Redefining Progress and the Case for Diversity in Innovation and Inventing

Colleen Chien
Santa Clara University School of Law, colleenchien@gmail.com

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REDEFINING PROGRESS AND THE CASE FOR DIVERSITY IN INNOVATION AND INVENTING

By Colleen Chien¹

In the United States, women represent over 50% of the workforce, but only 27% of STEM workers and 13% of inventors. This article surveys the scientific literature to make the empirical case for diversity in innovation and inventing, finding a growing body of research to show how diverse innovators expand the reach, quality, and quantity of innovation. It then surveys the history of patent law to make the legal case for prioritizing diversity in inventing, and for expanding conventional notions of “progress” in the patent system to include the promotion of a diverse set of innovators, rather than just innovation. It introduces the concept of the “innovator-inventor gap” in patenting to document how across dozens of settings, technical women are participating at 50% or less of the rate of their male counterparts. It then explores how the law and mechanics of inventorship and invention contribute to such gaps. The article concludes by discussing several steps for taking progress, redefined, seriously, including: (1) institutionalizing and broadening the Patent Office’s duties and authorities to promote a diversity of innovators and inventors, (2) launching a public-private innovator diversity pilots clearinghouse to support the rigorous evaluation and refinement of relevant policies, regulations and practices, and (3) creating a periodic, innovator-inventor survey for informing the design of policies and practices for diversifying innovation and inventorship.

¹ Professor and Co-Director, High Tech Law Institute, Santa Clara Law School, 2013–2015 Senior White House Advisor, Innovation and Intellectual Property, 2020-2021 member of the Biden-Harris transition team with primarily responsibility for the United States Patent and Trademark Office. <acknowledgments> This article will be the subject of a conference on “Innovator Diversity Pilots” co-organized with the United States Patent and Trademark Office.
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INTRODUCTION

As stated in the Constitution, 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.” The promise of limited rights compels “progress” by adding “fuel to the fire of genius.” 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 patent law, “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. 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.

But this Article calls for a broadening of how we think of “progress,” from being solely about advances in the useful arts to also being about the inventors and innovators who make these advances. It argues for this enlarged sense of progress on the basis of patent law’s overlooked but longstanding commitment to promoting a broad range of innovators. But it also does so on the basis of a growing body of evidence about the ways that diversity improves the reach and quality of innovation, according to four main mechanisms that are also recognized by patent law:

Novelty: novel insights extend the direction and reach of innovation. For example, female scientists, inventors, and entrepreneurs are more likely to produce ideas, inventions, and companies that benefit women; increasing the share of female inventors appears to shift the supply of inventions toward the needs of women. The age and socioeconomic status of innovators also correlates, as does the exposure of innovators to lower-income groups, with the age and status of the consumers of their innovations. Diversifying who is innovating can diversify the types of innovations developed and their reach.

Nonobviousness: diverse perspectives support nonobvious connection and combinations that lead to greater innovation. For example, gender and racial minority doctoral students are more innovative and able to introduce new conceptual linkages and connections missed by others. Studies have associated ethnic and disciplinary diversity on teams with greater radical innovation.

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2 Article I, Section 8, Clause 8, of the United States Constitution.
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 Rembrand Koning, Sampsa Samila & John-Paul Ferguson, Inventor Gender and the Direction of Invention, 110 AEA Papers and Proceedings 250-254 (2020), 250
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 [parenthetical needed].
innovation and gender diversity with improved innovation outcomes.\textsuperscript{12} Intersections of ideas, culture, disciplines, problems, geographies lead to breakthrough combinatorial insights.

Dissent: conflict and disagreement improve, even as they challenge innovation. A diversity of opinions on teams reduces the risks associated with groupthink, and requires groups with dissenting viewpoints and experiences to exchange more information, leading to “integrative complexity.”\textsuperscript{13} Mixed race juries perform better as they rely more on facts, rather than faulty assumptions,\textsuperscript{14} and in industry, tiger teams and red teams allow for objective criticism and iteration.

Numerosity: including diverse inventors means a reduced risk of missing out on the geniuses that make outsized contributions to the progress of science and useful arts.

Yet despite these benefits, participation in innovation is not representative of participation in the workforce -- women comprise nearly 50% of the workforce and 27% of STEM workers, but receive only 13% of patents and 2% of VC funding,\textsuperscript{15} with underrepresented minorities receiving a similarly tiny share\textsuperscript{16} -- suggesting a role for policy. The call to center and take seriously “progress” as encompassing diverse innovators, not just innovation, comes at a moment when America’s love affair with information technology is on the wane,\textsuperscript{17} and questions about who is participating in innovation are on the rise. The broad reach of technological goods and the narrow range of people making them mean that “underrepresented groups find themselves shut out of the development of products they use every day.”\textsuperscript{18}

This Article argues that the goals of patent law and policy would be well served by a more explicit sense of progress that explicitly, acknowledges and prioritizes diversity in innovation. Such a shift would represent a break with traditional conceptions of patent law as being purely about the promotion of innovation, regardless of by whom or in what setting. But it would also bring efforts to ensure diversity in inventing from the periphery to the center of the patent system, ground its recent inclusive turn\textsuperscript{19} in the doctrine and design of the law, and, 

\textsuperscript{12} Though not always. See Part I for a review of relevant studies.

\textsuperscript{13} Felix C Brodbeck, Katharina G. Kugler, Josef A. Fischer, Joerg Heinze & Dorothee Fischer, \textit{Group-level Integrative Complexity: Enhancing Differentiation and Integration in Group Decision-making}, 24 GRP. PROCESSES & INTERGROUP RESLS., 125, 130 (2020), https://journals.sagepub.com/doi/10.1177/1368430219892698#_i4. (describing experimental research that has found that group dissent enhances differentiation.)

\textsuperscript{14} Described in Phillips, infra note __


\textsuperscript{16} Courtney Connely, \textit{Black And Latinx Founders Have Received Just 2.6% Of Vc Funding So Far In 2020, According To New Report, CNBC} (Oct. 8, 2020), https://www.cnbc.com/2020/10/07/black-and-latinx-founders-have-received-just-2-point6percent-of-vc-funding-in-2020-so-far.html.

\textsuperscript{17} See, e.g., Jake Bekemeyer, \textit{Poll: Trust in Big Tech Continues to Decline}, DBUSINESS (Oct. 11, 2021), https://www.dbusiness.com/tech-mobility-news/poll-trust-in-big-tech-continues-to-decline/ (reporting “that the technology industry has seen the sharpest drop in trust over the past five years,” dropping its ranking from first to sixth over this period).


\textsuperscript{19} Discussed in Part I, infra.
ultimately, contribute to broadening the reach and impact of innovation through the greater participation of diverse innovators.

Part I makes the empirical and legal case for redefining patent “progress” to include the promotion of innovators, and not just innovation. Diverse innovators improve innovation through unique knowledge, approaches, and motivation (novelty), as well as the unique combinations, conflict, and numerosity they bring to innovative processes. A people-centered sense of progress is also supported by the doctrine and design of the patent system, which has long paid attention not only to what is being innovated, but also who is innovating and in what setting.

Part II of the Article explores challenges to “progress” in the diversification of inventorship and how they may be addressed. It presents fresh evidence of the gender “innovator-inventor gap” within the workplace, where women often patent at less than half the rate of their male counterparts, and then considers how the law and mechanics of inventorship, have contributed to this gap.

Part III proposes several steps for making progress in the promotion of a diversity of innovators. First, it discusses institutionalizing and broadening the USPTO’s commitment to promoting a broad and diverse set of innovators, consistent with a redefined sense of progress. Second, it proposes the creation of a public-private clearinghouse for pilot programs on best practices for achieving greater diversity in innovation. Finally, it argues in favor of a periodic national inventor-innovator survey for understanding the needs and experiences of diverse innovators and shaping policy.

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? While diversity has been called a moral and business imperative, the innovation case for diversity raises distinct questions in light of the perception of science and engineering as neutral and objective. As the dissent in the Fifth Circuit affirmative action case Fisher v. Austin has asked, “Will classroom diversity ‘suffer’ in areas like applied math, kinesiology, chemistry, [if by chance, few or no students of a certain race are enrolled]? The reported failure of corporate diversity initiatives to have their intended impact also serves as a reminder that diversity is hard and so it is important to examine, and not just assume, its benefits. Recent court challenges that have questioned the empirical basis for corporate board diversity mandates further underscore the need for rigor.

