, which eventually became the official writing system for

42. On the other hand, certain forms of viewpoint diversity—for example, based on religion—may not translate as readily into insights about how technology can be combined or repurposed to achieve new benefits.

43. 35 U.S.C. § 102.

44. *See* Mark A. Runco & Jill Nemiro, *Problem Finding, Creativity, and Giftedness*, 16 ROEPER REV. 235, 237 (1994).

45. Or, as Eric von Hippel has called it, "user innovation," as described in Martha E. Mangelsdorf, *The User Innovation Revolution*, MIT SLOAN MGMT. REV. (Sept. 21, 2011), https://sloanreview.mit.edu/article/the-user-innovation-revolution [https://perma.cc/99TR-KLYE] (interviewing Eric von Hippel).

46. For example, the ironing board was conceived in the late 1880s when Sarah Boone, a dressmaker and free woman born to parents who were enslaved, designed and patented a narrow, curved board that could be used for pressing and rotating her dresses without leaving wrinkle marks and could be collapsed easily for storage. *Sarah Boone*, BIOGRAPHY.COM (Jan. 23, 2024), https://www.biography.com/inventor/sarah-boone [https://perma.cc/MX4C-M7ZJ]. *See also* ANNE L. MACDONALD, FEMININE INGENUITY: WOMEN AND INVENTION IN AMERICA 37 (1992) (describing the contributions of women to fields that they dominated, such as nursing, household mechanics, and "field[s] [where] they had the greatest experience").

people who are blind.[47] Disability has been credited with motivating several of the world's leading innovations.[48]

Moving beyond anecdote, several studies have demonstrated the importance of who participates in innovation to its direction and who benefits. For example, although less than 13 percent of inventors on U.S. patents on average are women,[49] the female share of bioscience inventors is much higher.[50] While men can and do research and develop innovations for women's health conditions, diseases and conditions that predominantly impact women have long been neglected.[51] Based on a text analysis of all U.S. biomedical patents filed from 1976 through 2010, Rembrand Koning and his co-authors discovered that patents with all-female

47. *Louis Braille (1809–1852)*, LIBR. OF CONG.: NAT'L LIBR. SERV. FOR THE BLIND & PRINT DISABLED, https://www.loc.gov/nls/new-materials/book-lists/louis-braille-1809-1852 [https://perma.cc/JDY9-22Q5].

48. For example, Vinton Cerf, who has been called a "father of the internet," has credited having a hearing impairment with making the idea of email "hugely attractive . . . because it replaced uncertain voice calls with the clarity of text." *Vint Cerf on Accessibility, the Cello and Noisy Hearing Aids*, GOOGLERS (Oct. 4, 2018), https://www.blog.google/inside-google/googlers/vint-cerf-accessibility-cello-and-noisy-hearing-aids [https://perma.cc/VCK3-W7NJ]. Legend has it that the first working model of a typewriter, created by Italian inventor Pellegrino Turri, was motivated by the needs of a lover, whose onset of blindness made writing by hand difficult. *See* Carol Johnk, *Do You Remember the Typewriter? New Exhibit Explores the History!*, UNIV. OF IOWA LIBR. (July 16, 2015), https://blog.lib.uiowa.edu/eng/new-exhibit-on-the-history-of-the-typewriter [https://perma.cc/A6E9-SMMB]. Alexander Graham Bell's invention of the telephone was informed by, and credited by some to, his lifelong experience as a child, teacher, and husband of deaf persons. *Alexander Bell: The Telephone*, LEMELSON-MIT, https://lemelson.mit.edu/resources/alexander-bell [https://perma.cc/QR6C-FSN3]. The inventor of the telegraph, Samuel Morse, was married to a deaf woman, Sarah Griswold, who helped him develop what would later come to be known as Morse code. Joan Naturale, *HIST 330 Deafness and Technology: Overview*, RIT LIBRARIES (Aug. 18, 2023, 5:06 PM), https://infoguides.rit.edu/deaftech [https://perma.cc/MZ2Z-7WMD]. Thomas Edison has credited his deafness with allowing him to work "with total concentration," and also helping him "hear" the phonograph, one of his numerous inventions. Howard Markel, *The Medical Mystery That Helped Make Thomas Edison an Inventor*, PBS NEWSHOUR (Oct. 22, 2018, 3:58 PM), https://www.pbs.org/newshour/health/the-medical-mystery-that-helped-make-thomas-edison-an-inventor [https://perma.cc/M2X4-7QTA] ("My deafness has not been a handicap but a help to me.").

49. USPTO, *supra* note 17, at 3.

50. *Id.* at 7.

51. Rembrand Koning, Sampsa Samila & John-Paul Ferguson, *Who Do We Invent for? Patents by Women Focus More on Women's Health, but Few Women Get to Invent*, 372 SCIENCE 1345, 1348 (2021); *see also* Kristen Senz, *Lack of Female Scientists Means Fewer Medical Treatments for Women*, HARV. BUS. SCH.: WORKING KNOWLEDGE (Feb. 22, 2022), https://hbswk.hbs.edu/item/lack-of-female-scientists-means-fewer-medical-treatments-for-women [https://perma.cc/R6XM-DN7N].

inventor teams were more likely to focus on women's health than those with all-male teams.[52] These teams not only focused on conditions unique to women, but also the differential side effects of treatments on women, both positive and negative.[53] Even in corporate environments, where market factors typically prevail, the presence of women researchers on teams was associated with greater responsiveness to the concerns and needs of women.[54] Similarly, a recent study led by Diego Kozlowski found strong relationships between the characteristics of scientists and their research topics, suggesting that increases in diversity led to "expansion of the knowledge base."[55] Intersectional identity—such as the combination of a person's race and gender[56]—has also been found to correlate with invention focus;[57] consistent with other studies showing that gender, education, and minority status also influence the subject matters of invention.[58]

The Kozlowski study adds another data point to the question discussed above: if demand for a product exists, won't the market supply it? As its results show: not necessarily, as bias in the labor market has the potential to spill over into

52. Koning et al., *supra* note 51, at 1345.
53. *Id.* at 1346.
54. *Id.* at 1345.
55. Diego Kozlowksi, Vincent Larivière, Cassidy R. Sugimoto & Thema Monroe-White, *Intersectional Inequalities in Science*, 119 PNAS 1, 1 (2022). The study found evidence that Black and African American authors had a greater likelihood of studying racial disparities, while in the social sciences, Asian authors were most likely to be focused on economics and logistics. Latinx authors tended to write on topics associated with Latinx identity, literacy, and the learning of second languages. The study also reported, however, that the topics pursued by minoritized individuals were often underfunded and undercited, leading to a form of double marginalization. *Accord* Stephan Risi et al., *Diversifying History: A Large-Scale Analysis of Changes in Researcher Demographics and Scholarly Agendas*, 17 PLOS ONE, no. 1, Jan. 19, 2022, at 1, 1 (finding, in the field of history, that the addition of women to the field coincided with the broadening of research agendas and methodologies in the field).
56. Intersectionality also considers how dimensions other than race and gender interact to inform a person's lived experience, such as class, sexuality, education, and nationality. *See generally* Kimberlé Crenshaw, *Mapping the Margins: Intersectionality, Identity Politics, and Violence Against Women of Color*, 43 STAN. L. REV. 1241 (1991).
57. April Burrage, Janell Ciemiecki, Stephanie Couch & Ina Ganguli, *Inclusive Pathways to Invention: Racial and Ethnic Diversity Among Collegiate Student Inventors in a National Prize Competition*, 22 TECH. & INNOVATION 341, 342 (2022) (finding, based on 2000 student inventor-applicants to a national prize, "striking differences" in the focus of invention, such as men of color showing a focus on consumer-oriented inventions). For further studies of innovation at the intersection of gender and race, *see* Hofstra et al., *supra* note 13, and Kozlowski et al., *supra* note 55.
58. Vincenzo Corvello, Jaroslav Belas, Carlo Giglio, Gianpaolo Iazzolino & Ciro Troise, *The Impact of Business Owners' Individual Characteristics on Patenting in the Context of Digital Innovation*, 155 J. BUS. RSCH., Jan. 2023, at 1, 7–8 (concluding, after analyzing over five hundred patent-holding firms, that the identities of firm owners influenced the firm's digital innovation).

product-market bias. The relative absence of certain groups from innovation increases the risk that the unique needs of these groups remain unmet.[59] Caroline Criado Perez's book *Invisible Women* makes the related point that ignoring the female experience in the design of products has translated into worse products and outcomes, such as car designs that are 47 percent less safe, on average, for half of the population.[60] Product designs that take into account a wider variety of use cases and users could lead to not only safer products, but also a greater range of products on the market.

Two other studies provide further support for the idea that the direction of innovation depends on who is innovating. Francesca Truffa and Ashley Wong have quasi-experimentally studied the impact of universities transitioning from all-male to coed student bodies during the 1960s to the 1990s.[61] After universities welcomed women, they experienced a 44 percent increase in gender-related publications,[62] due to the greater diversification of researchers as well as a shift in existing research toward gender-related topics.[63] Moreover, a new working study by Elias Einio and his co-authors on the creators of mobile and desktop applications (or "apps") provides additional evidence of the influence of innovator identity, socialization, and geography on the direction of innovation.[64] Across sectors, rich, female, and older innovators were more likely to innovate for consumers like themselves.[65] Apps also drew users from the home states of their creators.[66] The authors found that even a person's social

59. For example, uterine fibroids, which disproportionately impact Black women, have long been overlooked by research. *See* Amanda D'Ambrosio, *Kamala Harris Introduces Bill on Uterine Fibroids*, MEDPAGE TODAY (Aug. 20, 2020), https://www.medpagetoday.com/obgyn/fibroids/88190 [https://perma.cc/E9ME-9FV4].

60. CRIADO PEREZ, *supra* note 10, at 190–91. Other examples of product market bias include "[p]ersonal protective clothing (PPC) and personal protective equipment (PPE) such as boots, gloves, pants, helmets, and other workwear items essential for physical work [which] are deemed unisex, but are designed with men in mind and do not account for female measurements." Vanessa M. Patrick & Candice R. Hollenbeck, *Designing for All: Consumer Response to Inclusive Design*, 31 J. CONSUMER PSYCH. 360, 360 (2021). Taking into account the distinct needs of consumers supports product differentiation, customization, and personalization.

61. *See* Francesca Truffa & Ashley Wong, Undergraduate Gender Diversity and the Direction of Scientific Research 1 (Dec. 20, 2023) (unpublished working paper), https://www.dropbox.com/s/qpz64fh8cs6dyg3/coed_draft.pdf?dl=0 [https://perma.cc/S8QT-YR52].

62. *Id.* at 3.

63. *Id.* at 3–4.

64. The authors measure social backgrounds in terms of one's schooling, parental income, and other observable demographic and social factors. Einio et al., *supra* note 9, at 13.

65. *Id.* at 8–10 (finding women to also be more likely to contribute to clean energy technologies and other innovation areas with environmental externalities).

66. *Id.* at 9 (reporting an 8.6 percent higher usage level by users in an app's home state).

experience made a difference: exposure to peers from lower-income groups increased an entrepreneur's propensity to create "necessity products" that served lower-income groups.[67] This pattern is mirrored in the work of Dr. Patricia Bath, who made pioneering breakthroughs in ophthalmology and cataracts treatment. Her innovations were spurred not by her personal conditions, but by her observations of the disparate impact of eye disease on her Black and female patients.[68] Across settings, who innovates, and their lived experiences, have implications for who benefits from innovation.

These findings make sense from a comparative advantage perspective. When diverse individuals research and innovate, they are more likely to bring personal knowledge of certain conditions and the motivations to study them. Novel perspectives also contribute to novel solutions. These examples show how innovation springs from what innovators uniquely experience, know, and need.

2. Through Non-Obvious Combinations

To be patentable, an invention need not only be novel, but also "nonobvious." over the prior art—that is, existing public information relevant to the invention. 35 U.S.C. § 103, which codifies the nonobviousness requirement, requires a factfinder to take several steps to determine whether the invention would have been obvious to a skilled artisan.[69] But consideration of "secondary factors [can] dislodge the determination that [a] claim . . . is obvious."[70] These factors include "commercial success, long felt but unsolved needs, failure of others, etc."[71] Although inventors are not required to combine prior art to devise

67. *Id.* at 2.

68. *See Biography: Dr. Patricia E. Bath*, CHANGING THE FACE OF MEDICINE (June 3, 2015), https://cfmedicine.nlm.nih.gov/physicians/biography_26.html [https://perma.cc/FF9S-U5U7] (describing Bath's development of the discipline of "community ophthalmology" based on her documentation of stark racial disparities in blindness between Black patients in Harlem and white patients at Columbia University, locations at which she interned); Fiona Murray, *Mothers of Invention*, 372 SCIENCE 1260, 1260–62 (2021) (describing Bath's commitment to advances in cataracts treatment due to the differences she observed between male and female patient populations and the higher incidence of cataract-blindness among women relative to men).

69. The steps include: to ascertain existing relevant innovations (called the "prior art") from the perspective of a "person [of] ordinary skill in the art," to consider the differences between the claimed invention and the prior art, and to determine whether the claimed invention "would have been obvious . . . to a person having ordinary skill in the art to which the claimed invention pertains." 35 U.S.C. § 103.

70. KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 426 (2007).

71. *Id.* at 406.

something new,[72] patent law rewards combinations that are considered nonobvious. When innovations address needs that are long felt—for example, by overlooked segments of the population—patentability is favored.[73]

As described above, braille is a system of raised dots that can be "read" by the fingertips of visually impaired persons.[74] But it was not the first such scheme—braille was inspired by a parallel writing system developed for the military that also comprised points that could be read on the battlefield at night.[75] Louis Braille's contribution was to shift the use of the code from situations of low light to people of low vision, and to popularize the solution among the visually impaired community.

The law of nonobviousness encodes the fundamentals of the innovative process. Complementing the process of problem finding, problem solving has been described as "making a connection between or combining two elements that have not previously been connected or combined" to create new knowledge.[76] Further, in patent law, the less "analogous"[77] the sources of inspiration that are combined, or the more unpredictable[78] the combination, the more likely it is to be found patentably nonobvious. In the words of the court in *Johnson & Johnson v. W.L. Gore*, "the bringing together of knowledge held in widely diverse fields itself becomes invention."[79]

Why and how does identity lead to nonobvious connections? A study of American PhD dissertations across three decades concluded that scholars from

72. *See* 35 U.S.C. § 103 ("Patentability shall not be negated by the manner in which the invention was made.").
73. Graham v. John Deere Co., 383 U.S. 1, 17–18 (1966) (describing the relevance of an invention's long-felt need to determinations of obviousness).
74. Darren Body, *A Brief History of Braille*, KENT-TEACH.COM (Jan. 4, 2018), https://www.kent-teach.com/Blog/post/2018/01/04/a-brief-history-of-braille-world-braille-day.aspx [https://perma.cc/LCU3-PDYK].
75. Alicja Zelazko et al., *Braille*, BRITANNICA (Aug. 24, 2023), https://www.britannica.com/topic/Braille-writing-system [https://perma.cc/9GVX-FTZM].
76. Shahid Yusuf, *From Creativity to Innovation*, 31 TECH. SOC'Y 1, 6 (2009).
77. Prior art is analogous when the prior art and the invention are from the "same field of endeavor, regardless of the problem addressed," or when the reference is "reasonably pertinent to the particular problem." Donner Tech., LLC v. Pro Stage Gear, LLC, 979 F.3d 1353, 1359 (Fed. Cir. 2020) (quoting *In re* Bigio, 381 F.3d 1320, 1325 (Fed. Cir. 2004)).
78. KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 416 (2007) ("[A] combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.").
79. Johnson & Johnson v. W.L. Gore & Assocs., Inc., 436 F. Supp. 704, 723 (D. Del. 1977) (citing Ling-Temco-Vought, Inc. v. Kollsman Instrument Corp., 372 F.2d 263, 268 n.1 (2d Cir. 1967)). The court also found that the mere act of combining references from diverse fields does not "necessarily render the invention nonobvious." *Id.*

underrepresented groups were more likely to have concerns and experiences that allowed them to "draw relations between ideas and concepts that have been traditionally missed or ignored."[80] The researchers found that the more underrepresented a doctoral student was in her discipline, in terms of gender or race, the more likely she was to introduce new "conceptual linkages."[81]

Radical innovation, characterized by the adaptation of existing innovations to new contexts, also appears to benefit from teams that are disciplinarily and ethnically diverse.[82] For example, a recent study of 23 million scientific publications and 4 million patents found that teams with diverse expertise tended to produce work that was more original and higher impact over the long term (though not short or medium term), and that gender-diverse teams had "relatively higher impact on average."[83] Moreover, a study of Swedish firms identified a positive link between higher shares of ethnic and disciplinary diversity and the share of a firm's profit attributable to radical innovation.[84] The study authors attributed this outcome to the enhanced ability of the teams to acquire and assimilate "distant" knowledge—knowledge that spans technological or organizational boundaries.[85] A number of studies have found similar, if not always consistent, associations between gender diversity and improved scientific discovery and innovation.[86] For example, a large study in Spain found companies with more women to be more likely to introduce new products or processes over a

80. Hofstra et al., *supra* note 13, at 9284.
81. *Id.* at 9286.
82. For a review of case studies supporting that both related and unrelated knowledge capabilities encourage the emergence of radical innovation, see Peter N. Golder, Rachel Shacham & Debanjan Mitra, *Innovations' Origins: When, by Whom, and How Are Radical Innovations Developed?*, 28 MKTG. SCI. 166 (2009), providing an examination of 29 radical innovations from initial concept to mass-market commercialization.
83. Hongwei Zheng, Weihua Li & Dashun Wang, *Expertise Diversity of Teams Predicts Originality and Long-Term Impact in Science and Technology* 2 (Oct. 11, 2022) (unpublished working paper), https://arxiv.org/pdf/2210.04422 [https://perma.cc/8YVK-NVZ5].
84. *See* Ali Mohammadi, Anders Broström & Chiara Franzoni, *Workforce Composition and Innovation: How Diversity in Employees' Ethnic and Educational Backgrounds Facilitates Firm-Level Innovativeness*, 34 J. PROD. INNOVATION MGMT. 406, 407–08 (2017).
85. *Id.* at 422 (finding further that while the benefits of disciplinary diversity could be substituted to some extent by external relationships—for example, with contractors and partners—the benefits of ethnic diversity, such as differences in experiences and perspectives, could not be outsourced).
86. *See, e.g.*, Mathias Wullum Nielsen, Carter Walter Bloch & Londa Schiebinger, *Making Gender Diversity Work for Scientific Discovery and Innovation*, 2 NATURE HUM. BEHAV. 726 (2018) (finding, in five of six studies of for-profit settings, a possible link between team gender diversity and positive innovation outcomes but failing to consistently find the same pattern in academic settings).

two-year period, due to the creation of new knowledge by individuals with different socializations and career paths.[87]

Novel combinations can come not only from diverse demographic backgrounds or teams, but also diverse personal experiences, like living abroad and being bicultural—each of which has been associated with higher creativity.[88] Close intercultural relationships among MBA students have been found to promote creativity and workplace innovation.[89] Moreover, in laboratory and field experiments, Roy Chua has observed that intercultural relationships and networks appear to promote idea flow and creativity.[90]

3. By (Overcoming) Dissent and (Embracing) Unconventional Thinking

But just as familiarity may lead to complacency, diversity also can lead to conflict, misunderstanding, and skepticism.[91] An extensive psychological and social science literature has described the challenging dynamics that team diversity can set in motion, including incompatible assumptions, values, and preferences.[92] Experimental work on innovation further suggests that while diversity's informational benefits are particularly helpful at the ideation phase, difficulties can emerge in the implementation stage when teams must coalesce around and implement solutions.[93] Indeed, a number of studies have found that the relationship between diversity and innovation outcomes is not straightforward but instead follows an inverted U-shape, and that moderate levels of diversity are

87. Cristina Díaz-García, Angela González-Moreno & Francisco Jose Sáez-Martínez, *Gender Diversity Within R&D Teams: Its Impact on Radicalness of Innovation*, 15 INNOVATION: MGMT. POL'Y & PRAC. 149 (2013).

88. *See* Galinsky et al., *supra* note 31, at 743.

89. Jackson G. Lu, Paul W. Eastwick, William W. Maddux, Andrew C. Hafenbrack, Dan J. Wang & Adam D. Galinsky, "*Going Out" of the Box: Close Intercultural Friendships and Romantic Relationships Spark Creativity, Workplace Innovation, and Entrepreneurship*, 102 J. APPLIED PSYCH. 1091, 1092 (2017).

90. Roy Y.J. Chua, *Innovating at Cultural Crossroads: How Multicultural Social Networks Promote Idea Flow and Creativity*, 44 J. MGMT. 1119, 1119 (2018).

91. *See* Katherine W. Phillips, *How Diversity Makes Us Smarter*, 311 SCI. AM., Iss. 3, Oct. 1, 2014, at 42 (listing some of the downsides of diversity).

92. *See, e.g.*, Jie Wang, Grand H.-L. Cheng, Tingting Chen & Kwok Leung, *Team Creativity/Innovation in Culturally Diverse Teams: A Meta-Analysis*, 40 J. ORG. BEHAV. 693 (2019).

93. Sarah Harvey, *A Different Perspective: The Multiple Effects of Deep Level Diversity on Group Creativity*, 49 J. EXPERIMENTAL SOC. PSYCH. 822, 822 (2013) (concluding, based on a series of experiments, that diversity can inhibit the ability to coalesce around a creative idea); *accord* Tomas Chamorro-Premuzic, *Does Diversity Actually Increase Creativity?*, HARV. BUS. REV. (June 28, 2017), https://hbr.org/2017/06/does-diversity-actually-increase-creativity [https://perma.cc/B9TT-QFMR].

more beneficial than high levels of diversity for creativity.[94] Others have found the innovation benefits of diversity to be present only under certain conditions.[95] For example, one study found "age polarization" to be detrimental to innovation, while a wider variety of ages was found to produce a positive impact.[96]

And yet, it is the very presence of difference and conflict that *contributes* to rigorous thinking and originality as well as the avoidance of groupthink. Unconventional thinking that challenges the status quo is a hallmark of ingenuity. In the group innovation context, people with dissenting viewpoints and experiences are required to exchange more information because diversity "prompt[s] [us] to work harder," as the late Katherine Phillips has observed.[97] In experimental settings, mixed-race juries, for example, have been found to perform better than single-race ones because they rely more on facts and less on faulty assumptions.[98] In addition, the presence of racial and opinion minorities correlates with both greater novelty and "integrative complexity,"[99] not unlike the

94. *See, e.g.*, Mumin Dayan, Muammer Ozer & Hanan Almazrouei, *The Role of Functional and Demographic Diversity on New Product Creativity and the Moderating Impact of Project Uncertainty*, 61 INDUS. MKTG. MGMT. 144, 144 (2017) (finding an inverted U-shape to characterize the relationship between functional team diversity (generally measured by variation in job title or skills) and new product creativity, based on a study of 103 new product development teams)); Riccardo Sartori, Giuseppe Favretto & Andrea Ceschi, *The Relationships Between Innovation and Human and Psychological Capital in Organizations: A Review*, 18 INNOVATION J.: PUB. SECTOR INNOVATION J., 2013, at 1, 6 (reporting the relationship between organizational openness and innovative output to be characterized by a U-shaped curve).

95. *See*, *e.g.*, Chua, *supra* note 90, at 1119 (reporting that the extent to which culturally diverse social networks benefit the creative process depends on the type of creative task); Christian R. Østergaard, Bram Timmermans & Kari Kristinsson, *Does a Different View Create Something New? The Effect of Employee Diversity on Innovation*, 40 RSCH. POL'Y 500, 500 (2011) (documenting the positive effect of educational and gender diversity, but not ethnic diversity, on the likelihood to innovate, but a negative effect of age diversity).

