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Redefining Progress and the Case for Diversity in Innovation and Inventing

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REDEFINING PROGRESS: THE CASE FOR DIVERSITY IN INNOVATION AND INVENTING

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This Article makes the empirical and legal case for redefining the constitutional 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 literature, it details four plausible mechanisms, also recognized in patent law, 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 workers are commonly patenting at half the rate or less 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.

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INTRODUCTION

As the 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."[2] The promise of the exclusive, yet limited right provided by a patent propels "progress" by adding "fuel to the fire of genius."[3] Consistent with this utilitarian bent, scholarship about the patent system has largely focused on how to reward innovation without over-rewarding it, and how to strike the right balance between promoting innovation and encouraging competition.

A focus on innovation, rather than innovators, is understandable. In innovation, as in U.S. 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, the ability to apply for a patent 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 innovators. It also does so on the basis of a new synthesis it presents, based on a review of the empirical literature, of the ways that promoting diverse innovators can advance the constitutional aims of the patent system according to four mechanisms also recognized by patent law:

Novelty: the novel insights and motivations of diverse innovators can extend the direction and reach of innovation, to populations that tend to be overlooked. That's because inventors are more likely to introduce inventions and products that benefit consumers like them.[8] The exposure of innovators to lower-income groups also appears to lead to more innovation in "necessity" products.[9] Diversifying who is innovating can diversify the types of innovations developed and expand their reach.[10]

Nonobviousness: diverse perspectives support nonobvious connection and combinations that lead to greater innovation. For example, research has found underrepresented doctoral students to be capable of introducing new conceptual linkages and connections missed by others.[11] Disciplinary and ethnic diversity on teams has been associated with greater radical

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[2] Article I, Section 8, Clause 8, of the United States Constitution.

[3] Abraham Lincoln, *Lecture on Discoveries and Inventions* (Feb. 11, 1859), *in* THE POLITICAL THOUGHT OF ABRAHAM LINCOLN 112, 121 (Richard N. Current ed., 1967).

[4] Through the utility requirement of patent law enshrined in 35 U.S.C. 101, which denies protection to inoperable inventions.

[5] Indeed, 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 in Part IB *infra*

[7] It is not the first attempt to do so; Part I summarizes important previous work.

[8] As discussed in Part __ and Rembrand Koning et al., *Inventor Gender and the Direction of Invention*, 110 AEA PAPERS & PROC. 250–254 (2020).

[9] Elias Einio et al., *Social Push and the Direction of Innovation,* NAT'L BUR. ECON. RSRCH. (NBER), at 3–4 (2022), https://conference.nber.org/conf_papers/f167561/f167561.pdf.

[10] Making it less likely that populations will be dangerously overlooked in the development of innovative products, as documented in CAROLINE CRIADO PEREZ, INVISIBLE WOMEN, VINTAGE BOOKS 2019.

[11] Bas Hofstra et al.,, *The Diversity–Innovation Paradox in Science*, 17 PROC NATL ACAD SCI U S A. 9284–9291 (2020).

innovation, and gender diversity, with improved innovation outcomes.[12] Intersections of cultures, disciplines, and geographies have also been shown to lead to breakthrough combinatorial insights.

(Overcoming) Conflict: conflict, under certain circumstances, can improve, even as they challenge innovation. Moving beyond disagreements and conventional wisdom leads to insights marked by greater complexity and synthesis. "Red teams" that are assigned the role of taking an attacking or opposing viewpoint in cybersecurity and related contexts allow for objective criticism and iteration.[13]

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.[14]

Despite these benefits, participation in invention and entrepreneurship are markedly *non*-diverse: men receive 87% of U.S. patents and 98% of VC funding.[15] Children from high-income (top 1%) families are 10 times as likely to become inventors as those from below-median income families, even controlling for aptitude.[16] Over 50% of new U.S. patents went to the top 1% of patentees, and more than 50% of all patents of U.S. origin were generated by just five states, all coastal.[17] 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 argues in favor of redefining the constitutional concept of "progress" in patents to include the promotion of a diversity of innovators and inventors, and not just innovation. Expanding "progress" in this way is supported both by the ways that diversity improves innovation as well as the patent system's long-standing but largely overlooked commitment to supporting a range of innovators. A more capacious understanding of "progress" brings into focus problems on the demand side, where the law of inventorship is limiting who can be named. Progress, redefined, also highlights challenges on the supply side – where the law and mechanics of inventing combined with diversity differences pertaining to inventor identity, perfectionism, and social networks, for example, are limiting participation. Unless and until these legal, administrative, and operational barriers to "progress" are addressed, equal opportunity and participation in invention, and the resulting benefits to innovation, 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: novel perspectives and motivation, unique combinations,

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[12] Though not always. See Part I.A.2 for a review of relevant studies.

[13] As discussed further in Part I.A.3, *infra*.

[14] As discussed further in Part I.A.4, *infra*.

[15] Cheridan Christnach & Anthony Martinez., *Women Making Gains In STEM Occupation 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. (reporting that women represent 27% of STEM workers); *Progress and Potential 2020 Update on U.S. Women Inventor-Patentees,* U.S. Pat. & Trademark Off. ("USPTO"), at 3 (2020), https://www.uspto.gov/sites/default/files/documents/OCE-DH-Progress-Potential-2020.pdf; Kim Elsesser, *Female Entrepreneurs Funded By Female VCs Face Difficulties Obtaining Future Funds*, Forbes (June 06, 2022).

[16] Alex Bell et al., *Who Becomes an Inventor in America? The Importance of Exposure to Innovation*, 134 Q.J. Econ. 647, 649 (May 2019), https://academic.oup.com/qje/article/134/2/647/5218522.

[17] Colleen V. Chien, The Inequalities of Innovation, 72 Emory L. J. 1, 71 (2022), at Part I.A.

(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, which has long paid attention not only to the products of innovation, but also who is innovating and in what setting.

Part II explores challenges to "progress" in the diversification of inventorship. Using the case study of gender, it 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.[18] It also shows how the laws and mechanics of inventorship have prevented many who have contributed to innovation from receiving credit on patents, and 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 Patent Office should take to promote a diversity of innovators, not just innovation. Third, it proposes the creation of a public-private clearinghouse to rigorously test and scale policy and practice interventions for overcoming the challenges to participation briefly highlighted, such as opt-out idea harvesting to overcome gaps in awareness and confidence and reframing patent office rejections to reduce the patent grant gap. Fourth, it discusses a periodic, innovator-inventor survey for informing the design of policies and practices for making progress.

PART I: THE CASE FOR REDEFINING PATENT PROGRESS

If the goal of the patent system, as defined by the Constitution, is "progress of science and the useful arts," why should the identity of who is making this progress matter? Though diversity in innovation has utilitarian and deontological rationales, both of which are relevant when considering "progress," rigorously considering the empirical case for diversity in innovation is important for a few reasons. First, the perception of science and engineering as neutral and objective has bred skepticism that diversity really matters.[19] The reported failure of corporate diversity initiatives to have their intended impact[20] also serves as a reminder that achieving diversity is hard and so it is important to examine, and not just assume, its benefits. Finally, while overstating the empirical case is dangerous — the difficulty of showing a consistent, causal link between upper management diversity and outcomes has felled board diversity mandates in California[21] — a failure to articulate the specific benefits of diversity is also fraught. At the centerpiece of Harvard University's defense of its race-conscious admissions

[18] Discussed in Part II, *infra.*

[19] Described for example in Leanne Son Hing, *The Myth of Meritocracy in Science Institutions*, 377 SCIENCE (Aug. 18, 2022), https://www.science.org/doi/10.1126/science.add5909.

[20] Frank Dobbin & Alexandra Kalev, *Why Diversity Programs Fail*, HARV. BUS. REV. (July 2016) (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, Case No. 19 STCV 27561 (Cal. Super. Ct. L.A. Cnty. May 13, 2022) 12–13 (citing studies that find proof that board diversity mandates have resulted in benefits beyond diverse boards to be scant).

[21] *See Id*. *Crest v. Padilla*, at 11 (striking down a California law that require the California corporate boards to include women as inconsistent with the state constitution's Equal Protection Clause due to the failure of the state to prove a compelling state interest because the relevant studies "failed to sufficiently show a causal connection between women on corporate boards and corporate governance [outcomes].")

policy pending before the Supreme Court is an accounting of the precise ways that diversity improves educational outcomes.[22]

To make the case for redefining "progress," this Part begins by reviewing studies that consider the link between innovator diversity[23] 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[24] are largely correlational, not causal.[25] In addition, care must be taken not to overgeneralize, particularly because of the varying forms of "diversity" and outcomes studied, and because understanding of diversity's impact on innovation is evolving. Other utilitarian as well as deontological rationales for diversity in innovation are then discussed before this Part turns to the legal case for redefining "progress" in the patent system, to being about the promotion of a diversity of innovators and inventors, and 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, it is well-recognized that the market may underproduce certain types of innovations; indeed, the patent system itself is a policy response to the public goods nature of knowledge creation and its appropriability by rivals. On the supply side, factors like discrimination have discouraged participation in ways that are hard to compensate for.[26]

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[22] See, *Students for Fair Admission, Inc. v. Harvard College*, Supreme Court No. 20-1199, oral argument transcript at p. 42, line 5 et seq, Counsel for the Respondent (citing specifically the reduction of prejudice, and improvement of: critical thinking, scientific creativity, medical professional effectiveness, and cohesion in the military as some of the benefits of diversity).

[23] Sources of diversity within individuals and teams include traits that are observable (e.g., gender, race, class, age, etc.), unobservable (e.g., derived from personality, experience, or values), or functional (e.g., based on knowledge, former training, or organizational standing). Diversity can further be vertical or horizontal, see*, e.g.,* Fidan A. Kurtulus, *What Types of Diversity Benefit Workers? Empirical Evidence on the Effects of Co-worker Dissimilarity on the Performance of Employees*, 50 INDUS. REL.: J. ECON. & SOC'Y 678, 683 (2011); John Qin et al., *A Review of Diversity Conceptualizations: Variety, Trends, and a Framework*, 13 HUM. RSCH. DEV. REV. 133, 139 (2014); Jeremy Dawson et al., *Harnessing Demographic Differences in Organizations: What Moderates the Effect of Workplace Diversity?*, J. ORG. BEHAV. 276, 278 (2017); Cedric Herring, *Does Diversity Pay? Race, Gender, and the Business Case for Diversity*, 74 AM. SOCIO. REV. 208, 209-210 (2009). The NSF is committed to expanding opportunity along 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 (last visited Nov. 16, 2022).

[24] For two survey articles, see Adam D. Galinsky et al., *Maximizing the Gains and Minimizing the Pains of Diversity: A Policy Perspective*, 10 PERSP. PSYCH. SCI. (2015) (describing positive associations between diverse personal experiences and creativity outcomes) and Mathias Wullum et al., *Gender Diversity Leads to Better Science*, PNAS (Feb. 21, 2017) (describing correlational and experimental evidence of the positive impacts of gender diversity on science). But in many cases, the evidence is mixed, cf, in the realm of patenting, G. McMillan, *Gender Differences in Patenting Activity: An Examination of U.S. Biotechnology Industry*, 80 SCIENTOMETRICS 683–691 (2009) (concluding that, "while women may patent much less than men, the quality of their patents is higher") with Cassidy R. Sugimoto et al., *The Academic Advantage: Gender Disparities in Patenting*, 10 PLOS ONE (May 27, 2015) (concluding that women's patents have a lower technological impact than that of men).

[25] Causal studies also have their limitations, including internal validity (was the study conducted free of bias) and external validity (do the results generalize?). See JOSHUA D. ANGRIST AND JÖRN-STEFFEN PISCHKE, MASTERING METRICS: THE PATH FROM CAUSE TO EFFECT, 114-115 (2015).

[26] Allison Scott et al., *Tech Leavers Study: A First-of-its-kind Analysis of Why People Voluntarily Left Jobs In Tech*, Kapor Center for Social Impact (April 27, 2017), https://www.kaporcenter.org/wp-content/uploads/2017/08/TechLeavers2017.pdf, 12-14. (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.)

Employment decisions are also often dictated by non-market factors. Women disproportionately shoulder childbearing and care burdens,[27] and female entrepreneurs, it appears, value autonomy and fulfillment to a greater degree than do their male counterparts.[28] 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.[29] The "misallocation of talent" literature recognizes the impact of all of these factors on occupational outcomes.[30] 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,[31] there is no reason to believe that the current composition of innovators is optimal or efficient.

A. How Diversity Can Improve Innovation: Four Plausible Mechanisms

Below I discuss the ways in which, studies suggest, diversity can improve innovation. Not all forms of diversity are equally relevant for each of the mechanisms discussed below – for example, distinct physical conditions, defined by, say, one's gender or physical ability are arguably more pertinent for innovation through the novelty channel than, for example, religious diversity. Skills, cultural, racial, and gender diversity, on the other hand, have been found to be vital to the discovery of nonobvious combinations.[32] 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, perhaps immigrant innovators, women, and other underrepresented groups that may have the potential to contribute the most to the storehouse of knowledge and inventions.

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.[33] 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,[34] requires a deep understanding of the

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[27] See, e.g. cites in Parts II.C.1 and II.D.1.

[28] Described in Minn. Legis. Coordinating Comm'n Off. on the Econ. Status of Women, *Why are women-owned businesses overall smaller than men-owned businesses?*, 1–4 (2016), https://www.oesw.mn.gov/PDFdocs/Why%20do%20women%20start%20disproportionately%20fewer%20businesses%20than%20menv2.pdf.

[29] As described in Chang-Tai Hsieh et al., *The Allocation of Talent and U.S. Economic Growth*, 87 Econometrica 1439–1474 (2019), https://onlinelibrary.wiley.com/doi/full/10.3982/ECTA11427.

[30] *Id.* For a review of this literature, see Murat Alp Celik, *Does the Cream Always Rise to the Top? The Misallocation of Talent in Innovation*, 132 J. Monetary Econ., at *4 (2022), https://muratcelik.faculty.economics.utoronto.ca/wp-content/uploads/2016/11/Celik-Does-the-Cream-Always-Rise-to-the-Top.pdf.

[31] Hsieh et al., supra note ___, at 1439-40.

[32] On the other hand, certain forms of viewpoint diversity, for example, based on political orientation, may not yield the same benefits.

[33] 35 U.S.C. § 102

[34] *See* Mark Runco & Jill Nemiro, *Problem Finding, Creativity, and Giftedness*, 16 Roeper Rev. 235, 237 (1994) ("As Albert Einstein was reputed to have said, if he had an hour to solve a problem, he'd spend all but five minutes thinking about the problem.").

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,[35] and in the process, solving them for others, too.[36] One such person was a blind boy who found reading books with raised letters tedious and difficult. At 15, Louis Braille came up with an alternative system of raised dots and lines which eventually became the official language of the blind.[37] Disability has been credited with motivating several of the world's leading innovations.[38]

Moving beyond anecdote, several recent studies have demonstrated the connection between who participates in and who benefits from innovation, with a focus on gender. For example, although less than 13% of inventors on U.S. patents are women on average,[39] the female share of bioscience inventors is much higher.[40] 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.[41] Based on a text analysis of all U.S. biomedical patents filed from 1976 through 2010, Rembrand Koning and his co-authors found that patents with all-female inventor teams were much more likely than all-male teams to focus on women's

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[35] Or as Eric von Hippel called it, "user innovation," as described in *The User Innovation Revolution*, MIT Sloan Mgmt. Rev. (2011).

[36] For example, the ironing board was conceived in the late 1880s when Sarah Boone, a dressmaker and free woman born to enslaved parents, designed, then patented, a narrow, curved board that included padding that could be used for pressing and rotating her dresses without leaving wrinkle marks and could be collapsed easily for storage. *Sarah Boone Biography*, Biography.com, https://www.biography.com/inventor/sarah-boone (last updated Jan. 13, 2021); Macdonald, *supra* note ____ at 68 (describing the contributions of women to fields that they dominated such as nursing and household mechanics, and "field[s] [where] they had the greatest experience).

[37] *Id*.