20 Discussed in Part II, infra.
21 https://www.science.org/doi/10.1126/science.add5909
22 Fisher v. University of Texas at Austin, 644 F.3d 301 (5th Cir. 2011).
23 Frank Dobbin & Alexandra Kalev, Why Diversity Programs Fail, Harv. L. 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).
24 See Id. Crest v. Padilla, (striking down a California law that require the boards of California corporations to include women as inconsistent with the state’s Equal Protection Clause on the basis that the law constituted a gender-based quota for which the State failed to prove a compelling state interest through, inter alia, benefiting the economy through increased gender diversity on boards. The court concluded that the relevant studies “failed to sufficiently show a causal connection between women on corporate boards and corporate governance [outcomes]”, at p.11).
Against this backdrop, this Part begins by considering the case for diversity in innovation and invention empirically. It surveys studies that consider the impact of several forms of diversity — demographic, skills, economic, cultural, geographic and other — on innovation processes and outcomes. As described below, taken together, this literature tends to show that the presence of diverse innovators has positive effects on innovation outcomes. Diversity does not always have these effects, and not always definitively, as many of studies that associate above-average diversity with better innovation outcomes are correlational, not causal. In addition, the conditions and nature of the innovation task matters, as explored further below. But a review of the literature reveals a host of mechanisms — including novelty, combination, conflict, and numerosity — by which the presence of diverse innovators positively influences the quality, reach, and quantity of innovation.

This Part next makes the legal case for diversity in innovation and invention and for redefining patent progress, from being exclusively about innovation to also being about the diversity of innovators. It traces the law of inventorship from the origin of the patent system to the present to argue that who is inventing matters in part because it has always mattered. It also describes the numerous features of U.S. patent law and administration — ranging from its embrace (until recently) of a “first-to-invent” “novelty” standard for patentability to the multiple ways the Patent Office has sought to cultivate regional, economic, and demographic diversity among patent filers — that support an enlarged sense of patent “progress.”

This Article is not the first to challenge conventional notions of the term “progress” as presented by the “Intellectual Property Clause” (Part 1, Section 8, Clause 8) of the Constitution. 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. Kurtulüs, What Types of Diversity Benefit Workers? Empirical Evidence on the Effects of Co-worker Dissimilarity on the Performance of Employees, 50 INDUS. REL.: J. OF ECON. AND SOC’Y 678, 683 (2011); John Qin, Nuttawuth Muenjohn & Prem Chhetri, A Review of Diversity Conceptualizations: Variety, Trends, and a Framework, 13 HUM. RESCH. DEV. REV. 133, 139 (2014); Jeremy Dawson, Yves R.F. Guillaume, Lilian Oyate-Ebede, Stephen A. Woods & Michael A. West, 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).

26 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, Chaqun Ni, Jevin D. West & Vincent Lariviere, 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).

28 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 Power, 94 GEO. L.J.
But rather than completely bucking the conventional utilitarian paradigm, this Article offers an alternative way to succeed within it, by framing the robust participation of innovators as a dimension of progress that advances the useful arts and their uptake, in a few ways. 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 innovation. As discussed below, present diversity in innovators also fosters future diversity in innovators, making it valuable separate and apart from any immediately measurable impact. Diversity in innovators may have a number of non-innovation related benefits. However, because the patent system is designed to promote the progress, that is the present focus. As I’ll argue below, patent law can, and has, to a degree, supported and promoted such diversity. As such the present claim is as descriptive as it is prescriptive – arguing for the recognition of patent law and policy as not just innovation law and policy but innovator law and policy.

A. How Diversity Improves Innovation, as Recognized by Patent Law

At its core, the concept of innovation – novel or improved ways of doing things better or differently – applies broadly to every realm of human endeavor. But while the dimensions along which innovations can vary are numerous, technological innovation generally comprises two distinct steps: first, the generation of a new idea; and second, the translation of the idea into a new method, product, or improvement. The processes of innovation benefit from – even while they are challenged by – a multiplicity of experiences and viewpoints, as explored below.

1. Through Novel and Different Experiences and Viewpoints

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).

29 For example, increases in the health and welfare of marginalized groups, or rising economic mobility among participants.


31 Including, e.g. social innovation, as described in James Holly & Amy E. Slaton, Pipelines and Pathways: Invention Education, Training, and Mentoring, Panel Discussion at The Smithsonian’s Lemelson Center (August 3, 2021) (describing the Underground Railroad, soul food, the Black church, and African American vernacular English (AAVE) as examples of social innovation), https://invention.si.edu/node/29159/p/742-pipelines.

32 Including the domain (e.g., product, process, or social innovation), nature (e.g., administrative or technological), and scale (incremental to radical).

33 See Fernando Cardoso de Sousa, Ileana Monteiro & Rene Pellissier, Creativity and Problem Solving in the Development of Organizational Innovation, Spatial and Organizational Dynamics Discussion Papers, CIEO-Research Center for Spatial and Organizational Dynamics 29, 31 (2009).
Ideas can only be patented if they are new. 35 U.S.C. § 102’s “novelty” standard defines what makes something new in patent law. 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, requires a deep understanding of the circumstances, settings, and dynamics of a situation. Just as necessity breeds invention, novel experiences lead to novel understandings of problems but also, and perhaps just as importantly, the motivation to solve these problems.

A number of innovations have been the result of people solving their own particular problems, and in the process, solving them for others, too. 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. Several recent studies have demonstrated how novel insights that spring from distinct physical experiences have been a fount of innovation, demonstrating the connection between who participates in and who benefits from innovation.

For example, although less than 13% of inventors on U.S. patents are women on average, the female share of bioscience inventors is much higher. While men can and do research and develop innovations for women’s health conditions, there is a long history of neglect of diseases and conditions that predominantly impact women. Based on a text analysis of all U.S. biomedical patents filed from 1976 through 2010, Rembrand Konig 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 health. Such teams not only focused on conditions unique to women, but also the differential side effects and benefits of treatments that worked better for women. Their study provides a partial answer to the question – if demand for a product exists, won’t the market supply it? As their results show: not necessarily, as bias in the labor market has the potential to spill over into product-market bias. 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 outcomes, such as cellphones that are 55% too large and car designs that are 47% less safe, on average, for half of the population.
Two other studies, still in development, provide further support for the idea that the direction of innovation depends on who is innovating. Francesca Truffa and Ashley Wong have studied the transition of universities from all-male to coed from the 1960s to the 1990s. When universities welcomed women, they also experienced a 42% increase in gender-related publications, due both to the greater diversification of researchers as well as a shift in existing research towards gender-related topics.

A new working study by Elias Einio and his co-authors provide additional evidence of the influence of innovator identity and socialization on the direction of innovation. The study documents how rich, and female, and older innovators are more likely to innovate for rich, and female, and older consumers, respectively. Even a person’s social experience makes a difference: exposure to peers from lower-income groups increased an entrepreneur’s propensity to create “necessity products,” that served lower-income groups. Patricia Bath made pioneering breakthroughs in cataracts, a condition that disproportionately impacts women, because of the differences she witnessed among patient populations. Who innovates, and their lived experiences, have welfare implications.

From a comparative advantage perspective, these findings make sense. 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 “non-obvious” 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. But consideration of “secondary factors...[can] dislodge the determination that [a] claim...is obvious.” These factors include “commercial success, long-felt but unsolved needs, failure of others, and others.” Although inventors are not required to recombine prior art, they

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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, 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.
52 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 Id.
55 See 35 U.S.C. § 103. (“Patentability shall not be negated by the manner in which the invention was made.”).
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.56

As described above, Braille is a system of raised dots that can be “read” by the fingertips of the blind.57 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.58 Louis Braille’s contributions were not only to reduce the number of points but 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 “estabishing a connection between or combining two elements that have not previously been connected or combined” to create new knowledge.59 Further, in patent law, the less “analogous”60 the sources of inspiration that are combined, or the more unpredictable61 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, “[a]t some point, the bringing together of knowledge held in widely diverse fields itself becomes invention.”62

Diverse perspectives support nonobvious combinations. A recent, sweeping, study of U.S. PhD recipients and their dissertations across three decades found scholars from underrepresented groups were more likely to have novel concerns and experiences that allowed them to “draw relations between ideas and concepts that have been traditionally missed or ignored.”63 Using machine learning techniques, the analysis found that the more underrepresented in their discipline a doctoral student was in terms of gender or race, the more likely they were to introduce new “conceptual linkages.”64 The study thus suggests a connection between demographic diversity and higher rates of combinatorial insights.

Radical innovations, which adapt existing innovations to new contexts, also appear to diverse teams.65 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

59 Shahid Yusef, From Creativity to Innovation, 31 TECH. SOC’y 1, 6 (2009).
60 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)).
61 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 Hofstra et al, supra note __.
64 Id.
65 For a review of articles that support that both related and unrelated knowledge capabilities support the emergence of radical innovation, see Peter N. Golder, Rachel Shacham and Debanjan Mitra, Innovations’ Origins: When, By Whom, and How Are Radical Innovations Developed?, Marketing Science Vol. 28, No. 1 (January-February 2009), pp. 166–179.
attributable to radical innovation.66 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.67 A number of studies have found similar, if not always consistent, associations between gender diversity and improved scientific discovery and innovation.68 For example, a large study in Spain found companies with more women to be more likely to introduce new products or processes over a two-year period, due to the creation of new knowledge by individuals with different socialization and career paths.69

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.70 A set of longitudinal, experimental, and field studies found that close intercultural relationships among MBA students promoted creativity and workplace innovation.71 In laboratory and field experiments, having intercultural relationships and networks has been found to promote idea flow and creativity.72

3. Through Dissent and Unconventional Thinking

But just as familiarity may lead to complacency, diversity also can lead to conflict, misunderstanding, and skepticism.73 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.74 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.75 Indeed, a number of studies have found that the relationship between diversity and

67 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.”)
68 Mathias Wullum Nielsen, Carter Walter Bloch & Londa Schiebinger, 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 Described in Galinsky et al, supra note __ at 743.
73 See Katherine W. Phillips, How Diversity Makes U.S. Smarter, 3 SCI. AM., (Sep 16, 2014) (listing some of the downsides of diversity)
innovation outcomes is not straightforward but instead follows an inverted U-shape, meaning that moderate levels of diversity can be more beneficial for creativity than high levels of diversity. 