96. *See* Caroline Mothe & Thuc Uyen Nguyen-Thi, *Does Age Diversity Boost Technological Innovation? Exploring the Moderating Role of HR Practices*, 39 EUR. MGMT. J. 829, 829 (2021).

97. Phillips, *supra* note 91 (listing, in addition, some of the downsides of diversity, such as "discomfort, rougher interactions, a lack of trust, . . . less cohesion, more concern about disrespect, and other problems").

98. *Id.* (citing Samuel R. Sommers, *On Racial Diversity and Group Decision Making: Identifying Multiple Effects of Racial Composition on Jury Deliberations*, 90 J. PERSONALITY & SOC. PSYCH. 597 (2006)); *see also* Katherine W. Phillips, Gregory B. Northcraft & Margaret A. Neale, *Surface-Level Diversity and Decision-Making in Groups: When Does Deep-Level Similarity Help?*, 9 GRP. PROCESSES & INTERGROUP REL. 467, 477 (2006) (finding that diverse groups were better than nondiverse groups at identifying hypothetical murder suspects from clues).

99. Integrative complexity is defined as "the degree to which cognitive style involves the differentiation and integration of multiple perspectives and dimensions." Anthony Lising Antonio, Mitchell J. Chang, Kenji Hakuta, David A. Kenny, Shana Levin & Jeffrey F. Milem,

discovery of "truth 'out of a multitude of tongues'" referred to by the Supreme Court in its discussions of diversity.[100] Moreover, the insight that overcoming dissent leads to better outcomes than if there had been no dissent at all has led to the formalization of "tiger teams"[101] at NASA in the 1960s and "red teams"[102] in innovative settings, that are tasked with finding flaws and vulnerabilities in products and systems.[103]

Along parallel lines, patent law has also recognized the benefit of intellectual conflict. Under the doctrine of "teaching away," which is a subtest of obviousness, an invention that "otherwise might be viewed as . . . obvious . . . will not be deemed obvious . . . when one or more prior art references 'teach away' from the invention."[104] That is to say, the law rewards the successful pursuit of a path that an inventor would normally be "discouraged from following."[105] Just as the consideration of diverse and dissenting views has been recognized to improve innovation, courts have found inventions pursued in spite of their difficulty, inefficiency, or disagreement with conventional wisdom more likely to be patentable.

For example, the Federal Circuit—the federal appellate court that hears patent appeals—has upheld the patentability of an invention that "a skilled artisan would have been dissuaded" from pursuing because, in the context of the invention, carrying out the contemplated combination "would introduce 'additional . . . complexity' and lead to 'decreased efficiency.'"[106] That the inventor

Effects of Racial Diversity on Complex Thinking in College Students, 15 PSYCH. SCI. 507, 508 (2004).

100. Keyishian v. Bd. of Regents, 385 U.S. 589, 603 (1967) (citing United States v. Associated Press, 52 F. Supp. 362, 372 (S.D.N.Y. 1943). This language was also cited by Justice Powell in his decision in the landmark affirmative action case *Regents of the Univ. of Cal. v. Bakke*, 438 U.S. 265, 312 (1978).

101. "Tiger teams" are typically drawn from across an organization and assembled in response to a problem, and can leverage diverse opinions and minority positions within the group to address the issue at hand. *See, e.g.*, Jordan Evans, *Taking the Tiger by the Tail: Leading Effective Tiger Teams and Working Groups on Flight Projects* (Inst. Elec'l. & Elec's Eng'rs Aerospace Conf., 2016) (unpublished conference paper), https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7500797 [https://perma.cc/JP6M-794D].

102. *See generally* ZENKO, *supra* note 15.

103. *See, e.g.*, Andrew Burt, *How to Red Team a Gen AI Model*, HARV. BUS REV. (Jan. 4, 2024), https://hbr.org/2024/01/how-to-red-team-a-gen-ai-model [https://perma.cc/BSA6-35TP]; *see also* TIMOTHY R. CLARK, THE 4 STAGES OF PSYCHOLOGICAL SAFETY (2020) (describing how innovation requires creative abrasion and constructive dissent—processes that rely on high *intellectual* friction and low *social* friction).

104. 2 DONALD S. CHISUM, CHISUM ON PATENTS § 5.03[3][a][i][G].

105. Monarch Knitting Mach. Corp. v. Morat, 139 F.3d 877, 885 (Fed. Cir. 1998).

106. Henny Penny Corp. v. Frymaster LLC, 938 F.3d 1324, 1332 (Fed. Cir. 2019).

persisted and arrived at the solution notwithstanding the weight of the status quo was deemed to provide evidence of the invention's nonobviousness.[107] Likewise, in favor of an invention's patentability, the Supreme Court has cited the pursuit of inventive routes that have "known disadvantages," or that require "a person reasonably skilled in the prior art [to] ignore" key portions of the prior art.[108] In patent law, as in innovation, overcoming skepticism and departing from the conventional wisdom to arrive at a solution is a feature, not a bug.

4. Through Deep Talent Pools

A final mechanism by which diverse innovators contribute to innovation is by deepening the talent pool. While in any specific context, "more" innovation does not necessarily translate into "better" innovation, the cumulative effects of greater participation in innovation are substantial, given the role of technological progress in driving economic growth[109] and improving the standard of living. The contributions of immigrant innovators to American innovation are illustrative. Petra Moser found that Jewish émigrés from Nazi Germany to the United States are responsible for a 31 percent increase in U.S. resident chemical innovations.[110] American immigrant innovators have collectively contributed to an estimated 23 percent of all inventions from 1990 through 2012, though they represent only 16 percent of the American inventor population.[111] Studying the *potential* contributions of female innovators to the economy, Jennifer Hunt and her co-authors found that closing the gender gap in engineering jobs and patents would increase U.S. GDP per capita by 2.7 percent.[112]

107. *Id.*
108. United States v. Adams, 383 U.S. 39, 52 (1966).
109. *See* Jennifer Hunt, Jean-Philippe Garant, Hannah Herman & David J. Munroe, *Why Are Women Underrepresented Amongst Patentees?*, 42 RSCH. POL'Y 831, 831 (2013) (finding that more than half of U.S. economic growth since the Second World War is attributable to technological progress).
110. Petra Moser, Alessandra Voena & Fabian Waldinger, *German Jewish Émigrés and US Invention*, 104 AM. ECON. REV. 3222, 3224 (2014). I thank Daniel Sokol for reminding me of this study.
111. Shai Bernstein, Rebecca Diamond, Abhisit Jiranaphawiboon, Timothy McQuade & Beatriz Pousada, *The Contribution of High-Skilled Immigrants to Innovation in the United States* 3 (NBER, Working Paper No. 30797, 2022), https://www.nber.org/system/files/working_papers/w30797/w30797.pdf [https://perma.cc/M7Y7-2SKQ].
112. Jennifer Hunt, Jean-Philippe Garant, Hannah Herman & David J. Munroe, *Why Don't Women Patent?* 2, 13 (NBER, Working Paper No. 17888, 2012), https://www.nber.org/system/files/working_papers/w17888/w17888.pdf [https://perma.cc/52CX-F9Q8]. Federal Reserve Governor Lisa D. Cook and Yanyan Yang have likewise reported that including more women and African Americans in the initial stages of the innovation process would grow the

Accordingly, the economic loss associated with *existing* participation gaps is also substantial. The risk to society of missing out on so-called lost Marie Curies or Patricia Baths[113] is particularly acute. That is because the distribution of technical talent is highly skewed, with "star" inventors having an outsized impact on their peers,[114] innovation, economic growth, and the trajectory of history. Studying inventor records and test scores, Raj Chetty and his co-authors have documented the extent of underrepresentation in innovation of talented women, minorities, and individuals from low-income families. If these groups were to invent at the same level as white men from well-off families, they find, there would be four times as many inventors.[115] They further find that underrepresentation extends across "star inventors," implying that "there are [likely] many 'lost Einsteins'—individuals who would have had highly impactful inventions had they been exposed to innovation in childhood—especially among women, minorities, and children from low-income families."[116]

B. Additional Rationales for Promoting Diversity in Innovation

In light of the emerging empirical case for diversity in innovation, it is worth considering diversity's other justifications, including deontological (or so-called "moral") and other utilitarian or instrumental (for example, business and economic) rationales. It is notable that instrumental rationales, despite their popularity, have been criticized for prioritizing the general benefits of diversity for the majority group (such as improving the educational experience of majority students) over the specific interests of racial minorities more likely to be centered by deontological justifications for diversity (for example, to repair past wrongs).[117]

economy by 0.6 percent to 4.4 percent. *See US-China: Winning the Economic Competition: Hearing Before the S. Subcomm. on Econ. Pol'y of the S. Comm. on Banking, Hous., & Urb. Affs.*, 116th Cong. 2 (2020) (testimony of Lisa D. Cook, Professor of Economics & International Relations, Michigan State University) [hereinafter *Hearing*].

113. *See supra* Part I.A.1.

114. Federico Caviggioli, Alessandra Colombelli & Chiara Ravetti, *Gender Differences Among Innovators: A Patent Analysis of Stars*, 32 ECON. INNOVATION & NEW TECH. 1000, 1002–03 (2023). (reciting, among the positive benefits of star innovators, the broader support of the organization, ability to attract resources and skilled personnel, and "productivity of peers and collaborators thanks to learning and emulation")

115. Bell et al., *supra* note 18, at 710.

116. *Id.* at 648, 709; *see also* Celik, *supra* note 40, at 126 (finding that the meritocratic allocation of talent would both increase economic growth and decrease consumption inequality).

117. Jordan G. Starck, Stacey Sinclair & J. Nicole Shelton, *How University Diversity Rationales Inform Student Preferences and Outcomes*, 118 PNAS 1, 2 (2021) (describing the stated purpose of race-conscious admissions efforts as "not only or even primarily to confer benefits upon

Equity interests are advanced, for example, when bias and structural impediments to participation in innovation[118] are dismantled. Jobs in innovation are lucrative and sought after, and diversifying who is participating in them can both boost economic mobility and help close the employment and pay gaps between minority and majority innovation workers.[119] Finally, the relationship between who innovates and who benefits from innovation implies that diversifying inventorship has implications for consumption inequality and broader welfare.[120] For example, using innovation to close female-male gaps in health outcomes is projected to increase life expectancy, reduce disease burdens, and reduce disruptions to work productivity.[121]

Diverse innovators can help companies meet performance and ESG (environmental, social, and governance) goals, reach diverse customers, and attract not only diverse talent, but also talent that is attracted to diversity.[122] Increasing the percentage of Americans of all backgrounds who participate in the innovation system would also likely advance national economic interests through the more efficient allocation of talent.[123]

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members of minorities," but rather "important educational objectives" in service of the student body writ large); *see also* Richard Delgado, *The Imperial Scholar: Reflections on a Review of Civil Rights Literature*, 132 U. PA. L. REV. 561, 570 n.46 (1984) (describing how a utilitarian diversity rationale "may well be perceived as treating the minority . . . as an ornament, a curiosity, one who brings an element of the piquant to the lives of white professors and students"); Oriane Georgeac & Aneeta Rattan, *Stop Making the Business Case for Diversity*, HARV. BUS. REV. (June 15, 2022), https://hbr.org/2022/06/stop-making-the-business-case-for-diversity [https://perma.cc/QV45-H4Q5] (reporting that underrepresented candidates preferred fairness or no rationales over business rationales in corporate statements on diversity).

118. *See infra* Part II.C (describing, as obstacles to full participation in innovation, differences in childcare burdens, perceptions of workplace fairness and safety, and levels of investment in human capital formation).

119. *See* Lisa D. Cook & Yanyan Yang, *Missing Women and Minorities: Implications for Innovation and Growth*, YANYANYANG.COM (Jan. 6, 2018), http://www.yanyanyang.com/uploads/5/6/5/2/56523543/aeapinkblack_cookyang.pdf [https://perma.cc/7278-FBNX] (reporting on NSF data showing that female and African American innovation workers earned only 71 percent and 79 percent of the salaries of their male and white counterparts, respectively).

120. *See* Celik, *supra* note 40, at 105; Einio et al., *supra* note 9, at 3.

121. *See* MATTHEW D. BAIRD ET AL., RAND CORP., RESEARCH FUNDING FOR WOMEN'S HEALTH: MODELING SOCIETAL IMPACT 18–19 (2021), https://www.rand.org/content/dam/rand/pubs/research_reports/RRA700/RRA708-4/RAND_RRA708-4.pdf [https://perma.cc/KBT2-P35P] (simulating the impact of increased research funding for Alzheimer's disease and Alzheimer's disease-related dementias (AD/ADRD), coronary artery disease (CAD), and rheumatoid arthritis (RA)).

122. *See* Richard Florida, *Cities and the Creative Class*, 2 CITY & CMTY. 3, 10–11 (2003).

123. *See, e.g.*, *Hearing*, *supra* note 112.

C. The Legal Case for Redefining Progress

While the previous paragraphs address *why* promoting a diversity of innovators is important for promoting innovation, they do not describe *how* to do so. This Subpart argues that the patent system has in fact long sought to encourage broad participation and details the numerous institutional features of the system—introduced at various points in time—designed to do so. This record supports the broader construction of progress as proposed in this Article, to include supporting and encouraging a diversity of innovators, and not just innovation.

1. Patent Law's History of Supporting Diverse Innovators

The first Patent Act of 1790 authorized anyone who invented or discovered "any useful art, manufacture, engine, machine, or device, or any improvement therein" to apply for a patent.[124] The Act was remarkably inclusive for its time: in contrast to naturalization, which was reserved for "free white person[s],"[125] "any person or persons" could apply for a patent.[126] Furthermore, all who succeeded on their patent applications received the same rights, unlike the discounting of enslaved persons to "three fifths of . . . Persons" for purposes of taxation and representation.[127] In contrast to suffrage, which was not guaranteed for women until 1920,[128] "he, she, or they" could apply for a patent.[129] As Anne L. Macdonald has recounted, while there was no express lobbying to extend patent rights to women, "early legislators were mindful that female descendants of the Revolution's plucky Daughters of Liberty should, as Abigail Adams coached her husband, be 'remembered.'"[130]

124. Patent Act of 1790, ch. 7, § 1, 1 Stat. 109, 110 (repealed 1793).
125. Naturalization Act of 1790, ch. 3, § 1, 1 Stat. 103 (repealed 1795). This racial prerequisite to citizenship remained in force until 1952. IAN HANEY LÓPEZ, WHITE BY LAW: THE LEGAL CONSTRUCTION OF RACE 1 (rev. ed. 2006).
126. Patent Act of 1790, § 1.
127. U.S. CONST. art. I, § 2.
128. Women were granted suffrage through the ratification of the Nineteenth Amendment to the U.S. Constitution, which states that "[t]he right of citizens of the United States to vote shall not be denied or abridged by the United States or by any State on account of sex." U.S. CONST. amend. XIX.
129. Patent Act of 1790, § 1.
130. MACDONALD, *supra* note 46, at 4.

Patents were historically viewed as a catalyst for economic growth, particularly in the manufacturing sector given the scarcity of labor.[131] To effectively stimulate such growth, the patent system needed to be open to all. For example, the early U.S. patent system allowed for patenting by mail to facilitate participation by rural inventors.[132] Low fees[133] and the award of patents based on merit rather than patronage[134] further facilitated what economic historian Zorina Khan has called the "democratization of invention."[135] Influential scholars have held up the early patent system and its embrace of all comers as an example of the type of democratic institution responsible for American prosperity. For example, as Daron Acemoglu and David Robinson wrote in their landmark book *Why Nations Fail*: not only was nineteenth century America "more democratic politically than [other nations], it was also more democratic than others when it came to innovation. This was critical to its path to becoming the most economically innovative nation in the world."[136]

But a closer look at the evolution of the law suggests that the characterization of the early US patent system as a bastion of democracy is, at best, incomplete. The 1790 Act was quickly superseded by the Patent Act of 1793, which restricted inventorship to U.S. citizens.[137] This meant that international people, enslaved

131. *See* Oren Bracha, Owning Ideas: A History of Anglo-American Intellectual Property (June 2005) (S.J.D. dissertation, Harvard Law School), https://law.utexas.edu/faculty/obracha/dissertation [https://perma.cc/7YY8-XXYK] (describing a variety of methods used in colonial times to stimulate economic growth); Robert P. Merges, *The Hamiltonian Origins of the U.S. Patent System, and Why They Matter Today*, 104 IOWA L. REV. 2559, 2563 (2019) (describing patents as part of the government's promotion of industry).

132. B. Zorina Khan & Kenneth L. Sokoloff, *Patent Institutions, Industrial Organization and Early Technological Change: Britain and the United States, 1790–1850*, *in* TECHNOLOGICAL REVOLUTIONS IN EUROPE 292, 301 (Maxine Berg & Kristine Bruland eds., 1998).

133. PETER DRAHOS, THE GLOBAL GOVERNANCE OF KNOWLEDGE: PATENT OFFICES AND THEIR CLIENTS 108–09 (2010) (describing U.S. patenting fees as being lower than fees in the United Kingdom and most European countries through the mid-nineteenth century). *Accord* B. ZORINA KHAN, THE DEMOCRATIZATION OF INVENTION: PATENTS AND COPYRIGHTS IN AMERICAN ECONOMIC DEVELOPMENT, 1790–1920, 29 (2005).

134. The practice of treating patents as favors bestowed by royalty onto favored subjects was prominent in Britain at the time of the founding of the United States. *See* KLAUS BOEHM & AUBREY SILBERSTON, THE BRITISH PATENT SYSTEM 14 (1967).

135. Khan, *supra* note 133.

136. DARON ACEMOGLU & JAMES A. ROBINSON, WHY NATIONS FAIL: THE ORIGINS OF POWER, PROSPERITY AND POVERTY 33 (1st ed. 2012).

137. Patent Act of 1793, ch. 11, § 1, 1 Stat. 318 (repealed 1836). Such a move appears to be consistent with a broader congressional decision to give states the right to regulate property holding by noncitizens. *See* Allison Brownell Tirres, *Ownership Without Citizenship: The Creation of Noncitizen Property Right*s, 19 MICH. J. RACE & L. 1, 9–10 (2013). The new Act also eliminated the pronoun "she" from the statute. *See* Kara W. Swanson, *Making Patents: Patent Administration, 1790–1860*, 71 CASE W. RES. L. REV. 777, 795 n.84 (2020). For a description of

people, and non-white immigrants—that is, those who were not "free white person[s]" under the Naturalization Act of 1790—could not apply for patents. And while federal patent law in the first century or so of the United States did not discriminate on the basis of gender, a number of states considered a woman's intellectual property to be assigned to her husband upon creation.[138]

The 1793 Act was amended in 1800 to make immigrants eligible to apply for patents, as long as they had resided in the United States for two years and swore that the invention in question had not been known or used previously in the United States or abroad.[139] The use of patent law as an inducement for international people to come, stay, and innovate was broadly consistent with the first patent system in the world, which sought to recruit to fifteenth-century Venice "every person who shall build any new and ingenious device."[140]

Until recently, a parallel desire to cultivate foreign contributions to the benefit of the United States was enshrined in American patent law: foreign inventions would not preempt subsequent patenting under U.S. law, unless they had been written down or patented.[141] Structural disadvantages for other certain inventors, however, persisted for decades.[142] Owners of enslaved people exploited the law to their advantage. For example, Eli Whitney became famous based on a cotton gin now attributed to an enslaved person named Sam, and, according to accounts, the McCormack reaper actually benefited greatly from the contributions of an enslaved person named Jo Anderson.[143] The rights of married women[144] and

the subsequent use of pronouns in the patent statute, see Dennis Crouch, *He, She, or They in US Patent Law*, PATENTLY-O (June 28, 2022), https://patentlyo.com/patent/2022/06/she-they-patent.html [https://perma.cc/KV7N-U6YZ].

138. *See* Eric S. Hintz, *Counting Women Inventors*, LEMELSON CTR. (Mar. 21, 2017), https://invention.si.edu/counting-women-inventors [https://perma.cc/UJ3H-CUQ5] (describing how, in the words of Matilda Joslyn Gage in 1883, a married female inventor—even if she was successful in getting her patent—would have no right, title, or power to enforce it independent of her husband, who unilaterally had the right to sell, give, enforce, or not implement the invention).

139. *See* Khan, *supra* note 133, at 57.

140. Edward C. Walterscheid, *The Early Evolution of the United States Patent Law: Antecedents (Part 1)*, 76 J. PAT. & TRADEMARK OFF. SOC'Y 697, 707 (1994); Ted Sichelman & Sean O'Connor, *Patents as Promoters of Competition: The Guild Origins of Patent Law in the Venetian Republic*, 49 SAN DIEGO L. REV. 1267, 1269–70 (2012).

141. 35 U.S.C. § 102 (2006) (amended 2011) (restricting foreign prior art in § 102(b) to patents, printed publications, and sales, whereas the post-amendment version considers all foreign knowledge or use to be prior art).

142. For the progression of these laws, see *infra* Appendix Table A.

143. *See* Brian L. Frye, *Invention of a Slave*, 68 SYRACUSE L. REV. 181, 187 (2018).

144. *See, e.g.*, Fetter v. Newhall, 17 F. 841, 843 (C.C.S.D.N.Y. 1883) (confirming that minors, married women, and others suffering from a legal disability were eligible to patent).

Black Americans to obtain and own patents were also being clarified well into the patent system's first century.[145]

As the country expanded geographically, so did the reach of the patent system, supporting innovators across the country. Regional patent libraries were introduced in the 1870s, and from 1975 to 1997, the USPTO expanded its network of libraries to all fifty states.[146] As part of the America Invents Act (AIA), U.S. Congress directed the USPTO to open satellite offices across the country in order to "ensure geographic diversity . . . in different States and regions throughout the Nation."[147] These offices serve as conduits of information about how to apply for a patent, the value of doing so, and how to find help in navigating the system.

2. Patent Law's Support for Institutional Diversity

Additional support for broadening the concept of progress in the patent system to include a diversity of innovators comes from the patent system's longstanding but overlooked commitment to institutional diversity. The participation of organizations of different sizes, motivations, geographies, and institutional capacities, has the potential to expand the reach and benefits of innovation.

For example, the principle that underresourced individuals should have the same rights as corporations to pursue patents led the United States to, until recently, follow a "first-to-invent" rather than a "first-to-file" approach to determining who among competing inventors should prevail.[148] By rewarding the

145. *See* Swanson, *supra* note 137, at 809 n.174. Both women and Black inventors, however, managed to get patents during this time. *See* Frye, *supra* note 143, at 185 (describing antebellum patenting by Black Americans); MACDONALD, *supra* note 46 (providing a history of early patenting by women). The legal concepts pf patent inventorship and patent ownership are distinct though related. Even now, under the current hired to invent doctrine, rights initially vested in inventors are often immediately assigned to their employers, as described in FN173.

146. This expansion resulted in measurable benefits to new innovators. *See* Jeffrey L. Furman, Markus Nagler & Martin Watzinger, *Disclosure and Subsequent Innovation: Evidence From the Patent Depository Library Program* (NBER, Working Paper No. 24660, 2018), https://www.nber.org/system/files/working_papers/w24660/w24660.pdf [https://perma.cc/SU5V-R6U5].

147. Leahy-Smith America Invents Act (AIA), § 23, Pub. L. No. 112-29, 125 Stat. 284, 337 (codified at 35 U.S.C. § 1 note). *See also* Unleashing American Innovators Act of 2022, H.R. 8697, 117th Cong. § 3(b) (2d Sess. 2022) (requiring the USPTO to open a regional office in the southeastern region of the United States).