[38] E.g. Vinton Cerf, who has been called the "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 Cell and Noisy Hearing Aids*, Googlers (Oct. 4, 2018), https://www.blog.google/inside-google/googlers/vint-cerf-accessibility-cello-and-noisy-hearing-aids/. Legend has it that the first working model of a typewriter, by Italian inventor Giuseppe Pellegrino Turri, was motivated by the needs of a lover, whose onset of blindness made writing by hand impossible. *See* Carol Johnk, *Do you Remember the Typewriter?* Univ. Iowa Libr. (2015), https://blog.lib.uiowa.edu/eng/new-exhibit-on-the-history-of-the-typewriter/
Alexander Graham Bell's invention of the telephone was informed by, and credited by some to, his lifelong experience as a child of, teacher to, and husband of deaf people. *Alexander Bell: The Telephone, Computing and Telecommunications*, Lemelson, https://lemelson.mit.edu/resources/alexander-bell. The inventor of the telegraph, Samuel Morse, was married to a deaf woman, Sarah Griswold, on whose hand he tapped a language that she helped him develop that would later come to be known as Morse code. Joan Naturale, *HIST 330 Deafness and Technology: Overview*, RIT Libraries (Apr. 6, 2022), https://infoguides.rit.edu/deaftech. 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 Market, *The Medical Mystery That Helped Make Thomas Edison an Inventor,* PBS (Oct. 22, 2018), https://www.pbs.org/newshour/health/the-medical-mystery-that-helped-make-thomas-edison-an-inventor. ("My deafness has not been a handicap but a help to me.").

[39] USPTO, *supra* note ___ , at 3 (2020).

[40] *Id*. at 7.

[41] Koning et al., *supra note ___Who Do We Invent for? Patents by Women Focus More on Women's Health, but Few Women Get to Invent*, 372 Science 1345–1348 (June 18, 2021); *see also* Kristen Senz, *A Lack of Female Scientists Means Fewer Medical Treatments for Women*, HBS Working Knowledge (Feb. 22, 2022), https://hbswk.hbs.edu/item/lack-of-female-scientists-means-fewer-medical-treatments-for-women.

health. Such teams not only focused on conditions unique to women, but also the differential side effects, positive or negative, on women.[42] Though situated in corporate settings, where market factors dictate, the presence of women researchers on teams correlated with greater responsiveness to the female concerns and needs.

This 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 product-market bias. The relative absence of certain groups from innovation increases the risk that the unique needs of these groups remains unmet.[43] 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 cellphones that are 55% too large and car designs that are 47% less safe, on average, for half of the population.[44]

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 the transition of universities from all-male to coed from the 1960s to the 1990s.[45] After universities welcomed women, they experienced a 42% increase in gender-related publications,[46] the researchers found, due both to the greater diversification of researchers as well as a shift in existing research towards gender-related topics.[47] A new working study by Elias Einio and his co-authors that matches detailed economic and demographic profile data with mobile and desktop applications (or "apps") data provides additional evidence of the influence of innovator identity, socialization, and geography on the direction of innovation.[48] Across industries and companies, rich, female, and older innovators were more likely to innovate for consumers like themselves.[49] Apps drew users from the home state of their creators.[50] Even a person's social experience makes a difference: exposure to peers from lower-income groups increases an entrepreneur's propensity to create "necessity products," that serve lower-income groups.[51] In the same way, Patricia Bath made pioneering breakthroughs in ophthalmology and cataracts, not because she herself was personally impacted but because of the disparate impact of

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[42] *Id.* at 1346.

[43] For example uterine fibroids, which disproportionately impact Black women, have long been overlooked by research. Amanda D'Ambrosio, *Kamala Harris Introduces Bill on Uternie Fibroids- More Funding will "Push the Needle" on Treatments for this Disease, Ob/Gyn says,* Medpagetoday (Aug. 20, 2020), https://www.medpagetoday.com/obgyn/fibroids/88190.

[44] Perez, *supra* note __, at ___.

[45] Francesca Truffa and Ashley Wong, *Undergraduate Gender Diversity and Direction of Scientific Research*, presented at NBER Summer Institute Innovation Workshop, July 2022 conference; draft paper available at https://www.dropbox.com/s/qpz64fh8cs6dyg3/coed_draft.pdf?dl=0.

[46] *Id.* at 2.

[47] *Id.* at 3.

[48] Which the authors measure in terms of one's schooling, parental income, and other observable demographic and social factors. Einio et al., *supra* note__ at 13.

[49] *Id*. at 8–10 (also finding women to be more likely to contribute to "clean tech" and other innovation areas with environmental externalities).

[50] *Id.* at 9 (reporting a 8.6% higher usage level in an app's home state).

[51] *Id.*

eye disease on her Black and female patients that she observed.[52] Across settings, who innovates, and their lived experiences, have welfare implications.

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. 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.[53] But consideration of "secondary factors...[can] dislodge the determination that [a] claim. . . is obvious."[54] These factors include "commercial success, long-felt but unsolved needs, failure of others, and others."[55] Although inventors are not required to recombine prior art,[56] they are rewarded for the nonobvious combinations they devise. When innovations address needs that are long-felt, for example, by overlooked segments of the population, patentability is favored.[57]

As described above, Braille is a system of raised dots that can be "read" by the fingertips of the blind.[58] 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.[59] 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 community of the blind.

The law of nonobviousness encodes the fundamentals of the innovative process. Complementing the process of problem-finding, problem-solving has been described as "establishing a connection between or combining two elements that have not previously been

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[52] Dr. Patricia E. Bath Biography, *Changing the Face of Medicine*, Nat'l Inst.'s Health: Nat'l Libr. Med. (last updated June 03, 2015), https://cfmedicine.nlm.nih.gov/physicians/biography_26.html (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 1260–62 (2021) (describing Bath's commitment to advances in cataracts due to the differences she observed between male and female patient populations and the higher incidence of cataract-blindness among women relative to men).

[53] 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.

[54] KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 403 (2007).

[55] *Id*.

[56] *See* 35 U.S.C. § 103. ("Patentability shall not be negated by the manner in which the invention was made.").

[57] Graham v. John Deere Co. 383 U.S. 1, 18 (1966) (describing the relevance of an invention's long-felt need to determinations of obviousness).

[58] Darren Kent, *A Brief History of Braille*, Kent-Tech (Jan. 4, 2018), https://www.kent-teach.com/Blog/post/2018/01/04/a-brief-history-of-braille-world-braille-day.aspx.

[59] Alicja Zelazko & The Editors of Encyclopedia Britannica, *Braille Writing System*, Britannica, https://www.britannica.com/topic/Braille-writing-system.

connected or combined" to create new knowledge.[60] Further, in patent law, the less "analogous"[61] the sources of inspiration that are combined, or the more unpredictable[62] the combination, the more likely it is to be found patentably nonobvious. In the words of the court in the leading case *Gore v. Garlock*, "the bringing together of knowledge held in widely diverse fields itself becomes invention."[63]

Why and how does identity matter to the processes and discovery of innovation? A study of U.S. PhD dissertations across three decades concluded that scholars from 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."[64] The researchers found that the more underrepresented in her discipline a doctoral student was in terms of gender or race, the more likely she was to introduce new "conceptual linkages."[65]

Radical innovation, which adapts existing innovations to new contexts, also appears to benefit from diverse teams.[66] For example, a study of Swedish firms identified a positive correlation between higher shares of ethnic and disciplinary diversity on teams and the share of a firm's profit attributable to radical innovation.[67] 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.[68] A number of studies have found similar, if not always consistent, associations between gender diversity and improved scientific discovery and innovation.[69] For example, a large study in Spain found companies with more women to be more likely to introduce new products or processes over the studied two-year period, due to the creation of new knowledge by individuals with different socialization and career paths.[70]

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.[71] A set of longitudinal, experimental, and field studies by

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[60] Shahid Yusef, *From Creativity to Innovation*, 31 Tech. Soc'y 1, 6 (2009).
[61] 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) (citing In re Bigio, 381 F.3d 1320, 1325 (Fed. Cir. 2004)).
[62] KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398 (2007) ("a combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.")
[63] Johnson & Johnson v. W. L. Gore & Assocs., Inc., 436 F. Supp. 704, 723 (D. Del. 1977). Also finding though that the mere act of combining references from diverse fields does not "necessarily lead to a finding of nonobviousness."
[64] Hofstra et al, *supra* note __.
[65] *Id.*
[66] For a review of articles that support that both related and unrelated knowledge capabilities support the emergence of radical innovation, see Peter N. Golder et al., *Innovations' Origins: When, By Whom, and How Are Radical Innovations Developed?,* Marketing Science Vol. 28, No. 1 (January-February 2009), pp. 166–179.
[67] Ali Mohammadi et al., *Workforce Composition and Innovation: How Diversity in Employees' Ethnic and Educational Backgrounds Facilitates Firm-Level Innovativeness*, 34 J. Prod. Innov. Manag. 406, 407–408 (2017).
[68] *Id*. at 422. (further finding 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 including differences in experiences and perspectives could not be "outsourced.")
[69] Mathias Wullum Nielsen et al., *Making Gender Diversity Work For Scientific Discovery And Innovation,* 2 Nat. Hum. Behav. 726–734 (2018) (Reporting that in five out 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).
[70] Cristtina Diaz-Garcia et al., *Gender Diversity Within R&D Teams: Its Impact on Radicalness of Innovation,* 10 Innovation 149–160 (2013), https://doi.org/10.5172/impp.2013.15.2.149.
[71] Described in Galinsky et al, *supra* note __ at 743.

Lu and co-authors found that close intercultural relationships among MBA students promoted creativity and workplace innovation.[72] In laboratory and field experiments, Chua has concluded, intercultural relationships and networks appear to promote idea flow and creativity.[73]

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.[74] 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.[75] Experimental work on innovation further suggests that though 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.[76] 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 more beneficial than high levels of diversity for creativity.[77] Others have found the innovation benefits of diversity to be present only under certain conditions.[78]

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. Because groups with dissenting viewpoints and experiences are required to exchange more information, diversity "prompt[s] [us] to work harder," the late Katherine Phillips has observed.[79] In experimental settings, mixed-race juries have been found to perform better than single-race ones because they rely more on facts

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[72] Jackson G. Lu et al., "*Going Out" of the Box: Close Intercultural Friendships and Romantic Relationships Spark Creativity, Workplace Innovation, and Entrepreneurship*, 102 J. APPL. PSYCHOL. 1091, 1092 (2017).

[73] Roy Chua, *Innovating at Cultural Crossroads: How Multicultural Social Networks Promote Ideas Flow and Creativity.* 44 J. MGMT 3, 1119–1146 (2018).

[74] *See* Katherine W. Phillips, *How Diversity Makes U.S. Smarter*, 3 SCI. AM., (Sep 16, 2014) (listing some of the downsides of diversity).

[75] S*ee generally* Jie Wang et al., *Team Creativity/Innovation in Culturally Diverse Teams: A Meta-Analysis*, 40 J. ORGAN. BEHAV. 693, 699 (2019).

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

[77] *See, e.g.*, Mumin Dayan et al., *The Role of Functional and Demographic Diversity on New Product Creativity and the Moderating impact of Project Uncertainty*, 61 ELSEVIER, 144 , 144 (2017), https://www.sciencedirect.com/science/article/abs/pii/S0019850116300748 (finding, based on the study of 103 new product development teams, an inverted U-shaped function to describe the relationship between team diversity and new product creativity); Riccardo Sartori et al., *The Relationships Between Innovation and Human and Psychological Capital in Organizations: A Review*, 18(3) INNOVATION J., 1–18 (2013) (reporting organizational openness and innovative output to be characterized by a U-shaped curve).

[78] See, for example, Chua, *supra* note ___, (reporting that the extent to which culturally diverse social networks benefit the creative process useful depends on the type of creative task), and Christian R. Østergaard et al., *Does a Different View Create Something New? The Effect of Employee Diversity on Innovation,* 40 RESEARCH POLICY 500, 500-509 (2011).

[79] Katherine W. Phillips, *How Diversity Makes U.S. Smarter*, 3 SCI. AM., (Sep 16, 2014). (also listing some of the downsides of diversity as "discomfort, rougher interactions, skepticism, less cohesion, more concern about disrespect, and other problems")

and less on faulty assumptions.[80] In addition, the presence of racial and opinion minorities has been correlated with both greater novelty and "integrative complexity,"[81] not unlike the discovery of "truth 'out of a multitude of tongues . . . '" referred to by the Supreme Court in its discussions of diversity.[82] 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" at NASA in the 1960s and "red teams" in innovative companies whose job it is to play devil's advocate.[83]

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 [won't be][] when one or more prior art references 'teach away' from the invention."[84] That is to say, the law rewards the successful pursuit of a path that an inventor would normally be "discouraged from following."[85] 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 the conventional wisdom to be 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" to pursue because, in the context of the invention, carrying out the contemplated combination, "would introduce 'additional [] complexity' and lead to "decreased efficiency."[86] That the inventor persisted and arrived at the solution notwithstanding the weight of the status quo was deemed to provide evidence of the invention's nonobviousness.[87] Likewise, the Supreme Court has cited in favor of an invention's patentability 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.[88] 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

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[80] *Id.* (citing Katherine W. Phillips et al., *Is the Pain Worth the Gain? The Advantages and Liabilities of Agreeing With Socially Distinct Newcomers*, 35 Personality & Soc. Psychol. Bull. 336 (2008)). See also Katherine W. Phillips et al., *Surface-Level Diversity and Decision-Making in Groups: When Does Deep-Level Similarity Help?*, 9 Grp. Processes & Intergroup Rels. 467, 477 (2006) (finding that diverse groups were better than nondiverse groups at identifying hypothetical murder suspects from clues.) See also adjacent studies cited in Chilton et al., *supra* note ___ at pp 180-181.

[81] Defined as "the degree to which a "cognitive style involves the differentiation and integration of multiple perspectives and dimensions,"Anthony Lising Antonio et al., *Effects of Racial Diversity on Complex Thinking in College Students*, 15 Ass'n. Psychol. Sci., 507, 508 (2004), https://www.jstor.org/stable/40064007?seq=2.

[82] Keyishian v. Board of Regents of Univ. of State of NY, 385 U.S. 589, 603 (1967) (opinion of Brennan, J.) (citing United States v. Associated Press. 52 F. Supp. 362, 372) (this language was also cited by Justice Lewis Powell in his decision in the landmark case *Regents of the University of California v. Bakke*).

[83] Timothy R. Clark, The Four Stages of Psychological Safety, at 119–120. (2020) (describing how innovation "requires creative abrasion and constructive dissent – processes that rely on high *intellectual* friction" but also, "low *social* friction. (at xi)).

[84] 2 Chisum on Patents § 5.03 (2021).

[85] Monarch Knitting Mach. Corp. v. Sulzer Morat GmbH, 139 F.3d 877, 885 (Fed. Cir. 1998).

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

[87] *Id.*

[88] United States v. Adams, 383 U.S. 39, 52 (1966).

into "better" innovation, the cumulative effects of greater participation in innovation are substantial, given the role of technological progress in driving economic growth[89] and improving the standard of living. The contributions of immigrant innovators to U.S. innovation are illustrative. Petra Moser has found Jewish emigres from Nazi Germany to the United States responsible for a 31% increase in U.S. resident chemical innovations.[90] Immigrant innovators have collectively contributed to an estimated 22% of all inventions from 1976 through 2012, though they represent only 16% of the inventor population.[91]

Conversely, the opportunity presented by closing participation gaps is also substantial. Jennifer Hunt and her co-authors find that closing the gender gap in engineering jobs and patents would increase U.S. GDP per capita by 2.7%.[92] The risk to society of missing out on so-called lost Marie Curies or Patricia Baths[93] is particularly acute. That is because highly talented individuals have an outsized impact on innovation, economic growth, and the trajectory of history.[94] 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 much innovation.[95] 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."[96]

B. Additional Rationales for Promoting Diversity in Innovation

Particularly in light of the emerging empirical case for diversity in innovation, it is worth considering its other justifications, including deontological (or so-called "moral") and other utilitarian or instrumental (e.g. business and economic) rationales. It is notable that instrumental

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[89] Jennifer Hunt et al., *Why Are Women Underrepresented Amongst Patentees?*, 42 RSCH. POL'Y. 831 (May 2013) (finding that more than half of U.S. economic growth since the Second World War is attributable to technological progress).

[90] Petra Moser et al., *German Jewish Émigrés and US Invention*, 104 AM. ECON. REV. 3222, 3224(2014), https://www.aeaweb.org/articles?id=10.1257/aer.104.10.3222. I thank Daniel Sokol for reminding me of this study.

[91] Shai Bernstein et al., *The Contribution of High-Skilled Immigrants to Innovation in the United States* (2019), https://web.stanford.edu/~diamondr/BDMP_2019_0709.pdf.