Others have found the innovation rewards of diversity to be experienced only under certain conditions. 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 Kathryn Phillips has observed. In experimental settings, mixed-race juries have performed better than single-race ones because they rely more on facts, and less on faulty assumptions. In addition, the presence of racial and opinion minorities has been correlated with both greater novelty and “integrative complexity,” not unlike the discovery of “truth ‘out of a multitude of tongues . . . ’” referred to by the Supreme Court in its discussions of diversity. The insight that dissent leads to better outcomes, and avoids the mistakes of groups 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.

Patent Law’s Reward of Unconventional Thinking Through the Teaching Away Doctrine

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.” That is to say, the law rewards the successful pursuit of a


77 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, Bram Timmermans & Kari Kristinsson, Does a Different View Create Something New? The Effect of Employee Diversity on Innovation, 40 RESEARCH POLICY 500, 500-509 (2011).

78 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”)

79 Id. (citing Katherine W. Phillips, Katie A. Liljenquist & Margaret A. Neale, Is the Pain Worth the Gain? The Advantages and Liabilities of Agreeing With Socially Distinct Newcomers, 35 PERSONALITY & SOC. PSYCHOL. BULL. 336 (2008)).


82 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)).

83 2 Chisum on Patents § 5.03 (2021).
path that an inventor would normally be “discouraged from following.” Just as diverse and dissenting views have 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 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’” (emphasis added). 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. 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. In patent law, as in innovation, departing from the conventional wisdom to arrive at a solution is a feature, not a bug.

4. Through Deep Talent Pools

A final mechanism by which diverse innovators contribute to innovation is by deepening the talent pool. While in any specific context, “more” innovation does not necessarily translate into “better” innovation, the cumulative effects of greater participation in innovation are substantial, given the role of technological progress in driving economic growth and improvements in the standard of living. The contributions of diverse immigrant innovators to U.S. innovation are illustrative. Non-native innovators have collectively contributed to an estimated 22% of all inventions, though they represent only 16% of the innovator population.

Conversely, the impact of missing innovators is also substantial. Jennifer Hunt and her co-authors find that closing the gender gap in engineering jobs and patents would increase U.S. productivity, as measured by GDP per capita, by 2.7%. 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%. Investing in women’s health research could make additional economic gains possible through increased life expectancy, reduced years with disease, and reductions in disruptions to work productivity.

85 Henny Penny Corp. v. Frymaster LLC, 938 F.3d 1324, 1332 (Fed. Cir. 2019).
86 Id.
88 Jennifer Hunt, Jean-Philippe Garant, Hannah Herman, David J. Munroe, 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 Hunt, supra note _.
92 Matthew D. Baird, Melanie A Zaber, Annie Chen, Andrew W. Dick, Chloe E. Bird, Molly Waymouth, Grace Gahlon, Denise D. Quigley, Hamad Al-Ibrahim & Lori Frank, Research Funding for Women’s Health: Modeling Societal Impact, RAND Corp. (2021), https://tinyurl.com/mr329cv4 (simulating the impact of increased research
The risk to society of missing out on so-called lost Marie Curies or Patricia Baths\textsuperscript{93} is particularly acute. That is because highly talented individuals have an outsized impact on innovation, economic growth, and the trajectory of history.\textsuperscript{94} Studying inventor records and test scores, 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.\textsuperscript{95} Research suggests that this underrepresentation extends across “star inventor groups,” implying that there are likely many lost Einsteins among underrepresented groups.\textsuperscript{96}

B. How Patent Law Advances Innovators, not only Innovation

While the previous paragraphs have addressed \textit{why} promoting a diversity of innovators is important for promoting innovation, they do not explore \textit{how} the patent system might do so. Though patent law has always been understood as the law of innovation, below I argue that it should also be understood as the law of innovators. Consistent with the democratic tradition in which it was conceived, U.S. patent law has been shaped by the needs of diverse innovator groups in multiple ways. The administration of patent examination by the USPTO has also been motivated by a desire to cultivate regional, socioeconomic, business-model, and, most recently, demographic diversity. Such an understanding of the design and doctrine of patent law supports redefining patent progress to encompass the promotion of innovators, and not just innovation.

1. By Attending to Diverse Innovators 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.\textsuperscript{97} The Act was remarkably inclusive for its time: in contrast to naturalization, which was reserved for “free White Persons,”\textsuperscript{98} “any person or persons” could apply for a patent.\textsuperscript{99} 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

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\textsuperscript{93} Profiled \textit{supra} in Part I.A.1.

\textsuperscript{94} Alexander M. Bell and his colleagues have documented this skew among inventors. \textit{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.)

\textsuperscript{95} https://academic.oup.com/qje/article/134/2/647/5218522 [cite]

\textsuperscript{96} Id. Accord Murat A. Celik, \textit{Does the Cream Always Rise to the Top? The Misallocation of Talent in Innovation}, University of Pennsylvania Mimeo (2015); Symposium, \textit{The Economics of Institutions, Innovation and Growth}, College De France (June 20, 2016), https://www.college-de-france.fr/site/en-philippe-aghion/symposium-2016-06-20-11h30.htm (finding that the most talented don’t necessarily persist through obstacles and “rise to the top” and estimating that capturing untapped innovative talent could grow the economy by a rate of 10%).

\textsuperscript{97} Patent Act of 1790, ch. 7, § 1, 1 Stat. 109 [hereinafter 1790 Act].

\textsuperscript{98} Naturalization Act of 1790, ch. 3, § 1, 1 Stat. 103. This racial prerequisite to citizenship remained in force until 1952. \textit{IAN HANEY-LOPEZ, WHITE BY LAW: THE LEGAL CONSTRUCTION OF RACE} 1 (New York Univ. Press rev. ed. 2006).

\textsuperscript{99} 1790 Act § 1.
representation.\textsuperscript{100} In contrast to suffrage, which was not guaranteed for women until 1920,\textsuperscript{101} “he, she, or they” could apply for a patent.\textsuperscript{102} As Anne McDonald 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 Liberty should, as Abigail Adams coached her husband, be ‘‘remembered.’’”\textsuperscript{103}

As they had during colonial times, patent grants provided a way to stimulate economic growth, particularly in manufacturing, given the scarcity of labor.\textsuperscript{104} 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.\textsuperscript{105} Low fees\textsuperscript{106} and the award of patents based on merit to the inventors of original ideas rather than patronage\textsuperscript{107} also contributed to the “democratization of invention,” in the words of Zorina Khan.\textsuperscript{108} 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: “[j]ust as the United States in the 19th Century was more democratic politically than most any other nation in the world at the time, 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.”\textsuperscript{109}

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.\textsuperscript{110} This meant that foreigners, slaves, and non-white immigrants, that is, those who were not “free White persons” under the 1790 Immigration and

\begin{footnotesize}
\begin{enumerate}
\item U.S. Const. art. II, § 2.
\item 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.”
\item 1790 Act § 1.
\item ANNE L. MACDONALD, FEMININE INGENUITY: WOMEN AND INVENTION IN AMERICA 25 (1994).
\item 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).
\item 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).
\item As described in Khan et al, supra note __, at 292–313.
\item DARON ACEMOGLU & JAMES ROBINSON., WHY NATIONS FAIL: THE ORIGINS OF POWER, PROSPERITY AND POVERTY 333 (2013).
\end{enumerate}
\end{footnotesize}
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.111

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.112 The use of patent law as an
inducement for foreigners to come, stay, and innovate was broadly consistent with the first patent
system, created in 1474 by the Venetian Senate, which sought to recruit to Venice “every person
who shall build any new and ingenious device.”113

Until recently, a parallel commitment to the geographic diversity of innovators was
enshrined in U.S. patent law, whereby foreign inventions would not preempt subsequent
patenting under U.S. law, unless they had been written down, patented, or sold.114 And yet,
structural disadvantages for certain inventors persisted until at least 1860.115 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.116 The rights of married
women117 and African Americans to obtain and own patents were being clarified well into the
patent system’s first century.118

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.119 As part of the America
Invents Act, Congress directed the USPTO to open satellite offices across the country,120 in order
to “ensure geographic diversity [] in different States and regions throughout the United States.”121
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.