148. *See* Mark A. Lemley & Colleen V. Chien, *Are the U.S. Patent Priority Rules Really Necessary?*, 54 HASTINGS L.J. 1299, 1303 (2003). The United States transitioned in 2013 to a "first-to-file" system with the passage of the America Invents Act in order to conform to international norms. *See, e.g.*, *The Global Impact of the America Invents Act*, WIPO MAG. (Dec. 2011),

person who has the idea first, not who has greater ability (and resources) to win the race to the Patent Office, the first-to-invent approach leveled the playing field.[149]

Consistent with the principle of supporting a diversity of types of institutions, patent law features several special accommodations for universities. One such accommodation was codified in 2011, when Congress enacted an immunity for university patents from defenses to infringement based on "prior user rights," in effect strengthening university patents relative to others.[150] It is easier for individual inventors and universities to get injunctions than it is for patent assertion entities.[151] Underresourced inventors have also enjoyed particular accommodations, including more intensive assistance[152] and deep fee discounts.[153] They have also had a seat at the table: not less than a quarter of the members of the USPTO's patent advisory committees must be from "small business concerns, independent inventors, and nonprofit organizations."[154] The patent system's commitment to innovators extends beyond inventors: the Supreme Court has at different times invoked the interests of independent innovators,[155] users and future innovators,[156] and entrepreneurs[157] to justify its patent law decisions.

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https://www.wipo.int/wipo_magazine/en/2011/06/article_0002.html [https://perma.cc/9S4N-FHSE] (describing the harmonizing effect of the change to US law).

149. Lemley & Chien, *supra* note 148, at 1305.
150. *See* Peter Lee, *Patents and the University*, 63 DUKE L.J. 1, 71–73 (2013) (describing the special statutory carveouts universities enjoy, but contrasting them with courts' refusal to give special treatment to academic institutions that behave like commercial actors).
151. Colleen V. Chien & Mark A. Lemley, *Patent Holdup, the ITC, and the Public Interest*, 98 CORNELL L. REV. 1, 10 (2012).
152. *See, e.g.*, Nicholas A. Pairolero, Andrew A. Toole, Peter-Anthony Pappas, Charles A.W. deGrazia & Mike H.M. Teodorescu, *Closing the Gender Gap in Patenting: Evidence From a Randomized Control Trial at the USPTO* 2–3 (USPTO, Economic Working Paper No. 2022-1, 2022), https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID4265093_code2599841.pdf?abstractid=4265093&mirid=1 [https://perma.cc/5TEW-XCH9].
153. *See* 13 C.F.R. § 121.802 (2023); 37 C.F.R. § 1.27 (2022) (providing fee discounts of 50 percent to 75 percent to small and "micro" entities).
154. 35 U.S.C. § 5(b).
155. *See, e.g.*, Aronson v. Quick Point Pencil Co., 440 U.S. 257, 266 (1979) (citing the desirability of enabling "independent innovator[s]" to proceed in "areas where patent law does not reach" in its decision to strike a contract's terms).
156. *See* Mayo Collaborative Servs. V. Prometheus Lab'ys, Inc., 566 U.S. 66, 86, 92 (2012) (citing concerns that the contested patent claims would "tie up the doctor's subsequent treatment decision" and subject "potential users to conduct costly and time-consuming searches of existing patents and pending patent applications").
157. *See* Halo Elecs., Inc. v. Pulse Elecs., Inc., 579 U.S. 93, 111 (2016) (warning about the business costs of patent litigation and of "prevent[ing] an innovator from getting a small business up and running").

3. Redefining Progress

Despite these commitments, the institutions of the patent system are still significantly limited in their ability to promote innovators as distinct from promoting innovation. For example, even though the 2018 SUCCESS Act asked the USPTO to report on individual-level diversity for the first time, and on patents applied for and obtained by women, minorities, and veterans,[158] the agency lacked the authority to ask applicants for demographic information due to privacy restrictions. As a result, the USPTO could only estimate the gender profile of patentees and did not even attempt to report on the current representation of other demographic groups or veterans in inventing, reporting data on Black inventors from the 1940s.[159] Consequently, efforts to diversify innovation and inventorship, however well intentioned, risk "flying blind" without a clear baseline from which to measure progress. The lack of data also hinders the ability to assess the adequacy of current law, provide guidance to the courts and Congress, and determine the effectiveness of interventions. With respect to socioeconomic diversity, the USPTO has the power to set fees and the ability to offer fee discounts, thereby increasing access, but agency fees are only a small fraction of the cost of filing for a patent.[160] Due to the agency's fee structure, which requires it to cover its own fees, the USPTO does not receive congressional appropriations and therefore is limited in its ability to receive funds earmarked for diversity efforts.

To address these limitations, this Article calls for redefining the term progress in Article 1, Section 8, Clause 8 of the Constitution to mean the promotion of innovators, and in particular a diversity of innovators and inventors, and not just innovation. Like earlier efforts, this Article's notion of progress is grounded in human welfare terms rather than the accumulation of intellectual property or private wealth, or even the generation of ideas.[161] But instead of

158. SUCCESS Act, Pub. L. No. 115-273, 132 Stat. 4158 (Oct. 31, 2018).

159. *See* U.S. PAT & TRADEMARK OFF., STUDY OF UNDERREPRESENTED CLASSES CHASING ENGINEERING AND SCIENCE SUCCESS: SUCCESS ACT OF 2018, at 1, 7–13 (2019), https://www.uspto.gov/sites/default/files/documents/USPTOSuccessAct.pdf [https://perma.cc/TCQ6-S238] (describing the lack of reliable race and ethnicity data of inventors and citing statistics from the 1940s for Black inventors).

160. *See* Russ Krajec, *How Much Does a Patent Cost?*, BLUEIRON (Jan. 16, 2022), https://blueironip.com/how-much-does-a-patent-cost [https://perma.cc/6C46-KESN] (describing typical attorney fees, for the filing of patents, as being between $9000 and $12,000, while USPTO fees are below $1000).

161. Investigating the term's meaning at the time of the drafting of the Constitution, Malla Pollack has argued that progress is best understood as the "spread," rather than mere generation, of new ideas, and that it should be read as a limitation, rather than an authorization, of the grant

bucking the conventional utilitarian paradigm, this Article offers an alternative way to succeed within it, by framing the robust participation of innovators as a dimension of progress that advances the "useful arts" and their uptake.

That is because, as the empirical record shows, the inclusion of diverse innovators improves the quality and quantity of ideas generated, leading to more innovation in the sense of novel ideas. But diversifying the base of participants also leads to more innovation that is relevant to a broader set of stakeholders, consistent with the idea of progress as "spread" and the betterment of the human condition, as advanced by previous originalist interpretations.[162]

Considered in view of the patent system's history and the contributions of diversity to innovation, the present proposal is modest: build on the many ways in which patent policy is and has always been people- and innovator-centric policy and enlarge the concept of patent progress to include the promotion of innovators. Such a redefinition would continue and build from, not newly create, the patent system's legal and policy commitment to promoting innovators and not just innovation.

In reality, a formal redefinition is likely not necessary—the Supreme Court has tended to be deferential to congressional interpretations of the progress clause, as long as the legislature's actions reflect a "rational exercise of the legislative

of intellectual property rights. *See* Malla Pollack, *What is Congress Supposed to Promote?: Defining "Progress" in Article I, Section 8, Clause 8 of the United States Constitution, or Introducing the Progress Clause*, 80 NEB. L. REV. 754, *passim* (2001); *see also* Dotan Oliar, *Making Sense of the Intellectual Property Clause: Promotion of Progress as a Limitation on Congress's Intellectual Property Power*, 94 GEO. L.J. 1771, *passim* (2006) (textually analyzing contemporaneous documents from the Constitution and Constitutional convention and arguing that they support an understanding of "progress" as "advancement" and "improvement," as well as a sense of the "betterment of the human condition"). Margaret Chon has advanced a "postmodern" sense of "progress" that eschews linear and forward conceptions of "progress" in favor of a progress "project" that is grounded in stewardship and trust for the betterment of all. *See* Margaret Chon, *Postmodern "Progress": Reconsidering the Copyright and Patent Power*, 43 DEPAUL L. REV. 97, 100–03 (1993). Jessica Silbey's novel *Against Progress* has relatedly argued that "progress" should be understood as more about basic human values and the common good and less about the accumulation of wealth and advancement of private interests. *See* JESSICA SILBEY, AGAINST PROGRESS: INTELLECTUAL PROPERTY AND FUNDAMENTAL VALUES IN THE INTERNET AGE 4–5 (2022). Chris Buccafusco and Jonathan Masur have advanced a hedonic account of human welfare as the aim of the intellectual property system. *See* Christopher Buccafusco & Jonathan Masur, *Intellectual Property Law and the Promotion of Welfare* (Coase-Sandor Inst. for L. & Econ., Working Paper No. 790, 2017), https://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?article=2463&context=law_and_economics [https://perma.cc/7SKG-CTXV].

162. Pollack, *supra* note 161, at 755, 794–803; *see also* Oliar, *supra* note 161, at 1808 n.180, 1809.

authority conferred" by the progress clause.[163] Absolute certainty that acts promoting a diversity of innovators will lead to more or better innovation is not required, but instead, that such a justification is rationally offered.

If that is the case, what might an explicit focus on innovators, and not just innovation, by the courts, the USPTO, and Congress actually mean in terms of how the law recognizes and rewards innovators and inventors, and the processes by which patents are obtained? The next Part considers this question in the context of who becomes an inventor and exposes the problematic ways that the law and mechanics of inventorship are contributing to what I call the "innovator-inventor gap"—the lower rate at which diverse innovators are becoming inventors—as well as the "patent grant gap," the lower rate at which underrepresented innovators that have applied for patents succeed on their applications.

II. PROGRESS AND THE INNOVATOR-INVENTOR GAP

Given the strong case for diversity in innovation, one might expect there to be broad-based participation in patenting. But, to return to the example of gender, women represent only 27 percent of the STEM workforce, and 13 percent of inventors.[164] While much attention has focused on boosting the share of women that work in STEM,[165] this Part focuses on what happens once they are in the STEM workforce. As it turns out, as described in the paragraphs below, even conditional upon their presence in the technical workforce, women are roughly only half as likely to reach the status of "inventor" as their male counterparts.

Before doing so, it is important to address, does diversity in inventorship actually matter? The mere act of adding a diverse name to a list of inventors, without more, does not necessarily mean that the invention is more likely to be

163. Eldred v. Ashcroft, 537 U.S. 186, 189 (2003) (ruling, in a challenge to the Copyright Term Extension Act (CTEA), which extended the duration of copyright, that "[t]he justifications that motivated Congress to enact the CTEA . . . provide a rational basis for concluding that the CTEA 'promote[s] the Progress of Science,'" and therefore that it should not be struck down).

164. Martinez & Christnacht, *supra* note 17.

165. These factors include both intrinsic and external variables, such as academic mindsets, STEM attitudes, family background, mentorship experiences, gender stereotypes, comparative advantages, and economic conditions. *See* Katherine Kricorian, Michelle Seu, Daniel Lopez, Elsie Ureta & Ozlem Equils, *Factors Influencing Participation of Underrepresented Students in STEM Fields: Matched Mentors and Mindsets*, 7 INT'L J. STEM EDUC., no. 16, Apr. 21, 2020, at 1, 2; Thomas Breda, Elyès Jouini, Clotilde Napp & Georgia Thebault, *Gender Stereotypes Can Explain the Gender-Equality Paradox*, 117 PNAS 31063, 31063, 31065 (2020).

introduced or commercialized. Indeed, patents give their holders rights to exclude, and the net welfare effects of any particular patent or its inventorship, depending on how it is used—such as for defensive, assertive, or licensing purposes[166]—may be ambiguous. It's also not obvious what efforts to diversify *inventorship* really add to ongoing efforts to diversify *innovation*. Finally, an overemphasis on the metric of inventorship in diversity can also create perverse incentives to take action for optical, rather than substantive reasons, at the risk of diluting patent quality or inventorship integrity.

These critiques elicit a few responses, which sound in both utilitarian and nonutilitarian justifications for the patent system. First, as a threshold matter, the push for diversity in inventorship should not be understood as a push for undeserved inventorship, or for patenting per se. Instead, what fairness and equality require is that—at whatever the level of patenting within an organization—the contributions of diverse innovators are equally visible and recognized, leading to their more equal inclusion on patents. Systematically or even inadvertently failing to name diverse innovators on the inventions for which they have satisfied the legal definition of inventorship is unjust and contrary to law. But as I suggest below, there is a real risk that the existing, exacting standard of inventorship is contributing to the exclusion of contributors from patents.

The consequentialist case for diversity in inventorship is grounded in the more general case for patents. The award of a first patent to a startup or small innovative firm has been associated with investment, access to credit, hiring, and a number of beneficial outcomes.[167] What happens at small firms is particularly important in light of new evidence that the majority of first-time female inventors are either independent or affiliated with a small entity.[168] But it is also important to focus on what is happening in larger firms, where the vast majority of innovation and patenting[169]—but only a small minority of first-time patenting by

166. Patents can be the basis for a lawsuit, but they may offer defensive "protection" for their holders in the form of an arsenal to be drawn upon for countersuit, should the patentholder be sued. Patents can also be licensed, as part of a broader transfer of technology or in a standalone transaction, in which the licensor gets the rights to develop or practice the invention. *See* Colleen V. Chien, *From Arms Race to Marketplace: The Complex Patent Ecosystem and Its Implications for the Patent System*, 62 HASTINGS. L.J. 297, 299 (2010).

167. Joan Farre-Mensa, Deepak Hedge & Alexander Ljungqvist, *What Is a Patent Worth? Evidence From the U.S. Patent "Lottery"*, 75 J. FIN. 639, 640 (2020).

168. Pairolero et al., *supra* note 152, at 4–5.

169. *See* Veera Korhonen, *Share of Utility Patent Grants Issued in the United States in FY 2021, by Entity Size and Origin*, STATISTA (June 2, 2023), https://www.statista.com/statistics/256715/number-of-technology-patent-grants-in-the-us-by-ownership

females[170]—is taking place, signaling potentially an even greater risk that the contributions of diverse innovators are being overlooked. In this context, talented people have less incentive to participate and more incentive to exit when their contributions are not appreciated or recognized through patent acknowledgments and associated commercialization efforts. As such, the failure to name diverse inventors on patents may signal or result in the failure to capture the benefits of diversity in innovation generally, and the undercommercialization of the ideas of diverse innovators specifically.

From the perspective of the individual, missing an opportunity to be named as an inventor also means missing out on the numerous benefits associated with patenting, including recognition, financial gains, professional reputation, and in cases where inventorship implies ownership, control over the invention and the legal rights to use it.[171] For example, patenting is associated with pay, promotion, and job retention benefits above and beyond employment.[172] Even in cases where the invention belongs to the employer and not the inventor,[173] as the Federal Circuit Court of Appeals has said, "being considered an inventor of important subject matter is a mark of success in one's field, comparable to being an author of an important scientific paper."[174] As Jason Rantanen and Sarah Jack have cataloged, patents act as credentials for individuals in numerous ways, signaling the expertise, creativity, and distinct contributions of the inventor.[175] The benefits accumulate over the course of one's career.

(showing that large entities were granted 69 percent (among U.S. origin companies) and 84 percent (among foreign companies) of patents) (last visited June 19, 2024).

170. Pairolero et al., *supra* note 152, at 4–5.

171. *See* 35 U.S.C. § 262 (providing joint owners of patents with the rights of the patent, including the right to license the patent to others, without the consent of or accounting to other joint owners).

172. *See* GAURI SUBRAMANI, ABHAY ANEJA & OREN RESHEF, ATTRITION AND THE GENDER INNOVATION GAP: EVIDENCE FROM PATENT APPLICATIONS 12 (2022), https://www.aeaweb.org/conference/2022/preliminary/paper/9iDf7ifd [https://perma.cc/XX74-R3JX] (describing studies by Kline and Melero on the direct benefits from patenting activity).

173. *See* United States. v. Dubilier Condenser Corp., 289 U.S. 178, 187 (1933) (establishing the hired-to-invent doctrine, according to which inventions made by inventors in the course of their normal employment belong to the employer).

174. Chou v. Univ. of Chi., 254 F.3d 1347, 1359 (Fed. Cir. 2001). Patenting also cuts across a wide range of organizational settings and has been linked to upward mobility among first-time patentors.

175. Jason Rantanen & Sarah E. Jack, *Patents as Credentials*, 76 WASH. & LEE L. REV. 311, 359–76 (2019) (discussing the use of patents as credentials by judicial opinions, universities, employers, and others).

There are also informational consequences to consider. Patents provide a layer of visibility to innovators not always present in the ranks of corporations. Research supports the relevance of "homophily"—he tendency for people to be attracted to those who are similar to themselves—in inventing, as girls are more likely to grow up to be inventors if their communities specifically included female inventors.[176] Diversifying inventorship can convert otherwise hidden and unseen innovators into relatable role inventor models, boosting efforts to grow the field.

In sum, just as the case for diversity in innovation has multiple dimensions, so too does the case for diversity in invention have deontological dimensions—like fairness, attribution, and inequality—as well as consequentialist considerations such as lost inventions and visibility. Both types of interests are advanced when innovators of all types have an equal opportunity to participate in inventorship, witness their innovations become inventions, and inspire future generations of innovators. As the following paragraphs will discuss, however, numerous barriers currently prevent this ideal from being fully realized.

A. Measuring the Innovator-Inventor Gap

Taking the case of gender, where the data is most available, I begin by using available data to approximate the innovator-inventor gap among male and female technical workers in over two dozen settings. The resulting glimpse underscores the importance of focusing on the hard-to-glimpse pre-application phase of patenting. Becoming an inventor requires a person to satisfy the legal requirements of inventorship, apply for a patent, have their application favorably evaluated by the Patent Office, and eventually be granted a patent. Below, I consider the role of the legal standard for inventorship, applicant factors like awareness, inventor identity, confidence, and social networks, and applicant evaluator factors like implicit bias against progress along the innovator-inventor pipeline.

Focusing primarily on the experiences of female inventors has limitations. As demonstrated by the failure of gains experienced by white women to extend to women of color, diversity challenges cannot be solved by looking at the experiences of a single underrepresented group.[177] Survey research suggests

176. Bell et al., *supra* note 18.

177. *See, e.g.*, Adia Harvey Wingfield, *Women Are Advancing in the Workplace, but Women of Color Still Lag Behind*, BROOKINGS (Oct. 9, 2020), https://www.brookings.edu/essay/women-are-advancing-in-the-workplace-but-women-of-color-still-lag-behind [https://perma.cc/CU6R-5TVZ].

isolation, hostility, and harassment[178] may present more acutely for Black and Latinx innovators than some of the barriers discussed below. Queer scientists and scholars have had to weigh whether it is safe to apply for new positions or attend conferences when located in more conservative places.[179] Asian American scientists have attributed their underrepresentation in scientific prizes, in part, to "the all-too-common experience of being confused for someone else."[180] An article by Yuh Nung Jan suggest that those interested in addressing the disparity: "[m]ake effort to treat Asian scientists as individuals. For example, learn their names . . . ."[181]

In addition, the challenge of measuring equal opportunity is significant—and given the role of preferences and comparative advantages, unequal outcomes do not necessarily imply unequal opportunity. Given the stakes, however, it is still worth examining, as this Part does, possible barriers to participation that come from patent law and practice and how to address them.

The underrepresentation of women on patents has been previously studied and documented in academia and industry.[182] The participation of women and minorities in the pre-application phase of inventing, however, has been the subject of limited research. This is primarily because, in contrast to the generally public

178. *See, e.g.*, SCOTT ET AL., *supra* note 36, at 4, 14.

179. *See* COLLEEN CHIEN & ERNEST FOK, SANTA CLARA L. DIGIT. COMMONS, COMMENTS TO THE NATIONAL STRATEGY FOR EXPANDING AMERICAN INNOVATION 34–35 (2021), https://digitalcommons.law.scu.edu/cgi/viewcontent.cgi?article=1989&context=facpubs [https://perma.cc/MJN5-JUMZ].

180. Yuh Nung Jan, *Underrepresentation of Asian Awardees of United States Biomedical Research Prizes*, 185 CELL 407, 409 (2022).

181. *Id.* at 410.

182. *See* Fatima Taha, *Sabra-Anne Truesdale– Western Digital*, VANGUARD (Jan. 6, 2022), https://www.vanguardlawmag.com/case-studies/sabra-anne-truesdale-western-digital [https://perma.cc/6HAD-2N9T] (reporting gaps of 50 percent at Western Digital); Kate Gaudry & Leron Vandsburger, *Across Industries, the Female Inventor Rate is Half the Female Employment Rate*, IPWATCHDOG (Apr. 20, 2020, 7:15 AM), https://www.ipwatchdog.com/2020/04/20/across-industries-female-inventor-rate-half-female-employment-rate/id=120717 [https://perma.cc/E7FV-F894] (concluding, based on data from the National Science Foundation and World Intellectual Property Organization, that across industries, women were "half as likely" to be listed as inventors); ELYSE SHAW, INST. FOR WOMEN'S POL'Y RSCH., GENDER AND RACIAL DIVERSITY IN INVENTION & PATENTING 9 (2021), https://increasingdii.files.wordpress.com/2021/07/20210728-shaw_diversity-in-patenting_dii-conference-compressed.pdf [https://perma.cc/V3TF-2YQB] (reporting that women-owned businesses were half as likely to have a granted patent than men-owned businesses); Serena Hanes, Katharine Ku, Lisa Primiano & Ann M. Arvin, *Gender Analysis of Invention Disclosures and Companies Founded by Stanford University Faculty From 2000–2014*, 53 les Nouvelles 85 (2018) (documenting that at Stanford, 13 percent of male faculty versus 7 percent of female faculty were inventors).

nature of the patent application process, , pre-application activities are generally private, taking place behind closed doors.[183] Consequently, there is a lack of accessible information about the pool of potential inventors and how internal factors such as seniority, technical roles, filing rates,[184] and corporate culture contribute to the observed disparities—information that is essential for a comprehensive understanding.

And yet, studying the conversion of innovators to inventors is vital for those interested in diversifying inventorship, because much more of the gap in inventing appears to be attributable to the failure of diverse innovators to apply for patents (the "application gap") than from a failure of diverse innovators to succeed on their patent applications (the "patent grant gap"). While there is about a 6 percent difference between male and female patent applicants in patent approval rates, there is about a 66 percent difference between men and women technical workers regarding who applies for a patent in the first place.[185] Furthermore, the diversification of STEM education has also not translated into commensurate improvements in the diversification of patenting,[186] suggesting that more than K-12 or even collegiate pipeline improvements will be needed to boost the participation of underrepresented groups in inventorship.

183. Inventors on upstream "provisional" patent filings that precede full utility patent applications are provided to the USPTO, but are neither published nor made available to the public unless they become the basis of published nonprovisional applications or patents. *See Section 103 Right of Public to Inspect Patent Files and Some Application Files [R-07.2022]*, USPTO, https://www.uspto.gov/web/offices/pac/mpep/s103.html [https://perma.cc/9CX2-9FT2].

184. The filing rate is the rate at which invention disclosures are turned into patent applications. *See* MICHAEL HALL, NAT'L INST. STANDARDS & TECH., FILING RATE AND TRANSFER RATE AT NIST: AN EXAMINATION OF INVENTION DISCLOSURES, PATENT APPLICATIONS, AND INVENTION LICENSES 8 (2021), https://nvlpubs.nist.gov/nistpubs/ttb/NIST.TTB.2.pdf [https://perma.cc/E5RJ-BMGJ] (finding the average filing rate within universities, for example, to be 60 percent).

185. Holly Fechner & Matthew S. Shapanka, *Closing Diversity Gaps in Innovation: Gender, Race, and Income Disparities in Patenting and Commercialization of Inventions*, 19 TECH. & INNOVATION 727, 728–29 (2018) (documenting a gender "application gap" of 66 percent, as compared to a "grant gap" of only 6 percent); *see also* JESSICA MILLI, EMMA WILLIAMS-BARON, MEIKA BERLAN, JENNY XIA & BARBARA GAULT, INST. FOR WOMEN'S POL'Y RSCH., EQUITY IN INNOVATION: WOMEN INVENTORS AND PATENTS 11 (2016), https://iwpr.org/wp-content/uploads/2020/12/C448-Equity-in-Innovation.pdf [https://perma.cc/HNU2-36BP] (noting that the difference rate between genders in patent success is less stark than the difference in patent application).