[92] Jennifer Hunt et al., *Why Don't Women Patent?*, 2 (Nat'l Bureau of Econ. Resch., Working Paper No. 17,888) https://www.nber.org/papers/w17888. Federal Reserve Governor Lisa Cook and Yanyan Yang have likewise found that including more women and African-Americans in the initial stages of the innovation process would grow the economy by 0.6% to 4.4%.Testimony of Lisa D. Cook,.*US-China: Winning the Economic Competition: Hearing Before the Subcomm. On Econ. Pol'y of the Sen. Comm. on Banking, Hous., and Urb. Aff.*, 116th Cong. 2 (July 22, 2020) https://www.banking.senate.gov/imo/media/doc/Cook%20Testimony%207-22-20.pdf.

[93] Profiled *supra* in Part I.A.1.

[94] Alexander Bell and his colleagues have documented this skew among inventors. Bell, et al., *Do Tax Cuts Produce More Einsteins? The Impacts of Financial Incentives vs. Exposure to Innovation on the Supply of Inventors*, NBER Working Paper No. 25493, 1, 3 (2019) (finding, e.g., that the top 1% of inventors collected more than 22% of total inventors' income.)

[95] Bell et al., *supra* note___ at 710.

[96] *Id*. *Accord* Murat A. Celik, *Does the Cream Always Rise to the Top? The Misallocation of Talent in Innovation*, https://muratcelik.faculty.economics.utoronto.ca/wp-content/uploads/2016/11/Celik-Does-the-Cream-Always-Rise-to-the-Top.pdf (2021) (finding that the meritocratic allocation of talent would both increase economic growth and decrease consumption inequality).

rationales, despite their popularity, have been criticized for prioritizing the general benefits of diversity for the majority group (e.g. 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).[97]

Equity interests are advanced, for example, when bias and structural impediments to participation in innovation are dismantled.[98] Innovation jobs 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.[99] Finally, the relationship between who innovates and who benefits from innovation implies that diversifying inventorship has implications for consumption inequality and broader welfare.[100] For example, using innovation to close female-male gaps in health outcomes is projected to, on average, increase life expectancy, reduce disease burdens, and reduce disruptions to work productivity.[101]

Diverse innovators can help companies meet performance and ESG (environmental, social, and governance) goals, reach diverse customers, and attract not only diverse talent but talent that is attracted to diversity.[102] Increasing the percentage of Americans of all backgrounds who participate in the innovation system would also advance national economic competitiveness interests.

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 Part turns to the patent system, and argues in favor of understanding its constitutional purpose of promoting "progress," as including the promotion of a diversity of innovators, and not just innovation. Doing so is supported by patent law's history and track record..

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[97] Jordan G. Starck et al., *supra* note ___(describing the stated purpose of race-conscious admissions efforts as "not only or even primarily to confer benefits upon 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." See also 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.
(reporting that underrepresented candidates preferred fairness or no rationales for diversity to "business" rationales, in corporate statements).

[98] *Described* e.g in Part II.C (describing differences in childcare burdens, perceptions of workplace fairness and safety, and levels of investment in human capital formation).

[99] Lisa D. Cook & Yanyan Yang, Slides, *Missing Women and Minorities: Implications for Innovation and Growth*, at 3 (2018), http://www.yanyanyang.com/uploads/5/6/5/2/56523543/aeapinkblack_cookyang.pdf (reporting on NSF data that showed that the average salaries of female and African-American innovation workers represented only 71% and 79% of their male and white counterparts, respectively).

[100] As described in Murat A. Celik, *supra* note ___and Einio et. al, *supra* note ____.

[101] Matthew D. Baird et al., *Research Funding for Women's Health: Modeling Societal Impact*, RAND Corp. (2021), https://tinyurl.com/mr329cv4 (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).)

[102] Richard Florida, *Cities and the Creative Class*, 2 CITY & COMMUNITY (2003).

1. Patent Law's History of Attending to Diverse Innovators, not Just Innovation, from the Start

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.[103] The Act was remarkably inclusive for its time: in contrast to naturalization, which was reserved for "free White Persons,"[104] "any person or persons" could apply for a patent.[105] Furthermore, all who succeeded on their patent applications received the same rights, unlike the discounting of slaves to "three-fifths of. . . Persons" for purposes of taxation and representation.[106] In contrast to suffrage, which was not guaranteed for women until 1920,[107] "he, she, or they" could apply for a patent.[108] As Anne Macdonald has recounted, while there was no express lobbying to extend patent rights to women, "early legislatures were mindful that female descendants of the Revolution's plucky Daughters of Library should, as Abigail Adams coached her husband, be "'remembered.'"[109]

Patents were seen as a way to stimulate economic growth, particularly in manufacturing given the scarcity of labor.[110] To succeed in doing so, 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.[111] Low fees[112] and the award of patents based on merit rather than patronage[113] also contributed to the "democratization of invention," economic historian Zorina Khan has described.[114] 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. As Daron Acemoglu and David Robinson wrote in their landmark work, *Why Nations Fail*: not only was 19th 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."[115]

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[103] Patent Act of 1790, ch. 7, § 1, 1 Stat. 109 [hereinafter 1790 Act].
[104] Naturalization Act of 1790, ch. 3, § 1, 1 Stat. 103. This racial prerequisite to citizenship remained in force until 1952. Ian Haney-López, White By Law: The Legal Construction of Race 1 (New York Univ. Press rev. ed. 2006).
[105] 1790 Act § 1.
[106] U.S. Const. art. II, § 2.
[107] Through the ratification of the 19th Amendment to the 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."
[108] 1790 Act § 1.
[109] Anne L. Macdonald, Feminine Ingenuity: Women and Invention in America 25 (1994).
[110] Oren Bracha, Owning Ideas: A History of Anglo-American Intellectual Property 99 (June 2005) (Ph.D. dissertation, University of Texas at Austin School of Law), https://law.utexas.edu/faculty/obracha/dissertation (describing the use of variety of methods, 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 (2019) at II A (describing patents as part of the government's promotion of industry).
[111] B. Zorina Khan & Kenneth L. Sokoloff, *Patent Institutions, Industrial Organization and Early Technological Change: Britain and the United States, 1790-1850 in* Technology Revolutions in Europe: Historical Perspectives (Maxine Berg & Kristine Bruland eds., Edward Elgar 1998).
[112] Peter Drahos, The Global Governance of Knowledge: Patent Offices And Their Clients 99–109 (2010) (describing the U.S. patenting fees as being lower than fees in the UK and most European countries,through the middle of the 19th century). *Accord* B. Zorina Khan, The Democratization of Invention: Patents and Copyright in American Economic Development, 1790-1920, at 29 (Cambridge Univ. Press 2005).
[113] As was prominent in Britain at the time of the founding of the U.S., as described in Klaus Boehm & Aubrey Silberston., 1 The British Patent System: Administration 14 (Cambridge Univ. Press 1967).
[114] As described in Khan et al., *supra* note__, at 292–313.
[115] Daron Acemoglu & James Robinson., Why Nations Fail: The Origins of Power, Prosperity and Poverty 333

But a closer look at the evolution of the law suggests that such a characterization is, at best, incomplete. The 1790 Act was quickly superseded by the Patent Act of 1793, which restricted inventorship to U.S. citizens.[116] This meant that foreigners, slaves, and non-white immigrants, that is, those who were not "free White persons" under the 1790 Immigration and Naturalization Act, could not apply for patents. And while the federal patent law did not discriminate on the basis of gender, a number of states considered a woman's marital property to be assigned upon creation to her husband.[117]

The 1793 Act was amended in 1800 to make immigrants eligible to apply for patents, as long as they had resided in the U.S. for two years and swore that the invention in question had not been known or used previously in the United States or abroad.[118] The use of patent law as an inducement for foreigners to come, stay, and innovate was broadly consistent with the first patent system which sought to recruit to 15th century Venice, "every person who shall build any new and ingenious device."[119]

Until recently, a parallel desire to cultivate foreign contributions to the benefit of the U.S. was enshrined in patent law: foreign inventions would not preempt subsequent patenting under U.S. law, unless they had been written down or patented.[120] Structural disadvantages for certain inventors persisted for decades.[121] Slave owners exploited the law to their advantage as Eli Whitney became famous based on a cotton gin now attributed to a slave named Sam, and, according to accounts, the "McCormack" reaper actually benefited greatly from the contributions of a slave named Jo Anderson.[122] The rights of married women[123] and African Americans to obtain and own patents were being clarified well into the patent system's first century.[124]

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 1975–97, the USPTO expanded its network of libraries to all 50 states.[125] As part of the America

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(2013).

[116] Patent Act of 1793 Act, ch.11, § 1, 1 Stat. 318–23. Such a move appears to be consistent with a broader Congressional decision to give states the right to regulate property-holding by non-citizens. Allison B. 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. Described in Kara W. Swanson, *Making Patents: Patent Administration*, 1790–1860, 71 Case W. Rsch. L. Rev. 777, 818 n. 84 (2020). For a description of the use of pronouns subsequently in the patent statute, see Dennis Crouch, *He, She, or They in U.S. Patent Law*, Patently-O (June 28, 2022).

[117] Eric S. Hintz, *Counting Women Inventors,* Lemelson Center (Mar. 21, 2017), https://invention.si.edu/counting-women-inventors.

[118] Described in Khan, *supra* note___ at 71.

[119] 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).

[120] *See* Pre-AIA 35 U.S.C. § 102(a) and (b) available at https://www.bitlaw.com/source/35usc102_(pre-AIA).html (restricting foreign prior art, in § 102(b) to patents, printed publications, and sales, and now considering foreign knowledge or use as prior art).

[121] For the progression of the laws, see Appendix, Table A.

[122] Described in Brian L. Frye, *Invention of a Slave,* 68 Syr. L. Rev. 181, 187 (2018).

[123] *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).

[124] As described in Swanson, *supra* note ___ at 809, although both women and black inventors managed to get patents during this time, see Frye, *supra* note __ at 185 (describing antebellum patenting by black Americans); Macdonald, *supra* note ___ (providing a history of early patenting by women)..

[125] Resulting in measurable benefits to new innovators as documented in Jeffery L Furman et al., *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.

Invents Act, Congress directed the USPTO to open satellite offices across the country,[126] in order to "ensure geographic diversity [] in different States and regions throughout the United States."[127] 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 long-standing but overlooked commitment to institutional diversity. The participation of organizations of different sizes, motivations, geographies, and institutional capacities, like individual and team-level innovator diversity, 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, has led the United States to, until recently, adopt a "first-to-invent " approach to determining who among competing inventors should prevail. This is because doing so rewards the person who has the idea first, not who has greater resources to get on file.[128] Universities enjoy numerous advantages in patent law including one 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.[129] It is easier for individual inventors and universities than for patent assertion entities to get injunctions.[130] Underresourced inventors have also enjoyed particular accommodations, including more intensive assistance[131] and deep fee discounts.[132] 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."[133] The patent system's commitment to innovators extends beyond inventors as the Supreme Court has at different times

[126] Pub. L. 112–29, §23, Sept. 16, 2011, 125 Stat. 336, codified at 35 U.S.C. 1 note.
[127] *Id.* at (C)(1)(a). See also "Unleashing American Innovators Act of 2021," introduced by Sen. Patrick Leahy, which would require the USPTO to open a regional office in the southeastern region of the United States.
[128] *See* Colleen V. Chien and Mark Lemley, *Are the U.S. Patent Priority Rules Really Necessary?*, 54 HASTINGS L. J. 1299, 1300 (2003), https://repository.uchastings.edu/hastings_law_journal/vol54/iss5/1/.
[129] Described in Peter Lee, *Patents and the Univer*sity, 63 DUKE L. J. 1 (2013) (describing the special statutory carveouts universities enjoy but also contrasting it with courts' refusal to give special treatment to academic institutions that behave like commercial actors).
[130] Colleen Chien and Mark A. Lemley, *Patent Holdup, the ITC, and the Public Interest*, 98 CORNELL L. REV. 1, 10 Figure 1 (2012)
[131] As described for example in Pairolero et al., infra note __.
[132] 13 C.F.R. § 121.802 (2011); 37 C.F.R. § 1.27(a)–(b) (2011) (providing fee discounts of 50%-75% to small and "micro" entities)
[133] 35 U.S.C. § 5 (b).

invoked the interests of independent innovators,[134] users and future innovators,[135] and entrepreneurs,[136] for example, to justify its patent law decisions.

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,[137] 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![138] As a result, however well-intentioned, efforts to diversify innovation and inventorship risk "flying blind," in light of the inability to determine a baseline from which to measure progress, much less to assess the adequacy of current law, for providing guidance to the courts and Congress and assessing whether or not interventions have been effective. With respect to socioeconomic diversity, the USPTO has the power to set fees and ability to offer fee discounts, increasing access, but agency fees are only a small fraction of the cost of filing for a patent.[139] Due to the agency's fee structure, which requires it to cover its own fees, the USPTO cannot receive appropriations earmarked for diversity efforts, for example.

To address these limitations, this Article calls for redefining the term "progress" in Part 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.[140] But instead of bucking

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[134] See, e.g. *Aronson v. Quick Point Pencil Co*., a case about the enforceability of a contract involving a patent that had been invalidated, the Court cited the desirability of enabling "independent innovators" to proceed in "areas where patent law does not reach." in its decision to strike a contract's terms. 440 U.S. 257, 266 (1979))

[135] Mayo Collaborative v. Prometheus Labs., 132 S. Ct. 1289, 1291 (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.")

[136] In *Halo Elecs., Inc. v. Pulse Elecs., Inc*., a case about the appropriate level of damages for knowing patent infringement, the Court warned about the business costs of patent litigation and of "prevent[ing] an innovator from getting a small business up and running." 579 U.S. 93, 111–12 (2016).

[137] SUCCESS Act, Pub. L. No. 115–273, 132 Stat. 4158 (Oct. 31, 2018).

[138] *USPTO*, Study of Underrepresented Classes Chasing Engineering and Science Success (SUCCESS) Act of 2018, Pub. L. No. 115–273, 1, 11–13 (2019), https://www.uspto.gov/sites/default/files/documents/USPTOSuccessAct.pdf (describing the lack of reliable race and ethnicity data of inventors and citing, for example, for Black inventors, statistics from the 1940s).

[139] Russ Krajec, *How Much Does a Patent Cost?*, BLUELRON (Jan. 16, 2022) https://blueironip.com/how-much-does-a-patent-cost/ (describing typical attorney fees, for the filing of patents, as being between $9-12K while USPTO fees are below $1K).

[140] 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 authorization, of the grant of intellectual property rights. *See 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, 755, 794–803 (2001); *see also* Dotan Oliar, *Making Sense of the Intellectual Property Clause: Promotion of Progress as a Limitation on Congress's Intellectual Property Powe*r, 94 GEO. L.J.

the conventional utilitarian paradigm, the present effort 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's 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 relevant, generative innovation, broadening the *impact* of these ideas, consistent with the idea of progress as "spread" and the betterment of the human condition, as advanced by previous originalist interpretations.[141] Considered in view of the patent system's history and the contributions of diversity to innovation, the legal proposal is modest: build on the many ways in which patent policy is and has always also been people and innovator policy and enlarge the sense of patent "progress" to include the promotion of innovators. Such a redefinition would continue and expand, 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 authority conferred" by the Progress Clause.[142] 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, PTO, 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 failure of diverse innovation workers to apply for patents, as well as the "patent grant gap," the lower rate at which underrepresented applicants succeed on their applications.

PART II: PROGRESS AND THE INNOVATOR-INVENTOR GAP

Given the strong case for diversity in innovation, one might expect there to be

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1771, 1808 n.180, 1809 (2006) (textually analyzing of 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 *Postmodern 'Progress': Reconsidering the Copyright and Patent Power*, 43 DEPAUL L. REV. 97, 100–101 (1993). Jessica Silbey's *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. JESSICA SILBEY, AGAINST PROGRESS, 1, 4–5 (Stanford Univ. Press 2022). Chris Buccafusco and Jonathan Masur have advanced a hedonic account of human welfare as the aim of the intellectual property system. Chris Buccafusco & Jonathan Masur, *Intellectual Property Law and the Promotion of Welfare*, *in* 1 RESEARCH HANDBOOK ON THE ECONOMICS OF INTELLECTUAL PROPERTY LAW, (Ben Depoorter & Peter Menell, eds.), ___

[141] *Id*., Pollack and Oliar.