Although addressing a different set of root causes than those posed by race and gender
disparities, measures to promote geographic diversity are crucial given the intense spatial

111 Eric S. Hintz, Counting Women Inventors, Lemelson Center (Mar. 21, 2017),
https://invention.si.edu/counting-women-inventors.
112 Described in Khan, supra note ___ at 71.
113 Ted Sichelman & Sean O’Connor, Patents as Promoters of Competition: The Guild Origins of Patent Law in the
114 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).
115 For the progression of the laws, see Appendix, Table A.
117 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).
118 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).
119 Resulting in measurable benefits to new innovators as documented in Jeffery L Furman, Marin Nagler & Markus
Watzinger, Disclosure and Subsequent Innovation: Evidence from the Patent Depository Library Program, NBER
121 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.
concentration of innovation. In 2020, 50% of new patents came from just five states, \(^{122}\) and 90% of the nation’s innovation-sector growth from 2005 to 2017 came from just five metropolitan areas. \(^{123}\)

2. **By Balancing the Needs of Innovators and Inventors**

If “progress” is the end, the rest of the Intellectual Property Clause appears to specify the means: “by securing for limited times [] exclusive rights to inventors.” \(^{124}\) One might plausibly read this to mean that any enlarged sense of progress should be limited to inventors, the “efforts of ingenious persons,” \(^{125}\) rather than innovators in general. But a closer reading of the Intellectual Property Clause in context reveals why this interpretation is incorrect. The strong anti-monopolist sentiment of the day and antipathy to the British “benefactor” model of awarding rights based on royal munificence led Congress to craft an inclusive and accessible, while also limited, patent system, one that would carefully avoid “reward[ing] the ingenuity of the citizens of one State, and neglect[ing] a much greater genius of another.” \(^{126}\)

This sense of equipoise – of not unduly privileging one over another in order to support the greatest advance – is key to recognizing “progress” as being about the promotion of innovators, not just inventors. Achieving a balance between multiple innovators is at the core of patent law. For example, though not required by the patent statute, the Supreme Court has frequently invoked the equities of “others” in its patent law decisions, particularly with respect to its doctrine of “preemption,” the “concern that patent law not inhibit further discovery by improperly tying up the future use of laws of nature,” \(^{127}\) and a desire to ensure future innovators have access to the “building blocks of human ingenuity.” \(^{128}\) The “disclosure” doctrines \(^{129}\) in patent law like balance the rights of writers and readers of patents. The written description within a patent, after all, is what society gets in exchange for giving exclusive rights to the “writer” or inventor of a patent. \(^{130}\)

\(^{122}\) Colleen V. Chien, *The Inequalities of Innovation*, (Forthcoming) EMORY L.J. (2022) Part II.


\(^{124}\) Article I, Section 8, Clause 8, of the United States Constitution.

\(^{125}\) Jake Linford, *Datamining the Meaning(s) of Progress*, 2017 BYU L. REV. 1531 (2017) at fn 179 (citing from copyright statutes of Massachusetts, New Hampshire, and Rhode Island).

\(^{126}\) Oliar, *supra* note __ at fn143.

\(^{127}\) Bilski v. Kappos, 561 U.S. 593, 3220, 3222 (2010) (citing its earlier decisions in *Morse, Benson, and Flook*). *Accord* Mayo Collaborative v. Prometheus Labs, 132 S. Ct. 1289, 1291 (expressing concerns that patents would “tie up the doctor’s subsequent treatment decision,” subject “potential users to conduct costly and time-consuming searches of [existing and pending patents],” and foreclose future innovation.) *Id.* at 1032–1035; See also Association for Molecular Pathology, Inc. v. Myriad Genetics, Inc., 133 S. Ct. 2107, 2116 (2013) (explaining that patent law’s ban on patenting laws of nature, natural phenomena, and abstract ideas guards against the “considerable danger that the grant of patents would tie up the use of” innovation by future generations of innovators.)


\(^{129}\) As enshrined in 35 U.S.C. § 112, which requires in relevant part a patent to “contain a written description of the invention, enable skilled artisans to make and use the claimed invention, and use ‘clear, concise, and exact’ terms, so that future innovators can learn and read from it.”

\(^{130}\) Which the Supreme Court has called the “quid pro quo” of the patent system. Brenner v. Manson, 383 U.S. 519, 533 (1966).
A final illustration of how patent law operates to safeguard the interests of innovators – beyond just inventors – is through equitable doctrines. The test for determining when to award a permanent injunction to a prevailing patentee requires balancing hardships between patentees and infringers, as well as the interests of the public.\textsuperscript{131} In applying it, courts have tended to award injunctions to competitors and startups, but not to non-practicing entities who are less likely to experience irreparable harm in the absence of injunctive relief.\textsuperscript{132} As such, the standard as applied is both business model-specific and also sensitive to the needs of inventors and non-inventors. In a similar vein, the doctrine of equitable estoppel similarly safeguards the rights not of inventors, but of those accused of patent infringement.\textsuperscript{133}

3. By Supporting a Diversity of Business Models

Another way in which the patent system has embraced an innovator-specific sense of patent progress is through its support for particular business models. In theory, the patent system is unitary, with discrimination based on the “field of technology”\textsuperscript{134} prohibited under international law.\textsuperscript{135} But U.S. lawmakers have accounted for the different settings and business models in which innovation is done.\textsuperscript{136}

For example, in support of the idea that under-resourced individuals should have the same rights as corporations to pursue patents, the United States has, until recently, uniquely adopted a “first-to-invent” approach to determining who among competing inventors should prevail. This is because favoring the “first-to-invent” rather than the “first-to-file” innovator rewards the person who has the idea, rather than filing the application, first.\textsuperscript{137}

Although the 2011 America Invents Act (AIA) transitioned the U.S. towards a first-to-file system in order to conform to international norms, U.S. patent law retained a “grace” period.\textsuperscript{138} Section 102(b) of 35 U.S.C. gives inventors an additional year after they have disclosed their


\textsuperscript{132} Colleen V. Chien & Mark A. Lemley, Patent Holdup, the ITC, and the Public Interest, 98 CORNELL L. REV. 101, 102 (2012).


\textsuperscript{134} Agreement on Trade-Related Aspects of Intellectual Property Rights, art. 27(1), Apr. 15, 1994, 1869 U.N.T.S. 299 (establishing that World Trade Organization (“WTO”) countries must offer protection to any invention without discrimination based on the field of technology).


\textsuperscript{136} So long as foreigners are treated as well or better than domestic citizens, as to intellectual property. See TRIPS art. 3.

\textsuperscript{137} 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/.

inventions to get their patent applications on file. For a cash-strapped entity like a university or independent inventor—the intended beneficiaries of the grace period—this additional time can be used to vet the commercial potential of the invention, raise funds, or build and test a prototype before investing in patenting.

The AIA also included a “University Exception” that immunizes university patents from defenses to infringement based on “prior user rights,” in effect strengthening university patents relative to others. Not only are university patents stronger, they are also cheaper to acquire. Beginning in 2000, “small entities” – including universities, independent inventors, and companies with less than 500 employees – have received discounts of 50% for filing fees.

4. Through the Patent System’s Recent, Inclusive Turn and Focus on Demographic Diversity and First-Time Filers

In the past decade, Congressional and administrative efforts to support new and underrepresented inventors have intensified, ushering in a new era of innovator-centric patent policy. Perhaps partly as a counterweight to the first-to-file change, these policies have largely centered on making it easier for first-time, underresourced, and underrepresented filers to file for and get their patents, as well as on supporting diversity among both applicants and patent service providers.

Under the AIA, the smallest filers, as well as universities, became eligible for “micro entity” discounts of 75% off regular filing fees. These discounts are meant to remove barriers to patenting for cost-sensitive applicants. New firms are not only more cost-sensitive but also more sensitive to delays in the patenting process; to accommodate them, the AIA created a “fast track” (Track One) process for getting patents issued quickly, in as few as 12 months. The agency has recently announced that it will provide expedited examination for first-time micro

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139 Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011); Matal, supra note __, at 457–62, 479 n.282. (quoting Senator Orrin Hatch, one of the bill’s sponsors, as describing the grace period provision as one that “will benefit independent and university inventors in particular.”)

140 2011 America Invents Act § 5(e)(5). See also Robert Barrett et al., Did University Patents Become the World’s Most Valuable Patents Following Enactment of the America Invents Act?, INTELL. PROP. TODAY, at 32 (July 2012). But see, Peter Lee, Patents and the University, 63 DUKE L. J. 1 (2013) (contrasting the special statutory carveouts universities enjoy with courts’ refusal to give special treatment to academic institutions that behave like commercial actors).

141 37 C.F.R. § 1.29(a)–(b) (2012). “Small” is defined as having less than 500 employees. 13 C.F.R. § 121.802 (2011); 37 C.F.R. § 1.27(a)–(b) (2011).

142 Such as the AIA’s transition from a first-to-invent to a first-to-file system, described supra in Matal, Part I at 155.

143 Micro entities must meet the small entity requirements and, also be employed by a university or other qualifying institute of higher education or have a gross income less than three times the median household income in the U.S. and not have been named on four prior applications within a specified time frame. 37 C.F.R. § 1.29(a)–(b) (2012).