186. *See* Mercedes Delgado & Fiona Murray, *Mapping the Regions, Organizations, and Individuals That Drive Inclusion in the Innovation Economy*, 1 ENTREPRENEURSHIP & INNOVATION POL'Y & ECON. 67, 70 (2022) (finding that while women received about 35 percent of STEM PhDs from 2010–2015, the comparable rate among women inventors was only 10 percent).

The collective experiences of potential inventors can be gleaned from articles and reports, as well as court cases and accounts concerning innovators and authors who are left off patents. Studies of scientific publishing, which shares many similarities with patenting,[187] can also be instructive. So can the extensive social science literature on diversity differences and how they operate in application processes. I draw upon these and related accounts below to reveal the ways in which the definition of inventorship under patent law and mechanics of invention are contributing to a lack of progress in the diversification of inventorship.

Just how leaky is the pipeline between technical worker and inventor? To approximate it, I matched firm-level worker data reported to the Securities and Exchange Commission through EEO-1 reports to women inventor rate data on the top 29 firms published by the USPTO.[188] Although EEO-1 reports are generally not public, there has been growing pressure on companies to increase transparency regarding their diversity and inclusion performance.[189] The comparison is admittedly inexact—the years of coverage are different, and variation in the way that companies report technical workers make direct comparisons between firms difficult.[190] Firm-level differences, for example, regarding who among technical workers realistically is likely to become an inventor, also are not captured. But the story—across industries including tech, biosciences, and aerospace sectors, and settings, both university and corporate—is broadly consistent. Among major patent filers, women are inventing at a fraction of the rate (in many cases less than 50 percent) at which they are employed in technical roles. Figure 1 shows that out of 27 companies, only a handful have achieved parity or show women having greater representation in inventorship

187. Both involve, for example, the submission and evaluation of ideas and naming of collaborators.

188. EEO-1 reports list report the breakdown of male and female "technicians." I also used self-reported data from MIT and Intel in the absence of EEO-1 data. *Campus Diversity*, MASS. INST. TECH.: INST. RSCH., https://ir.mit.edu/diversity-dashboard (last visited June 19, 2024); *Global Diversity and Inclusion*, INTEL, https://www.intel.com/content/www/us/en/diversity/diversity-at-intel.html [https://perma.cc/7APW-8PUC].

189. Thomas Bourveau, Rachel W. Flam & Anthony Le, *Behind the EEO Curtain*, CLS BLUE SKY BLOG (May 31, 2023), https://clsbluesky.law.columbia.edu/2023/05/31/behind-the-eeo-curtain/ [https://perma.cc/2ZCC-8YKC].

190. Further, what qualifies as a "technical worker" is broad, encompassing occupations that require knowledge and manual skill and do not necessarily require a four-year degree; "computer programmers" who plausibly would be eligible to become inventors are included, but so are "engineering aides" or "scientific assistants" who may not carry out inventive activities as part of their jobs. *See* U.S. EQUAL EMP. OPPORTUNITY COMM'N (EEOC), 2022 EEO-5 DATA COLLECTION INSTRUCTION BOOKLET 10 (2022), https://eeocdata.org/pdfs/EEO-5%20Instruction%20Booklet.pdf [https://perma.cc/AR3W-8257]. Further, it may be the case that companies want to increase the diversity numbers they report to the EEOC, and this may also inflate the size of the innovator-inventor gap.

than the technical workforce; and that the average among the remaining 23 firms was around 54 percent. Moreover, the 50 percent figure is generally consistent with company and university self-reports, as well as more systematic studies of academic and industry patenting.[191]

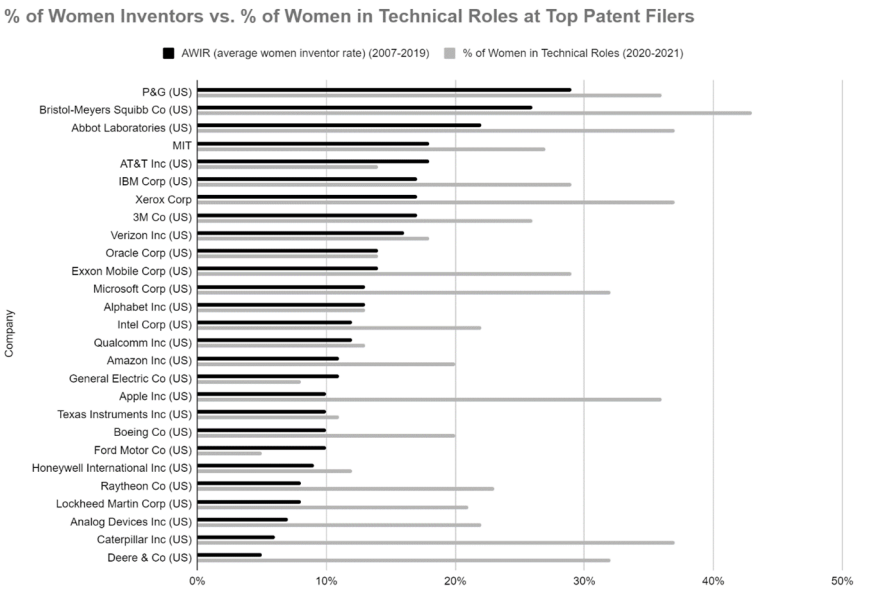


Figure 1: The Innovator-Inventor Gender Gap at Top Patent Filers

The data underscore a few things about the broadened sense of patent progress promoted by this Article. First, despite the strong case for diverse participation, gender disparities remain stark across leading companies. Second, although differences in inventorship reflect educational pipeline effects, there is a distinct gap between who is playing technical roles—and potentially innovating as part of doing so—and who is being named as an inventor *even within the workplace*. And finally, there appear to be significant opportunities to improve

191. *See* Taha, *supra* note 182; Gaudry & Vandsburger, *supra* note 182; SHAW, *supra* note 182; Hanes et al., *supra* note 182; *USIPA Applauds Diversity Pledge Update*, LENOVO STORYHUB (Sept. 27, 2022), https://news.lenovo.com/pressroom/press-releases/usipa-applauds-diversity-pledge-update [https://perma.cc/RQH7-ZKGY] (reporting that women at Lenovo and Meta patented at 66 percent and 71 percent of their employment rate, respectively); Waverly W. Ding, Fiona Murray & Toby E. Stuart, *Gender Differences in Patenting in the Academic Life Sciences*, 313 SCIENCE 665, 665 (2006) (reporting that, within a random sample of academics, female faculty patented at about 40 percent the rate of male faculty).

who is participating in invention at the largest filers, with potential ramifications for the direction of innovation.

B. Progress and the Law of Inventorship

1. Lack of Attribution

The Constitution grants Congress the power to promote the progress of science and the useful arts by securing to "inventors" exclusive, yet limited rights. The Supreme Court has held that the term "inventor" need not be "construed in [its] narrow literal sense but, rather, with the reach necessary to reflect the broad scope of constitutional principles."[192] 35 U.S.C. § 100 defines an inventor as "the individual or, if a joint invention, the individuals collectively who invented or discovered the subject matter of the invention."[193] Court decisions have repeatedly confirmed that an inventor must be a natural person[194] who conceives of subject matter that falls within the scope of patentability.

The requirement of conception is met by the formation in the mind of the inventor of a "definite and permanent idea of the complete and operative invention."[195] "Conception is 'the touchstone of inventorship,'" and a person must contribute to this conception of the claimed invention in order to be an inventor.[196] But despite this facially neutral formulation, the construction of inventorship is frequently contested, viewed as "one of the muddiest concepts in the muddy metaphysics of the patent law."[197]

As described earlier, enslaved people, international people, and women were limited in their ability to be named as inventors or own inventions for much of the

192. Goldstein v. California, 412 U.S. 546, 561 (1973).
193. 35 U.S.C. § 100.
194. *See* Thaler v. Vidal, No. 21-2347, slip. op. at 11 (Fed. Cir. Aug. 5, 2022) (confirming that only natural persons can be inventors); *see also* David L. Schwartz & Max Rogers, *"Inventorless" Inventions? The Constitutional Conundrum of AI-Produced Inventions*, 35 HARV. J.L. & TECH. 531, 535 (2022). Indigenous communities that steward shared knowledge and innovation also have difficulty meeting patentability requirements. *See* Marcia Ellen DeGeer, *Biopiracy: The Appropriation of Indigenous Peoples' Cultural Knowledge*, 9 NEW ENG. J. INT'L & COMP. L. 179, 184 (2003).
195. Burroughs Wellcome Co. v. Barr Lab'ys, Inc., 40 F.3d 1223, 1228 (Fed. Cir. 1994).
196. Bd. of Educ. *Ex rel.* Bd. of Trs. of Fla. State Univ. v. Am. Bioscience, Inc., 333 F.3d 1330, 1337 (Fed. Cir. 2003) (quoting *Burroughs*, 40 F.3d at 1227).
197. Michael A. Whittaker & Richard J. Warburg, *What Is Sufficient to Show Possession of an Invention in Biology and Chemistry?*, 14 EXPERT OP. ON THERAPEUTIC PATS. 593, 593 (2004) (quoting Jamesbury Corp. v. United States, 518 F.2d 1384, 1396 (Fed. Cir. 1975)).

first century of the patent system.[198] But while many earlier restrictions have fallen away, the hierarchical nature of inventorship—which distinguishes conceptualizer-inventors from non-inventor contributors—has remained. Liza Vertinsky has argued, persuasively, that this model of inventorship neglects the social contexts in which innovation is increasingly happening.[199] Because while an inventor is someone who forms a definite and permanent idea of an invention, under the current law an inventor is not someone who, without more, reduces an invention to practice by exercising ordinary skill, or performs experiments, or adds important but obvious elements to the invention.[200] As such, the law currently excludes from inventorship parties who have put in valuable time, resources, and even ingenuity to realize an invention.[201] Yet the iterative and increasingly collaborative nature of innovation means that power dynamics and traditionally gendered roles may color the determination, as described below.

Technologies that range from the paper bag and wireless communication to light pulses and the structure of DNA—and, allegedly, the technology CRISPR—have all involved claims of men taking credit for the inventions of women.[202] In the book *Feminine Ingenuity*, a history of female invention, Anne Macdonald describes the various reasons why women have been left off of inventions, ranging from a lack of indisputable evidence of their critical suggestions and contributions,[203] to the "giving" of their ideas to male relatives, to the outright

198. *See supra* Part I.B.
199. Liza Vertinsky, *Boundary-Spanning Collaboration and the Limits of Joint Inventorship Doctrine*, 55 HOUS. L. REV. 401, 406–07 (2017).
200. *See* Patrick G. Gattari, *Determining Inventorship for US Patent Applications*, 17 INTELL. PROP. & TECH. L.J. 16, 16–17 (2005).
201. *See* Eugene C. Rzucidlo & Dorothy R. Auth, *Will the Real Inventor Please Stand Up?*, 14 NATURE BIOTECHNOLOGY 358, 358 (1996). Dan Burk has similarly argued that patent law disfavors the more "intuitive" or "emotive" rather than "analytical" or "rational" ways that women have been socialized to approach problems. *See* Dan L. Burk, *Diversity Levers*, 23 DUKE J. GENDER L. & POL'Y 25, 31 (2015).
202. *See* Chien, *supra* note 19, at 48 n.253. The film HIDDEN FIGURES and novels of author Marie Benedict have also sought to tell the story of innovators like Katherine Johnson, Rosalind Franklin, and Mileva Einstein whose contributions to major inventions have often gone unrecognized. *See From Hidden to Modern Figures*, NASA (Jan. 19, 2024), https://www.nasa.gov/from-hidden-to-modern-figures [https://perma.cc/ES2G-JFTF]; *About Marie Benedict*, MARIE BENEDICT, https://www.authormariebenedict.com/about-marie.html [https://perma.cc/5K3J-9VCT].
203. MACDONALD, *supra* note 46.

appropriation of their inventive work by men.[204] The distinction between these scenarios is often not clear.

2. Omitting Authors as Inventors

In one high-profile case, Joany Chou, a postdoctoral fellow, sued her former University employer and mentor for patenting her gene-discovery work without informing her, even though she was the first author in the corresponding paper.[205] According to a follow-up report in *Science*, three of the other researchers believed she had incorrectly been left off the patent.[206] But a lower court dismissed the claim for correction of inventorship on the basis of a lack of standing since Chou had assigned her rights to the invention to the University as part of her employment agreement.[207] Citing the continued financial and reputational interest the plaintiff had in the correct inventorship, the Federal Circuit reversed,[208] and Chou's name now appears on the patent.[209]

While this example is anecdotal, a few studies have taken a more comprehensive view. A recent study in the journal *Nature* by Matthew Ross and his colleagues investigated the extent to which differences in female and male patenting and publication were due to differences in productivity or acknowledgement.[210] Analyzing data on over 100,000 researchers and their related patents and publications, the researchers found women were less likely to be named as authors on articles or as inventors on patents, despite doing the same amount of work.[211] Using detailed administrative records, their study was able to control for position, seniority, and other factors that might plausibly explain differences in publication and patenting patterns.[212] Evidence of the credit gap was

204. *Id.* at 49, 291–92 (describing a 1923 Department of Labor report that described the practice of women allowing their male relatives to perfect their ideas and secure patents, as well as an earlier report by Matilda Gage that also described men patenting women's inventions).
205. *See* Eliot Marshall, *Patent Suit Pits Postdoc Against Former Mentor*, 287 SCIENCE 2399, 2399–400 (2000).
206. *See id.* at 2400–01.
207. *See* Chou v. Univ. of Chi., 254 F.3d 1347, 1354 (Fed. Cir. 2001).
208. *Id.* at 1359.
209. *See 07/579,834 | 8235: Recombinant Herpes Simplex Viruses Vaccines and Methods*, USPTO: PATENT CENTER, https://patentcenter.uspto.gov/applications/07579834 [https://perma.cc/P4MB-QRW3].
210. *See generally* Matthew B. Ross, Britta M. Glennon, Raviv Murciano-Goroff, Enrico G. Berkes, Bruce A. Weinberg & Julia I. Lane, *Women Are Credited Less in Science Than Men*, 608 NATURE 135 (2022).
211. *Id.* at 135.
212. *Id.* at 138.

present in almost all research fields and career stages.[213] Though the report focused on women, the authors observed similar patterns among other marginalized groups in science.[214] The researchers speculated that much of the gap existed because the contributions of women were "often not known, not appreciated or ignored."[215]

Another set of studies has considered the role of power dynamics in patent attribution. One study, based on structured interviews of innovators, found that women in particular reported "experiences of being left off a patent," and that being included depended on the willingness of their superiors to advocate for them.[216] Another report by Lissoni and co-authors analyzed hundreds of patent-paper pairs involving authors that were left off of related patents.[217] They found junior and female co-authors at greater risk of being excluded from inventorship than senior and male co-authors, even after controlling for other factors.[218] A similar, smaller study of inventor-author pairs observed that industry-inventors had a tendency to exclude co-authors from academia on corresponding industry-owned patents, which in turn reflected funding-related power dynamics.[219] Because inventorship is evaluated with respect to the invention as claimed,[220] and the claims of a patent typically evolve during the application process, a party seeking to leave off another inventor can do so by changing the claims of the patent to exclude certain subject matters.

These studies suggest that who gets named on a patent is not just about who meets the legal definition, but also about the decisions of those in power. For example, the omission of nonprofit authors on corporate inventions continues to

213. *Id.* at 138–39.
214. *See* Holly Else, *'Ignored and Not Appreciated': Women's Research Contributions Often Go Unrecognized*, NATURE (June 22, 2022), https://www.nature.com/articles/d41586–022–01725–9 [https://perma.cc/6HFB-A52W].
215. *Id.*
216. ELYSE SHAW & HALIE MARIANO, INST. FOR WOMEN'S POL'Y RSCH, TACKLING THE GENDER AND RACIAL PATENTING GAP TO DRIVE INNOVATION 3 (2021), https://iwpr.org/wp-content/uploads/2021/07/Key-Findings_Tackling-the-Gender-and-Racial-Patenting-Gap.pdf [https://perma.cc/JU4P-QXLR].
217. Francesco Lissoni, Fabio Montobbio & Lorenzo Zirulia, *Misallocation of Scientific Credit: The Role of Hierarchy and Preferences*, 29 INDUS. & CORP. CHANGE 1471, 1471 (2020).
218. *Id.*
219. Philippe Ducor, *Coauthorship and Coinventorship*, 289 SCIENCE 873, 875 (2000) (reporting that out of seven papers coauthored by individuals from academia and from industry, corresponding industry-owned patents named no non-industry inventors).
220. *See, e.g.*, *In re* VerHoef, 888 F.3d 1362, 1366–67 (Fed. Cir. 2018) (emphasis added) (asserting that a person who "share[s] in the conception of [a] *claimed invention* . . . is a joint inventor" of that invention).

be a sore point, arising recently in high-profile cases involving the exclusion of government researchers on COVID-19 vaccines and medicines.[221]

These cases underscore that in comparison to authorship, which is generally viewed as relatively more flexible and inclusive,[222] inventorship is a rigid concept that is often exclusionary in practice. In combination with what some have observed as women's tendency to understate their contributions relative to men,[223] those within the lower ranks in an organization have a greater risk of being relegated to a non-inventing, fungible "pair of hands."[224] Whether in any particular case it may be the exacting and outdated construct of inventorship, the power dynamics at play, or sharp claim drafting practices,[225] the current law results in the failure of many who contribute to innovation—in particular, women and more junior innovators—to be recognized as inventors.

C. Progress and the Mechanics of Inventorship

Even when the legal requirements are met, inventorship does not necessarily follow. In contrast to copyright, which vests upon the creation of protectable

221. *See, e.g.*, Heidi Ledford, *What the Moderna-NIH COVID Vaccine Patent Fight Means for Research*, 600 NATURE 200, 200–01 (2021) (describing the exclusion of NIH researchers from vaccine patents filed by Moderna); Justin Hughes & Arti K. Rai, *Acknowledging the Public Role in Private Drug Development: Lessons From Remdesivi*r, STAT (May 8, 2020), https://www.statnews.com/2020/05/08/acknowledging-public-role-drug-development-lessons-remdesivir [https://perma.cc/LU4Y-YLY4] (describing the exclusion of government scientists and co-authors on patents for the antiviral drug remdesivir).

222. *See* Rzucidlo & Auth, *supra* note 201, at 358 (describing authorship standards as significantly relaxed as compared to inventorship standards), *accord* Lissoni et al., *supra* note 217, at 1472; Ducor, *supra* note 219, at 873. In comparison, under the Copyright Act, copyright subsists in "original works of authorship fixed in any tangible medium of expression," setting a lower bar than for inventorship in patent law. 17 U.S.C. § 102(a).

223. *See, e.g.*, MILLI ET AL., *supra* note 185, at 27 (describing male academics as more likely to characterize their work using "sweeping terms that gave the impression of 'a grand research agenda,'" whereas female academics were more likely to focus on the details, "perhaps assuming that the value of their work would speak for itself").

224. "Pair of hands" is a term that the Federal Circuit used to describe non-inventors. *See* Burroughs Wellcome Co. v. Barr Lab'ys, Inc., 40 F.3d 1223, 1230 (Fed. Cir. 1994) (finding that despite *not* being a mere "pair of hands," government scientists were also not considered inventors, because the invention had been conceived before they became involved in proving the invention worked).

225. In a patent application, the claims define the scope of the protection sought in the patent application. Sharp claim drafting practices, as such, include one person drafting patent claims in a way that intentionally excludes the contribution of a potential inventor.

works immediately,[226] becoming an inventor requires one to apply and endure an examination process before being awarded a patent. Below, I discuss how the mechanics and costs of doing so, like the legal standards of inventorship and their application, have contributed to the innovator-inventor gap.

Although the details vary by setting, to become an inventor, one must generally start by self-identifying as a potential inventor and disclosing one's inventive idea (see Figure 2: "Idea Disclosure"). The resulting invention disclosure is evaluated—in larger settings usually through a committee or formal process—before being passed over or used as the basis of a patent application,[227] with filing rates on submissions ranging in the 20 to 60 percent range[228] (see Figure 2: "Patent Application"). Patent applications that are submitted to the Patent Office are likely to be rejected, often several times, during a process called patent prosecution (see Figure 2: "Patent Prosecution") before they are, in most cases, granted[229] (see Figure 2: "Patent Grant").

Figure 2: The Inventorship Pipeline
Idea Submission → Patent Application → Prosecution → Grant

Among the few available accounts of the inventorship pipeline from innovator to inventor, a few stand out. One is from the Diversity in Innovation initiative by the Women in IP Committee of the Intellectual Property Owners Association (IPO), a trade association of intellectual property-focused companies, law firms, and service providers.[230] Since 2019, the IPO has maintained a diversity in invention "toolkit" for soliciting, collecting and disseminating best practices to

226. Works are considered under copyright protection upon creation and fixation in a tangible medium, and no registration is required, though it will be required before enforcement in a court of law. *See Copyright in General*, U.S. COPYRIGHT OFF., https://www.copyright.gov/help/faq/faq-general.html [https://perma.cc/Q4WY-L8Y9].

227. *See, e.g.*, LAURA NORRIS, MARY FULLER, JOY PEACOCK & SYDNEY YAZZOLINO., HIGH TECH L. INST., DIVERSITY IN INNOVATION BEST PRACTICES GUIDE 6 (2021), https://digitalcommons.law.scu.edu/cgi/viewcontent.cgi?article=1992&context=facpubs [https://perma.cc/4K3Q-MRCV].

228. *Compare* HALL, *supra* note 184, at 1 (describing a mean filing rate of 60 percent within universities), *with* Michelle R. Henry, Mildred K. Cho, Meredith A. Weaver & Jon F. Merz, *DNA Patenting and Licensing*, 297 SCIENCE, 1279, 1279 (2002) (reporting patent filing rates at premier universities, from 1986 to 1990, of 15 to 17 percent).

229. *See* SUBRAMANI ET AL., *supra* note 172, at 1, 4.

230. *See About IPO*, INTELL. PROP. OWNERS ASS'N, https://ipo.org/index.php/about [https://perma.cc/K2BG-U2WV].

achieve greater participation in invention (hereinafter IPO Toolkit).[231] Additionally, in 2020, the regional offices of the USPTO—in conjunction with an academic institution—held roundtable sessions with dozens of in-house counsel and attorneys to discuss ways to increase diversity in invention and innovation, resulting in a published "Best Practices" guide.[232] These efforts build on earlier ones, such as the creation of a Women Inventors Committee in 2013 by the Association of University Technology Managers (AUTM) to increase the participation of academic women in innovation.[233]

Though these initiatives are meant to suggest and lead to corrective action, they also provide insights into the experiences of female, first-time, and underrepresented innovators. Though the chance that any individual diverse innovator faces a specific obstacle to participation at any particular milestone may be small, the cumulative effect of these disparities contributes to the observed innovator-inventor gap.