[142] 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 "the justifications that motivated Congress to enact the CTEA, set forth supra, provide a rational basis for concluding that the CTEA "promote[s] the Progress of Science," and that therefore it should not be struck down.)

broad-based participation in patenting. But, to return to the example of gender, women represent only 27% of the STEM workforce, and 13% of inventors.[143] While who participates in the innovation workforce is the product of a broad range of factors,[144] this Part focuses narrowly on what happens next, when women are 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 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, e.g., for defensive, assertive, or licensing purposes, 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 non-utilitarian 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.[145] 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.[146] But it is equally and perhaps even more important to focus on what is happening in larger firms, where the vast majority of innovation and patenting,[147] but only a small minority of first-time patenting by females,[148] 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

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[143] Christnach et al., *supra* note ___.
[144] Some of which are discussed, for example, in Chien, *Inequalities*, at ___.
[145] Joan Farre-Mensa et al., *What Is a Patent Worth? Evidence from the U.S. Patent "Lottery,"* 75 J. FIN. 639, 640 (2019).
[146] Nicholas Pairolero et al., *Closing the Gender Gap in Patenting: Evidence from a Randomized Control trial at the USPTO* (USPTO Economic Working Paper No. 2022-1, 2022).
[147] Erin Duffin, *Share of utility patent grants issued in the United States in FY 2021, by entity size and origin*, STATISTA (Nov. 22, 2021), https://www.statista.com/statistics/256715/number-of-technology-patent-grants-in-the-us-by-ownership/ (showing large entities to have filed 69% (among US origin applicants) -84% (among foreign applicants) of patents).
[148] Pairolero et al, supra note __, at 4-5.

diversity in innovation generally, and the under commercialization 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.[149] For example, patenting is associated with pay, promotion, and job retention benefits above and beyond employment.[150] Even in cases where the invention belongs to the employer and not the inventor,[151] as the Federal Circuit 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."[152] 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. [153] The benefits accumulate over the course of one's career.

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," the 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.[154] 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 (fairness, attribution, inequality) and consequentialist (lost inventions, visibility) dimensions. Both types of interests are advanced when innovators of all types have an equal opportunity to participate in inventorship, witness their inventions become innovations, and inspire future generations of innovators. As the paragraphs below argue, it is not obvious that they do.

Taking the case of gender, where the data is most available, I begin by approximating, using available data, the "innovator-inventor gap" among male v. female technical workers in over two dozen settings.The resulting glimpse underscores the importance of focusing on the to-date largely neglected *pre* application phase of patenting. To become an inventor requires a person to satisfy the legal requirements of inventorship, apply for a patent, and be evaluated and eventually 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 to progress along the innovator-inventor pipeline.

Focusing primarily on the experiences of female inventors has limitations. As the failure of the gains experienced by white women to translate to women of color well demonstrates, diversity challenges cannot be solved by looking at the experiences of a single underrepresented

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[149] 35 U.S.C. § 262 (2012) (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 owners).

[150] Described in Gauri Subramani et al., *Attrition and the Gender Innovation Gap: Evidence from Patent Applications,* 1-2 (November 2022), available at InnovationGap_1122.pdf (describing studies by Kline and Melero).

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

[152] Chou v. University of Chicago, 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 patenters).

[153] Jason Ratanen & Sarah Jack, *Patents As Credentials*, 76 WASH. & LEE L. REV. 311, 359-376 (2019) (discussing the use of patents as credentials by judicial opinions, universities, employers, and others).

[154] Bell, *supra* note ___ at 2.

group.[155] Survey research suggests isolation, hostility, and harassment[156] 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 because when located in more conservative places.[157] Asian-American scientists have attributed their underrepresentation in scientific prizes, in part, to the "the all-too-common experience of being confused for someone else," and includes the recommendation: "Make effort to treat Asian scientists as individuals. For example, learn their names".[158]

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. However, given the stakes, it is still worth examining, as this Part does, possible barriers to participation that come from patent law and patent practice and how to address them.

A. Why and How to To Study Potential Inventors and the Innovator-Inventor Gap

The underrepresentation of women on patents has been previously studied and documented, in academia and industry.[159] However, the participation of women and minorities in the *pre*-application phase of inventing has been the subject of scant research, for a few reasons. First, while the patent application process is, for published applications and patents, generally public, *pre*-application activities are generally private, taking place behind closed doors.[160] Not available is information about the pool of potential inventors, nor information about the contributions of within-firm factors like seniority, nature of technical roles, filing rate,[161] and corporate culture to observed gaps, which are necessary for a complete picture.

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 7% difference between men and women who apply for patents in terms of who gets a patent, there is about a 50% difference between men and women technical workers with respect

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[155] Described, e.g. in Adia Harvey Wingfield, *Women are Advancing in the Workplace, but Women of Color Still Lag Behind*, Bookings (2020), https://www.brookings.edu/essay/women-are-advancing-in-the-workplace-but-women-of-color-still-lag-behind/.

[156] As described, e.g. in Scott et al., *supra* note____ at 4, 14.

[157] *See* Colleen Chien & Ernest Fok*, Comments to the National Strategy for Expanding American Innovation* at 61 (2021), http://digitalcommons.law.scu.edu/facpubs/986/ 33- 38

[158] Yun Nung Jan, *Underrepresentation of Asian Awardees of United States Biomedical Research Prizes*, 185 Cell 407, 410 (2022), https://www.cell.com/cell/fulltext/S0092-8674(22)00004-6.

[159] This gap has been previously approximated as being "about half" in various settings and studies. See cites infra at note ___ .

[160] Inventors on upstream informal "provisional" patent filings that precede full 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.

[161] The rate at which invention disclosures are turned into patent applications, described in Michael Hall, *Filing Rate and Transfer Rate at NIST: An Examination of Invention Disclosures, Patent Applications, and Invention Licenses*, Nat'l Inst. Standards & Tech., 1,1 (2021), https://nvlpubs.nist.gov/nistpubs/ttb/NIST.TTB.2.pdf (describing the average filing rate within universities to be 60%).

to who applies for a patent in the first place.[162] Gains in the diversification of STEM education have also not translated into commensurate improvements in the diversification of patenting,[163] suggesting that more than K-12 or even collegiate pipeline improvements will be needed to increase the participation of underrepresented groups in inventorship.

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 the patenting,[164] 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 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.

The Innovator-Inventor Gap

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.[165] Though generally not public, an increasing number of firms have started to release EEO-1 data under pressure to diversify. 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.[166] Firm-level differences, for example, regarding who among technical workers realistically is likely to become an inventor, also are not captured. However, the story, across industries (e.g. tech, biosciences, and aerospace) and settings (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%) at which they are employed in technical roles. (FIG___) The 50% figure is generally consistent with company and university self-reports, and more systematic studies of academic and industry patenting.[167]

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[162] Holly Fechner & Matthew S Shapanka, *Closing Diversity Gaps inn Innovation: Gender, Race, and Income Disparities in Patenting and Commercialization of Inventions,* 19 TECH. & INNOVATION 727–734 (2018), https://www.cov.com/-/media/files/corporate/publications/2018/06/closing_diversity_gaps_in_innovation_gender_race_and_income_disparities_in_patenting_and_commercialization_of_inventions.pdf (documenting a gender "application gap" of 66%, as compared to a "grant gap" of only 6%); *see also* Jessica Milli et al., *Equity in Innovation: Women Inventors and Patents*, INST. WOMEN'S POL'Y RSCH. 11 (Nov. 29, 2016), https://iwpr.org/wp-content/uploads/2020/12/C448-Equity-in-Innovation.pdf (noting that the difference rate in patent success is less stark than the difference in patent application).

[163] Delgado and Murray, *supra* note ___(while women captured about 35% of STEM PhDs from 2010-15, the comparable rate among inventors remained at less than 14%).

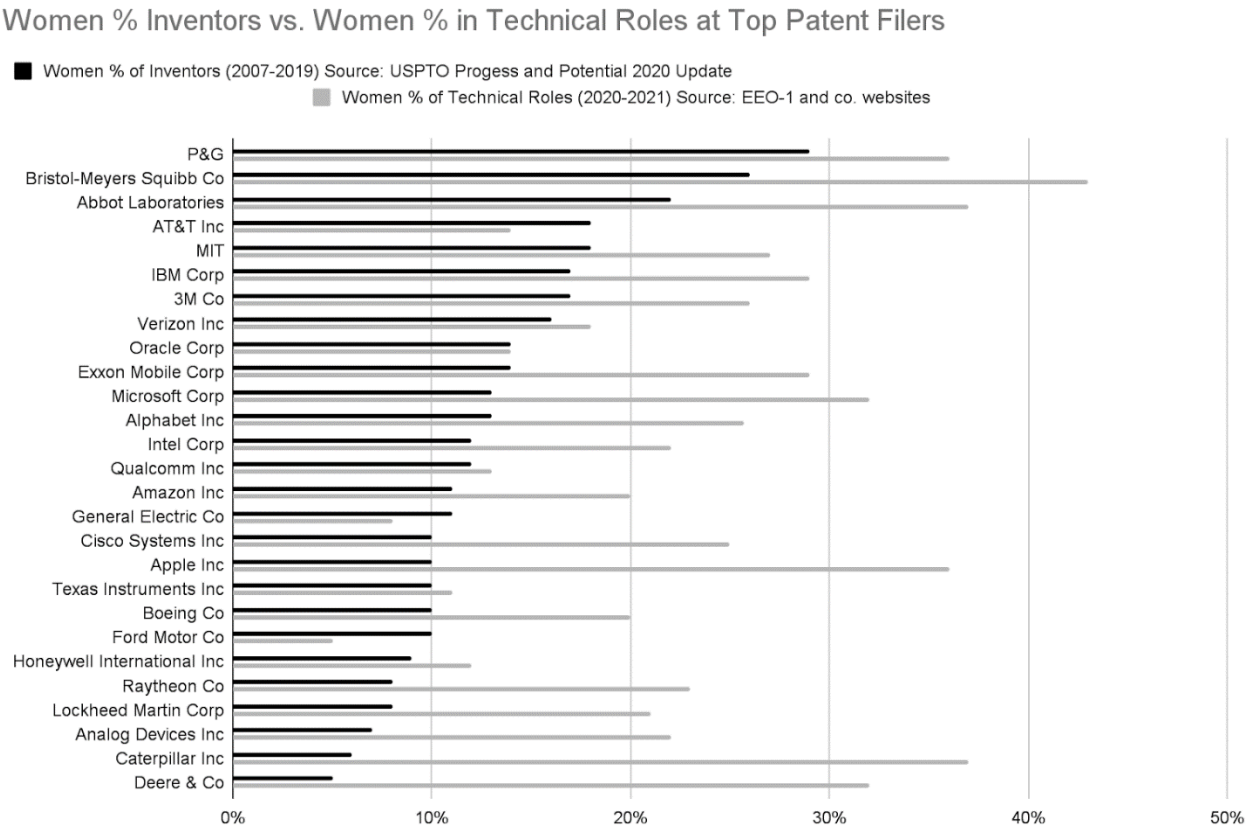
[164] As both involve, for example, the submission and evaluation of ideas and naming of collaborators.

[165] EEOC-1 reports list report the breakdown of male and female "technicians"; I also used self-reported data for MIT, *Campus Diversity*, Institutional Research Office of the Provost (2022), https://ir.mit.edu/diversity-dashboard., and Intel in the absence of EEOC-1 data. (https://www.intel.com/content/www/us/en/diversity/diversity-at-intel.html).

[166] Further, it may be the case that companies want to increase any way possible the numbers they report so therefore may exaggerate jobs that don't include any innovative responsibilities, inflating the size of the innovator-inventor gap.

[167] For company self-reports, see *USIPA Applauds Diversity Pledge Update*, LENOVO STORYHUB (Sept. 27, 2022), https://news.lenovo.com/pressroom/press-releases/usipa-applauds-diversity-pledge-update/ (reporting that women at Lenovo and Meta patented at 65% and 70% of their employment rate, respectively). *See* Fatima Taha, *Protecting and Progressing Gender Diversity in Innovation*, VANGUARD (2022),

FIG:___ 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 innovating and who is being named as an inventor *even within the workplace*. And finally, there appear to be significant opportunities to improve who is participating in invention at the largest filers, with potential

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https://www.vanguardlawmag.com/case-studies/sabra-anne-truesdale-western-digital/ (reporting gaps of 50% at Western Digital). For university studies: *see* also Serena Hanes et al., *Gender Analysis Of Invention Disclosures And Companies Founded By Stanford University Faculty From 2000-2014*, Les Nouvelles (documenting that at Stanford, 13% of male faculty versus 7% of female faculty were inventors). Waverly W. Ding et al., *Gender Differences in Patenting in the Academic Life Sciences*, 313 SCIENCE (Aug. 2006), https://www.science.org/doi/abs/10.1126/science.1124832 (reporting that, within a random sample of academics, female faculty patented at about 40% the rate of men). *See also* e.g. Kate Gaudry & Leron Vandsburger, *Across Industries, the Female inventor Rate is Half the Female Employment Rate,* IP WATCHDOG (2020), https://www.ipwatchdog.com/2020/04/20/across-industries-female-inventor-rate-half-female-employment-rate/id=120717/ (concluding, based on an analysis of 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, *Gender and Racial Diversity in Invention & Patenting*, Institute for Women's Policy Research (July 28, 2021), https://increasingdii.files.wordpress.com/2021/07/20210728-shaw_diversity-in-patenting_dii-conference-compressed.pdf, slide 9 (reporting that women-owned businesses were half as likely to have a granted patent than male-owned businesses).

ramifications for the direction of innovation. In the next section I consider how the law of inventorship is contributing to the innovator-inventor gap.

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."[168] 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." Court decisions have repeatedly confirmed that an inventor must be a natural person[169] 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."[170] "Conception is 'the touchstone of inventorship,'" and a person must contribute to this conception of the claimed invention in order to be an inventor.[171] 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."[172]

As described earlier,[173] slaves, foreigners and women were limited in their ability to be named as inventors or own inventions for much of the first century of the patent system. 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.[174] 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.[175] As such, the law currently excludes inventorship parties who have put in valuable time, resources, and even

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[168] Goldstein v. Cal., 412 U.S. 546, 561 (1973).
[169] Thaler v. Hirshfeld, App No. 21–2347 (Fed. Cir. 2022), 11 (confirming that only natural persons can be inventors). For an overview, *see* David Schwartz and Max Rogers, *Inventorless Inventions? The Constitutional Conundrum of AI-Produced Inventions,* 35 Harv. J. L. & Tech. (2022 Forthcoming). The human being requirement also excludes indigenous communities that steward shared knowledge and innovation. See Marcia E. DeGeer, *Biopiracy: The Appropriation of Indigenous Peoples' Cultural Knowledge*, New Eng. J. Int'l & Comp. L. 179, 184.
[170] Burroughs Wellcome Co. v. Bar Labs., Inc., 40 F.3d 1223, 1227–1228 (Fed. Cir. 1994).
[171] Board of Educ. ex rel. Board of Trustees of Florida State University v. American Bioscience Inc., 333 F.3d 1330, 1337–38 (Fed. Cir. 2003).
[172] Michael A. Whittaker & Richard J Warburg, *What is Sufficient to Show Possession of an Invention In Biology and Chemistry?*, 14 Expert Opin. Ther. Patent 593, 596 (2004), https://www.tandfonline.com/doi/pdf/10.1517/13543776.14.5.593.
[173] In Part I.B, *supra*.
[174] Liza Vertinsky, *Boundary-Spanning Collaboration and The Limits of Joint Inventorship Doctrine*, 55 Hous. L. Rev. 401, 406-07 (2017).
[175] Patrick G. Gattari, *Determining Inventorship for U.S. Patent Applications*, 17 Intell. Prop. & Tech. L.J. 16, 16–17 (2005).

ingenuity to realize an invention.[176] 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 to 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.[177] 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,[178] to the "giving" of their ideas to male relatives, to the outright appropriation of their inventive work by men.[179] The distinction between these scenarios is often not clear.

2. Omitting Authors as Inventors

In one high-profile case, Joanny 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, published in leading journal *Science*.[180] According to a follow-up report in *Science*, three of the other researchers believed she had incorrectly been left off the patent.[181] 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 University. Citing the continued financial and reputational interest the plaintiff had in the correct inventorship, the Federal Circuit reversed,[182] and Chou's name now appears on the patent.[183]

While this example is anecdotal, a few studies have taken a more comprehensive view. A recent study in *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.[184] 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.[185] 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. Evidence of the credit gap was present in almost all research fields and career stages. Though the report focused on women, the authors observed similar patterns among other marginalized groups in science.[186] The

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[176] Eugene C. Rzucidlo & Dorothy R. Auth, *Will the Real Inventor Please Stand Up?*, 14 NATURE BIOTECH. 358, 358 (1996), https://www.nature.com/articles/nbt0396-358.pdf. (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 Diversity Levers*, 23 DUKE J. GENDER L. & POL'Y 25–43, 31 (2015)).