144 Several accounts have identified the high cost of patenting as the reason for not patenting. See, e.g., Berlan et al., supra note __, at 18–20 for an overview.

145 Described in Jeffrey M. Kuhn & Mike H. M. Teodorescu, The Track One Pilot Program: Who Benefits from Prioritized Patent Examination?, 15 STRATEGIC ENTREPRENEURSHIP JOURNAL 185 (June 2021), https://onlinelibrary.wiley.com/doi/abs/10.1002/sej.1387. (finding that despite TrackOne eligibility not being limited to small filers, small firms with limited patent portfolios are the most likely to expedite their patent applications.)
entity filers. The Office has also launched a “pro se” art unit and expanded pro bono legal services to help under-resourced and self-represented applicants.

While these initiatives have been focused on cultivating business and socioeconomic diversity, supporting the demographic diversity of patent applicants has also emerged as a policy priority. The 2018 SUCCESS Act required the USPTO and SBA to report on patents applied for and obtained by women, minorities, and veterans, and to make recommendations on ways of increasing their participation. While it was not the first time the USPTO had specifically considered women in inventing, the Act led to a landmark report by the USPTO, Progress and Potential, that officially documented the sizable gender gap in invention. The USPTO has also pushed for passage of the IDEA Act, which would enable it to collect demographic data, on a voluntary basis, from patent applicants and inventors.

Diverse innovators often have networks that are more likely to intersect with diverse attorneys, but patent attorneys and agents suffer from the same gaps in representation as do inventors. To address them, the Office has also taken some modest steps to promote diverse attorneys. At the urging of lawmakers, the Office has started to expand the list of degrees eligible for qualifying to sit for the “patent bar,” on the theory that expanded eligibility will lead to diversified participation. The Patent Trial and Appeal Board (PTAB) of the USPTO has also

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149 The USPTO already makes it possible for older applicants to get patent examination services accelerated, through a petition to make special based on inventor age, described at Make Special - Age or Health, USPTO, https://www.uspto.gov/patents/apply/petitions/23-make-special-age-and-health. (last visited Aug. 1, 2022).
151 See MacDonald supra note _ at ~167 (describing the agency’s efforts in the late 1800s and then again in the 1900s, to identify female inventors and characterize their contributions).
152 Though it was certainly not the first to do so, see Jennifer Hunt, Jean-Philippe Garant, Hannah Herman & David J. Munroe, Why Don’t Women Patent? 3 (NAT’L BUREAU OF ECON. RESCH., Working Paper No. 17888, March 2012), https://www.nber.org/system/files/working_papers/w17888/w17888.pdf (reporting that “only 10.3% of U.S. origin patents granted in 1998 are estimated to have had at least one female inventor”).
153 Introduced and passed in the Senate as part of the Innovation and Competition Act as Sec. 6204, Collection of demographic information for patent inventors. The bill was separately introduced and passed in the House as part of the America Competes Act, https://www.law360.com/articles/1507928/idea-act-would-help-remove-barriers-to-inventor-equity?copied=1.
156 Described id.
created a program to train young lawyers, in order to promote “junior practitioners from every demographic by helping them gain court access and experience.”

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Across the various innovator-specific aspects of the patent system described above, a few themes stand out. One is that, despite the patent system being “one-size fits all,” the courts and Congress have long recognized that different types of innovators may have different needs, and sought to accommodate them doctrinally, through features like the grace period and various exceptions for universities. Another is that the design of the patent system, as administered by the Patent Office, also has a track record of addressing structural and systemic disparities through accommodations like fee discounts and regional libraries and offices. These forms of support address the gap in “invention capital” – the resources, network, know-how, and trust that are needed to succeed in invention and innovation. Together, they embody an expanded sense of patent “progress” focused on supporting and promoting a diversity of innovators in order to promote innovation.

C. Conclusion

This Part has made the innovation case for diversity, and the legal case for redefining the concept of patent progress to include the promotion of a diversity of innovators, and not just innovation. Considered in view of the patent system’s track record and the contributions of diversity to innovation, the legal proposal is modest: acknowledge the many ways in which patent policy is also people and innovator policy, and about promoting a diverse set of innovators, under an enlarged sense of “progress.” But what does an explicit focus on innovators, and not just innovation, actually mean in terms of how the law recognizes and rewards inventorship, and the processes by which patents are obtained? The next Part explores this question in the context of the “innovator-inventor” gender gap in inventing.

PART II: PROGRESS AND THE INNOVATOR-INVENTOR GAP

Given the strong case for diversity in innovation, one would expect the robust participation of a wide variety of innovators in scientific and technical endeavors. And yet, while women make up more than 50% of the workforce in the US, they only represent 27% of the STEM workforce, and 13% of inventors. Statistics on the representation of other demographic groups and veterans in inventing are not even available.

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157 The Legal Experience and Advancement Program (LEAP) provides training and oral advocacy opportunities for less experienced advocates to gain experience in proceedings before the Patent Trial and Appeal Board (PTAB), https://www.uspto.gov/sites/default/files/documents/PTABLEAPFlyer_11182021_v2.pdf.

158 Chien, Inequalities, supra note __, at 23.

159 Christnach et al., supra note ___.

to innovation to workplace policies.\textsuperscript{161}

This Part focuses narrowly on the final stage, the underrepresentation of diverse innovators, conditional upon participation in the innovative workforce, in inventing. That’s because even in workplaces that are able to hire women and underrepresented minorities to work in innovative jobs, 90\% of which are companies,\textsuperscript{162} there are substantial differences in who, among innovative workers, becomes an inventor. The underrepresentation of women and minorities, who are in many cases highly educated and employed in innovative industries, in inventing and its causes as rooted in the law and mechanics of patenting are the subject of this Part.

I begin by documenting the “innovator-inventor gap” among male v. female innovators in over two dozen settings before moving on to the laws and mechanics of inventorship to explore their contributions to this gap. 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 “applicant” factors like confidence, inventor awareness, and time pressure as well as applicant “evaluator” factors like bias and support structures on both the company and patent office sides, to these innovator-inventor.

Before proceeding, I address a few limitations of this exercise. First, though the discussion below focuses primarily on patenting by women, diversification along many other dimensions are also priorities. As is widely understood, it is insufficient to view underrepresentation through the lens of one dominant minority group. Indeed, isolation, hostility, intolerance, harassment, and pipeline problems\textsuperscript{163} likely represent more acute challenges to participation for Black, Hispanic, and LGBTQ+ innovators than some of the barriers discussed below. It is also important to acknowledge that the mere act of diversifying inventorship will not necessarily lead to “progress” in the form of more or improved innovation, generated or taken up. Many factors besides patenting influence whether a product is introduced or commercialized. In addition, given the range of ways patents are used, e.g., for defensive, assertive, or licensing purposes, the net welfare effects of any particular patent or its inventorship may be ambiguous.

But ensuring that the contributions of diverse innovators are equally visible and recognized, leading to their more equal inclusion on patents, is important for several reasons. First, the failure to put underrepresented innovators on patentable projects or to recognize their contributions represents a lost opportunity to tap into the advantages of diversity, as described in Part I. Further, systematically or even inadvertently failing to name diverse innovators on the patents to which they have satisfied the legal definition of inventorship is unfair, discouraging, and contrary to law. Talented people have less incentive to participate and more incentive to exit, when their contributions are not appreciated or recognized.\textsuperscript{164} In addition, unrecognized innovators risk losing out on the numerous benefits (e.g., pay and promotion, venture capital funding, etc.)\textsuperscript{165} associated with patenting. Even in cases where the invention belongs to the

\\textsuperscript{161} Some of which are discussed, for example, in Chien, \textit{Inequalities}, at ___.

\textsuperscript{162} See Id. and author’s analysis based on Appendix Figure 3: Patent Owner Shares by Decade (finding that less than over 90\% of patent owners are corporations, rather than nonprofits or independent inventors).


\textsuperscript{164} Kapor, supra note ___.

employer and not the inventor, 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.” The benefits of inventorship thus accumulate over the course of one’s career.

Finally, the non-participation of diverse innovators in inventing means that future innovators and the industry suffers as well, as relatable role models remain hidden or “unseen.” 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. This makes representation important for efforts to grow the field. In sum, fairness, innovation, industry, and future innovator interests are served when underrepresented groups have equal opportunities to access the benefits of inventorship, witness their inventions become innovations, and inspire future generations of innovators. As the paragraphs below argue, it is not obvious that they do.

A. The Innovator-Inventor Gap

The lower participation of women in inventing, in general, has been previously studied and documented in academia and industry. However, data at the individual company or

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).

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) See Philippe Aghion, Ufuk Akcigit, Antonin Bergeaud, Richard Blundell & David Héamous, Innovation and Top Income Inequality, 86 Rev. Econ. Stud. 1, 2 (2019) and worker retention. See https://pubsonline.informs.org/doi/abs/10.1287/mnsc.2019.3500 [cite], which finds that one additional patent granted decreases the likelihood of changing employers, on average, by 23%.