1. Barriers to Idea Disclosure

Figure 3: The Inventorship Pipeline
Idea Submission → Patent Application → Prosecution → Grant

As described above, the invention process generally starts with an innovator devising and disclosing an idea for consideration. A number of well-documented diversity differences, however, can make this initial step more difficult for innovators from underrepresented groups. While hardly exhaustive, differences in awareness, inventorship identity, and confidence appear to span the settings of innovation.

a. Lack of Awareness and Comfort With Inventor Identity

To submit an "invention disclosure" requires a person to be aware of the option and desirability of doing so. But while the same legal standard applies to all, the awareness, relatability and desirability of being an inventor differs across

231. *See* THE IPO WOMEN IN IP COMM., INTELL. PROP. OWNERS ASS'N, DIVERSITY IN INNOVATION TOOLKIT (2019) [hereinafter IPO TOOLKIT], https://ipo.org/wp-content/uploads/2023/04/Toolkit-Final-delivered-1.28.22-standard-pdf.pdf [https://perma.cc/A253-PV4S].
232. *See* NORRIS ET AL., *supra* note 227, at 2.
233. Jean Baker, Linda Suzu Kawano & Nichole Mercier, *Realizing Potential: Keys to Nurturing Female-Led Innovation*, 9 TECH. TRANSFER TACTICS, May 2015, at 65, 65.

demographic groups. Raj Chetty and his co-authors have documented the lack of "exposure" that girls and low-income and minority children have to inventing, and how that lack of exposure explains much of the gap in inventing.[234] A general lack of resources, role models, trusted mentors, and knowledge of the value of innovation and invention—or, in so many words, "invention capital"[235]—limits the diversification of patenting. The invention capital gap is broad and pervasive, reflecting historical, structural, socioeconomic, and geographic disparities in innovation and invention.[236]

Even within well-resourced settings, strikingly, the awareness gap appears to be present. Surveys conducted at innovative firms suggest that members of underrepresented groups are less aware of invention processes, and less likely to have mentors to seek out when they are unsure of the worthiness of their inventions.[237] The IPO Toolkit describes how lack of awareness can have multiple root causes at the firm level.[238] A lack of training or mentoring, processes that are too hidden, too complex, or insensitive to the unique needs of diverse inventors, and a lack of diverse outside counsel have all been cited as contributors to low participation.[239]

Part of the challenge appears to be that the construction of inventorship may be alienating, unwelcoming, and intimidating to diverse innovators. As the Best Practices guide finds, "[t]he term 'inventor' may be unrelatable to diverse inventors, in part because the celebrated historical inventors from U.S. history tend to be non-diverse."[240]

In-house counsel at IBM has expressed in a co-authored piece that even at settings like IBM, which has for decades been the most prolific patenter,[241] often

234. Bell et al., *supra* note 18, at 2.

235. Invention capital is a construct that draws upon the concept of social capital into invention and encompasses the various forms of "capital"—financial, relational, informational, and psychological—needed to take advantage of the patent system. Chien, *supra* note 19, at 30–31.

236. *See Enhancing Patent Diversity for America's Innovators: Hearing Before the H. Comm. on Small Bus.*, 116th Cong. 9 (2020) (statement of Janeya Griffin).

237. Colleen Chien & Jillian Grennan, Unpacking the Innovator-Inventor Gap: Evidence From Engineers 18 (March 15, 2015) (unpublished manuscript) (on file with SSRN), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4721522 [https://perma.cc/RN3V-KGAK].

238. IPO TOOLKIT, *supra* note 231, at ch. 3.

239. *Id.*

240. NORRIS ET AL., *supra* note 227, at 6; *accord* IPO TOOLKIT, *supra* note 231, at 42 (noting that "most recognized scientists are male (e.g., Einstein, Steve Jobs, etc.) and often the version of a scientist promoted to kids is male (e.g., 'Bill Nye the Science Guy')").

241. Darío Gil, *How Do You Measure Innovation?*, IBM (Jan. 9, 2023), https://research.ibm.com/blog/Ibm-innovation-2022 [https://perma.cc/WSE8-V6MY] (describing how, for 29 years, IBM has led the United States in patenting).

"demographic groups express the . . . feeling that 'if I thought of it, it can't really be innovative.'"[242] In-house counsel at one company has likewise reported that "many women consider their daily work to be routine and not worthy of intellectual property protection."[243] The idea that inventors must fit a certain profile feeds into misconceptions about invention. Rather than inventing something, diverse inventors within companies have tended to perceive themselves as "just solving a problem," or "just helping on a project."[244] It was only when someone else recognized the invention of these diverse inventors that they themselves realized the significance of their own contribution.[245]

The lack of personal identification with inventorship may be compounded by a seeming lack of correspondence between invention values, which tend to be more individualistic, and problem solving values that advance service and collaboration. One observation from a series of conversations about Black inventorship convened by the Lemelson Center, for example, was that notions of innovation and invention were narrow and atomistic, especially in comparison to the more communal, cooperative view of invention embraced by certain Black innovators.[246]

The IPO Toolkit describes the related desire of diverse employees to not stand out or be perceived as "attention-hogging" when they participate in inventing as another obstacle to participation.[247] The requirements and rewards of inventing, and sense of alignment with the title of inventor, even within a single firm, are not necessarily equally appreciated and may be transmitted by word of mouth and through informal networks. When there is a lack of mentoring or support—for example, through affinity groups—the advantages of dominant groups are intensified.

242. David Kaminsky & Jana Jenkins, *Mentorship Is Viable Solution to Inventor Diversity Crisis*, LAW360 (Sept. 30, 2020), https://www.law360.com/articles/1315039/mentorship-is-viable-solution-to-inventor-diversity-crisis?copied=1 [https://perma.cc/6NGU-NLWE].
243. Taha, *supra* note 182.
244. NORRIS ET AL., *supra* note 227, at 6.
245. *Id.*
246. *Compare Black Inventors & Innovators: New Perspectives*, LEMELSON CTR. (Aug. 3, 2021), https://invention.si.edu/node/29159/p/739-executive-summary [https://perma.cc/82ZN-67W8] (articulating a "Black view of invention and innovation [that] includes an emphasis on aiding the community . . . and promoting cooperation").
247. *See* IPO TOOLKIT, *supra* note 231, at 38.

b. Lack of Confidence

With as few as 20 percent of idea submissions maturing into a patent application,[248] and not all patent applications turning into patents, "failure is an intrinsic part of the invention process."[249] Consequently, fostering a belief that one's idea is worthy and will be well received can be crucial, as this confidence may significantly boost the likelihood of submitting ideas. But various studies have documented the presence of a "confidence gap" between men and women in several domains. For example, Katty Kay and Claire Shipman have shown how, compared to women, men are more likely to consider themselves ready for promotions.[250] At the company Hewlett-Packard, an internal review of personnel records found that men applied for promotions when they possessed only 60 percent of the qualifications listed for the job, while women applied when they believed they met 100 percent of the qualifications.[251] The result of the confidence gap is that while "[u]nderqualified and underprepared men don't think twice," "[o]verqualified and overprepared" women "still hold back."[252] Whether the gap is because of men's greater tendency to self-promote on the one hand,[253] or women's underconfidence and aversion to "tooting one's horn" on the other, is in the eye of the beholder.

A lack of clarity about what is required to invent can intensify the effect of the confidence gap. As the Ross study found, "the rules of credit allocation were . . . unclear and [allocations were] often determined by senior investigators."[254] But such investigators may lack the resources, relationships, wherewithal, or incentives to award credit equitably. When applicants must fill in the gap, confidence matters. For example, a field experiment involving salary negotiation terms in job advertisements found that ambiguous messages tended to lead to higher wages by lower skilled men relative to skilled women, who tended to be

248. Henry et al., *supra* note 228, at 1279 (reporting university patent filing rates as between 15 and 17 percent).
249. Kaminsky & Jenkins, *supra* note 242.
250. Katty Kay & Claire Shipman, *The Confidence Gap*, ATLANTIC (May 2014), https://www.theatlantic.com/magazine/archive/2014/05/the-confidence-gap/359815 [https://perma.cc/7SQ5-FS79].
251. *Id.*
252. *Id.*
253. *See* Christine Exley & Judd Kessler, *Why Don't Women Self-Promote as Much as Men?*, HARV. BUS. REV. (Dec. 19, 2019), https://hbr.org/2019/12/why-dont-women-self-promote-as-much-as-men [https://perma.cc/7UBX-B6CZ]; MILLI ET AL., *supra* note 185, at 27 (describing difference in male and female academic communication patterns).
254. Ross et al., *supra* note 210, at 136.

more cautious.[255] In a similar vein, the IPO Toolkit identifies opaque standards for invention and attribution as a contributor to the participation gap.[256] It recommends ensuring that the process for idea submission is clearly written and easily accessible to everyone in the company, with help available if needed.[257]

An extensive literature has also explored whether there is a gender "competitiveness" gap that stems from differences in risk preferences and personality.[258] The AUTM study cited earlier found that, among academics, patenting and commercialization activities were considered risky and more comfortable for male as compared to female professors.[259] As an analog of the "confidence gap," perfectionism can also inhibit progress in diversifying inventorship. As the IPO Toolkit describes, "perfectionist tendencies can result in women not submitting their ideas for consideration for patenting because 'more data is needed' or the idea is 'not good enough.'"[260] One large data storage company surveyed in-house engineers and asked what they would do if they had an idea that they weren't sure was "good enough" to be patented. The difference in responses was stark: male engineers were 150 percent more likely than women to submit an invention disclosure, even when they were unsure about their ideas.[261] This suggests that the confidence gap observed in employment settings may extend to invention disclosure.

The idea that a lack of confidence in one's idea is inhibiting female participation in invention and innovation is not new. In a comprehensive study

255. *See* Andreas Leibbrandt & John A. List, *Do Women Avoid Salary Negotiations? Evidence From a Large-Scale Natural Field Experiment*, 61 MGMT. SCI. 2016, 2016 (2015) (finding, in a field experiment advertising identical jobs that varied in the negotiability of wages, that women exercised caution in the face of ambiguity whereas men—particularly lower-skilled men—asked for and received higher wages).

256. IPO TOOLKIT, *supra* note 231, at 50.

257. *Id.*

258. *See* Muriel Niederle, *Gender* 107 (NBER, Working Paper No. 20788, 2014), https://www.nber.org/system/files/working_papers/w20788/w20788.pdf [https://perma.cc/TPF7-K3KP] (characterizing gender differences as "large and robust in attitudes to competition"). *But see* Bernd Frick & Katharina Moser, *Are Women Really Less Competitive Than Men? Career Duration in Nordic and Alpine Skiing*, 5 FRONTIERS SOCIO., Jan 20, 2021, at 1, 1 (finding that competitive differences disappear conditional upon selection into highly competitive environments).

259. Baker et al., *supra* note 233, at 68.

260. IPO TOOLKIT, *supra* note 231, at 39.

261. Angela Morris, *Western Digital Uncovered "Root Causes" of Female Innovator Under-Representation, Says IP Chief*, IAM (June 2, 2022), https://www.iam-media.com/article/western-digital-uncovered-root-causes-of-female-innovator-under-representation-says-ip-chief [https://perma.cc/7NQL-NTT5] (describing a survey in which male engineers were "150% more likely than women to submit an invention disclosure, even when they were unsure they ought to disclose their ideas").

published in the 1920s by the Department of Labor, based on a review of 5000 female inventions, the authors concluded that the restrictions society imposed "led women to be timid about even applying for patents for their inventions and fostered their tendency to allow their male relatives, possessed of a 'greater self-confidence born of freedom from restricting customs,' to perfect their ideas and secure the patents for them."[262] This observation underscores the importance of the social contexts of patenting and the potentially detrimental role of seemingly unattainable inventorship standards. Conversely, building women's confidence and helping them overcome perfectionism—for example, through practices like opt-out framing,[263] targeted support structures, greater clarity, and coaching—can make them more cognizant of the quality and importance of their ideas, and more interested in commercialization, with spillovers beyond patenting.

2. Barriers to Patent Application

Figure 4: The Inventorship Pipeline

262. *See* MACDONALD, *supra* note 46, at 292.

263. One idea for achieving greater participation in invention is to make submission the rule rather than the exception. Experimental studies have found that "opt-out framing" (when the default expectation is of participation) rather than "opt-in framing" (when individuals must proactively select into an activity) can reduce gender disparities. In both leadership and task contexts, researchers have documented smaller gender gaps when women were expected to participate rather than given the option to participate or not. *See* Joyce C. He, Sonia K. Kang & Nicola Lacetera, *Opt-Out Choice Framing Attenuates Gender Differences in the Decision to Compete in the Laboratory and in the Field*, 118 PNAS 1, 4 (2021); Nisvan Erkal, Lata Gangadharan & Erte Xiao, *Leadership Selection: Can Changing the Default Break the Glass Ceiling?*, 33 LEADERSHIP Q., Apr. 2022, at 1, 12. How might insights about opt-in versus opt-out framing be applied to invention harvesting processes? As described above, the submission process is generally voluntary, involving providing one's idea for consideration, for example, by answering a set of questions. Akin to raising one's hand in a classroom when a teacher asks a question, an innovator volunteers their potentially patentable ideas in response to an open call. But another way to get patentable ideas for submission is for patent professionals or others to actively harvest them from all potential inventors, similar to using a panel or "on-call" system in a classroom setting. Rather than relying on innovators to volunteer their ideas by "raising their hands," the patent professional or harvester initiates. As such, factors like the time, knowledge, or confidence level needed to start the process are less important. These factors are plausibly relevant not only to female inventors, but also to first-time inventors. If opt-out framing has a similar, positive impact on reducing disparities in idea submission as it has had in other contexts, one would expect opt-out, attorney-initiated idea harvesting processes to be marked by greater diversity than standard, opt-in, or innovator-initiated harvesting. Emerging work provides suggestive evidence that opt-out framing can help in invention contexts: in two separate settings, the participation of women and underrepresented groups were 5 percent to 36 percent higher under attorney-initiated vs. applicant-initiated disclosures, controlling for quality and other factors. *See* Chien & Grennan, *supra* note 237.

Idea Submission → **Patent Application** → Prosecution → Grant

After an idea is submitted, in many settings, the resulting invention disclosure is evaluated by a reviewer or committee of reviewers tasked with deciding whether to file a patent based on the idea.[264] Rates of filing based on submitted ideas range widely based on setting, but are in the 20 to 40 percent range.[265] Filing for a patent generally costs $10,000 to $20,000 in legal fees alone,[266] and budgets are limited. Once a patent application process is submitted, the evaluation process begins again, but this time at the Patent Office, where an application is routed to an Examiner who will then evaluate and typically initially "reject" the patent application.[267] This process will generally repeat itself several times before grant, but at each phase, the patent applicant has the opportunity to either abandon the application or advance it.

The decision to file and move forward (or not) on an application is in theory based on technical (such as novelty) and market considerations, but bias can infect the process. Sometimes this bias has been more explicit. For example, a nineteenth-century patent commissioner once infamously stated: "If it had been known [that it was] the invention of a woman, it would have been regarded as a failure."[268] Numerous authors have discussed the historical phenomenon of "masking" one's identity to increase the odds of patenting and commercial success.[269] As described below, the possibility of bias against female applicants has been suggested as present in the evaluation of patent applications.[270] These

264. Chien & Grennan, *supra* note 237, at 40 fig. 1.
265. This analysis is based on confidential information disclosure databases from firms. *Compare* HALL, *supra* note 184, at 1(describing a mean filing rate within universities of 60 percent), *with* Henry et al., *supra* note 228, at 1279 (reporting that between 1986 to 1990, Stanford, Columbia, and the University of California system had patent filing rates between 15 and 17 percent).
266. *See* Krajec, *supra* note 160.
267. For a description of the process, see SUBRAMANI ET AL., *supra* note 172, at 4.
268. MACDONALD, *supra* note 46, at xx (alteration in original).
269. *See, e.g.*, Kara W. Swanson, *Centering Black Women Inventors: Passing and the Patent Archive*, 25 STAN. TECH. L. REV. 305, 349–52 (2022) (relaying stories like that of Black inventor Henry Boyd, who patented his bedstead under the name of a white man and built a successful business to white buyers unaware of his racial identity). In publishing, female authors ranging from Emily Brontë (also known as Ellis Bell) to Joanne Rowling (J.K. Rowling) masked their names at times, it is speculated, to avoid gender bias. *See* Nettie Finn, Pseudonymous Disguises: Are Pen Names an Escape From the Gender Bias in Publishing? 35–38 (2016) (Honor Scholar Thesis, DePauw University), https://scholarship.depauw.edu/cgi/viewcontent.cgi?article=1044&context=studentresearch [https://perma.cc/2BFJ-KQ2E].
270. *See infra* Part II.C.3.

suggestions build on studies that have established the presence of implicit bias against women and minorities in legal and employment contexts,[271] as well as gender bias and stereotyping along the innovation pipeline.[272]

There do not appear to be any published studies on the extent to which rates of patent filing on invention disclosures vary by demographic or other group. A recent study published in the Proceedings of the National Academy of Sciences, however, found a large "take-up gap" when it comes to novel ideas in STEM that are presented by gender and racial minorities as compared to the presentation of ideas by individuals in the majority.[273] The finding that novel ideas in innovation are less likely to be favorably received when presented by underrepresented innovators may have implications for patent idea take-up, too. The IPO Toolkit and Best Practices Guide both acknowledge the possible role of "unconscious bias" in patent application evaluation within firms and recommend taking steps to ensure that disclosure reviews are carried out on fair and impartial terms. In the Best Practices Guide, blinding or double blinding the invention disclosure and review process and removing the inventor and reviewer identities are recommended.[274] The IPO Toolkit also recommends training to remove unconscious biases as well as ensuring diversity on the committee of reviewers.[275] But bias can manifest not only in the pre- but also the post-applicant submission phase of inventing, as explored next.

3. Barriers to Patent Grant and the "Patent Grant Gap"

Figure 5: The Inventorship Pipeline
Idea Submission → Patent Application → **Prosecution** → Grant

271. *See* Jaclyn Alcantara, *The Impact of Implicit Bias on Female Patent Applicants in an Age of Increasingly Vague Patent Standard*s, 88 UMKC L. REV. 161, 167–69 (2019) (describing studies of implicit bias in prosecution, jury, and hiring contexts).
272. *See* SUBRAMANI ET AL., *supra* note 172, at 1–2, 5 (describing the lower success rate of patent applications by inventors with female-sounding first names, which could be the product of implicit bias).
273. Hofstra et al., *supra* note 13, at 9284 (finding, based on an analysis of doctoral recipients from 1977 to 2015, novel contributions to be taken up at significantly lower rates when presented by gender and racial minorities).
274. NORRIS ET AL., *supra* note 227, at 12. But the efficacy of this process has not been proven—for example, a study of French name-blinding found that the process actually hurt minority applicants. *See* Luc Behaghel, Bruno Crépon & Thomas Le Barbanchon, *Unintended Effects of Anonymous Résumés*, 7 AM. ECON. J.: APPLIED ECON. 1, 1 (2015).
275. IPO TOOLKIT, *supra* note 231, at 37; *see also* LISA D. COOK, HAMILTON PROJECT, POLICIES TO BROADEN PARTICIPATION IN THE INNOVATION PROCESS 14–15 (2020).

a. Potential Bias in the Evaluation of Patent Applications

After a patent application is submitted, the likelihood of it becoming a granted patent has generally depended, to a degree, on the demographic and economic profile of its inventor(s). Applications by female inventors are about 7 percent less likely to be granted and otherwise fare worse, on average, than applications by male inventors.[276] Minority inventors also do worse,[277] as do small and micro entities: after ten years, 73 percent of large-entity applications matured into patents, but only 51 percent of small or micro entity applications did, contributing to a large "patent grant gap."[278]

The analyses referred to above are descriptive, not causal, and any number of factors could contribute to a patent application failing to mature into a patent. The quality of the underlying application might be too low and the subject matter unpatentable, the technology area might become obsolete or not within the company's focus for patenting, a company may pivot, and grant rate trends may become stricter over time, to name a few. But in terms of inputs, two are most salient: (1) the examiner's evaluation, and (2) the patent applicant's response to the examiner's evaluation and her decision to go forward or not in the face of rejection.[279]

Studies have considered the extent to which success at the Patent Office is influenced by the gender of the inventors, as detectable based on inventor's first names.[280] Kyle Jensen and his co-authors found that while applications that listed

276. *See* Fechner & Shapanka, *supra* note 185, at 728–29; *see also* Kyle Jensen, Balázs Kovács & Olav Sorenson, *Gender Differences in Obtaining and Maintaining Patent Rights*, 36 NATURE BIOTECHNOLOGY 307, 307 (2018) (documenting a 7 percent grant gap after controlling for technology); W. Michael Schuster, R. Evan Davis, Kourtenay Schley & Julie Ravenscraft, *An Empirical Study of Patent Grant Rates as a Function of Race and Gender*, 57 AM. BUS. L.J. 281, 305 (2020) (finding, across five models, lower patent grant rates for women, Black, Asian, and Hispanic inventors); SUBRAMANI ET AL., *supra* note 172, at 2.

277. Schuster et al., *supra* note 276, at 305.

278. Jason Rantanen, *Guest Post: Advancing Inclusive and Entrepreneurship Through the Patent System*, PATENTLY-O (Nov. 4, 2020), https://patentlyo.com/patent/2020/11/advancing-innovation-entrepreneurship.html [https://perma.cc/F4PV-33UU].

279. Depending on the technology, the combined fees to the attorney and Patent Office combined for responding to an office action, are about 25 to 40 percent of the initial filing fees. Krajec, *supra* note 160.

280. The gender of a person can be inferred, to a degree, based on someone's first name. Some names, like Jill, are easier to distinguish; others are more difficult, and require context. Andrea is a woman's name in American contexts, but a man's name in Italy; moreover, Kunnath is a little-known woman's name. *See* Jensen, *supra* note 276, at 309.

women inventors generally did worse than applications that listed male inventors in general, highly feminine names were less likely to have their patents granted than those with female, but androgynous sounding names.[281] These differences, other researchers found, were more likely to reflect implicit bias at the Patent Office than at the applicant company, where interactions between the patent team and inventor were more likely to be face to face.[282]

While observational, these findings of potential gender bias based on first names resemble those of an experiment published by the Proceedings of the National Academy of Sciences. Scientists were asked to rate applicants for a position as a lab manager based on application materials, half of which were labeled with a male applicant's name and half with a female name.[283] The female applicants were rated as less competent by a majority of reviewers, even though the application materials, other than the names, were identical.[284] This rating gap was observed even when the reviewers themselves were women.[285]

b. Applicant Attrition and Responses to Rejection

Another major source of the patent grant gap is differential responses, not only by evaluators in *giving* rejections, but also by applicants and their representatives in *responding to* rejections.[286] A study by the USPTO of low-resource filers has documented major differences in the quality of representation associated with small and micro entities—they tend to be "less experienced (based on patent applications submitted to the USPTO), have lower allowance rates, and

281. *Id.* (women with unusual names had a 2.8 percent lower probability of being granted a patent than male applicants, whereas the women with common female-associated names had an 8.2 percent lower probability of being granted a patent); *see also* Schuster et al., *supra* note 276, at 310 (finding inventors with highly feminine names to be 81 percent as likely to have their patents granted as those with androgynous names). No parallel correlation was found between more racialized names and worse outcomes. *Id.* at 282–83.

282. Id. at 282–83, 286.

283. Corinne A. Moss-Racusin, John F. Dovidio, Victoria L. Brescoll, Mark J. Graham & Jo Handelsman, *Science Faculty's Subtle Gender Biases Favor Male Students*, 109 PNAS 16474, 16475 (2012).

284. *Id.*

285. *Id.* at 16474.