[177] Described in Chien, *Inequalities*, *supra* note ___ at fn 245.

[178] MACDONALD, *supra* note __, at 36 (1994)

[179] *Id.* at ~392, and ~191 (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).

[180] Eliot Marshall, *Patent Suit Pits Postdoc Against Former Mentor*, SCIENCE 287, 2399 (2000).

[181] *Id.*

[182] Chou v. University of Chicago, 254 F.3d 1347, 1359 (Fed. Cir. 2001).

[183] File history of U.S. Patents 5, 328, 688, available at https://portal.uspto.gov/pair/PublicPair.

[184] Matthew B. Ross et al., *Women are Credited Less in Science than are Men*, NATURE (2022), https://doi.org/10.1038/s41586-022-04966-w.

[185] *Id.*

[186] Holly Else, *'Ignored and Not Appreciated': Women's Research Contributions Often Go Unrecognized,* NATURE NEWS, (June 22, 2022), https://www.nature.com/articles/d41586-022-01725-9.

researchers speculated that much of the gap existed because the contributions of women were "often not known, not appreciated or ignored."[187]

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.[188] Another report, by Lissoni and co-authors analyzed hundreds of patent-paper pairs involving authors that were left off of related patents. 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.[189] 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.[190] Because inventorship is evaluated with respect to the invention as claimed,[191] and the claims of a patent typically evolve during the application process, a party hoping to exclude another can do so by changing the claims of the patent to exclude certain subject matter. These studies suggest that who gets named on a patent isn't just about who meets the legal definition but also, about the decisions of those in power. The omission of nonprofit authors on corporate inventions continues to be a sore point, arising recently in high-profile cases involving the exclusion of government researchers on COVID-19 vaccines and medicines.[192]

These cases underscore that in comparison to authorship, which is generally viewed as relatively more flexible and inclusive,[193] 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,[194] those within the lower ranks in an organization have a

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[187] *Id.*

[188] Elyse Shaw & Halie Mariano, *Tackling The Gender And Racial Patenting Gap to Drive Innovation*, Inst. Women's Pol'y Rsch., (July 2021), https://iwpr.org/wp-content/uploads/2021/07/Key-Findings_Tackling-the-Gender-and-Racial-Patenting-Gap.pdf.

[189] Francesco Lissoni et al., *Misallocation of Scientific Credit: The Role of Hierarchy and Preferences*, 6 Indus. & Corp. Change 1471 (2020).

[190] Philippe Ducor, *Coauthorship and Coinventorship*, 289 Science 873–875 (2000) https://www.dropbox.com/s/mplxnu4p2iilfb8/Authorship%20and%20Inventorship.pdf?dl=0 (reporting that out of seven papers coauthored by individuals from academia and from industry, corresponding, industry-owned, patents named no non-industry inventors).

[191] See, e.g *In re VerHoef,* 888 F.3d 1362, 1366-67, 126 F.2d 1561, 1564-65 (Fed. Cir. 2018) ("A person who shares in the conception of a *claimed invention* is a joint inventor of that invention.")

[192] Heidi Ledford, *What the Moderna- NIH COVID Vaccine Patent Fight Means for Research,* Nature (Nov. 30, 2021), https://www.nature.com/articles/d41586-021-03535-x (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/ (describing the exclusion of government scientists and co-authors on patents over the drug Remdesivir).

[193] See Dorothy R. Auth & Eugene C. Rzucidlo, *Patents: Will the Real Inventors Please Stand Up?,* Nat Biotechnol (Mar. 1 1996), https://www.nature.com/articles/nbt0396-358.pdf. (describing authorship standards as significantly relaxed as compared to inventorship standards), accord Lissoni et al., *supra* note ___, and Ducor, *supra* note ___. Under the Copyright Act, copyright subsists in original works of authorship fixed in any tangible medium of expression, 17 U.S.C.. § 102(a), setting a lower bar than for inventorship.

[194] Among many examples, see, e.g. Meika Berlan et al., *Equity in Innovation: Women Inventors and Patents*, Inst. Women's Pol'y Rsch., at 27 (2016), https://iwpr.org/wp-content/uploads/2020/12/C448-Equity-in-Innovation.pdf. (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.")

greater risk of being relegated to a non-inventing, fungible "pair of hands."[195] 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, the current law results in the failure of many who contribute to innovation, and in particular women and more junior innovators, to be recognized as inventors.

C. Progress and the Mechanics of Inventorship

But even when the legal requirements are met, inventorship does not necessarily follow. In contrast to authorship, which vests upon the creation of protectable works immediately,[196] to become an inventor requires one to apply and endure an examination process for, and be 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 Fig __: "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,[197] with filing rates on submissions ranging in the 20-60% range.[198] (See Fig __: "Patent Application") Patent applications that are submitted to the Patent Office are likely to be rejected, often several times, before they are, in most cases, granted.[199] (See Fig __: "Patent Grant")

Fig. ___: The Inventorship Pipeline

Idea Disclosure --> Patent Application--> Patent Prosecution --> Patent Grant

Among the few available accounts of the inventorship pipeline from innovator to inventor, a few stand out. One is by the "Diversity in Innovation" initiative of the Women's Committee of Intellectual Property Owners' Association (IPO), a trade association of intellectual property-focused companies, law firms, and service providers.[200] Since 2019 the IPO has maintained a diversity in invention "toolkit," based on consultations with its members, that describes current practices for soliciting inventions and ideas and ways to improve them to achieve greater participation in invention. ("IPO Toolkit")[201] In 2020, the USPTO regional

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[195] A term to describe non-inventors as referred to by the Federal Circuit in Burroughs Wellcome v. Barr Laboratories, 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.)

[196] Under the terms of the Berne convention.

[197] Described, e.g. in Laura Norris et al., *Diversity in Innovation Best Practices Guide*, Santa Clara Univ. 6 (2021), "Best Practices Guide," https://digitalcommons.law.scu.edu/facpubs/989/.

[198] Cf. Hall, *supra* note ___, at 1(describing a mean filing rate, within universities, of 60%) with Michelle R. Henry et al., *DNA Patenting and Licensing*, 297 Science, 1279 (2002), https://tinyurl.com/2znd6hks (reporting patent filing rates at premier universities, from 1986 to 1990, of 15 -17%).

[199] Described in Subramani et al., *supra note*__.

[200] *About IPO*, Intell. Prop. Owners Ass'n, https://ipo.org/index.php/about/ (last visited Jul. 2022).

[201] The IPO Women in IP Committee, Diversity in innovation, IPO (last updated 2022), https://ipo.org/index.php/diversity-in-innovation-toolkit/. [hereinafter, "IPO Toolkit"]

offices, 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,[202] a second resource. These efforts build on earlier ones, like the creation by the Association of University Technology Managers (AUTM) of a Women Inventors Committee in 2013 to increase the participation of academic women in innovation.[203]

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 chances 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

Fig. ___: The Inventorship Pipeline

Idea Submission--> Patent Application--> Patent Prosecution --> Patent Grant

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

a) Lack of Awareness, Comfort with Inventor Identity and Confidence

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 demographic groups. Chetty and his co-authors have documented the lack of "exposure" that girls and poor and minority children have to inventing, and how that exposure explains much of the gap in inventing.[204] 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"[205] – limits the diversification of patenting. The invention capital gap is broad and pervasive, reflecting historical, structural, socio-economic, and geographic disparities in innovation and invention.[206]

Even within well-resourced settings, strikingly, the awareness gap appears to be present.

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[202] Best Practices Guide. *supra* note ___ at 2.
[203] Jean Baker & Linda Suzu Kawano, *Realizing Potential: Keys To Nurturing Female-Led Innovation*, 9 TECHN. TRANSFER TACTICS, 65–80 (2015).
[204] Bell et al, *supra* note __, at 2.
[205] Defined in Chien, *Inequalities*, *supra* note __ , at Part II.
[206] For a summary see the testimony of Janeya Griffin, Managing Member and Principal Consultant, Commercializer, LLC, *Enhancing Patent Diversity for America's Innovators* (Jan 15, 2020), https://docs.house.gov/meetings/SM/SM00/20200115/110372/HMTG-116-SM00-Wstate-GriffinJ-20200115.pdf.

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.[207] The IPO Toolkit describes how lack of awareness can have multiple root causes at the firm level. 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.[208]

Part of the challenge appears to be that the construction of "inventorship" may be alienating, unwelcoming, and intimidating to diverse innovators. As the Best Practice guide finds, "the term 'inventor' may be unrelatable to diverse inventors, in part because the celebrated historical inventors from U.S. history tend to be non-diverse."[209]

In-house counsel at IBM has expressed that even in his company, which has for decades been the most prolific patenter, "often demographic groups express the. . . feeling that 'if I thought of it, it can't really be innovative.'"[210] 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."[211] 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."[212] It was only when someone else recognized the invention of these diverse inventors that they themselves realized the significance of their own contribution.

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 of a series of conversations about Black inventorship convened by the Lemelson Center 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.[213]

The IPO Toolkit describes the related desire of diverse employees to not stand out or be perceived as engaging in an "act of attention-hogging" when they participate in inventing as an obstacle to participation.[214] 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

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[207] Colleen Chien and Jillian Grennan, *Addressing Organizational Barriers to Patenting Through Opt-Out Framing and Other Diversity Nudges*, INNOVATOR DIVERSITY PILOTS CONFERENCE (Nov. 18, 2022) https://law.scu.edu/wp-content/uploads/4.-Chien-and-Grennan.pdf.

[208] *Id.* at 31.

[209] Best Practices Guide, *supra* note __ at 6. Accord, IPO Toolkit, (noting that "most recognized scientists are male (e.g., Einstein, Steve Jobs, etc.)" and citing e.g., "Bill Nye the Science *Guy*" (emphasis added); *supra* note __ at 42.

[210] David Kaminsky & Jana Jenkins, *Mentorship Is Viable Solution To Inventor Diversity Crisis*, LAW360 (Sep. 30, 2020), https://www.law360.com/articles/1315039/mentorship-is-viable-solution-to-inventor-diversity-crisis?copied=1.

[211] Fatima Taha, *Protecting and Progressing Gender Diversity in Innovation*, VANGUARD, (2022), https://www.vanguardlawmag.com/case-studies/sabra-anne-truesdale-western-digital/.

[212] Best Practices Guide, *supra* note __ at 6.

[213] *Cf Black Inventors & Innovators: New Perspectives* Lemelson Center (Aug. 3, 2021), https://invention.si.edu/node/29159/p/739-executive-summary. (articulating a "Black view of invention and innovation [that] []includes an emphasis on aiding the community [] and promoting cooperation.") with accounts of inventorship in the early American patent system as imbued with "the values of the American Dream – inventiveness, rugged individualism, and self-reliance [which][] associated with a particular kind of whiteness," as described by ANJALI VATS, THE COLOR OF CREATORSHIP 51–52 (*Stanford University Press,* 2020).

[214] *See* IPO Toolkit, *supra* note __ page 38.

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.

b) Confidence

With as few as 20% of idea submissions or less proceeding to the patent application stage,[215] and not all patent applications turning into patents, "failure is an intrinsic part of the invention process."[216] As such, a sense that one's idea is worthy and will be well-received can increase the odds of idea submission. But various studies have documented the presence of a "confidence gap" between men and women in various domains. For example, Kay and her co-authors have shown how, compared to women, men are more likely to consider themselves ready for promotions.[217] At the company Hewlett-Packard, an internal review of personnel records found that men applied for promotions when they possessed only 60% of the qualifications listed for the job while women applied when they believed they met 100% of the qualifications.[218] The result of the confidence gap is that while "under qualified and underprepared men don't think twice. . . . Overqualified and over-prepared women. . . still hold back."[219] Whether the gap is because of men's greater tendency to self-promote on the one hand,[220] or women's underconfidence or aversion to "tooting one's horn" is in the eye of the beholder.

A lack of clarity about what is required can intensify the effect of the confidence gap. As the Ross study cited earlier found, when "the rules of credit allocation were [] unclear [allocations were][] often determined by senior investigators."[221] But such investigators may lack the resources, relationships, wherewithal, or incentives to award credit equitably. When applicants must fill in the gap, confidence matters. 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 more cautious.[222] In a similar vein, the IPO Toolkit identifies opaque standards for invention and attribution as a contributor to the participation gap. 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.[223]

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[215] Henry et al., *supra* note ___ (reporting university patent filing rates between 15 and 17%).
[216] Kaminsky et al., *supra* note __ .
[217] Katty Kay & Claire Shipman, *The Confidence Gap,* ATLANTIC (May 2014), https://www.theatlantic.com/magazine/archive/2014/05/the-confidence-gap/359815/.
[218] *Id.*
[219] *Id.*
[220] See, e.g. Meika Berlan et al., *Equity in Innovation: Women Inventors and Patents*, INST. WOMEN'S POL'Y RSCH., at 27 (2016), https://iwpr.org/wp-content/uploads/2020/12/C448-Equity-in-Innovation.pdf. (describing difference in male and female academic communication patterns), Jennifer Exley & Judd Kessler, *Why Don't Women Self-Promote as Much as Men?*, HAR. BUS. REV. (Dec. 19, 2019), https://hbr.org/2019/12/why-dont-women-self-promote-as-much-as-men.
[221] Ross, *supra* note ___.
[222] Andreas Leibbrandt and John A. List. *Do women avoid salary negotiations? Evidence from a large-scale natural field experiment.* Management Science 61.9 (2015): 2016-2024. (finding, in a field experiment advertising identical jobs that varied 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).
[223] IPO Toolkit, *supra* note__ ,at 50.

An extensive literature has also explored whether there is a gender "competitiveness gap" that stems from differences in risk preferences and personality.[224] 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.[225] 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.'"[226] 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% more likely than women to submit an invention disclosure, even when they were unsure they ought to disclose their ideas.[227] This suggests that the confidence gap observed in employment settings may extend to invention disclosure.

Opting-Out into Diversity?

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,[228] researchers have documented smaller gender gaps when women were *expected* to participate rather than *given the option* to participate or not.

How might insights about opt-in v. 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 first-time inventors. If opt-out framing has a similar, positive impact on

[224] Muriel Niederle, *Gender.* Working Paper 20788, Cambridge, MA: Nat'l Bureau Econ. Rsch. (characterizing gender differences as "large and robust in attitudes towards competition"). But *see* Bernd Frick & Katharina Moser, *Are Women Really Less Competitive Than Men? Career Duration in Nordic and Alpine Skiing,* 6 Frontiers in Soc'y (2021), https://www.frontiersin.org/articles/10.3389/fsoc.2020.539766/full#B63 (finding that such differences disappear conditional upon selection into highly competitive environments).

[225] AUTM, *supra* note __ at 68.

[226] IPO Toolkit, *supra* note ___ at 39.

[227] Angela Morris, *Western Digital Uncovered "Root Causes" of Female Innovator Under-Representation, says IP Chief*, IAM, (June 2022) (describing a survey in which male engineers described themselves as "150% more likely than women to submit an invention disclosure, even when they were unsure they ought to disclose their ideas").

[228] See Joyce C. He et al., *Opt-out Choice Framing Attenuates Gender Differences in the Decision to Compete in the Laboratory and in the Field,* PNAS (Oct. 11, 2021), https://www.pnas.org/content/118/42/e2108337118, (Fig. 2A) and Erkal et. al. *Leadership Selection: Can Changing the Default Break the Glass Ceiling?,* 33 Leadership Q. (April 2022), https://www.sciencedirect.com/science/article/pii/S1048984321000680.

reducing disparities in idea submission like 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 to be 5%-36% higher under attorney-initiated vs. applicant-initiated disclosures, controlling for quality and other factors.[229]

[229] Colleen Chien and Jillian Grennan, *Addressing Organizational Barriers to Patenting Through Opt-Out Framing and Other Diversity Nudges*, INNOVATOR DIVERSITY PILOTS CONFERENCE (Nov. 18, 2022), 5-6 https://law.scu.edu/wp-content/uploads/4.-Chien-and-Grennan.pdf.)