Bell, supra note ___ at 2.

This gap has been previously approximated as being “about half” in various settings and studies: Kate Gaudry & Leron Vandsburger, Across Industries, the Female inventor Rate is Half the Female Employment Rate, IPWATCHDOG (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). Companies have also reported similar gaps in their own participation. See Fatima Taha, Protecting and Progressing Gender Diversity in Innovation, VANGUARD (2022), https://www.vanguardlawmag.com/case-studies/sabra-anne-truesdale-western-digital/ (reporting industry-wide average gaps of 50%). See also Serena Hanes, Katharine Ku, Lisa Primiano and Ann M. Arvin, Gender Analysis Of Invention Dislosures And Companies Founded By Stanford University Faculty From 2000-2014 [cite], Les Nouvelles (documenting that at Stanford, 13% of male faculty versus 7% of female faculty were inventors). Accord Waverly W. Ding, Fiona Murray & Toby E. Stuart, 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, with a random sample of academics, female faculty patented at about 40% the rate of men); see also Jordana Goodman, Sy-STEM-ic Bias: An Exploration of Gender and Race Representation on University Patents, 87 BROK. L. REV. 853, 856 (2022) (documenting, within a sample, gender gaps between faculty inventors and finding male full-time professors four times as likely to patent than their female counterparts).
university level has historically been hard to come by, for a few reasons. First, while patent data is public, reliable information about the gender of inventors, and in particular inventors within certain workplaces\textsuperscript{170} is not readily available. Second, information about the technical workforce at any particular firm, much less the specific demographic traits of individual workers, is largely locked in corporate human resource systems. To circumvent these information challenges, I turned to a few sources. First, for company-level “average women inventor rates,” I relied on a report published by the USPTO in 2021, which reported this statistic among 29 top patenting firms. Next, I turned to “EEO-1” reports filed by firms with the Securities and Exchange Commission that report on the demographic characteristics of employees working in technical roles.\textsuperscript{171} Though generally not public, an increasing number of firms have started to release these data under pressure to diversify.

Though the comparison is inexact – the years of coverage are different, and variation in the way that companies report technical workers may make absolute comparisons among firms difficult – the overall message is clear, and somber: in the vast majority of settings, women are inventing at a fraction of the rate – in many cases less than 50% – at which they are employed in technical roles.

\textsuperscript{170} Doing so made more difficult by the inconsistent ways that companies can and do refer to themselves in patent ownership records, e.g. International Business Machines v. IBM v. IBM Ltd.

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 in inventorship
and innovation as articulated in Part I, the disparities remain stark across companies. Second,
although differences in inventorship also reflect pipeline effects, there is an independent gap
between who is innovating and who is being named as an inventor. And third, despite the patent
system’s worthy accommodation of those who invent independently and without
representation, most inventing is happening in companies, and with counsel, making it
important to attend to diversity gaps in such settings.

B. Why and How to Study Potential Inventors

Studying potential inventors, as opposed to established ones, is challenging for a few
reasons. First, unlike the details about inventors and applicants placed into the public record once
a patent or patent application is published, the submission and evaluation of ideas prior to patent

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172 E.g., through the pro bono and pro se services it offers to inventors that cannot afford legal counsel, described
infra at Part ____.
application happens behind closed, usually corporate, doors. As a result, much less work has been done to understand which innovators become patent applicants than, for example, which patent applicants become inventors. In addition, there is a dearth of public information about the population of potential inventors within particular firms, much less the contribution of within-firm factors like seniority, nature of technical roles, filing rate, and corporate culture to observed gaps.

And yet studying the conversion of innovators to inventors is vital, because much more of the gap in inventing results from a 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”). Gains in the diversification of STEM education have also not translated into commensurate improvements in the diversification of patenting, suggesting that more than 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 the publishing process in STEM, which shares many similarities with the patenting process, can also be instructive. So can the extensive social science literature on diversity differences and how they operate in application processes that resemble patenting. I draw upon these and related accounts below to evaluate how the regulation of inventorship under patent law and corporate practices may be contributing to a lack of progress in the diversification of inventorship.

C. Progress and The Law of Inventorship

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

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173 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.

174 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%).


177 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%).

178 As both involve, for example, the submission and evaluation of ideas and naming of collaborators.
reach necessary to reflect the broad scope of constitutional principles.”

The law requires two things: a natural person, and conception by that natural person 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.” “Conception is ‘the touchstone of inventorship,’ and each joint inventor must generally contribute to the conception of the invention” in order to be an inventor. 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.”

As described in Part I.B., slaves, foreigners and married women were limited in their ability to be named as inventors for much of the first century of the patent system. But while many earlier restrictions have fallen away, the hierarchical nature of inventorship – which separates “conceptualizer-inventors” from non-inventor contributors – has remained. Because while an inventor is someone who forms a definite and permanent idea of an invention, an inventor is not someone who, without more, reduces an invention to practice by exercising ordinary skill, performing experiments, or adding important but obvious elements to the invention. As such, the law excludes from inventorship parties who have put in valuable time, resources, and even ingenuity to realize an invention. Yet the iterative nature of innovation means that power dynamics and traditionally gendered roles may color the determination.

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. 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, to the “giving” of their ideas to male relatives, to the outright appropriation of their inventive work by men. The distinction between these scenarios is often not clear.

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185 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)).
186 Described in Chien, *Inequalities*, supra note ___ at fn 245.
188 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).
For example, 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*. According to a follow-up report in *Science*, three of the other researchers believed she had incorrectly been left off the patent. 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, and Chou’s name now appears on the patent. 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. 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. Using detailed administrative records, their study was able to control for position, seniority, and other factors that might plausibly explain differences in 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. The researchers speculated that much of the gap existed because the contributions of women were “often not known, not appreciated or ignored.”

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. Another report, based on analyzing hundreds of patent-paper pairs involving authors that were left off of related patents, found junior co-authors at greater risk of being excluded from inventorship, even after controlling for other factors. 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

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190 Id.
194 Id.
196 Id.

Electronic copy available at: https://ssrn.com/abstract=4213799
reflected funding-related power dynamics. 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 contributors to corporate inventions continues to be a sore point, arising recently in high-profile cases involving the exclusion of government researchers on COVID19 vaccines and medicines.

These cases underscore that in comparison to authorship, which is generally viewed as more flexible and inclusive, inventorship is a rigid concept and can be exclusionary in practice. In combination with men’s documented tendency to overstate and women’s documented tendency to understate their contributions, those within the lower ranks within an organization have a greater risk of being relegated to a non-inventing, fungible “pair of hands.”

While this article calls for redefining progress, it stops short of calling for inventorship to be redefined as a more flexible concept, like authorship. A more rigid but consistently implemented standard is less likely to fall prey to the well-documented challenges of authorship, including favoritism, questionable gift practices, and abuses of power. But it is worth considering ways that patent law can discourage the omission of inventors, intentional or inadvertent.

Under current Patent Office regulations, the Director of the USPTO has the ability to correct inventorship on a patent when “through error” a person is named or not named as an inventor on a patent. Yet, following the passage of the AIA, the burden is much lighter than it once was as the law eliminated the requirement that the omission “arose without any deceptive intention on [the inventor’s] part.” This means not only that the burden of proving errors in


201 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 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.

202 Among many examples, see, e.g. Meika Berlan, Jessica Milli, Emma Williams-Baron, Jeny Xia & Barbara Gault, 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.”)

203 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.)

204 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 201.035 U.S.C. § 256(b) specifies that correction is available any time after a patent is issued, even during its litigation.

205 See redline of 35 U.S.C. 256(a), https://www.bitlaw.com/source/35uscaia_redline/256.html (showing “and such error arose without any deceptive intention on his part”)
inventorship by clear and convincing evidence rests on a patent challenger.\textsuperscript{206} but that the patentee might still nevertheless be able to cure the error, even when asserting the patent, and potentially without having to show good faith.\textsuperscript{207}

While the intent of the legislative change was to reduce litigation burdens by focusing on “objective” facts rather than “subjective intent,”\textsuperscript{208} it has the potential to diminish the incentive to get inventorship right at the outset. Given the leeway the USPTO and courts have in interpreting the revised rule, it makes sense to shore up incentives for correct inventorship and the inclusion of all inventors. For example, safeguards put into place to ensure women and underrepresented minorities are neither inadvertently left off patents nor that their contributions remain “not known, not appreciated or ignored,” should be viewed favorably in correction of inventorship requests, whether evaluated by the courts or the USPTO.

D. Progress and the Mechanics of Inventorship

Satisfying the legal requirements of inventorship does not automatically make someone an inventor. In contrast to authorship, which vests upon the creation of protectable works immediately,\textsuperscript{209} inventorship requires one to apply for patents. Below, I discuss how the mechanics and costs of doing so have slowed progress in the diversification of inventorship.