286. The importance of paying attention to how applicants respond to rejection is underscored by studies that show that credit worthy BIPOC business owners are less likely to apply for loans than their white counterparts, attributable to their anticipation of rejection. *See* Eric Goldschein, *Racial Funding Gap Shows Black Business Owners Are Shut Out From Accessing Capital*, NERDWALLET (Jan. 8, 2021), https://www.nerdwallet.com/article/small-business/racial-funding-gap [https://perma.cc/Z9LK-ZQ2G].

make substantially more changes to their applications during the examination process."[287]

These differences intersect with gender as well: building upon an existing literature about how men and women respond differently to rejection,[288] a study of patent examination data by Gauri Subramani and her colleagues found female inventor applicants much less likely to persist in the face of initial examiner rejections than their male counterparts. This difference was so substantial that it "account[ed] for more than half of the overall gender gap in issued patents."[289] Digging into the data, the authors further concluded that while the inventor's name didn't make a difference in terms of ultimate success (contrary to earlier cited studies), the support of a firm *did* make a difference: female inventors that enjoyed the support of a company were much more likely to proceed beyond an initial rejection than those without it.[290] The researchers speculated that the resources of institutional support—in the form of paying for associated costs and managing the application process—shielded the inventors from the financial and psychological burdens of continuing with an application in the face of rejection.[291]

Assistance from the Patent Office, it appears, can also effectively stem attrition and close gaps. In 2014 and 2015, the USPTO randomly selected a cohort of self-represented applicants to receive extra support—including education and one-on-one assistance from experienced and specifically trained patent examiners—to overcome office action rejections through the auspices of a "pro se" (self-represented) unit.[292] A subsequent evaluation found that women applicants were 11 percentage points more likely to benefit from the assistance.[293] Further, the benefits were largest "for new U.S. inventors, and in technology areas where women had the worst relative outcomes."[294]

These insights are broadly consistent with the commonsense recommendations of the Best Practices Guide to provide more support and information to first-time and underrepresented innovators. To "take some of the potential intimidation out of the patent approval process," it recommends having

287. Pairolero et al., *supra* note 152, at 4.
288. SUBRAMANI ET AL., *supra* note 172, at 2–3.
289. *Id.* at 1.
290. Id. at 2–3, 12.
291. *Id.* at 12–13.
292. Pairolero et al., *supra* note 152, at 7–10. *See also Filing a Patent Application on Your Own*, USPTO, https://www.uspto.gov/patents/basics/using-legal-services/pro-se-assistance-program [https://perma.cc/XZ2V-G5RA].
293. *Id.* at 3.
294. *Id.* at 1.

a "supportive third party [be] responsible for presenting [the idea] to the [patent] committee."[295] Akin to the institutional support described above, third parties can then assume the burden of advocating for the invention. The Guide further recommends taking measures to address the "black box" nature of patent go/no-go decisions to advance diversity.[296] These include greater transparency and substantive feedback,[297] in order to remove speculation as to why a patent was or wasn't filed on. This recommendation is akin to demystifying noisy feedback, which studies have found men and women respond to differently.[298] To overcome interim "failure"—whether in the pre-application process within firms or in the patent examination process at the USPTO—information and support appear to be helpful not only in general, but also specifically for female innovators.

D. Summary of the Inventorship Pipeline

The accounts above provide a glimpse into the complex series of events that line the path from innovator to inventor. While Part I of this Article discusses the patent system's gradual shift in orientation from excluding to including a diversity of innovators, the paragraphs above illuminate how the law and mechanics of inventorship operate to limit who becomes an inventor. Inventorship decisions, particularly those that are made before the point of patent application, have been largely outside the view of patent policymakers and the public. But efforts to make progress in the diversification of inventorship can benefit from an understanding of how inventorship law and practice are contributing to the innovator-inventor gap. The next Part considers steps the courts and USPTO could take to make this progress.

III. MAKING PROGRESS

This Article has made the case for redefining patent progress to explicitly include the promotion of a broad and diverse set of innovators and inventors. A number of developments are aligned with doing so. The CHIPS and Science Act

295. NORRIS ET AL., *supra* note 227, at 15.
296. *See id.*
297. *Id.*
298. Gauri Kartini Shastry, Olga Shurchkov & Lingjun Lotus Xia, *Luck or Skill: How Women and Men React to Noisy Feedback*, 88 J. BEHAV. & EXPERIMENTAL. ECON., no. 101592, Aug. 10, 2020, at 1, 2 (finding that even among high-skill workers, men are more likely to consider negative feedback from supervisors as bad luck, whereas women tend to see it as confirmation of a lack of their own ability).

directs billions of dollars into boosting not only regional innovative capacity, but also the participation of women and underrepresented minorities in innovation.[299] The recently enacted Unleashing American Innovators Act, strikingly, directs the USPTO to keep in mind "individual inventors, small businesses, veterans, low-income populations, students, rural populations, and any geographic group of innovators that the Director may determine to be underrepresented in patent filings" in outreach, patent examiner and administrative judge retention, and satellite office location.[300] The USPTO, under the leadership of Director Kathi Vidal and the Council for Inclusive Innovation, has launched a host of initiatives intended to get talent "off the bench," and into the innovation ecosystem.[301] More than fifty companies, law firms, and others, including some of the largest patent filers, have publicly signed a "diversity pledge" to take action to narrow intrafirm inventor diversity gaps, and many have created programs to take steps to do so.[302] But unless the root causes of the existing gaps—in patent application and grant—are addressed, current patterns are likely to persist and the potential to make progress will remain unrealized. Below, I discuss suggestions to (1) reconsider inventorship law and policy; (2) institutionalize and strengthen the Patent Office's commitment to progress; (3) create a public-private "innovator diversity pilots clearinghouse" to test policy and practice interventions for making progress; and (4) establish a periodic, innovator-

299. CHIPS Act of 2022, §§ 10321–10330, Pub. L. No. 117-167, 136 Stat 1366, 1537–51 (specifying investment in research to increase the participation of women, underrepresented minorities, and rural areas in innovation). Title V of the Act, "Broadening Participation in Science," further provides, inter alia, for flexibility for caregivers (§ 10501), collection of demographic data (§ 10502, § 10504), best practices in advancement of women and underrepresented minorities (§ 10505), and Research in Rural STEM Education (Subtitle B) and Minority-Serving Institution (MSI) achievements (§ 10521). CHIPS Act of 2022, tit. V, §§ 10501–10521.

300. Unleashing American Innovators Act of 2022, S. 2273, 117th Cong. § 3(c) (2d Sess. 2022).

301. These initiatives include an expedited examination pilot program that provides fast-track examination to eligible first-time filers, the expansion of free legal services, and an innovation internship program. *See Council for Inclusive Innovation (CI2) Initiatives*, USPTO, https://www.uspto.gov/initiatives/equity/ci2/initiatives [https://perma.cc/VZJ6-BZ8Z]; Kathi Vidal, Under Sec'y of Com. for Intell. Prop. & Dir. of USPTO, Remarks by USPTO Director Kathi Vidal at Women in IP: Diversity and Inclusion (Mar. 27, 2023) (transcript available at the USPTO website), https://www.uspto.gov/about-us/news-updates/remarks-uspto-director-kathi-vidal-women-ip-diversity-and-inclusion [https://perma.cc/JHL3-L8PZ] (describing UPSTO mentoring initiatives and the USPTO Director's exhortation that "we need to get everybody off the bench").

302. *Increasing Diversity in Innovation: Pledge Companies*, INCREASING DIVERSITY IN INNOVATION, https://increasingdii.org/companies [https://perma.cc/C6QU-2XMS]. Among its members, the pledge lists top patent filers Google (Alphabet Inc.) and Microsoft, who are ranked within the top 20 companies that file patents. *See 2024 Patent 300 List*, HARRITY LLP, https://harrityllp.com/patent300 [https://perma.cc/KWQ5-RLTJ].

inventor survey for informing the design of policies and practices for making innovation more inclusive.

A. Reconsidering Inventorship Law and Policy

What would reconsidering patent law consistent with the promotion of a diversity of innovators, and not just innovation, look like? Below, I consider this question in the context of the law and administration of inventorship. As discussed in the previous Part, while the benefits of being named on a patent are significant, the share of inventors that are women or underrepresented minorities remain small. To broaden inventorship, I discuss ways the courts and the USPTO can shore up inventorship integrity and reduce the exclusion of legitimate inventors from patents, through correction of inventorship proceedings and the recognition of patent attributional interests. I also discuss reconsidering the legal standard of inventorship to support a broader range of contributors.

1. Discouraging the Omission of Inventors from Patents

One simple way to promote inclusion in inventorship is to ensure that all who meet the standard of inventorship are named on patents. Unfortunately, the once-strong incentives to properly include all inventors on a patent from the beginning of the filing process have been weakened substantially in the past ten years. Pursuant to 35 USC § 256(a), the Director of the USPTO can correct inventorship on a patent application when "through error" a person is incorrectly named or left off as an inventor on a patent.[303] Yet, following the passage of the America Invents Act (AIA), the showing required to do so is much lighter than it previously was. This is because the law eliminated the requirement for the inventorship change that the omission "arose without any deceptive intention."[304]

303. 35 USC § 256(a). Under current Patent Office regulations, to add or subtract names from a list of inventors, patent owners are required to fill out a petition requesting the change and pay the relevant fee. *See* 37 C.F.R. § 1.48. 35 U.S.C. § 256(b) specifies that correction is available any time after a patent is issued, even during its litigation. 35 U.S.C. § 256(b).

304. *See Redline Version (2011) 35 U.S.C. 256, Correction of Named Inventor*, BITLAW (Nov. 2011), https://www.bitlaw.com/source/35usc/aia_redline/256.html [https://perma.cc/J6F7-VMLS] (showing that the language "and such error arose without any deceptive intention on his part" was struck from the statute). Although the law technically specified that the deceptive intent must be on "his" part, meaning the part of the inventor, courts have understood this language to mean deceptive intent in general, by the inventors, employers, or privies in interest. *See* Jordana R. Goodman, *Who Benefits?: How the AIA Hurt Deceptively Non-Joined Inventors*, 50 HOFSTRA L. REV. 735, 746 n.73 (2022).

While the revision was part of a wholesale set of changes to eliminate the various deceptive intent requirements in patent law by focusing on "objective" facts rather than "subjective intent,"[305] it also diminished the incentive to get inventorship right at the outset. Previously, a company that deliberately left off an inventor's name from a patent application would have had a hard time making the required good-faith attestation under the law. But following the passage of the AIA, all that is required to add (or subtract) names from a pending patent application is a petition from the owner requesting the change and paying the relevant fee.[306] While this may seem to foster inclusion in principle, in practice, it means a smaller penalty for incorrectly leaving (or including) someone's name on a patent. After a patent has been granted, a request for correction of inventorship must also be accompanied by a statement from the originally named and new inventors that they do not object to the change, but there is no diligence requirement or real penalty.[307]

There is a way forward, however. Although the law no longer requires that the inventorship mistake be made in good faith, it does provide a way for the USPTO to require more or less information in order to make its decision, stating that the correction is at the discretion of the Director, who "may . . . with proof of the facts and such other requirements as may be imposed, issue a certificate correcting such error."[308] The USPTO Director could use this discretion to shore up inventorship integrity and send a strong signal in favor of inclusive inventorship practices that minimize the risk that inventors will be left off of patents or their contributions will remain "not known, not appreciated or ignored."[309] For example, the Director could ask, in the petition, for information about the conditions that led to the inventorship mistakes for which correction is sought, but also for remedial actions that have been or will be taken following the discovery of the error.[310] Making these petitions available to independent

305. *See* Joe Matal, *A Guide to the Legislative History of the America Invents Act: Part II of II*, 21 FED. CIR. BAR J. 539, 642–43 (2012). The move was supported by the university community as strengthening patents. *Id.* at 642.

306. 37 C.F.R. § 1.48; *see also* USPTO, DOC. CODE R48.REQ,REQUEST FOR CORRECTION IN A PATENT APPLICATION RELATING TO INVENTORSHIP OR AN INVENTOR NAME, OR ORDER OF NAMES, OTHER THAN IN A REISSUE APPLICATION (37 CFR 1.48) (2024),https://www.uspto.gov/sites/default/files/documents/aia0040.pdf [https://perma.cc/NBH5-6267].

307. *See* 37 C.F.R. § 1.324(b). Though, in extreme cases, the patent may be deemed invalid on other grounds.

308. 35 U.S.C. § 256(a).

309. Else, *supra* note 214.

310. For example, the Director could add to the correction of inventorship form a request for information like "describe the conditions that led to this petition."

researchers would support evaluation of whether the rule change is having an unintended negative impact on patent equity that requires attention.

2. Recognizing Attributional Interests in Inventorship

Another way to support inventorship integrity and promote a diversity of innovators would be for courts to recognize the reputational benefits of being named on patents. To date, they have not consistently done so, to the detriment of allegedly omitted inventors whose inventions belong to their employers, not them. This legal inquiry has arisen in the context of legal actions for judicial correction of inventorship, which are available pursuant to 35 USC § 256(b). Bringing such a case requires plaintiffs to demonstrate that they have standing to bring a legal case on the basis of being named on a patent, separate from the financial interests associated with patent ownership or direct economic rewards (such as employee inventor bonuses) associated with inventorship. Standing to bring correction of inventorship cases requires injury-in-fact, the ability to trace the injury to the omission, and that the injury is redressable by a favorable decision.[311]

The case of *Chou v. University of Chicago* raised the question of whether a woman who was allegedly left off a university patent could bring her inventorship dispute despite the patent being owned by the university. The Federal Circuit opined that the plaintiff's assertion that reputational interests alone were sufficient to confer standing was "not implausible."[312] But because the court found another basis for standing—a concrete financial interest[313]—it stopped short of endorsing the principle of reputational-injury-as-standing. Moreover, in *Shukh v. Seagate Tech.*, the court squarely considered the question again in the context of a scientist who was fired and asked for correction of inventorship as part of a broader suit.[314] Finding that the specific evidence presented "supports the conclusion that Dr. Shukh's reputation as an inventor would have been higher had he been named on the patents," the Federal Circuit ruled that "concrete and particularized reputational injury can give rise to Article III standing."[315] In this case, however, the tie between Shukh's reputational interest and economic interests was particularly strong in light of his inability to obtain employment in the field of technology covered by disputed patents, in part due to his reputation for poor

311. Chou v. Univ. of Chi., 254 F.3d 1347, 1357 (Fed. Cir. 2001).
312. *Id.* at 1359.
313. *Id.*
314. Shukh v. Seagate Tech., LLC, No. 10-404, 2013 WL 1197403, at *8–9 (D. Minn. Mar. 25, 2013) *aff'd in part*, *vacated in part*, *remanded*, 803 F.3d 659, 663 (Fed. Cir. 2015).
315. Shukh v. Seagate Tech., LLC, 803 F.3d 659, 663, 665 (Fed. Cir. 2015).

teamwork arising from his accusations that others were stealing his work,[316] thus casting doubts on how broadly the case holding applies.

Indeed, the courts are considered split on this question—decisions before and after *Shukh* have found certain assertions of reputational interests to be insufficient to pass constitutional muster.[317] But given the wide range and strong evidence of reputational interests at stake,[318] courts should more broadly recognize attributional interests, per se, to be sufficient to confer standing in correction of inventorship claims.

3. Rethinking the Standard for Crediting Inventions

The standard for recognizing contributions for invention itself may also be worth revisiting. As previously discussed, for decades the inventorship standard has been that those who conceive of the invention are inventors, but others who contribute valuable time and effort are not.[319] But this "lone genius" model of invention is quickly becoming outdated in light of the increasingly collaborative nature of innovation.[320] It can also be hard to apply and risks reinforcing existing power structures. As the Federal Circuit has acknowledged, "[t]he line between actual contributions to conception and the remaining, more prosaic contributions to the inventive process that do not render the contributor a co-inventor is sometimes a difficult one to draw."[321]

Rather than trying to make the current line clearer, it may be worthwhile to consider revising it. For example, if the inventing standard became closer to the scientific authorship standard, research suggests the gender gap in patenting

316. *Id.* at 663.

317. *See, e.g.*, Faryniarz v. Ramirez, No. 3:13-CV-01064, 2015 WL 6872439, at *15–17 (D. Conn. 2015) (comparing court decisions relating to reputational injury, and citing numerous authorities for the proposition that parties lacking ownership interests or other direct financial rewards from being declared the inventor of the patent do not have standing to sue, and finding the same); Huster v. j2 Cloud Servs., Inc., 682 F. App'x 910, 915–16 (Fed. Cir. 2017) (denying Article III standing on a reputational injury theory on the basis of a lack of evidence of injury).

318. *See* discussion *supra* Part II.C.2.

319. See discussion *supra* Part II.C.1.

320. *See, e.g.*, Dennis Crouch, *Continued Growth in the Number of Inventors Per Patent*, PATENTLY-O (Mar. 11, 2021), https://patentlyo.com/patent/2021/03/continued-growth-inventors.html [https://perma.cc/6SBR-UTNF]; Dennis Crouch, *Average Number of Inventors Per Patent Continues Steady Rise*, PATENTLY-O (Jan. 24, 2019), https://patentlyo.com/patent/2019/01/average-inventors-continues.html [https://perma.cc/Y6QP-6V8C] (showing a steady rise in the average number of inventors per patent, approaching three).

321. Eli Lilly & Co. v. Aradigm Corp., 376 F.3d 1352, 1359 (Fed. Cir. 2004).

would narrow considerably—as described earlier, women authors are disproportionately left off patents.[322] A study I conducted with Lisa Ouellette found, based on analyzing authorship records on scientific papers, that expanding recognition beyond only those responsible for conception to also include those who perform experiments could boost female recognition by as much as 75 percent, and could close the patent gender gap by 10 percent.[323]

To be sure, the question of whether or how to change the inventorship standard has many dimensions. A more rigid standard, consistently implemented, is less likely to fall prey to the well-documented challenges of authorship—including favoritism, questionable gift practices, and abuses of power.[324] But it is also worth noting that a mandatory, more inclusive inventorship regime may not necessarily serve a particular innovator's preferences—for example, "better" authorship credit.[325] To know whether or not a change is justified requires a better understanding of what is at stake—how broadened authorship credit may or may not put innovators that currently do not qualify for inventorship on the path to greater innovation and inventorship—and in other work, I have recommended gathering this evidence experimentally through a pilot program that would recognize a broader set of contributors to patents than just those who qualify as "inventors" under the law.[326]

In addition, though researchers have studied the impact of first-time patents on businesses and firms,[327] little work has been done to date to consider the impact of patenting and inventorship on individuals. Perhaps this is because inventors are, in most cases, workers whose inventions and patents belong to firms. But an exploratory survey I conducted in conjunction with a publicly traded company that asked the question, "What has becoming an inventor meant to you?," revealed some surprising answers. Respondents reported the act of becoming an inventor as bringing the benefits of a down payment on a home, the esteem of one's family

322. See discussion *supra* Part II.C.2.
323. Colleen V. Chien & Lisa Larrimore Ouellette, *Improving Equity in Patent Inventorship*, 382 SCIENCE 1128, 1128–29 (2023) (documenting a lower female participation rate among those who contributed to "conceptualization" as compared to "investigation"); *see also* Ross et al., *supra* note 210, at 136 (reporting a 13 percent gap for articles and a 58 percent gap for patents in the naming of women on teams).
324. *See generally* Lissoni et al., *supra* note 217 (casting doubts on the reliability of authorship as a tool for allocating scientific credit due to inconsistencies in how credit is determined).
325. *Id.* at 1473 (suggesting that inventors may prefer to "trade" inventorship for greater credit on papers).
326. Chien & Ouellette, *supra* note 323, at 1129.
327. *See* discussion *supra* Part II.

and peers, confidence, and the forging of one's identity, among others.[328] But just as a firm's first patent has a very different impact than its thousandth, patenting likely has different impacts on inventors of different demographic and experience profiles.

While a fulsome analysis is beyond the scope of this article, efforts to rethink inventorship and conform it to the realities of how innovation takes place can benefit from parallel efforts in the realm of scientific publication to rethink authorship.[329] The Contributor Roles Taxonomy (CRediT), originally developed in 2014, describes fourteen roles that represent the range of contributions to scientific publications,[330] from activities at the core of original research—conceptualization, investigation, validation, and writing—to its administrative aspects, including funding acquisition, administration, and supervision.[331] The purpose of the taxonomy is to enable recognition of the "myriad contributions" researchers can make to scientific research.[332] Supporters of the standard, which boasted adoption by fifty organizations by early 2022,[333] have also cited the importance of "a broader array of signals . . . to improve the discovery and review of diverse scholarly materials," and the importance of greater precision in attribution for incentivizing research contributions.[334]

For example, one version of the CRediT model requires the corresponding author to indicate each other's contributions not only in the first version, but also in each revision thereafter.[335] Along with the right to be named, contributors are

328. Colleen V. Chien, *What Does it Mean to Be an Inventor? The Inventor Diary Project and Kicking Off the Diversity Pilots Initiative Blog Series*, PATENTLY-O (Apr. 26, 2023), https://patentlyo.com/patent/2023/04/inventor-diversity-initiative.html [https://perma.cc/F2S6-ZV4R]. This study was carried out pursuant to Santa Clara IRB approval 23-04-1941.

329. *See* JONATHAN S. MASUR & LISA LARRIMORE OUELLETTE, PATENT LAW 316–17 (2d ed. 2022) (probing differences in the standards for inventorship versus authorship).

330. CREDIT, https://credit.niso.org [https://perma.cc/CBN5-ZX3P].

331. *Id.*

332. *See* Alison McGonagle-O'Connell, *Contributor Roles Taxonomy (CRediT) Formalized as ANSI/NISO Standard*, CREDIT (Feb. 23, 2022), https://credit.niso.org/press-releases/contributor-roles-taxonomy-credit-formalized-as-ansi-niso-standard [https://perma.cc/6FSG-UWFU].

333. *Id.*

334. Alison McGonagle-O'Connell, *CRediT Secures Philanthropic Funding*, CREDIT (Nov. 11, 2020), https://credit.niso.org/press-releases/credit-secures-philanthropic-funding [https://perma.cc/TW59-24E4].

335. Alison McGonagle-O'Connell, *AACR Adopts CRediT Across Nine Journals*, CREDIT (Aug. 7, 2020), https://credit.niso.org/publisher-adopters/aacr-adopts-credit-across-nine-journals [https://perma.cc/LR2G-3BQ3] (describing the adoption of such a policy by the American Association for Cancer Research across nine journals).

also given the right to be informed of changes to attribution.[336] Mapped to patent law, this model suggests that those who contribute to patent could be inclusively listed in a way that reflects not only the final claims as issued, but also versions of the claimed invention through prosecution.[337]

B. Institutionalizing and Strengthening the PTO's Commitment to Diversity

While changing the inventorship standard would require action by the courts, there are numerous steps the USPTO could take to promote progress. While some of these could be taken immediately on the basis of the agency's existing authorities, Congress should take some modest steps to institutionalize and strengthen the agency's ability to promote a diverse set of inventors and innovators. First, though some demographic information capture is arguably already within the USPTO's authority,[338] the agency should be granted any needed expanded authority to collect demographic and related information about inventors and applicants, as contemplated by the IDEA Act.[339] Data collection would allow the Patent Office to better understand the needs of diverse inventors and innovators, as well as enable evaluations of diversity interventions, focused on patenting or otherwise. The USPTO would need to develop ways to keep sensitive data confidential, while still enabling aggregate reporting.[340] Taking the additional step of allowing the USPTO to collect demographic data on practitioners could also help support initiatives to diversify the practice of patent prosecution.

A more significant reform would be to make it easier for the Patent Office, which is currently entirely user fee-funded, to receive appropriations specifically to subsidize or support underresourced innovators. Previously, I have proposed the idea of institutionalizing the USPTO's commitment to progress through the creation of an Independent Office of the Small Inventor Advocate, akin to the

336. *Id.*
337. Chien & Ouellette, *supra* note 323, at 1129.
338. Indeed, as it will be required to implement the Unleashing American Innovators Act of 2022. *See* Unleashing American Innovators Act of 2022, H.R. 8697, 117th Cong. § 3(b) (2d Sess. 2022).
339. Inventor Diversity for Economic Advancement (IDEA) Act of 2021, H.R. 1723, 117th Cong. § 124 (1st Sess. 2021).
340. *Id.* (specifying that the demographic information submitted would be kept protected, exempt from Freedom of Information Act (FOIA) disclosure, but also be reported on regularly at the aggregate level).

National Taxpayer Advocate that resides in the Internal Revenue Service.[341] Such an Office—which could be supported through such earmarked appropriations—would have the responsibility of reaching out to first-time, underrepresented, and underresourced inventors, and ensuring a level playing field and a voice within the agency in key decisionmaking contexts.[342]

Providing the agency with a more general statutory authority to promote innovators, not just inventors, would also foster deliberation and action to promote innovators whose contributions fall short of inventorship on a granted utility patent. These include putative inventors who are listed on—for example—patent applications that are submitted but never published (called "provisional"), publications made for defensive patenting purposes, patent applications that are abandoned before the patent issues, or works dedicated to the public or kept trade secret[343] and whose identities may be kept confidential or are not easily found. Often business decisions, not technical merit, determine whether an invention is pursued as a fully granted patent, rather than, for example, a defensive publication.[344] But innovators can also potentially benefit from the attribution of credit. It would be worth exploring ways to provide such credit to them—for example, through an innovator registry, without compromising business objectives.