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 published in the 1920s by the Department of Labor based on a review of 5,000 female inventions, the authors concluded that the restrictions society imposed on women:

> 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.[230]

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, 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

Fig. ___: The Inventorship Pipeline

Idea Submission --> **Patent Application**--> Patent Prosecution --> Patent 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. Filing for a patent generally generates $10,000–20,000 in legal fees alone,[231] 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.[232] 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, with rates ranging widely based on setting, but reported to be in the 20-40% range.[233]

The decision to file and move forward (or not) on an application is in theory based on technical (e.g., novelty) and market (e.g., market size) considerations, but bias can infect the process. Sometimes this bias has been more explicit: for example, a nineteenth-century patent

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[230] As described in MACDONALD, *supra* note ___ at 392.
[231] See *How Much Does A Patent Cost?,* BLUEIRON, (Updated 2022), https://blueironip.com/how-much-does-it-cost-to-file-a-patent/
[232] For a description of the process, see Subramani et al., *supra* note __ at 4.
[233] Author's analysis based on confidential information disclosure databases from firms. Cf. also, Michael Hall, *Filing Rate and Transfer Rate at NIST: An Examination of Invention Disclosures, Patent Applications, and Invention Licenses*, NAT'L INST. STANDARDS & TECH., 1,1 (2021), https://nvlpubs.nist.gov/nistpubs/ttb/NIST.TTB.2.pdf. (describing a mean filing rate, within universities, of 60%) with Michelle R. Henry et al., *DNA Patenting and Licensing*, 297 SCIENCE, 1279 (2002), https://tinyurl.com/2znd6hks (reporting that, from 1986 to 1990, Stanford, Columbia, and the University of California system had patent filing rates between 15 and 17%).

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."[234] Numerous authors have discussed the historical phenomenon of "masking" one's identity to increase the odds of patenting and commercial success.[235] As described below, the possibility of bias against female applicants has been suggested as present in the evaluation of patent applications. These suggestions build on studies that have established the presence of implicit bias against women and minorities in legal and employment contexts,[236] as well as gender bias and stereotyping along the innovation pipeline.[237]

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. However, a recent study published in the Proceedings of the National Academy of Sciences found a large "take-up gap" when it comes to novel ideas in STEM that are presented by gender and racial minorities.[238] 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. Blinding or double blinding the invention disclosure and review process and removing the inventor and reviewer identities are recommended.[239] The IPO Toolkit also recommends training to remove unconscious biases as well as ensuring diversity on the committee of reviewers.[240] 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"**

Fig. ___: The Inventorship Pipeline

Idea Submission --> Patent Application--> **Patent Prosecution** --> Patent Grant

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[234] MacDonald, *supra* note __ at ~35.

[235] *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 of, for example, 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 Bronte (aka Ellis Bell) to Joanne Rowling (aka J.K. Rawling) masked their names at times, it is speculated, to avoid gender bias. Described in Nettie Finn, *Pseudonymous Disguises: Are Pen Names An Escape From the Pseudonymous Disguises: Are Pen Names An Escape From the Gender Bias in Publishing?*, Honor Scholar Thesis 44 (2016), 9, 35-38 https://scholarship.depauw.edu/cgi/viewcontent.cgi?article=1044&context=studentresearch.

[236] Reviewed, e.g., in Jaclyn Alcantara, *The Impact of Implicit Bias on Female Patent Applicants in an Age of Increasingly Vague Patent Standard*s, 88 UMKC L. Rev. 167–169 (2019) (describing studies of implicit bias in prosecution, jury, and hiring contexts).

[237] Reviewed, e.g. in Subramani et al., *supra* note __ at 2.

[238] Hofstra et al., *supra* note ___ (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).

[239] Best Practices Guide, *supra* note ___ , at 12. However the efficacy of this process has not been proven and, for example, a study of French name-blinding found that it actually hurt minority applicants; *See* Luc Behaghel et al., *Unintended Effects of Anonymous Résumes*, 7 American Econ. J.: Applied Econ., 1 (2015).

[240] *Id.* at 7; IPO Toolkit, *supra* note ___ , at 37. *See* also Lisa Cook, *Policies to Broaden Participation in the Innovation Process*. Technical Report, Brookings Institution (August 2020), https://www.hamiltonproject.org/assets/files/Cook_PP_LO_8.13.pdf.

a) Potential Bias in the Evaluation of Patent Applications

After a patent application is submitted, the likelihood of its 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% less likely to be granted and otherwise fare worse, on average, than applications by male inventors.[241] Minority inventors also do worse,[242] as do small and micro entities: after 10 years, 73% of large-entity applications mature into patents but only 51% of small or micro entity applications do, contributing to a large "patent grant gap."[243]

The analyses referred to above are descriptive, not causal, and any number of factors could contribute to a patent application going abandoned: the quality of the underlying application, the technology area, a company's pivot, and grant rate trends over time, to name a few. But in terms of inputs, two are most salient: the examiner's evaluation, and the patent applicant's response to the examiner's evaluation and her decision to go forward or not in the face of rejection.[244]

Studies have considered the extent to which success is correlated with inventor's first names.[245] Jensen and his co-authors found that while applications that listed 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.[246] These differences, the researchers found, were more likely to reflect implicit bias at the Patent Office than at the applicant, where interactions between the patent team and inventor were more likely to be face to face.

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. The female applicants were rated as less competent by a majority of reviewers,

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[241] Described in Fechner, *supra* note ___, *see* also Kyle Jensen et al., *Gender Differences in Obtaining and Maintaining Patent Rights*, 36 Nat Biotechnol 307, 307 (Apr. 2018) (documenting a 7% grant gap after controlling for technology); Michael W. Schuster et al., *An Empirical Study of Patent Grant Rates as a Function of Race and Gender*, 2 Am. Bus. L. J., 281, 305 Table 1 (2020) (finding, across models, lower patent grant rates for women, black, Asian, and Hispanic inventors), and Subramani et al., *supra* note __ at 2.

[242] Schuster et al., *supra* note__.

[243] Colleen V. Chien et. al., *Advancing Inclusive and Entrepreneurship through the Patent System*, Patently-O (Nov. 4, 2020), https://patentlyo.com/patent/2020/11/advancing-innovation-entrepreneurship.html.

[244] Depending on the technology, the combined fees to the attorney and patent office combined for responding to an office action, are about 25-40% of the initial filing fees. (*How Much Does A Patent Cost?,* BlueIron, (Updated 2022), https://blueironip.com/how-much-does-a-patent-cost/.)

[245] As described in Jensen, 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; Kunnath is a little-known woman's name.

[246] *Id.* (women with unusual names had a 2.8% lower probability of being granted a patent than the male applicants, whereas the women with common female-associated names had an 8.2% lower probability of being granted a patent). *Accord*, Schuster et al., *supra* note ___ at 310 (finding inventors with highly feminine names to be 81% 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 282–283.

even though the application materials, other than the names, were identical. This rating gap was observed even when the reviewers themselves were women.[247]

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 by applicants and their representatives in *responding to* rejections.[248] A study by the USPTO of low-resource filers has documented major differences in the quality of representation associated with small and micro entities, that they tend to be less experienced (based on patent applications submitted to the USPTO), have lower allowance rates, and make substantially more changes to their applications during the examination process.[249]

These differences intersect with gender as well: building upon an existing literature about how men and women respond differently to rejection,[250] a study by Gauri Subramani and her colleagues of patent examination data 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 "accounted for more than half of the gender gap in granted patents."[251] 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. 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.[252]

Assistance from the Patent Office, it appears, can also effectively stem attrition and close gaps. In 2014-2015, 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.[253] A subsequent evaluation found that women applicants were 11 percentage points to benefit from the assistance.[254] Further, the benefits were largest "for new inventors, and in areas of technology where women have the worst relative outcomes." [255]

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

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[247] Corinne A. Moss-Racusin et al., *Science Faculty's Subtle Gender Biases Favor Male Students*,109 Proc. Nat'l Acad. Sci. 16474, 16474 (2012).

[248] 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 in anticipation of rejection, as described in 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.

[249] Pairolero, *supra* note at ___, at 4.

[250] Subramani et al., *supra* note __, at 2–3.

[251] *Id.* at 5.

[252] *Id.* at 5.

[253] *Filing a Patent Application on Your Own*, USPTO (May 2022), https://www.uspto.gov/patents/basics/using-legal-services/pro-se-assistance-program.

[254] Pairolero et al., *supra* note ___ at 3.

[255] *Filing a Patent Application on Your Own*, USPTO (May 2022), https://www.uspto.gov/patents/basics/using-legal-services/pro-se-assistance-program.

innovators. To "take some of the potential intimidation out of the patent approval process," it recommends having a "supportive third party [be][] responsible for presenting the idea to the [patent] committee."[256] 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.[257] These include greater transparency and substantive feedback,[258] in order to remove speculation as to why a patent was or wasn't filed on, akin to demystifying noisy feedback, which studies have found men and women respond to differently.[259] 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 specifically for female innovators.

D. Conclusion

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 discussed the patent system's gradual orientation towards *including* a diversity of innovators, the paragraphs above illuminate how the law and mechanics of inventorship work to *exclude* 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 is contributing to the innovator-inventor gap. The next Part considers steps the courts and USPTO could take.

PART 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 current developments are aligned with doing so. The CHIPS and Science Act of 2022 directs billions of dollars into boosting regional innovative capacity as well as the participation of women and underrepresented minorities in innovation.[260] The just-passed Unleashing American Innovation 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.[261] More than 50 companies, law firms, and others, including some of the largest patent filers, have publicly

[256] Best Practices Guide, *supra* note __ at 15.
[257] *Id*.
[258] *Id.*
[259] Gauri Kartini Shastry et al., *Luck or Skill: How Women and Men React to Noisy Feedback,* 88 J. BEHAV. & EXP. ECON. 2 (2020) (finding that even among high-skill workers, men are more likely to consider negative feedback from supervisors to represent bad luck, whereas women tend to see it as confirmation of a lack of their own ability.)
[260] CHIPS and Science Act, at Secs.10321–11330 (specifying investment in research to increase the participation of women, underrepresented minorities, and rural areas in innovation), see also Title V: "Broadening Participation in Science" (which, inter alia, provides for flexibility for caregivers (Sec. 10501), collection of demographic data (Secs. 10502, 10504), best practices in advancement of women and underrepresented minorities (Sec.10505) and Research in Rural STEM Education (Subtitle B) and Minority-Serving Institution (MSI) achievements (10521)).
[261] Unleashing American Innovation Act, at Sec 103

signed onto a "diversity pledge" to take action to narrow within-firm inventor diversity gaps.[262] 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," to remain unrealized. Below I discuss suggestions for (1) reconsidering inventorship law and policy; (2) institutionalizing and strengthening the Patent Office's commitment to progress; (3) creating a public-private innovator diversity pilots clearinghouse to test policy and practice interventions for making progress; and (4) a periodic, innovator-inventor survey for informing the design of policies and practices for making progress.

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 credited on a patent are considerable, the share of inventors that are women and underrepresented minorities remain limited. To broaden who can access them, I discuss ways the courts and USPTO can shore up inventorship integrity to discourage inventors being left off, through correction of inventorship proceedings and the recognition of patent attributional interests. I also discuss reconsidering the legal standard of inventorship itself to support a broader range of contributors.

1. Discouraging and Requiring Explanations for 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 have been weakened substantially in the past 10 years. Pursuant to 35 USC 256 (a), the Director of the USPTO has the ability to correct inventorship on a patent application when "through error" a person is incorrectly named or left off as an inventor on a patent.[263] Yet, following the passage of the America Invents Act, 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."[264]

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,"[265] it also diminished the incentive to get inventorship right at the outset.

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[262] *Increasing Diversity in Innovation*, increasingdii.org, https://increasingdii.org/companies/ (last visited Aug. 1, 2022) (listing, among its members, top patent filers Google (Alphabet) and Microsoft, who are ranked in the top 20 of patent filers, *2022 Patent 300 List*, (2022), https://harrityllp.com/patent300/).

[263] 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 paying the relevant fee. (see 37 CFR 1.48,) There is no diligence requirement, although certain timeliness requirements apply. MPEP 201.0335 U.S.C. § 256(b) specifies that correction is available any time after a patent is issued, even during its litigation.

[264] *See* redline of 35 U.S.C. 256(a), https://www.bitlaw.com/source/35usc/aia_redline/256.html (showing "~~and such error arose without any deceptive intention on his part~~") Although the law technically specified that the deceptive intent to be on "his" part, meaning the part of the inventor, courts have understood to mean deceptive intent in general, by the inventors, employers, or privvies in interest. See discussion in Jordi Goodman, *Who Benefits?* __ Hofstra L. R. 735 (2022), at note 73.

[265] Described in Joe Matal, A Guide to the Legislative History of the America Invents Act: Part II of II, 21 FED. CIR. B.J. 539, 642–643 (2012). The move was supported by the university community as strengthening patents.

Previously a company that deliberately left off an inventor from being listed on 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.[266] Though, after a patent has been granted, a request for correction of inventorship must also be accompanied by a statement from the relevant persons that they do not object to the change, there is no diligence requirement or real penalty.[267]

There is a way forward, however. Although the law no longer requires that the inventorship mistake be made 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."[268] 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." 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.[269] Making these petitions available to independent researchers would support evaluation of whether the rule change is having unintended impacts on patent equity and who gets named that need to be corrected.

2. *Recognizing the Attributional Interests Associated with Inventorship as Sufficient for Conferring Standing*

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 actions for judicial correction of inventorship which are available pursuant to 35 USC §256(b). To bring such a case requires plaintiffs to demonstrate that they have Article III standing on the basis of being named on a patent, separate from the financial interests associated with patent ownership or direct economic rewards (e.g. 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.[270]

The case of *Chou v. University of Chicago* raised the question of whether a woman who allegedly left off a university patent could bring her inventorship dispute despite the patent's ownership by the university.The Federal Circuit opined that the plaintiff's assertion that reputational interests alone were sufficient to confer standing was "not implausible."[271] But

[266] 37 CFR 1.48, see also USPTO Form: Request under Rule 48 Correcting Inventorship, USPTO (last visited Feb. 3. 2023) https://www.uspto.gov/sites/default/files/documents/aia0040.pdf.
[267] 37 CFR 1.324(b). Though, in extreme cases, the patent may be deemed invalid on other grounds.
[268] 35 U.S. Code § 256 (a).
[269] For example, by adding to its correction of inventorship form a request for information like, "Describe the conditions that led to this petition."
[270] Chou v. Univ. of Chi., 254 F.3d 1347, 1357 (Fed. Cir. 2001).
[271] Id. at 1359.

because the court found another basis for standing, it stopped short of endorsing the principle of reputational-injury-as-standing. 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 also alleging a breach of contract and discrimination.[272] 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."[273] However, in this case, 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 teamwork due to his accusations that others were stealing his work,[274] casting doubts on how broadly the case holding applies.

Indeed, the courts are considered "split" on this question - with decisions before and after Shukh finding certain assertions of reputational interests to be insufficient to pass constitutional muster.[275] But given the wide range and strong evidence of reputational interests at stake,[276] courts should consider more broadly adopting a per se rule that attributional interests, per se, are sufficient to confer standing in correction of inventorship claims.

3. Rethinking the Standard for Inventorship Credit

The inventorship standard itself may also be worth revisiting. As previously discussed, for decades the standard has been that those who conceive of the invention are inventors, but others who contribute valuable time and effort but don't are not. But this "lone genius" model of invention is quickly becoming outdated in light of the increasingly collaborative nature of innovation.[277] 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."[278]

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, the research suggests, the gender gap in patenting would narrow considerably women and lower – as described earlier, women authors are disproportionately left off of patents, and one study found that among research teams, the gender gap in patenting was 4x higher than the

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[272] Shukh v. Seagate Tech., LLC, 2013 WL 1197403.
[273] Shukh v. Seagate Tech., LLC, 803 F.3d 659, 663 (Fed. Cir. 2015)
[274] Id. at 663.
[275] Faryniarz v. Ramirez, No. 3:13-cv-01064(CSH) (D. Conn. Nov. 9, 2015), 30-35 (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 same.) See also Huster v. j2 Cloud Services, Inc., 682 F. App'x 910, 916–19 (Fed. Cir. 2017) (unpublished decision) (denying Article III standing on a reputational injury theory on the basis of a lack of evidence of injury).
[276] Discussed infra in Part II.
[277] See e.g.. among other sources, Dennis Crouch, *Continued growth in the number of inventors per patent*. PATENTLY-O (Mar. 11, 2021), *Average Number of Inventors per Patent Continues Steady Rise* PATENTLY-O (Jan. 24, 2019) (showing a steady rise in the average number of inventors per patent, beyond three)
[278] Eli Lilly & Co. v. Aradigm Corp., 376 F.3d 1352, 1359 (Fed. Cir. 2004).

gender gap in articles.[279]

The calculus is not self-evident, however. 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.[280] It's also worth noting that a mandatory inventorship regime may not necessarily serve a particular innovator's preferences, for example, for "better" authorship credit.[281] Though research has been done to understand that impact of patenting and first-time on businesses,[282] more empirical research should be done to understand the impact of inventorship attribution on entrepreneurs and workers of different demographic and experience profiles. It may be the case that expanding the definition of inventorship beyond the current standard may lead to a more fair, efficient, and effective patent law.