Although the details vary by setting, to become an inventor, one must generally start by self-identifying as a potential inventor and submitting one’s inventive idea. (See Fig __: “Idea Submission”). 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.\textsuperscript{210} The process is generally voluntary and initiated by the innovator.\textsuperscript{211} (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.\textsuperscript{212} (See Fig __: “Patent Grant”)

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\textsuperscript{206} Hess v. Advanced Cardiovascular Sys. Inc., 106 F.3d 976, 980 (Fed. Cir. 1997).


\textsuperscript{208} 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.

\textsuperscript{209} Under the terms of the Berne convention.


\textsuperscript{211} Cf. Hall, supra note __, at 1 (describing a mean filing rate, within universities, of 60%) with Michelle R. Henry, Mildred K. Cho, Meredith A. Weaver & Jon F. Merz, 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%).

Among accounts of the experiences of potential inventors a few stand out. One is 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. Since 2019 the IPO has maintained a diversity in invention “toolkit” based on consultations with its members, that describes practices for encouraging greater participation in invention. (“IPO Toolkit”). In 2020, Santa Clara University’s High-Tech Law Institute, in conjunction with the USPTO regional offices, held roundtable sessions with in-house counsel and attorneys to discuss “best practices” for increasing diversity in invention and innovation. Their resulting guide (“Best Practices Guide”) represents “the collective wisdom of 73 Intellectual Property professionals and attorneys from the United States’ leading companies.”

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.

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 innovator faces a specific obstacle to participation at any particular milestone may be small, the cumulative effect of these disparities contributes to the sizable innovator-inventor gap.

1. Barriers To Idea Submission

As described above, the invention process generally starts with an innovator devising and submitting 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, the differences in inventorship identity and (mis)perceptions of what is required in terms of confidence and time, described below, span the settings of innovation.

   a) Inventorship Identity & Familiarity with Patenting

To submit an “invention disclosure” requires a person to, consciously or not, see themselves as a potential “inventor.” But while the same legal standard applies to all, the relatability and desirability of being an “inventor” differs across demographic groups. One of the
top findings of the Best Practices Guide is that the construction of “inventorship” may be alienating, unwelcoming, and intimidating to diverse innovators. As the 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.”

In-house counsel at IBM has described that even in his company, which has for decades been the most prolific patentee, “often demographic groups express the...feeling that ‘if I thought of it, it can’t really be innovative.’” 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.” 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.” 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 of service and collaboration. One observation of a recent 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 Black innovators. The IPO Toolkit describes a related desire of diverse employees not to stand out as an obstacle to participation. The requirements and rewards of inventing, and sense of alignment with the title of “inventor,” even within a single firm, are not necessarily equally appreciated and may be transmitted by word of mouth and through informal networks. When there is a lack of mentoring or support, for example through affinity groups, the advantages of dominant groups are intensified.

b) Confidence

With as few as 20% of idea submissions or less proceeding to the patent application stage, and not all patent applications turning into patents, “failure is an intrinsic part of the invention process.” As such, submission of an idea requires some sense that one’s idea is...
worthy and will be well-received. Numerous studies have observed the presence of a “confidence gap” between men and women. Kay and her co-authors have documented how, compared to women, men tend to overestimate their abilities and are more likely to consider themselves ready for promotions.\footnote{Katty Kay & Claire Shipman, The Confidence Gap, ATLANTIC (May 2014), https://www.theatlantic.com/magazine/archive/2014/05/the-confidence-gap/359815/} For example, 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.\footnote{Id.} 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.”\footnote{Id.} Whether the gap is because of men’s overconfidence\footnote{Among many examples, see, e.g. Meika Berlan, Jessica Milli, Emma Williams-Baron, Jenny Xia & Barbara Gault, 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)} and greater tendency to self-promote,\footnote{Described in 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.} or women’s underconfidence or aversion to “tooting one’s horn” is in the eye of the beholder. The requirements aren’t always clear: like research on the gender gap in STEM attribution by Ross and co-authors cited earlier, the IPO Toolkit identifies opaque standards for invention and attribution as one culprit. 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.\footnote{AUTM, supra note __ at 68.}

An extensive literature has also documented a gender “competitiveness gap” that stems from differences in risk preferences and personality.\footnote{IPO Toolkit, supra note __ at 50.} 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.\footnote{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).} 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.’”\footnote{IPO Toolkit, supra note __ at 39.} 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.”\footnote{Angela Morris, Western Digital Uncovered “Root Causes” of Female Innovator Under-Representation, says IP Chief, IAM, (June 2022).} This suggests that the confidence gap observed in employment settings may extend to invention disclosure.

The idea that a lack of confidence in one’s idea is inhibiting female participation in invention and innovation is not new. In a comprehensive study 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.\(^\text{235}\)

This observation underscores that patenting cannot be divorced from social contexts. Conversely, building women’s confidence and helping them overcome perfectionism, through 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.

c) Time

Another discrete challenge to participation in invention is the time that it requires. The AUTM initiative found one reason female faculty invented less was because of their reluctance to take on additional time commitments in light of the multiple roles they may juggle in addition to work, such as caring for children or elderly parents.\(^\text{236}\) The Best Practices Guide reported a similar finding.\(^\text{237}\) Female academic scientists have also cited work and family balance issues as the most significant challenges they face.\(^\text{238}\)

Validating their concerns, studies have documented the career and earning penalties women in the workforce face as a result of their more intensive domestic burden on average, even accounting for increases in the time spent by men in domestic work.\(^\text{239}\) For example, nearly half of new mothers leave full-time STEM employment, compared to only one-quarter of new fathers.\(^\text{240}\)

Again, the observation that women don’t necessarily have the time to invent, even when they have potentially patent-worthy ideas, is not original. In the late 1800s book *Think and Act*, based on interviews with manufacturers and women innovators, the author found that although women often came up with ingenious solutions to solve their own problems, the time needed to turn these ideas into inventions was lacking. “Women were so bogged down with household

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\(^{235}\) As described in *MACDONALD*, *supra* note ___ at 392.
\(^{236}\) AUTM, *supra* note ___ at 68.
\(^{238}\) Milli et al., *supra* at note ___.
\(^{240}\) *Id.* Cech & Blair-Loy, Among those who left scientific positions, 71% of female parents cited reasons for departing STEM fields due to “family-related” matters compared to 5% of childless women, holding race, age, and education level constant.
responsibilities that they had scant time to devote” to inventive projects. The risk is that innovations women develop will be under-promoted, under-commercialized, and under-disseminated.

2. Barriers to Patent Application and Grants

a) Outside Firms: A Lack of Invention Capital

Though the previous paragraphs have focused on patenting within large companies, the challenges for diverse innovators are arguably even more acute outside of such settings. A general lack of resources, role models, trusted mentors, and knowledge of the value of innovation – or, in so many words, “invention capital” – 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.

For example, independent inventors, regardless of demographic background or geographic location, often lack access to affordably-priced, ethical lawyers. The problem of unscrupulous “invention marketing companies” that promise much in exchange for hefty fees, but provide little, in the way of promised patenting and commercialization services, has attracted the attention of Congress and the Federal Trade Commission. The USPTO accepts and publicly reports complaints about invention marketing companies.

Janeya Griffin has polled Black scientists and engineers, finding that the majority of those surveyed stated that they only learned about patents and their value “in graduate school or after starting their careers.” 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.

Trusted, affordable, and diverse counsel are an important conduit to the patent system. But the problems of women and underrepresented groups finding attorneys that look like them has been widely acknowledged.

b) Inside Firms: Potential Challenges in Take-Up

Fig. ___: The Stages of Inventorship


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.

241 As described in MacDonalD, supra note ___ at 60.
242 Defined in Chien, Inequalities, supra note ___, at Part II.
244 Summarized, along with dozens of the complaints received by the USPTO, at Invention Marketing Companies: Are They For Real?, Brown & Michaels, PC (2020), https://www.bpmlegal.com/content/pinvmktg#aipa.
246 Bell et al, supra note __, at 2.
247 Chien, Inequalities, supra note __, at Part II.__.
based on the idea. Filing a patent is not a trivial commitment, typically costing $10,000—20,000 per patent specification,248 and budgets are limited, making for a selective process. 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.249 This process will generally repeat itself several times before grant, but at each phase, the patent applicant has the opportunity to either abandon the application or advance it.

The decision to file and move forward (or not) on an application is generally 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 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.”250 Numerous authors have discussed the historical phenomenon of “masking” one’s inventorship to increase the odds of patenting and commercial success.251 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,252 as well as gender bias and stereotyping along the innovation pipeline.253

As far as I am aware, there have been no 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 minorities.254 The finding that novel ideas in innovation are less likely to be favorably received when presented by underrepresented innovators has 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.255 The IPO Toolkit also recommends training to remove unconscious biases as well as ensuring diversity on the committee of reviewers.256 But bias can

249 For a description of the process, see Aneja et al., supra note __ at 4.
250 MacDONALD, supra note __ at ~35.
251 See Kara W. Swanson, Centering Black Women Inventors: Passing and the Patent Archive, 25 Stan. Tech. L. Rev. 305, ___ (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.)
253 Reviewed, e.g. in Aneja et al., supra note __ at 2.
254 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).
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”**

   **a) Potential Bias in the Evaluation of Patent Applications**

   After a patent application is submitted, the likelihood of its becoming a granted patent has historically reflected, to a degree, the demographic profile of its inventor(s). Applications by female inventors are less likely to be granted and otherwise fare worse, on average, than applications by male inventors. Minority inventors also do worse, as do small 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.”