In the meantime, there are numerous steps the agency can take within its existing authority to promote a diversity of inventors and innovators.[345] Below, I discuss what promoting progress, redefined, might look like in carrying out the USPTO's basic functions of examination and information dissemination.

1. Promoting "Progress" in Patent Examination by Narrowing Patent Application and Grant Gaps

The USPTO's primary responsibility is to grant patents and register trademarks.[346] But the likelihood of having one's patent granted is unequal across groups. To make progress in the diversification of inventors, the Office should

341. Chien, *supra* note 19, at 72–76.
342. *Id.*
343. *See generally* Colleen V. Chien, *Opening the Patent System: Diffusionary Levers in Patent Law*, 89 S. CAL. L. REV. 793, 798, 848, 855 (2016) (describing the array of ways in which contributors to inventions may fail to be recognized as inventors).
344. Described in Chien & Grennan, *supra* note 237, at 9 (describing the different strategic considerations that patent review boards take into account when deciding on the fate of a patent application).
345. *See* Chien, *supra* note 19, at 63–84.
346. *See* 35 U.S.C. § 2(a)(1).

commit to taking steps to address the "patent grant gap."[347] While there may be multiple reasons one's patent application may not succeed, lack of support is one of them, as the USPTO's pro se pilot suggests. Based on an evaluation of the pilot, women applicants were 11 percentage points more likely than men to benefit from the assistance.[348] Further, the benefits were largest for "new U.S. inventors, and in technology areas where women had the worst relative outcomes."[349] While the assistance helped all, it so benefitted women that it closed the gender gap in allowance rates.[350]

The PTO should consider whether this intervention could be scaled to address gaps more systematically. Consistent with the idea that technological interventions are easier to expand to serve a larger population,[351] it would be worth exploring the extent to which artificial or automation tools or templates could be leveraged.[352] Making tools that are *already* commercially available to help with patent quality more broadly available to underresourced innovators might serve as a test case.

There are an estimated 40,000 first-time filers per year;[353] and offering a certain number of them free services on a randomized basis would provide an easy way to test whether this form of assistance could effectively be used to level the playing ground. A simpler implementation of this model would be for existing technology providers to offer discounts to underresourced applicants that parallel the fee discounts offered by the Patent Office.[354]

The USPTO's adoption of the DOCX standard—a new, structured way to submit applications that includes an error correction component[355]—in some

347. *See* discussion *supra* Part II.C.3.a.
348. Pairolero et al., *supra* note 152, at 3.
349. *Id.* at 1.
350. *Id.* at 29.
351. *See, e.g.*, JOHN A. LIST, THE VOLTAGE EFFECT 10–20 (2022) (describing technical—as opposed to people-based—interventions as more likely to scale due to the difficulty of replicating humans).
352. *See* Colleen V. Chien, *Rigorous Policy Pilots the USPTO Could Try*, 104 IOWA L. REV. ONLINE 1, 8 (2019).
353. Kathi Vidal, *Secretary of Commerce Gina Raimondo and the USPTO's Council for Inclusive Innovation Expand Innovation to Promote Jobs and U.S. Prosperity*, USPTO DIR.'S BLOG (July 27, 2022), https://www.uspto.gov/blog/director/entry/secretary-of-commerce-gina-raimondo [https://perma.cc/3FYQ-QF5W].
354. The case for doing so is more fully explored in Colleen V. Chien & Christopher A. Cotropia, *Using AI to Boost Patent Quality and Equity*, REGULATION (forthcoming 2024).
355. Andrew Faile & Jamie Holcombe, *Modernizing Patent Filing With DOCX*, USPTO DIR.'S BLOG (May 25, 2021), https://www.uspto.gov/blog/director/entry/modernizing-patent-filing-with-docx [https://perma.cc/MH6Z-882K] (citing improved application quality as a benefit of adopting the DOCX word-processing file format).

ways provides the first step toward universally available quality technology.[356] When evaluating the implementation of this and other patent quality programs, the USPTO should consider distributional effects, and in this case whether patent quality technology can increase patent equity.

2. Promoting "Progress" by Measuring, Communicating, and Managing It

The second of the USPTO's duties is to disseminate information about patents and trademarks to the public.[357] But in contrast to metrics of invention, which the USPTO reports regularly,[358] metrics of innovators and inventors are not regularly collected.[359] In the spirit of measuring progress to make progress, the USPTO should consider tracking and regularly reporting on metrics concerning applicants and inventors, not just invention. Such data could include rates of patent application and grants of all kinds (plant, utility, provisional, and design)[360] by various innovator groups—including first-time inventors, women, underrepresented minority groups, and veterans—as well as patenting by region and technology. This would make possible relevant benchmarking and differentiation by business model or industry, as well as the commemoration of milestones based not on inventions, but on inventors—pertaining to, for example, bringing the newest inventors into the system.

356. Although, DOCX also shows what can go wrong in the rollout of government technology. *See* Michael Borella, *USPTO Delays Transition to DOCX (Again)*, PAT. DOCS (Jan. 2, 2023), https://www.patentdocs.org/2023/01/uspto-delays-transition-to-docx-again.html [https://perma.cc/YV86-N8T5] (describing DOCX implementation as "fraught with legal and technical glitches").

357. 35 U.S.C. § 2(a)(2).

358. *See, e.g.*, U.S. PAT. & TRADEMARK OFF., FISCAL YEAR 2021 PERFORMANCE AND ACCOUNTABILITY REPORT (PAR) 23–47 (2021), https://www.uspto.gov/sites/default/files/documents/USPTOFY21PAR.pdf [https://perma.cc/GA5J-MTH4] (reporting on, for example, numerous patent metrics pertaining to quantity (applications, grants, and filings) and quality).

359. *See id.* The PAR *does* include patent filing counts by country of origin and payment tier. *See id.* at 209–14.

360. *See id.* at 7. Utility patents cover new and useful processes, machines, articles of manufacture, compositions of matter, or any new and useful improvements or others claiming patentable subject matter (and are the most common kind); design patents cover new, original ornamental designs for articles of manufacture; and plant patents provide for the protection of distinct and new varieties of asexually reproducing plants. Provisional patent applications are placeholder applications for associated nonprovisionals that can be filed within twelve months and claim the benefit of the provisional filing date. Provisional patent applications are not examined and automatically abandoned twelve months after filing. *Applying for Patents*, USPTO (Apr. 27, 2023), https://www.uspto.gov/patents/basics/apply [https://perma.cc/XXV6-FKFP].

Reporting on the extent to which different types of innovators are engaging in activities—like patent maintenance, assignment (and reassignment), litigation, post-grant adjudication, and licensing—can also provide a sense of the utilization and impact of the patent system by diverse groups. This reporting may inform the development of examination supports and options that are better tailored to the needs of different business models and innovator archetypes. The ability to report data by applicant demographic profile, of course, depends on the agency's ability to collect such data.[361]

3. Promoting "Progress" by Piloting Openly and Collaboratively

Another step the USPTO could take is to publicly share both what it is doing to advance progress and, upon rigorous evaluation, how effective it has been.[362] The steps the agency has taken to support a diversity of applicants and workers—like providing extra support to inexperienced filers, supporting affinity groups,[363] and providing flexible work options[364]—are potentially valuable to others also seeking to attract and retain diverse workforces. This presents an opportunity for the agency to multiply its impact beyond the participants in its programs.

While the agency has taken some promising steps to share information about its diversity measures,[365] the impact of policies intended to broaden

361. The IDEA Act specifically contemplates the reporting of aggregate filing and related trends by demographic group. *See* IDEA Act of 2021, H.R. 1723, 117th Cong. § 124 (1st Sess. 2021).

362. *See* Foundations for Evidence-Based Policymaking Act of 2018, Pub. L. No. 115-435, 132 Stat. 5529 (2019) [hereinafter Evidence Act] (requiring participating agencies to develop multi-year learning agendas (evidence-building plans) and a capacity assessment as part of the agency strategic plan, as well as develop annual evaluation plans, create an agency evaluation policy, and designate an evaluation officer).

363. *See Establishing Employee Research Groups*, USPTO (Mar. 23, 2020), https://www.uspto.gov/initiatives/equity/employee-resource-groups [https://perma.cc/9N3K-ZRUH].

364. U.S. PAT. & TRADEMARK OFF., 2019–2020 TELEWORK ANNUAL REPORT (2020), https://www.uspto.gov/sites/default/files/documents/Telework_Annual_Report_2019–2020.pdf [https://perma.cc/2MCW-CB8T] (describing telework options dating back to 1997 when the agency offered remote work options to eighteen trademark examining attorneys, and reporting in 2019, 11,000 employees were working remotely at least one day per week).

365. For example, through the pro se report described earlier in Part II, as well as in reporting the metrics of its pro bono user base, which appears to be significantly more diverse than the base of normal filers. *See* Kathi Vidal, Under Sec'y of Com. for Intell. Prop. & Dir. of USPTO, Remarks by USPTO Director Kathi Vidal at the PTAB Pro Bono Fireside Chat (June 9, 2022) (transcript available at the USPTO website), https://www.uspto.gov/about-us/news-updates/remarks-uspto-director-kathi-vidal-ptab-pro-bono-fireside-chat [https://perma.cc/RN6L-LBVM] (reporting that 30 percent of pro bono survey respondents identified as African American or Black; 14 percent identified as Hispanic;

participation—such as the first-to-file system and fee discounts,[366] the opening of regional offices, and the relaxation of patent bar requirements—have not been the subject of rigorous evaluation and study. They should be.[367] Neither does the agency systematically consider how other policies with broad impact, like the adoption of new application formats and standards,[368] may have differential impacts on different types of inventors. But doing so can help ensure that the Office is meeting and adapting to the needs of a wide range of users.

The Office is also uniquely positioned to provide information and guidance on cultivating diversity in inventorship in its role advising federal departments and agencies on matters of intellectual property policy.[369] Every year, 8000 or so patents are issued that include a U.S. government owner or interest.[370] Distilling rigorously developed diversity best practices and disseminating them among government applicants, and even government grantees, would not only be a way to boost inventions, but also boost inventors. In addition, fostering connections between stakeholders—for example, the government, the private sector, and academia—is another role that the USPTO can play, including through an innovator diversity pilots clearinghouse, explored next.

5.6 percent identified as Asian or Pacific Islander; and 1.5 percent identified as Native American).

366. *See infra* Box 1.

367. An earlier version of this article recommended the launch of a Scholars Program named after a diverse innovator, such as Patricia Bath. This would be similar to the Edison Visiting Scholars program that the Office already hosts. *See Croak Visiting Scholar Program*, USPTO (Oct. 30, 2018), https://www.uspto.gov/ip-policy/economic-research/visiting-scholar-program [https://perma.cc/A2VG-XJWH]. In August of 2023, the USPTO announced it would rename the Edison Scholars Program to the Dr. Marian Rogers Croak Scholars program, in recognition of Croak's pioneering contributions in the advancement of Voice over Internet Protocol (VoIP). *See* Press Release, U.S. Pat & Trademark Off., USPTO Renames Visiting Scholars Program After Pioneering Inventor of Technology for Virtual Phone Calls, Text-to-Donate System Dr. Marian Rogers Croak (Aug. 17, 2023), https://www.uspto.gov/about-us/news-updates/uspto-renames-visiting-scholars-program [https://perma.cc/CHM6-66E2].

368. For example, the adoption of a new required format for filing applications, like the DOCX format discussed *supra* Part III.B.1.

369. *See* 35 U.S.C. § 2(b)(9).

370. This calculation is based on data provided by Dennis Church, *U.S. Government Property Interests in Patent Rights*, PATENTLY-O (Mar. 6, 2022), https://patentlyo.com/patent/2022/03/government-interest-patent.html [https://perma.cc/6W95-3MAU]; Dennis Crouch, *Replication Data for: U.S. Government Property Interests in Patent Rights*, HARV. DATAVERSE, (Mar. 6, 2022), https://dataverse.harvard.edu/file.xhtml?fileId=6077410&version=1.0 [https://perma.cc/TF3B-VMYB].

C. Race-Neutral Policies and an Innovator Diversity Pilots Clearinghouse

Numerous suggestions for making progress in the diversification of inventorship have been proposed. But as companies begin to undertake steps to increase inclusion in innovation, one factor influencing how they can do so is the Supreme Court's recent affirmative action decision in *Students for Fair Admissions v. Harvard College*, and associated attacks on corporate diversity programs.[371] A review of these programs in light of the ruling suggests factors that will make them less susceptible to liability.

The Court's ruling applies first to race-based affirmative action and second, to higher education institutions and other entities that receive federal funding.[372] It has no application to race-neutral programs. At present, it also has no application to private corporations of the type contemplated in this paper, though extensions of the ruling to Title VII employers would change this.[373] Further, diversity is generally not the goal of inclusive innovation programs, but rather a means to the end of innovation improved by one of the four mechanisms described earlier. Programs that, for example, support and celebrate first-time innovators, female innovators, and disciplinarily or geographically diverse innovators should not trigger constitutional challenges, even if these categories overlap with racial underrepresentation in many cases.

371. Students for Fair Admissions, Inc. v. President & Fellows of Harvard Coll., 600 U.S. 181 (2023). For example, following a lawsuit brought by conservative group American Alliance for Equal Rights, the law firm of Morrison & Forrester LLP reportedly removed restrictions on applicants for a 1L paid summer fellowship to make it open to people of all races, not only underrepresented minorities and LGBT applicants. *See* Nate Raymond, *US Law Firm Alters Diversity Fellowship Criteria After Lawsuit*, REUTERS (Sept. 6, 2023), https://www.reuters.com/sustainability/society-equity/us-law-firm-alters-diversity-fellowship-criteria-after-lawsuit-2023-09-06 [https://perma.cc/5S6H-PQ38]. As in the case of race-based college admissions, the fellowship criteria were revised to emphasize the importance of a diverse perspective based on a number of factors, including life experiences. But this and related lawsuits have had "sort of a chilling effect" on corporate diversity, equity, and inclusion (DEI) programs, and a more direct impact on government contracting programs like the Small Business Administration's 8(A) program. *See* Tonya Mosley, *Ending Affirmative Action in College Admissions Opened a Floodgate, Reporter Says*, NPR (Jan. 11, 2024, 1:54 PM), https://www.npr.org/2024/01/11/1224150505/ending-affirmative-action-in-college-admissions-opened-a-floodgate-reporter-says [https://perma.cc/YJ6V-869T].

372. *See supra* Part I.

373. For example, the scope of actionable "adverse employment actions" under Title VII, which does apply to private employers, is the subject of the case pending before the U.S. Supreme Court, *Muldrow v. City of St. Louis*, No. 22-193 (argued Dec. 6, 2023).

Moreover, the types of "pipeline widening" interventions contemplated in this paper—like broadening who is recognized as an innovator and ensuring that the processes and benefits of inventing are understood by all—are much more akin to the mechanisms of "aggressive recruitment"—undertaken in the wake of the demise of affirmative action in states like California and Michigan decades ago—than they are to affirmative action, which is conditional upon application. Like targeted outreach to particular minority groups, interventions aimed at widening the pipeline of who is engaged in invention and innovation are easily distinguishable from actionable racial quotas.[374] Yet as described earlier, it is these interventions where the greatest gains are possible, given the relatively much larger size of the innovator-inventor gap (around 50 percent) as compared to the grant rate gap conditional upon submission of an application (7 percent).[375]

Finally, although programs to boost success rates—conditional upon submission of an invention disclosure form—will often be perfectly legal, companies have strong built-in incentives to not artificially boost unworthy applications for the sake of diversity. That is because the ultimate arbiter of a patent application is the Patent Office, which will not favorably evaluate applications that are advanced based on diversity factors but do not pass technical muster.

Putting aside legality considerations, another challenge facing practice or policy reforms to boost participation in innovation is determining their effectiveness. Those charged with enacting initiatives may lack the mandate to evaluate them. Those with the ability and motivation to evaluate, on the other hand, may not have access to the relevant data. As a result, details about the implementation and impact of interventions—ranging from the AIA's small inventor policies[376] to the adoption of patent harvesting strategies practices like opt-in framing[377]—are at risk of remaining largely unknown, hampering the path to progress.

One way to address some of these gaps is through a public-private "Innovator Diversity Pilots Clearinghouse" that could support the dissemination and evaluation of effective diversity interventions. Similar to other federally supported

374. Racial quotas were ruled illegal by the Supreme Court in Regents of the Univ. of Cal. v. Bakke, 438 U.S. 265 (1978). But on the point of outreach and recruitment based on race, see Hi-Voltage Wire Works v. City of San Jose, 24 Cal. 4th. 537 (2000) (holding that race-based outreach and recruitment based on race violated California's Proposition 209). I thank Berkeley Law Dean Erwin Chemerinsky for making this point to me.

375. *See* discussion *supra* note 263.

376. *See* discussion *supra* Part I.C.1; *see also infra* Box 1.

377. *See supra* note 263.

clearinghouses, described below in Part III, C.1, an innovator diversity pilots clearinghouse would distribute information about promising practices for making progress. It would also build on the increasing use of "piloting"—the practice of temporarily introducing a policy to learn from it, as embraced by the USPTO[378]—as well as the administrative requirement for agencies to engage in "retrospective review" of their regulations to determine whether they are achieving the intended result.[379] An innovator diversity pilots clearinghouse could also yield critical data about the innovator-inventor gap. To access sensitive personal data, link outcomes across different realms, and overcome commercial secrecy concerns, the clearinghouse could form collaborations between academic and other evaluators on the one hand, and between corporate and governmental partners on the other. Such a clearinghouse could be supported by the National Science Foundation in furtherance of its charge, under the CHIPS and Science Act, to "utilize the full talent and potential of the entire Nation."[380] The Act instructs the Foundation to set aside funds specifically to broaden participation in innovation and to support organizational research, including research on diversity, equity, and inclusion in the technology sector.[381]

378. *See* DANIEL RYMAN, USPTO., PILOTING IN THE PATENT OFFICE 5–7 (2019), https://www.law.upenn.edu/live/files/9492-presentation-slides-dan-rymanpdf [https://perma.cc/A76V-CMUH].

379. *See* ADMIN. CONF. OF THE U. S., ADMINISTRATIVE CONFERENCE RECOMMENDATION 2014-5, at 2–3 (Dec. 4, 2014), https://www.acus.gov/sites/default/files/documents/Recommendation%25202014-5%2520%2528Retrospective%2520Review%2529_1.pdf [https://perma.cc/833G-CNVD] (describing numerous retrospective review regulations).

380. CHIPS Act of 2022, § 10301, Pub. L. No. 117-167, 136 Stat 1366, 1506 (2022).

381. *Id.* §§ 10321–30.

Box 1: Evaluating Inclusive Innovation Policy: The America Invents Act

The America Invents Act (AIA) included numerous provisions to increase access to patenting by small and independent inventors.[382] But it also included a major policy change: the adoption in the United States of a "first-to-file" regime. The change was highly criticized for the burden it placed on independent inventors who had fewer resources to "race" to the Patent Office.[383] So, did American independent inventors lose under the AIA? Addressing this question requires tracking independent inventor activity before and after the rule change. Patents are territorial, and previous analyses of a similar rule change in Canada split out Canadian and U.S. independent inventors and hypothesized that the former would be more affected by the rule change than the latter, though the populations in many ways otherwise resembled each other.[384] Under a "differences-in-differences" approach, if the control and treated populations follow "parallel paths" before a rule change, but diverge after it, then this provides some evidence of an impact.[385]

Before the AIA rule change, which went into effect on March 16, 2013, Canadian and U.S. independent inventor trends moved in parallel (see Figure A below). But as shown in Figure A, after the AIA was passed, rather than declining as feared, the share of filings by U.S. independent inventors actually grew, both in absolute terms and in relative terms as compared to Canadian filings. Contrary to expectations, the U.S. relative to Canada advantage in terms of independent inventor filings share more than doubled.[386] The analysis provides some evidence that the effect of the transition to a first-to-file system might have been offset and even reversed by other AIA changes, including the adoption of deepened discounts.[387] It may also be the case that the United States'

382. JOSH LERNER, ANDREW SPEEN & ANN LEAMON, SMALL BUS. ADMIN., THE LEAHY-SMITH AMERICA INVENTS ACT (AIA): A PRELIMINARY EXAMINATION OF ITS IMPACT ON SMALL BUSINESSES 13, 31–32 (2015), https://advocacy.sba.gov/wp-content/uploads/2019/05/rs429tot_AIA_Impact_on_SB.pdf [https://perma.cc/GV9R-DKBF] (describing the AIA's fee reductions, a Patent Ombudsman Program, and pro bono and pro se supports).

383. *Id.* at 6.

384. *Id.* at 90–91 (describing studies that evaluated a similar rule change in Canada).

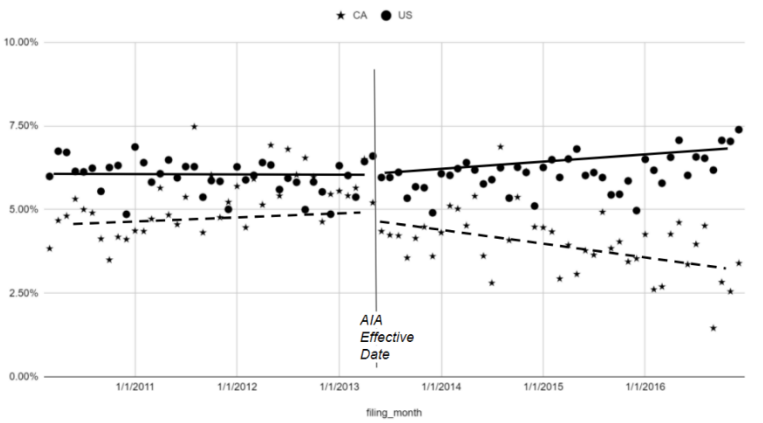
385. *Id.* at 91–92 (describing difference-in-differences approaches).

386. *See infra* Figure A (showing that just before the rule change, the US independent inventor share was approximately 6.25 percent as compared approximately 5 percent in Canada, translating into a 1.25 percent difference, as compared to, for example in 2016, a 7.1 percent independent inventor rate in the U.S. and a 3.75 percent rate in Canada translating a much larger difference after the rule change).

387. LERNER ET AL., *supra* note 382, at 31, 40–41.

preservation of a "grace period"[388] mitigated the impacts of the transition to a first-to-file policy.

Figure A: Canadian (CA) and U.S. Independent Inventor Shares of Patents Before and After Introduction of the America Invents Act (Data Source: PatentsView)[389]



1. The Case for and Elements of a Diversity Pilots Clearinghouse

The purpose of a clearinghouse is straightforward: to facilitate knowledge sharing around a particular shared goal and foster a community of practice.[390] To advance its policy objectives, the federal government has supported clearinghouses in areas ranging from education[391] and civic engagement, to family and child welfare programs.[392] In recent years, for example, the White House

388. *Id.* at 15–16.
389. *See generally* PATENTSVIEW, https://www.uspto.gov/ip-policy/economic-research/patentsview.
390. *See generally* Haluk Soydan, Edward J. Mullen, Laine Alexandra, Jenny Rehnman & You-Ping Li, *Evidence-Based Clearinghouses in Social Work*, 20 RSCH. ON SOC. WORK PRAC. 690 (2010).
391. *See What Works Clearinghouse*, INST. ED. SCIS., https://ies.ed.gov/ncee/WWC [https://perma.cc/5QLE-AYPC].
392. *See* Off. of Plan., Rsch. & Evaluation, *Research and Evaluation Clearinghouses*, ADMIN. FOR CHILD. & FAMS., https://www.acf.hhs.gov/opre/research-and-evaluation-clearinghouses

launched a clearinghouse to support school reopenings across the country via an Executive Order,[393] and a best practices guide to diversity and inclusion in the federal STEM workforce.[394] Across this range of efforts are a few common ingredients. First, clearinghouses generally publicly disclose and disseminate summaries of interventions or practices and their evaluation in accessible and practical terms. Second, these summaries are usually accompanied by the review and rating of each practice, in line with criteria set forth by the clearinghouse (such as distinguishing practices supported by "strong" evidence from those supported by "promising" or no evidence).[395] As such, clearinghouses not only support the sharing of both operational ("how to") and evaluation ("does it work") information across firm and sector boundaries, but also provide the measurement of success. Below, I discuss a few other gaps an innovator diversity clearinghouse could address.