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.[283] The Contributor Roles Taxonomy (CRediT), originally developed in 2014, describes 14 roles that represent the range of contributions to scientific publications,[284] from activities at the "core" of original research – conceptualization, investigation, validation, and writing – to its administrative aspects, including funding acquisition, administration, and supervision.[285] The stated purposes of the taxonomy are to enable researchers to have "all facets of their work recognized."[286] Supporters of the standard, which boasted adoption by 50 organizations by early 2022, have also cited the importance of " a broader array of signals… to improve the discovery and review of diverse scholarly materials" and that greater precision is important for appropriate incentives.[287]

For example, one adaptation of the CRediT model requires the corresponding author to indicate each other's contributions not only in the first version, but each revision thereafter.[288] Along with the right to be named, contributors are also given the right to be informed of changes to attribution. Mapped to patent law, this could imply that the list of contributors to an invention reflect not only of the final claims as issued, but versions of the claimed "invention" through prosecution.

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[279] See studies cited in Part II.A., and Ross, supra note ___ at extended Data Table 4, column 5 (reporting a 13.24% gap for articles and a 58.40% gap for patents in the naming of women on teams).

[280] As described, e.g., in Lissoni et al., *supra* note ___ (casting doubts on the reliability of authorship as a tool for allocating scientific credit due to inconsistencies in how it is determined.)

[281] Id. at 1473 (suggesting that inventors may prefer to "trade" inventorship for greater credit on papers).

[282] As described in Part II.

[283] As discussed in Lisa Oullette and Jonathon Masur, PATENT LAW: CASES, PROBLEMS, AND MATERIALS (2022 edition), at p 316-7, q.2 (probing differences in the standards for inventorship and authorship).

[284] CONTRIBUTOR ROLES TAXONOMY (CREDIT), https://credit.niso.org/ (last visited Feb. 3, 2023).

[285] Id.

[286] 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/.

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

[288] 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/ (describing adoption of such a policy by the American Association for Cancer Research across 9 journals).

B. Institutionalizing and Strengthening the PTO's Commitment to Promoting a Diversity of Innovators

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,[289] 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.[290] Data collection would allow the Office to better understand the needs of diverse inventors and innovators, as well as to 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.[291] 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 Office, which is currently entirely user fee-funded, to receive appropriations specifically to subsidize or support underresourced innovators.

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, provisional patents, defensive publications, abandoned but not published applications, or works dedicated to the public, 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. But innovators can also potentially benefit from the attribution of credit, and a way to provide such credit to them for example through an opt-in "innovator registry," without compromising business objectives, would be worth exploring.

In the meantime, there are numerous steps the agency can take within its existing authority to promote a diversity of inventors and innovators.[292] Below I discuss what promoting progress, redefined, in carrying out the PTO's basic functions of examination and information dissemination might look like.

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.[293] But the likelihood of having one's patent granted is unequal across groups. To make progress in the diversification of inventors, the Office should commit to taking steps to address the "patent grant gap."[294] While there may be multiple reasons one's patent application may not succeed, lack of

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[289] Indeed as it will be required to implement the Unleashing American Innovation Act, described supra at note ___.
[290] IDEA Act, *supra* note ___ at Sec. 6204(a).
[291] *Id.* at Sec. 6204(b) which specifies that the demographic information submitted would be kept protected, exempt from FOIA disclosure, but also, be reported on regularly at the aggregate level.
[292] Chien, *Inequalities*, *supra* note __, at Part III.
[293] 35 U.S.C. § 2 (a).
[294] As described in Part II.C.3.A.

support is one of them, 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."[295] Further, the benefits were largest "for new inventors, and in areas of technology where women have the worst relative outcomes." While the assistance helped all, it so benefitted women that it closed the gender gap in allowance rates.[296]

The PTO should consider, could this intervention be affordably scaled, to address gaps more systematically? Consistent with the idea that technological interventions are easier to expand to serve a larger population,[297] it could be worth exploring if tools or templates for automating assistance could be developed.[298] 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;[299] 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 would could effectively level the playing ground. A simpler implementation of this model would be for existing technology providers to offer discounts that parallel the fee discounts offered by the Office, to underresourced applicants.

The USPTO's adoption of the "DOCX" standard, a new, structured way to submit applications that includes an error correction component,[300] in some ways provides the first step towards universally available quality technology.[301] 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. It would be worthwhile for the USPTO to keep in mind the different needs of inexperienced and smaller inventors and seek to accommodate them in examination.

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.[302] But in contrast to metrics of invention, which the USPTO reports regularly,[303] metrics of innovators and inventors are not regularly collected.[304] In the spirit of measuring progress to make it, the USPTO should consider tracking and regularly reporting on

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[295] Pairolero et al., *supra* note ___ at 3.
[296] Id. supra note ___ at 2-3.
[297] Described, for example, in JOHN LIST, THE VOLTAGE EFFECT: HOW TO MAKE GOOD IDEAS GREAT AND GREAT IDEAS (2022). (describing technical, as opposed to people-based interventions as more likely to scale due to the difficulty of replicating humans)
[298] Colleen V. Chien, *Rigorous Policy Pilots the USPTO Could Try*, 104 IOWA L. REV. ONLINE 1, 21 (2019).
[299] 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 (July 2022), https://www.uspto.gov/blog/director/entry/secretary-of-commerce-gina-raimondo.
[300] https://www.uspto.gov/blog/director/entry/modernizing-patent-filing-with-docx (citing improved application quality as a benefit of adoption of the DOCX standard)
[301] Although it also shows what can go wrong in the rollout of government technology, see Michael Borella, *USPTO Delays Transition to DOCX (Again)*, PATENT DOCS (Jan. 2, 2023) https://www.patentdocs.org/2023/01/uspto-delays-transition-to-docx-again.html (describing DOCX implementation as fraught with technical glitches).
[302] 35 U.S.C. § 1 (b).
[303] *See, e.g.,* 2021 USPTO Performance and Accountability Report (PAR) which reports on, for example, numerous patent metrics pertaining to quantity (applications, grants, and filings) and quality. https://www.uspto.gov/sites/default/files/documents/USPTOFY21PAR.pdf, at Tables 1– 7.
[304] The PAR *does* include patent filing counts by country of origin and payment tier. *Id.*

metrics concerning applicants and inventors, not just invention. Such data could include rates of patent application and grant of all kinds (plant, utility, provisional, and design) by various innovator groups including first-time inventors, women, underrepresented minority groups, and veterans, as well as patenting by regional origination. This would make possible reporting and commemorating milestones based, not on inventions, but on inventors, pertaining to, for example, bringing the most new inventors into the system.

Reporting on the extent to which different types of innovators are engaging, for example, 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, to 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.[305]

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.[306] The diversity interventions pursued by the USPTO thus far, like providing extra support to inexperienced filers, supporting diverse technical employees through affinity groups,[307] and providing flexible work options,[308] are potentially valuable to others 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,[309] the impact of diversity policies at the Office such as the first-to-file system and fee discounts (Box 1), the opening of regional offices described earlier, and the relaxation of patent bar requirements in order to allow enable more to sit for the examination to represent clients before the Patent Office have not been the subject of rigorous evaluation and study. They should be.[310]

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[305] The IDEA Act specifically contemplates the reporting of aggregate filing and related trends by demographic group. IDEA Act, *supra* note __.

[306] Evidence Act, Title I requires participating agencies to develop multi-year Learning Agendas (evidence-building plans) and a Capacity Assessment as part of the agency strategic plan, develop Annual Evaluation Plans, create an agency evaluation policy, and designate an Evaluation Officer. Though these obligations bind the Department of Commerce, rather than the USPTO specifically, the Office has designated an evaluation officer and participated in the drafting of these documents.

[307] *Establishing Employee Resource Groups*, USPTO (May 19, 2022), https://www.uspto.gov/initiatives/equity/employee-resource-groups.

[308] *Telework Annual Report*, USPTO (2020), https://www.uspto.gov/sites/default/files/documents/Telework_Annual_Report_2019-2020.pdf (describing telework options as dating back to 1997 when the agency offered remote work options to 18 trademark examining attorneys; in 2019, 11,000 employees were working remotely at least one day per week).

[309] For example, through the pro se report described earlier in Part II, and, also, in reporting the metrics of its pro bono user base, which appears to be significantly more diverse than the base of normal filers, Kathi Vidal, *Remarks by USPTO Director Kathi Vidal at the PTAB Pro Bono Fireside Chat*, USPTO (2022), https://www.uspto.gov/about-us/news-updates/remarks-uspto-director-kathi-vidal-ptab-pro-bono-fireside-chat (reporting that 30% of pro bono survey respondents identified as as African American or Black; 14% identified as Hispanic; 5.6% identified as Asian or Pacific Islander; and 1.5% identified as Native American.)

[310] To evaluate such information, the Office could launch a Diversity Scholars Program named after a diverse innovator, such as Patricia Bath. This would be similar to the Edison Visiting Scholars program the Office already

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.[311] Every year, 8,000 or so patents are issued that include a U.S. government owner or interest.[312] Distilling rigorously developed diversity best practices and disseminating them among government applicants, and even government grantees, would be a way to disseminate not only ways to boost inventions but also inventors. In addition, fostering connections between stakeholders – for example from the government, private sector, and academia is another role that the USPTO can play, including through an innovator diversity pilots clearinghouse, explored next.

C. An Innovator Diversity Pilots Clearinghouse

Numerous suggestions for making progress in the diversification of inventorship have been proposed and adopted, whether by Congress, the PTO, or companies. But determining whether practice or policy reforms to boost participation actually work is not easy. Those charged with enacting these programs may lack the mandate to determine their effectiveness. 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 that range from the AIA's small inventor policies (see Part I and Box 1) to the adoption of patent harvesting strategies practices like opt-in framing as discussed in Part II are at risk of remaining largely unknown, hampering the path to progress.

A public-private "Innovator Diversity Pilots Clearinghouse" could address these gaps and support the dissemination and evaluation of diversity interventions. Similar to other federally-supported clearinghouses, an innovator diversity pilots clearinghouse would distribute information about promising practices for making progress. It would also build on the increasing use of "rigorous piloting" – the practice of temporarily introducing a policy to learn from it, as promoted by the 2019 Evidence Act and embraced by the USPTO[313] – 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.[314] 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, it 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

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hosts; described at *Edison Visiting Scholar Program*, USPTO (Jul. 22, 2022), https://www.uspto.gov/ip-policy/economic-research/edison-visiting-scholar-program.

[311] 35 USC § 2A(9).

[312] Author's calculation based on data provided by Dennis Church, *U.S. Government Property Interests in Patent Rights*, PATENTLYO (Mar. 6, 2022), https://patentlyo.com/patent/2022/03/government-interest-patent.html; Dennis Crouch, *Replication Data for: U.S. Government Property Interests in Patent Rights*, 1 HARVARD DATAVERSE (2022), https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/8CXI6Y.

[313] Described in Daniel Ryman, *Piloting in the Patent Office*, USPTO (May 2019), https://www.law.upenn.edu/live/files/9492-presentation-slides-dan-rymanpdf, at 5–7 (listing numerous external and internal USPTO pilots).

[314] See numerous retrospective review regulations are described in Administrative Conference of the United States, *Retrospective Review of Agency Rules*, at 2-3 and adopted Dec. 4, 2014, *available at* https://www.acus.gov/sites/default/files/documents/Recommendation%25202014-5%2520%2528Retrospective%2520Review%2529_1.pdf.

Science Act, to utilize "the nation's full talent." 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."[315]

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.[316] But it also included a major policy change: the adoption in the United States of a "first to file" regime that prioritized speed to the Patent Office. The change was highly criticized for the burden it placed on independent inventors who had fewer resources to "race" to the Patent Office.[317] So, did American independent inventors lose under the AIA? To address this question requires tracking independent inventor activity before and after the rule change. Previous analyses split out Canadian and U.S. independent inventors, and have hypothesized that the former would be affected while the latter would not.[318] Under a "differences-in-differences" approach, if the control and treated populations follow "parallel paths" prior to a rule change, but diverge after it, then this provides some evidence of an impact.[319]

Prior to the America Invents Act rule change, which went into effect on March 16, 2013, Canadian and U.S. independent inventor trends moved in parallel. (Fig.__) But 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. advantage in terms of independent inventor filings more than doubled (from 0.75% to between 2–3%). The analysis provides some evidence that the transition to first-to-file effect might have been offset and even reversed by the other changes, including the adoption of deepened discounts. It may also be the case that the United States' preservation of a "grace period" mitigated the impacts of the transition to a first-to-file policy.

Fig. __Canadian (CA) and U.S. Independent Inventor Shares of Patents Before and After Introduction of the America Invents Act (Data Source: PatentsView)

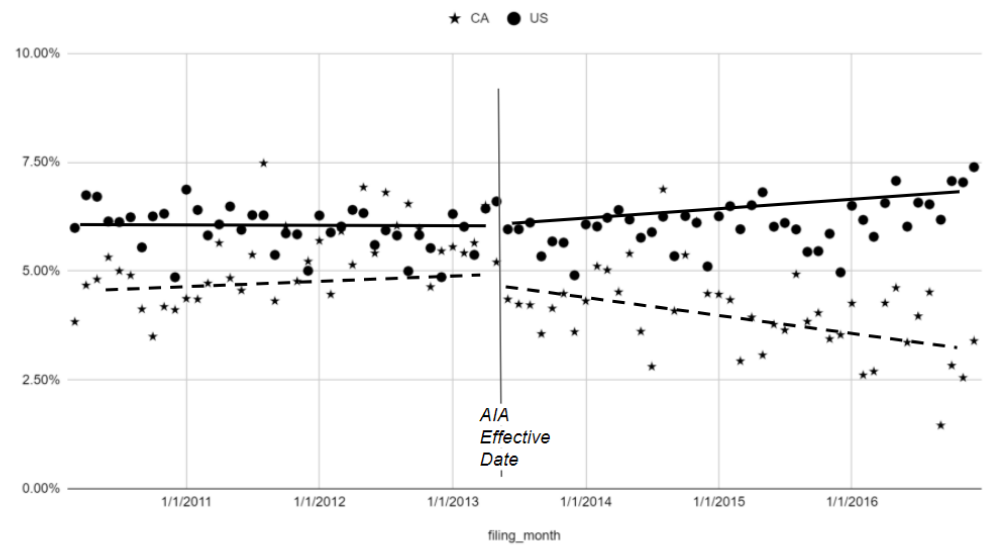
[315] CHIPS and Science Act, *supra* note __ at Title III, Subtitle C ("Broadening Participation") and Sec. 10326, Diversity in Tech Research.

[316] Josh Lerner et al., *The Leahy-Smith America Invents Act (AIA): A Preliminary Examination of Its Impact on Small Businesses*, Small Business Admin. 13, 31–32 (2015), https://www.sba.gov/sites/default/files/advocacy/rs429tot_AIA_Impact_on_SB.pdf (describing the AIA's fee reductions, a Patent Ombudsman Program, and pro bono and pro se supports).

[317] *Id*. at 8.

[318] *Id.* at 91 (describing studies by Wagner, Abrams, Lo, and Sutthiphisal, which compared Canadian and U.S. filings to evaluate a similar rule change in Canada).

[319] *Id.* at 91–92 (describing difference-in-differences approaches).



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.[320] To advance its policy objectives, the federal government has supported clearinghouses in areas ranging from education[321] and civic engagement, to family and child welfare programs.[322] In recent years, for example, the White House launched a clearinghouse to support school reopenings across the country via Executive Order,[323] and a best practices guide to diversity and inclusion in the federal STEM workforce.[324] 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 (e.g., distinguishing practices supported by "strong" evidence with those supported by "promising" or no evidence).[325] As such, clearinghouses not only support the sharing of both operational ("how-to")

[320]As described in Haluk Soydan et al., *Evidence-Based Clearhouses in Social Work*, 20 Rsch. Soc. Work Practice (Aug. 2010), https://journals.sagepub.com/doi/pdf/10.1177/1049731510367436.
[321] *What Works Clearinghouse*, Inst. Ed. Sci.'s (IES) (2022), https://ies.ed.gov/ncee/WWC.
[322] Office of Planning, Research & Evaluation, *Research and Evaluation Clearinghouses*, Administration for Children & Families (April 2, 2014), https://www.acf.hhs.gov/opre/research-and-evaluation-clearinghouses; for a longer list, see *Clearinghouses and Evidence-Based Resources*, Research-to-Policy Collaboration (Aug. 1, 2020), https://research2policy.org/clearinghouses-and-evidence-based-resources/.
[323] Best Practices Clearinghouse, https://bestpracticesclearinghouse.ed.gov/.
[324] Best practices for Diversity and Inclusion in STEM Education and Research: A Guide by and for Federal Agencies, (Sept. 2021), https://www.whitehouse.gov/wp-content/uploads/2021/09/091621-Best-Practices-for-Diversity-Inclusion-in-STEM.pdf.
[325] IES, *supra* note ___ ; Soydan, *supra* note __.

and evaluation ("does it work") information across firm and sector boundaries, but also the measurement of success. Below I discuss a few other gaps an innovator diversity clearinghouse could address.