2. Supporting Innovator Data Disclosure and the Tracking of Progress

Though this Article has made the case for redefining and promoting progress, the existing data infrastructure leaves much to be desired. Invention disclosures, as well as innovator demographic information, are largely siloed in corporate and workplace databases, and privacy restrictions make it difficult to share data even internally. Moreover, data on federal research and other grant applications are not necessarily integrated into patent records. Information on downstream impacts related to income, although possible through the linking of administrative data, is generally accessible only to select researchers.

A diversity pilots clearinghouse infrastructure can support the standardization of innovator data disclosure and access protocols with respect to data shared within companies as well as beyond them.[396] For example, the

[https://perma.cc/AD7B-3C4S]. For a longer list, see *Clearinghouse Database*, EVIDENCE-TO-IMPACT COLLABORATIVE (Feb. 12, 2024), https://evidence2impact.psu.edu/results-first-resources/clearing-house-database [https://perma.cc/M32B-KNH3].

393. *See Best Practices Clearinghouse*, U.S. DEP'T EDUC., https://bestpracticesclearinghouse.ed.gov [https://perma.cc/XL8W-J4HA].

394. *See* INTERAGENCY WORKING GRP. ON INCLUSION IN STEM ET AL., BEST PRACTICES FOR DIVERSITY AND INCLUSION IN STEM EDUCATION AND RESEARCH (2021), https://www.whitehouse.gov/wp-content/uploads/2021/09/091621-Best-Practices-for-Diversity-Inclusion-in-STEM.pdf [https://perma.cc/4PQN-BC58].

395. *See What Works Clearinghouse*, *supra* note 391; Soydan et al., *supra* note 390.

396. The capacity of the USPTO to access outcome data should be improved considerably if the agency gains Confidential Information Protection and Statistical Efficiency Act (CIPSEA) status to access information in a way similar to a statistical agency. *See* CIPSEA of 2022, Pub. L.

community around a clearinghouse could provide input on how to regularize reporting of technical worker statistics to the Equal Employment Opportunity Commission's "EEO-1 Component 1 Data collection" form, which employers with more than 100 employees must provide[397] to ensure a consistent point of comparison to inventorship. Such a community could also help advise the Securities and Exchange Commission's development of human capital reporting requirements.[398] Rates of participation are known to vary by industry—and potentially even by entity type and region—and a data service could provide different benchmarks for firms to compare themselves to others. The recent establishment of a National Secure Data Service will likely create additional opportunities for valuable agency administrative data on outcomes like employment and income to be connected to inventorship events.[399] Supporting safe, privacy-respecting ways to share restricted data should also be a priority.

3. Fostering Collaboration and Partnerships Through Transparency

A clearinghouse can also foster partnerships for carrying out rigorous pilots and learning across disciplines and organizations. Innovator and inventor diversity problems are complex; but despite differences in setting, in many cases the root causes and mechanisms for addressing them—such as support, mentoring, and proactive approaches—are similar. Pilot partnerships could be formed around such common potential obstacles to progress. For example, the possibility of bias in evaluation, in both firm and Patent Office settings, could be studied cooperatively. The importance of reducing the costs of participation,

No. 107-347, 116 Stat. 2962. As of this writing, however, the Office of Management and Budget has not promulgated guidance on how to do so.

397. *EEO Data Collections*, U.S. EQUAL EMP. OPPORTUNITY COMM'N, https://www.eeoc.gov/data/eeo-data-collections, [https://perma.cc/S3UP-7E3A].

398. Under this framework, however, the Securities and Exchange Commission does not mandate specific topics or data points that must be disclosed to investors; therefore, reporting varies widely. Regulation S-K requires a registrant to describe its human capital resources to the extent material to the understanding of that registrant's business taken as a whole. *See* Peter H. Haslag, Berk A. Sensoy & Joshua T. White, Human Capital Disclosure and Workforce Turnover 1, 2 (Sept. 17, 2022) (Research paper, Vanderbilt Owen Graduate School of Management) (on file with author).

399. *See Congress Authorizes Establishment of National Secure Data Service to Improve Data Analytics*, DATA FOUND. (July 28, 2022), https://www.datafoundation.org/press-releases/congress-authorizes-establishment-of-national-secure-data-service-to-improve-data-analytics/2022#:~:text=Washington%2C%20D.C.%20%2D%20Today%20Congress%20passed,at%20the%20National%20Science%20Foundation [https://perma.cc/H2GG-UA4G].

whether financial (like USPTO fee discounts and pro bono work) or in terms of time or information (like affinity group practices), also cuts across the innovation ecosystem. Likewise, "rejection"[400] is an integral part of both the intrafirm idea disclosure process (before application) as well as the intra-USPTO process of patent prosecution (following submission of an application). Experimenting with how to provide rejections in a supportive and encouraging way to first-time applicants in one environment can inform efforts in the other.[401] The ability to "pitch a pilot"—as solicited through a request for comment issued by the USPTO or other agencies—could also allow stakeholders to offer ideas and suggestions for companies, firms, the USPTO, universities, and others to try.[402]

Collaboration can also make rigorous experimentation and evaluation possible. The gold standard for determining impact is through a randomized control trial, in which a set of potential participants is assembled, the intervention is applied to one subset (the "treatment" group), and the outcomes of this group are compared to the outcomes of the remaining participants (the "control" group). Collaborative pilots across settings can make it more likely that sufficient numbers of participants for a rigorous trial can be recruited. As it examines over half a million patents filed each year,[403] the USPTO is well positioned to randomize any number of interventions and should consider doing so where practicable and ethical.[404]

By virtue of their openness, clearinghouses are uniquely positioned to transcend disciplinary and institutional silos, facilitating partnerships between—for example—firms and companies seeking diverse talent, historically black colleges and universities (HBCUs), and minority-serving institutions (MSIs) that

400. *See* discussion *supra* Part II.C.3.b.

401. *See* Gauri Subramani, Colleen Chien, Abhay Aneja & Steve Gong, *Reframing Rejections: Interventions to Increase Patent Conversion and Reapplication*, INNOVATOR DIVERSITY PILOTS CONF. (Nov. 18, 2022), https://law.scu.edu/wp-content/uploads/14.-Subramani-.pdf [https://perma.cc/E5PV-K9RU].

402. The idea of pitching a pilot is not entirely original. Another agency, the Consumer Financial Protection Bureau, has previously encouraged companies to pitch pilot programs. *See* CONSUMER FIN. PROT. BUREAU, SEMI-ANNUAL REPORT OF THE CONSUMER FINANCIAL PROTECTION BUREAU 82 (2015). Jurisdictional oversight challenges and a lack of an incentive for firms to pitch pilots were cited as reasons the recommendation failed.

403. Patent Technology Monitoring Team, *U.S. Patent Statistics Chart Calendar Years 1963 - 2020*, USPTO (May 2021), https://www.uspto.gov/web/offices/ac/ido/oeip/taf/us_stat.htm [https://perma.cc/E589-KCNC] (showing the total number of patent applications to be over 500,000 per year since 2010).

404. An example of a practicable and ethical situation would be, for example, in the case of oversubscription to a service for which there is limited capacity. *See* Colleen V. Chien, *Rigorous Policy Pilots: Experimentation in the Administration of the Law*, 104 IOWA L. REV. 2313, 2329 (2019).

can supply this talent. A diversity clearinghouse can also make it easier for research, academic, and company partners, as well as potential mentors and mentees, to find each other.[405]

Public clearinghouses also support information flows across organizations and sectors. This means that information can be shared not just among members of select industry consortia, but also among members of the innovation community at large. For example, biopharma and tech companies can learn from universities and vice versa, and the knowledge produced by larger, more deeply pocketed firms can spill over to smaller players.

D. Surveying Diverse Innovators and Inventors

Another idea for building the infrastructure for progress is to launch a periodic survey of diverse innovators and inventors. A better understanding of the distinct needs of innovators and inventors can both inform policy prospectively, and gauge awareness and impact of interventions retrospectively. The paragraphs below combine these observations with insights gleaned from reviewing existing (largely piecemeal) surveys of inventors, and briefly address how such a survey could be administered. Previous relevant inventor and innovator surveys include the PatValEU[406] and Community Innovation surveys of Europe.[407]

1. Understanding the Root Causes of Participation (or Not) in Innovation and Invention

One impetus for a survey is that, as underscored in Part II, much less is known about innovators that have the potential to become inventors than is known about inventors,[408] and even less is known about the relationship between

405. *See* COOK, *supra* note 275, at 15.

406. PatValEU was a one-time survey of 9216 European inventors from six countries carried out in 2003 and 2004. *See* Dietmar Harhoff & Karin Hoisl, Everything You Always Wanted to Know About Inventors (But Never Asked): Evidence From the PatVal-EU Survey 1 (Munich Sch. of Mgmt., Discussion Paper No. 2006–11, 2006).

407. The Community Innovation surveys are biennial surveys that provide information on innovative enterprises, their strategies, and their knowledge management and innovation activities, as well as on factors that facilitate or hinder innovation. *See Community Innovation Survey: Latest Results*, EUROSTAT (Jan. 15, 2021), https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20190312–1 [https://perma.cc/G9F3-YPRP].

408. *See* Bell et al., *supra* note 18, at 1. Inventors have been studied extensively by economists and social scientists, who have taken advantage of the openness of patent administrative records to extract details, but also their location, their employer, if any, to which a patent is assigned, in

them. Conducting a survey that specifically compares and contrasts the experiences of the two groups can usefully probe the ways and the extent to which much-studied inventors are (or are not) representative of all innovators, and serve as a check to ensure that policies to support innovators are not inadvertently tilted toward inventors. Specific questions of interest could pertain to awareness and accessibility of government supports and programs available for small and underresourced innovators,[409] as well as the initiatives geared at new or underresourced innovators described in Part I, such as the pro bono and pro se programs at the USPTO.

A survey could also address the differences in motivations, experiences, and needs of diverse innovators in order to inform policy development. Many of these differences—as discussed in Part II, for example, regarding time, trust, and more generally, the distribution of "invention capital"—are external to patent law. As such, the enablers and blockers of inventing may be grounded to a greater extent in non-patent policies than in patent policy, and conversely, non-patent policies may have substantial and overlooked innovation premiums.

Take, for example, the issue of time: child-rearing, having a STEM career, and inventing are all time-intensive endeavors. Although a number of surveys of inventors have been conducted, none that I am aware of has explored inventors' domestic situations. But surveys of technical workers[410] have found that midlevel technical women are more than twice as likely as midlevel technical men to have a partner who worked full time,[411] and only around a quarter as likely to have a partner with primary responsibility for the household and children.[412] The gender differences were more dramatic among women of color.[413]

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some cases their income, and previous and subsequent patents. Because they reveal the specific names of inventors, patent records can further be connected to administrative records at an individual level, allowing for even more extensive research into the lives and backgrounds of inventors—including their test scores, socioeconomic backgrounds, the backgrounds of their parents and children, and many other details.

409. Examples include the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs of the Small Business Administration. *See The SBIR and STTR Programs*, U.S. SMALL BUS. ADMIN., https://www.sbir.gov/about [https://perma.cc/9HUJ-SZF8].

410. The Kapor Center "Tech Leavers" survey, for example, examined why people—particularly Black people, Latinx people, and women—left their jobs in tech. *See* SCOTT ET AL., *supra* note 36, at 11.

411. OBSTACLES AND SOLUTIONS, *supra* note 37; *see also* CLIMBING THE TECHNICAL LADDER, *supra* note 37.

412. CLIMBING THE TECHNICAL LADDER, *supra* note 37, at 29–30.

413. *See* OBSTACLES AND SOLUTIONS, *supra* note 37, at 12 (reporting that partnered women of color were 2.3 times as likely to have a partner than worked full-time than men of color, and that underrepresented minority men were over five times more likely to have a partner with

The disproportionate burden and impact of household responsibility and childcare needs among women in STEM, particularly women of color, on display during the COVID-19 pandemic transcends patenting. But, as discussed earlier, it shapes the lived experiences of those with childcare responsibilities who effectively are being asked to "do more" when they participate in inventing. Companies have launched a variety of family support, part-time, and flexible work policies in order to accommodate caregiver schedules.[414] A survey may be able to tease out the impact and importance of these sorts of general accommodations—as compared to patent-specific measures—as potential enablers of innovation and invention.

2. Learning from Surveys

The idea of surveying inventors and innovators is not new, and past surveys can indicate the types of insights that can be gained. Demographic questions about educational background, age, location, immigration status, degrees, and parental influences can uncover surprising and meaningful differences between different groups of innovators. For example, a survey of midlevel technical women and men working at seven leading high-tech companies documented that "[w]omen of color are significantly more likely to come to high-technology through degrees outside of computer science and engineering."[415] A survey of high-value patent inventors, in contrast, has uncovered differences in age and past education level between women and immigrant inventors.[416]

Surveys and studies have also probed motivations to patent and perceptions of success, both of which are important and relevant to designing initiatives to

primary responsibility for the household and children than their female counterparts). Simard's study also found that technical women in general are more likely to be single than technical men, providing evidence of a family penalty among technical women, and that, again, the difference was even more stark for underrepresented minority technical employees. *Id.*

414. These policies also meet the preferences of diverse employees that prefer hybrid to in-person work. *See* Sheela Subramanian & Ella F. Washington, *Why Flexible Work Is Essential to Your DEI Strategy*, HARV. BUS. REV. (Feb. 25, 2022), https://hbr.org/2022/02/why-flexible-work-is-essential-to-your-dei-strategy [https://perma.cc/XD52-SHCC].

415. OBSTACLES AND SOLUTIONS, *supra* note 37, at 14.

416. ADAMS NAGER, DAVID HART, STEPHEN EZELL & ROBERT D. ATKINSON, INFO. TECH. & INNOVATION FOUND., THE DEMOGRAPHICS OF INNOVATION IN THE UNITED STATES 5, 44 (2016), https://www2.itif.org/2016-demographics-of-innovation.pdf [https://perma.cc/83H9-K3FB] (finding that women who contribute to important patents tend to be younger than men by five years on average, and that immigrant inventors tend to have higher levels of education than their domestic counterparts).

encourage participation. Some of these have focused on business-model diversity, documenting the different reasons that small and large companies seek patents and how they leverage the ones they have on hand.[417] A few others have asked individual inventors what motivates them to invent.[418] While "task-related" motivations—including the intrinsic "satisfaction from solving technical problems" and the "progress of science"—rated highly among workers generally,[419] engagement in *socially* useful work was disproportionately viewed by underrepresented minority technical employees as factors of success.[420]

The career priorities of inventors and innovators, as ascertained through surveys, is also relevant for the design of incentive and retention initiatives. Among underrepresented technical workers, for example, Simard has found that earning money, career development and challenging work, and job security are all important.[421] But career development opportunities for updating technical skills have been reported to be especially important for underrepresented minorities, and harder for women of color to do on their "own time,"[422] often because of a lack of company or personal funds.[423] Such insights can inform diversity initiatives and incentives targeted at inventors or STEM workers more generally.

417. Stuart J.H. Graham, Robert P. Merges, Pam Samuelson & Ted Sichelman, *High Technology Entrepreneurs and the Patent System: Results of the 2008 Berkeley Patent Survey*, 24 BERKELEY TECH. L.J. 1255, 1255 (2009) (reporting such company reasons, such as to gain competitive advantages, prevent copying of technology, secure financing, and enhance firm reputation).

418. *See* John P. Walsh & Sadao Nagaoko, Who Invents?: Evidence From the Japan-U.S. Inventor Survey 3–4 (Rsch. Inst. Econ., Trade, & Indus., Discussion Paper No. 09-E-034, 2009) (finding—while unfortunately not carried out in a way that allows for comparing responses by demographic group—similarities and contrasts between the motivations of inventors in the United States and Japan). These motivations fell into three categories. "Task" motivations—including the intrinsic "satisfaction from solving technical problems" and the "progress of science"—rated highly in both countries. "Pecuniary" motivations such as career advancement, beneficial working conditions, and monetary rewards, in contrast, all scored much lower than task motivations in both the United States and Japan. But differences between the countries were observed with respect to "social" motivations like prestige and reputation—motivations like generating value for one's firm and the esteem of peers was much more important in the United States than in Japan. *Id.* at 1–2, 22–23.

419. *Id.* at 22; *see also* CAPITAL ONE, WOMEN IN TECHNOLOGY SURVEY 2 (2019), https://ecm.capitalone.com/DevExchange/assets/PDFs/WIT_Report_2019.pdf [https://perma.cc/JWH7-S26W] (reporting that among women who stayed in technology jobs, "love of the work" and being good at the job were top motivators).

420. OBSTACLES AND SOLUTIONS, *supra* note 37, at 24.

421. *Id.* at 20.

422. *Id.* at 24.

423. *Id.* at 25.

CONCLUSION

The patent system exists to promote innovation but can only succeed in doing so through the initiative, ingenuity, and participation of innovators. This article has argued in favor of an enlarged sense of patent progress, which includes the promotion of innovators—and in particular, a diversity of innovators—and not just innovation. This approach is justified not only by the ways in which diverse innovators improve innovation, but also by the doctrine and design of the patent system, which has long rewarded these very mechanisms and paid attention not only to what is being innovated, but also to who is innovating and in what setting.

Achieving greater diversity in inventorship will require engaging and studying not only those that have already sought and obtained patents—where most of the focus has been—but also those who never have, despite being part of the innovative workforce. Focusing on the innovator-inventor gap has elucidated some of the possible root causes of a lack of participation—including the inventorship standard, bias, power dynamics, confidence levels, perfectionism, and differential responses to rejection—and revealed steps that can be taken to address them, including affirming inventorship integrity, recognizing reputational harm as standing, reconsideration of the inventorship standard, and institutionalizing and further strengthening the USPTO's commitment to promoting and including a diversity of innovators. But closing gaps in participation will require additional research, experimentation, and rigorous evaluation of interventions. A willingness to pilot and scale innovator diversity interventions within the private sector and the enhanced ability of the patent system and the USPTO to support these efforts—through survey and evaluation efforts—can advance progress, redefined.

APPENDIX

Table A: The Differential Treatment of Classes of Innovators Over Time

Law	Summary/State of the Law	Legal Provision
The Patent Act of 1790	All could apply for patents	Anyone—"he, she, or they"—who invented or discovered "any useful art, manufacture, engine, machine, or device, or any improvement therein not before known or used"[424] could apply for patents.
The Patent Act of 1793	U.S. citizens ("free white persons") could apply for patents	"[C]itizen or citizens of the United States"[425] could apply for patents. Under the Naturalization Act of 1790, citizenship was reserved exclusively to "free white person[s]."[426]
Act of April 17, 1800	U.S. citizens and foreign residents of two years could apply for patents	In addition to citizens, "all aliens who at the time of petitioning . . . shall have resided for two years within the United States"[427] could apply for patents.
Act of 1832	U.S. citizens and foreign residents intending to become citizens could apply for patents	Alien residents who signed an oath attesting to their intention to become citizens could apply for patents; those who did not work their patents within a year of grant had their patents revoked.[428]

424. Patent Act of 1790, ch. 7, § 1, 1 Stat. 109, 110 (repealed 1793).
425. Patent Act of 1793, ch. 11, § 1, 1 Stat. 318 (repealed 1836).
426. Naturalization Act of 1790, ch. 3, § 1, 1 Stat. 103 (repealed 1795). This statute excluded the naturalization of people from Asian, Native Americans, and free Black immigrants. According to Ian Haney López, this racial prerequisite to citizenship remained in force until 1952. *See* HANEY LÓPEZ, *supra* note 125, at 1.
427. Act of April 17, 1800, ch. 25, § 1, 2 Stat. 37, 38.
428. *See* Cont'l Paper Bag Co. v. E. Paper Bag Co., 210 U.S. 405, 429 (1908). Speaking of the right to patent, the court stated:

> The only qualification ever made was against aliens in the act of 1832. That act extended the privilege of the patent law to aliens, but required them 'to introduce into public use in the United States the invention or improvement within one year from the issuing thereof,' and indulged no intermission of the public use for any period longer than six months. A violation of the law rendered the patent void. The act was repealed in 1836.

Id. The actual language of the statute was a codification of the Supreme Court's decision in Grant v. Raymond, 31 U.S. 218 (1832).

Table A (cont'd): The Differential Treatment of Classes of Innovators Over Time

Law	Summary/State of the Law	Legal Provision
Patent Act of 1836	U.S. and foreign citizens could apply for patents, foreign citizens paid higher fees	U.S. Citizens and foreign citizens[429] could apply for patents. U.S. citizens and foreign residents that promised to become citizens within a year paid an application fee of $30; British nationals paid $500, and all other foreign citizens, $300.[430] The Supreme Court's *Dred Scott* decision in 1857 excluded all "persons of African descent," free or enslaved, from U.S. citizenship,[431] but the decision was overturned by the Fourteenth Amendment in 1868, granting American citizenship to all American-born individuals regardless of color.[432]
Patent Act of 1870	U.S. citizens and those who were about to become U.S. citizens could apply for patents	Designers of "new and original design[s]" that were or were about to become U.S. citizens[433] could apply for design patents.
1930 Tariff Act	Exclusion orders against infringing	Patentholding complainants with domestic industries[434] are entitled to

429. Patent Act of 1836, ch. 357, §§ 6, 9, 5 Stat. 117, 119, 121 (repealed 1870) [hereinafter 1836 Act] (specifying that each patent applicant was to provide an "oath" describing, among other things, "of what country he is a citizen," as well as contemplating applicants could be "a citizen of the United States, or an alien").
430. *Id.* § 9; *see also id.* § 12 (limiting the filing of a caveat, an instrument similar to a patent, to citizens and foreign individuals intending to become citizens).
431. Dred Scott v. Sandford, 60 U.S. 393, 393 (1857) (finding that persons of African descent cannot be, nor were ever intended to be, citizens under the U.S. Constitution). *Dred Scott* not only precluded free Black individuals from rights to their inventions, but also precluded owners of enslaved people—who could not take an oath attesting to be the "inventor" of an enslaved person's inventions—from such rights as well, defying the claim that owners of enslaved people actually "owned" people and their ideas.
432. U.S. CONST. amend. XIV.
433. Patent Act of 1870, ch. 230, §§ 40, 71, 16 Stat. 198, 203–04, 209–10 (repealed 1952).
434. Section 337 of the Tariff Act of 1930, 19 U.S.C. § 1337 (2)-(3) (stating that the protections of Section 337 only apply if "an industry in the United States . . . exists or is in the process of being

	imports are available for patentholders with domestic industries	apply for exclusion orders against infringing imports.[435]
1952 Patent Act	Foreign inventive activity, unless published down, is not considered for the purposes of determining prior art, whereas U.S. knowledge and use is considered prior art	Only internationally printed publications count as prior art; in contrast, domestic knowledge, public use, sale, or printed publications count as prior art.[436] This changed when the United States joined the World Trade Organization (WTO) in 1995 and, like other members, was required to treat citizens of other member countries as well or better than its own citizens under the principle of national treatment.[437] In 2011, as part of the America Invents Act, equal treatment was extended to all countries.[438]

established" and explaining the conditions under which a domestic industry is considered to exist.

435. *Id.* § 1337.

436. 35 U.S.C. § 102 (1952).

437. The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), Article 3 (describing the requirements of National Treatment) Adherence to TRIPS is generally required of World Trade Organization (WTO) members as a condition of their accession to the WTO.

438. *See* 35 U.S.C. § 102(b) (2006); *cf.* 35 U.S.C. § 102(a)(2) (2012).