1. 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. 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 pilot 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.[326] For example, the community around a clearinghouse could provide input on how to regularize reporting of technical worker statistics via the EEOC-1 form to ensure a consistent point of comparison to inventorship. Such a community could also help advise the Security and Exchange Commission's development of human capital reporting requirements.[327] The recent establishment of a National Secure Data Service (NDSS) will likely create additional opportunities for valuable agency administrative data on outcomes like employment and income to be connected to inventorship events.[328] Supporting safe, privacy-respecting ways to share "locked up" data should also be a priority.

2. 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 –e.g. 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, whether financial (e.g., USPTO fee discounts and pro bono work) or in terms of time or information (e.g., affinity group practices), also cuts across the innovation ecosystem. Likewise, "rejection" is an integral part of both the within-firm

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[326] The capacity of the USPTO to access outcome data should be improved considerably if the agency gains CIPSEA "Confidential Information Protection and Statistical Efficiency Act" status to access information in a way similar to a statistical agency. However, as of this writing, the Office of Management and Budget has not promulgated guidance on how to do so.

[327] However, under this framework, the SEC 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." Peter H. Haslag et al., *Human Capital Disclosure*, VAND. OWEN GRAD. SCH. MGMT.. 1, 2 (Jan. 11, 2022), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3991257#.

[328] Data Coalition, *Congress Authorizes Establishment of National Secure Data Service to Improve Data Analytics*, Data Foundation (July 2022), https://www.datacoalition.org/congress-authorizes-establishment-of-national-secure-data-service-to-improve-data-analytics/.

idea disclosure process (prior to application) as well as the within-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.[329] 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 PTO, universities, and others to try.[330]

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. In its examination of over half a million patents filed each year,[331] the USPTO is well-positioned to randomize any number of interventions and should consider doing so where practicable and ethical.[332]

By virtue of their openness, clearinghouses are uniquely positioned to transcend disciplinary and institutional silos, facilitating partnerships for example between, law firms and companies seeking diverse talent, and historically black colleges and universities (HBCUs), and minority-serving institutions (MSIs) with greater access to this talent. A diversity clearinghouse can also make it easier for research academic and company partners, as well as potential mentors and proteges, to find each other.[333]

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, wherein 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 also briefly address how a

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[329] As discussed in Gauri Subramani et. al., *Reframing Rejections: Interventions to increase patent conversion and reapplication*, Presentation to INNOVATOR DIVERSITY PILOTS CONFERENCE (Nov. 18, 2022) https://law.scu.edu/wp-content/uploads/14.-Subramani-.pdf.

[330] 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. Described at *Semi-Annual Report of the Consumer Financial Protection Bureau*, CFPB (2014–15), https://files.consumerfinance.gov/f/201506_cfpb_semi-annual-report-spring-2015.pdf. Jurisdictional oversight challenges and a lack of an incentive for firms to do so were cited as reasons it did not succeed.

[331] Patent Technology Monitoring Team, *U.S. Patent Statistics Chart Calendar Years 1963-2020*, USPTO (2020), https://www.uspto.gov/web/offices/ac/ido/oeip/taf/us_stat.htm (showing the number of applications to be over 500,000 since 2011).

[332] For example, in the case of oversubscription to a service for which there is limited capacity, as described in Colleen Chien, *Rigorous Policy Pilots: Experimentation in the Administration of the Law*, 104 IOWA L. REV. 2313, 2315 (2019).

[333] As suggested by Lisa Cook, *supra* note ___, at 15.

survey could be administered. Previous relevant inventor and innovator surveys include the PatValEU[334] and Community Innovation surveys of Europe.[335]

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 potential inventor-innovators than is known about inventors,[336] and even less is known about the relationship between them. Conducting a survey that specifically compares and contrasts the experiences of the two groups can help to check the ways and extent to which much-studied inventors are or are not representative of all innovators and ensure that policies to support all innovators are not inadvertently ignoring the particular needs of the non-inventor innovator population. Specific questions of interest could pertain to awareness and accessibility of government supports and programs available for small and underresourced innovators,[337] as well as initiaitives geared at new or underresourced innovators described in Part I like Track One, and the pro bono and pro se programs at the PTO.

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, as described, none that I am aware of has explored their domestic situation. But

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[334] A one-time survey of 9,216 European inventors from six countries carried out in 2003-2004. Desribed in Dietmar Harhoff & Karin Hoisl, *Everything you Always Wanted to Know About Inventors (But Never Asked): Evidence from the PatVal-EU Survey*, Discussion Paper, No. 2006-11 (July 2006), https://www.researchgate.net/publication/5164052_Everything_you_Always_Wanted_to_Know_About_Inventors_But_Never_Asked_Evidence_from_the_PatVal-EU_Survey, herein "PatVal-EU".

[335] A biennial biennial survey that provides "information on statistics about enterprises that have product and business process innovations, their strategies, knowledge management and innovation activities, as well as about factors that facilitate or hinder innovation. Described in *Community Innovation Survey: Latest Results, European Commission (2016),* https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20190312-1.

[336] As illustrated by Bell et al, supra note ___ , 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 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 person level allowing for even more extensive research into the lives and backgrounds of inventors including their test scores, socioeconomic background, the backgrounds of their parents and children, and many other details.

[337] Like the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs of the Small Business Administration, described at https://www.sbir.gov/about.

surveys of technical workers[338] have found that mid-level technical women are more than twice as likely as partnered mid-level men to have a partner who worked full-time,[339] and only around a quarter as likely to have a partner with primary responsibility for the household and children.[340] The gender differences were more dramatic among women of color.[341]

The disproportionate burden and impact of household and childcare needs among women in STEM, particularly women of color, on display during the COVID pandemic, "transcends" patenting, but, as discussed earlier, shapes the lived experiences of those with childcare responsibilities who may effectively be 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 accomodate caregiver schedules.[342] 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 provide insights into 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. Asking them, a survey of tech workers has documented that "[w]omen of color are significantly more likely to come to high-technology through degrees outside of computer science and engineering."[343] A survey of high-value patent inventors, in contrast, has uncovered differences in age and past education level by women and immigrant inventors.[344]

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[338] Another is the Kapor "Tech Leavers" survey, which examined why people, particularly Black, Latinx, and women, left their jobs in tech. See Allison Scott, Freada Kapor Klein & Uriridiakoghene Onovakpuri, Tech Leavers Study 11 (2017).

[339] Caroline Simard, *Obstacles and Solutions for Underrepresented Minorities in Technology*, Anita Borg Institute for Women and Technology 11 (2009) [hereinafter *Obstacles and Solutions*], https://www.exponentialtalent.com/uploads/1/6/8/4/16841408/abi-obstacles-solutions-for-underrepresented-in-tech.pdf; *see also*, Simard et al., *Climbing the Technical Ladder: Obstacles and Solutions for Mid-level Women in Technology* (2008) [Hereinafter *Climbing the Technical Ladder*], https://4b7xbg26zfmr1aupi724hrym-wpengine.netdna-ssl.com/wp-content/uploads/2020/08/Climbing_the_Technical_Ladder.pdf. at 29.

[340] *Climbing the Technical Ladder*, *supra* note__, at 29.

[341] *Obstacles and Solutions*, *supra* note_, at 12. (reporting that partnered women of color were 2.3 times as likely to have a full time partner than men of color and underrepresented minority men were over 5 times more likely to have a partner with primary responsibility for the household and children than their female counterparts) Conversely, Simard's study found that technical women in general are more likely to be single than technical men, and that, again, the difference were even more stark for underrepresented minority technical employees, providing evidence of a family penalty among technical women. *Id.*

[342] And also, to meet the preferences of diverse employees that prefer hybrig to in-person work as discussed in Sheela Subramanian & Ella Washingtonn, *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.

[343] Simard, *supra* note __, at 14.

[344] Adam Nager, David Hart, Stephen Ezell & Robert D. Atkinson, The Demographics of Innovation in the United States, ITIF at 5, 44 (Feb. 2016), https://www2.itif.org/2016-demographics-of-innovation.pdf, (finding that women

Surveys and studies have also probed motivations to patent and perceptions of success, which are important and relevant to the design of initiatives to encourage participation. Some of these have focused on business-model diversity, and documenting the different reasons that small and large companies seek patents and how they leverage the ones they have on-hand.[345] A few others have asked individual inventors what motivates them to invent.[346] While "task-related" motivations including the intrinsic "satisfaction from solving technical problems" and the "progress of science," have rated highly among workers generally,[347] engagement in *socially* useful work disproportionately likely to be viewed by underrepresented minority technical employees as factors of success.[348]

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.[349] However, career development opportunities for updating technical skills have been reported to both be especially important for underrepresented minorities, and harder for women of color to do on their "own time,"[350] including because of a lack of company or personal funds.[351] Such insights can inform diversity initiatives and incentives targeted at inventors or STEM workers more generally.

3. Administering a Survey of Diverse Innovators and Inventors

While the PTO, as well as the scientific agencies that fund R&D, would be natural partners in a innovator-inventor survey due to their direct contacts with the relevant populations,

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that contribute to important patents tend to be younger than men by 5 years on average (44) and that immigrant inventors have tended to have higher levels of education than their domestic counterparts (5).

[345] 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), [hereinafter, *Berkeley Patent Survey*]. (reporting, among the reasons and uses: to gain competitive advantages, prevent copying of technology, secure financing, and enhance firm reputation).

[346] See John Walsh & Sadao Nagaoko, *Who Invents?: Evidence from the Japan-U.S. inventor survey*, Research Institute of Economy, Trade, and Industry, Discussion Paper Series 09-E -034, at 2 (2009), https://www.researchgate.net/publication/239807036_Who_Invents_Evidence_from_the_Japan-US_inventor_survey . at 1, 22–23. (While unfortunately not carried out in a way that allows for comparing responses by demographic group, finding similarities and contrasts between the motivations of inventors in the US and Japan, along three categories: "Task-related" 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-related motivations, in both the US and Japan. But differences between 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 US than in Japan.

[347] *Id.* at 23; see also Capital One, Women in Technology Survey 4 (2019), https://ecm.capitalone.com/DevExchange/assets/PDFs/WIT_Report_2019.pdf (reporting that among women that stayed in technology jobs, "love of work" and being good at the job were top motivators)

[348] Simard, *supra* note __ at 24.

[349] *Id.* at 20.

[350] *Id.*

[351] *Id.* at 25.

the U.S. Census Bureau and NSF likely have the broadest authorities to spearhead such surveys. Indeed, a straightforward step towards such a survey would involve more systematically adding questions about inventorship on existing surveys of innovators, as has been done previously as part of the National Survey of College Graduates (NSCG), collected by Census.[352]
Given the well-worn challenges of identifying women and minority inventors, much less innovators, any survey meant to advance diversity would specifically need to oversample or otherwise seek intensified participation from underrepresented groups. Perhaps the most relevant previous inventor survey efforts, PatValEU, a large-scale survey designed to be representative of patenting in six EU countries, included a female respondent share of less than 3%, which survey authors characterized as too small to make statistically relevant observations.[353] Private surveys focused on women and minorities have contained valuable insights, but in a number of cases they have not included a control comparator, making it difficult to draw conclusions about the distinct needs and experiences of diverse innovators.

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. It has done so on the basis of the mechanisms by which diverse innovators improve innovation but, also, on 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 who is innovating and in what setting.

Achieving greater diversity in inventorship will require engaging and studying not only those that have already sought patents, where most of the focus has been, but 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 duty to promote a diversity of innovators and inventors, and not just innovation and invention. But to close gaps in participation will require additional research, experimentation, and rigorous evaluation of interventions. A diversity pilots clearinghouse and the enhanced ability of the USPTO together can support progress, redefined.

[352] Described in Jennifer Hunt et al., *Why are Women Underrepresented Amongst Patentees?*, 42 Research Policy 831 (2013), https://doi.org/10.1016/j.respol.2012.11.004.
[353] Described at PatVal-EU, supra note __.

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 who invented or discovered "any useful art, manufacture, engine, machine, or device, or any improvement therein not before known or used;[354] "he, she, or they" 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"[355] could apply for patents. Under the Immigration and Naturalization Act of 1790, citizenship was reserved exclusively to "free White Persons"[356]
Act of April 17, 1800	U.S. citizens and foreigners resident for two years could apply for patents	In addition to citizens, "[a]ll aliens who at the time of petitioning [] shall have resided for two years within the United States" [357] 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[358]

[354] Patent Act of 1790, ch. 7, § 1, 1 Stat. 109 [hereinafter 1790 Act].
[355] Patent Act of 1793, ch. 11, § 1, 1 Stat. 318 [hereinafter 1793 Act].
[356] Naturalization Act of 1790, ch. 3, § 1, 1 Stat. 103. This excluded naturalization of Asians, American Indians, and free black immigrants. According to Haney-Lopez, this racial prerequisite to citizenship remained in force until 1952. *See* Ian Haney Lopez, White by Law: The Legal Con truction o Race 1 (New York Univ. Press rev. ed. 2006).
[357] Act of April 17, 1800, ch. 25, § 1, 2 Stat. 37, 38.
[358] *See Continental Paper Bag Co. v. Eastern Paper Bag Co.*, 210 U.S. 405, 429 (1908) (speaking of the right to patent, that "[t]he 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.") The actual language of the statue was a codification of the Supreme Court's decision in *Grant v. Raymond*, 31 U.S. (6 Pet.) 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, foreigners paid higher fees.	Citizens and alien citizens[359] could apply for patents. U.S. citizens and resident aliens that promised to become citizens within a year paid an application fee of $30; British nationals paid $500, and all other foreigners, $300.[360] The Supreme Court's *Dred Scott* decision in 1857 excluded "persons of African descent," free or slave, from U.S. citizenship[361] but was overturned by the 14th amendment, granting all American born individuals, regardless of color in 1868.
Act of July 8, 1870	U.S. citizens and those who were about to become U.S. citizens could apply for patents	Designers of "new and original fabrics," that were or were about to become U.S. citizens[362] could apply for design patents.
1930 Tariff Act	Exclusion orders against infringing imports are available for patentholders with "domestic industries"	Patentholding complainants with "domestic industries"[363] are entitled to apply for exclusion orders against infringing imports.[364]
1952 Patent Act	Foreign inventive activity, unless published down, not considered for the purposes of determining prior art whereas U.S. knowledge and use considered prior art.	Only foreign printed publications count as prior art; domestic knowledge, public use, sale or printed publication count.[365] This changed when the United States joined the 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.[366] In 2011, as part of the America Invents Act, equal treatment was extended to all countries,[367]

[359] Patent Act of 1836, ch. 357, §§ 6 & 9, 5 Stat. 117, 119 & 12 [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.")
[360] 1836 Act § 6; *see also* § 12 (limiting the filing of a caveat, an instrument similar to a patent, to citizens and aliens intending to become citizens).
[361] *Dred Scott v. Sandford*, 60 U.S. (19 How.) 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 blacks from rights to their inventions, but also precluded their slave owners, who could not take an oath attesting to be the "inventors" of their slaves' inventions, from such rights as well, defying the claim that slave owners "owned" slaves and their ideas.
[362] Act of July 8, 1870, ch. 230, §§ 40, 71, 16 Stat. 198, 203-04, & 209-10, *repealed by* Act of May 9, 1902, ch. 783, 32 Stat. 193.
[363] *Id.*
[364] Pursuant to Section 337 of the Tariff Act of 1930, 19 U.S.C. § 1337 (2012).
[365] 35 U.S.C. §§ 102(a)-(b) (1952).
[366] *See* TRIPS. For a summary of how joining TRIPS resulted in a change to U.S. novelty rules, see https://www.uspto.gov/web/offices/com/doc/uruguay/SUMMARY.html.
[367] *Cf.* 35 U.S.C. § 102(b) (2006) & 35 U.S.C. § 102(a)(2) (2012).