   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 decision 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.

   Controlling – to the extent possible – for all other variables, studies have considered the extent to which success is correlated with traits of the inventor first named. Inventors with female names fare worse than male names, controlling for a wide variety of factors. In particular, inventors with highly feminine names were less likely to have their patents granted than those with female, but androgyous sounding names. These differences, the researchers found, were consistent with implicit bias on the Patent Office side. On the applicant side, workplace interactions made gender inferences from names alone less likely.

   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 an applicant for a position as a lab manager based on identical application materials – half labeled with a male applicant’s name and half with a female


   **258** Schuster et al., *supra note __*.


   **260** Depending on the technology, the combined fees to the attorney and patent office combined for responding to an office action, are around 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/.)

   **261** 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.

   **262** 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
name. The female applicants were rated as less competent by a majority of reviewers, even though the application materials, other than the names, were identical. This rating gap was observed even when the reviewers themselves were women.263

b) Holding Back and Responses to Rejection

Another contributor to lower success rates may be gendered responses, not by evaluators in giving rejections, but by applicants in responding to rejections.264 Building upon an existing literature about how men and women respond differently to rejection,265 a study by Abhay Aneja and his 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.”266 Diving 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 the 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.267

These insights provide empirical support for the commonsense recommendations of the Best Practices Guide. 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.”268 Akin to the institutional support referred to in the Aneja study, the burdens are shifted to the third parties, who can then advocate for the invention. The Guide further recommends taking measures to address the “‘black box’” nature of patent go/no-go decisions to advance diversity.269 It recommends providing greater transparency, and substantive feedback,270 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 differently.271

264 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.
265 Aneja et al., supra note __, at 2–3.
266 Id. at 5.
267 Id. at 5.
268 Id. at 5.
269 Id.
270 Id.
271 Gauri Kartini Shastry, Olga Shurchkov, Lingjun Lotus Xia, 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.)
E. Conclusion

The accounts above provide a view into the complex series of events that line the path from being an innovator to becoming an inventor. While Part I of this Article discussed discounts to address the out-of-pocket costs of patenting, the paragraphs above highlight the additional non-economic costs - informational, psychological, and time - associated with inventorship. Such costs have largely been out of the view of patent policymakers and the public, especially those that involve decisions before the point of application. But to take “progress” in the diversification of inventorship seriously, engagement on the “workplace” front of inventorship is just as important as engagement on the “Patent Office” front.

Although each of the stages of patenting has its own unique hurdles, there are a few common threads. First, heightened censorship on both the part of the “evaluator” and the innovator, are important to consider. Company evaluators may disproportionately decline to extend inventorship to innovators that lack power, standing or knowledge of the importance of patenting, or have a tendency to pass on submitted ideas. Patent Office evaluators may be unconsciously biased when evaluating female inventors. But diverse innovators may also disproportionately decline --- to submit an idea, apply for a patent, or persist in the face of rejection. In the next part I discuss ways of testing interventions to address these diversity differences.

PART III: MAKING AND MEASURING 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 just-passed CHIPS and Science Act directs billions of dollars into boosting regional innovative capacity as well as the participation of women and underrepresented minorities in innovation. The USPTO is developing a strategy for “encouraging, empowering, and supporting all future innovators.” More than 50 companies, law firms, and others, including some of the largest patent filers, have publicly signed onto a “diversity pledge” to take action to narrow within-firm inventor diversity gaps. These developments make it an opportune time to focus not just on any single fix or set of fixes, but the more general infrastructure for making progress. Below I discuss three ideas for doing so: (1) strengthening and institutionalizing the USPTO’s commitment to progress in diversifying

272 CHIPS and Science Act, supra note 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)).
273 As described in Part I. Agencies across the U.S. government, many of them large patent filers, have also made commitments to diversity in innovation, as described at https://www.whitehouse.gov/ostp/news-updates/2022/04/14/the-white-house-office-of-science-and-technology-equity-action-plan/.
innovators and inventors; (2) creating a public-private innovator diversity pilots clearinghouse, and (3) launch a periodic innovator-inventor survey to probe the evolving experiences, motivations, and needs of a diversity of innovators and inventors over time.

A. Institutionalizing and Strengthening the PTO’s Commitment to Promoting a Diversity of Innovators

The USPTO’s responsibility to support a broad range of innovators is encoded in several parts of the Patent Act. First, the agency is statutorily required to include a diversity of innovator views on the public advisory committees that advise it. Not less than a quarter of the members of each of the USPTO’s patent and trademark advisory committees must be from “small business concerns, independent inventors, and nonprofit organizations,” and at least one member must be an independent inventor.275 One of the agency’s specifically enumerated powers is also to make regulations that “recognize the public interest in continuing to safeguard broad access to the United States patent system,”276 which is expressly specified “through the reduced fee structure for small entities.” The agency also has the power to open satellite offices to cultivate the geographic diversity of patent filers.277 The Patent Act also contains a provision that states, as a policy of Congress, that the patent system be used to “encourage maximum participation of small business firms in federally supported research and development efforts; to promote collaboration between commercial concerns and nonprofit organizations, including universities.”278

But broadening the PTO’s powers in a few ways would further institutionalize and strengthen the agency’s ability to promote a diverse set of inventors and innovators. First, the agency should be granted explicit authority to collect demographic and related information about inventors and applicants, as contemplated by the IDEA Act.279 As it stands, the USPTO does not definitively know the gender, race, or veteran status of its applicants. The available classifiers for estimating certain demographic traits have well-recognized weaknesses, for example, with respect to predicting non-binary gender and identifying Black inventors. Giving the agency the explicit authority to collect demographic information would allow the Office to better understand the needs of diverse inventors and innovators, as well as to publicize information about their participation in patenting in the aggregate. It would allow for it to keep sensitive demographic data confidential and separate from FOIA requirements, while still enabling aggregate reporting.280 It could also lead to the creation of a “walled garden” protecting sensitive data, to which only approved researchers would have access, following the model offered under the

277 35 U.S.C. 1 (b).
279 IDEA Act, supra note ___ at Sec. 6204 (a).
280 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.
Federal Statistical Research Data Centers infrastructure.\textsuperscript{281} “Progress” in innovators would also be served by enabling the agency to collect demographic data about owner assignees, and their demographic (e.g., minority or women-owned) as well as business-model (e.g., startup or university) profiles. This would enable it to monitor the impact of efforts like expanding the eligibility criteria.\textsuperscript{282} Such data could also potentially help support independent transparency-based initiatives to diversify the practice of patent prosecution.

It would also be worth considering whether the agency’s ability to promote innovators, and not just inventors, should be codified and perhaps expanded. The agency’s recent forays into promoting inclusive innovation, which aims to provide “increased access to the innovation ecosystem,”\textsuperscript{283} reflect its growing appreciation of an enlarged sense of progress. But providing explicit statutory authority could also foster more deliberate consideration of how to support those who devise unpatented innovations that are the subject of defensive publications, abandoned applications, or works dedicated to the public, but whose inventors can also benefit from a proper attribution of credit. Broadened authority might also make it easier for the Office, which is entirely user fee-funded, to receive appropriations and to engage in activities like an innovator-inventor survey, briefly described below.

In the meantime, there are numerous steps the agency can take within its existing authority to promote a diversity of inventors and innovators. In related work, I have recommended that the USPTO institutionalize its commitment to equity in the patent system by promoting equity metrics and creating an Independent Office of the Small Inventor.\textsuperscript{284} Below I build on these ideas and discuss what promoting progress, redefined, in carrying out the PTO’s basic functions might look like.

1. Promoting “Progress” in Patent Examination and Education

The USPTO’s primary responsibility is to examine and grant patents and register trademarks. To make progress in the diversification of inventors, the Office should commit to addressing the “patent grant gap” to ensure that the playing field is level for the women, small entities, and first-time applicants that, at present, disproportionately do not succeed in their applications.\textsuperscript{285} Steps like the agency’s \textit{pro se} program are a good start. However, more will be required to understand the share of the grant gap that arises from patent-, as opposed to firm-, specific factors. Additionally, the Office could investigate and correct potential implicit name

\textsuperscript{281} Through which approved researchers, on approved projects, can access restricted-use microdata from a variety of statistical agencies to address research questions. Described at https://www.census.gov/about/adrm/fsrdc/about/available_data.html

\textsuperscript{282} As described in Part IB.

\textsuperscript{283} \textit{About the Council for Inclusive Innovation, supra} note __ (https://www.uspto.gov/initiatives/equity/ci2/about); USPTO, (stating that the council will “develop a comprehensive, lifelong approach that spurs interest in innovation and inventing, and then provides for increased access to the innovation ecosystem”).

\textsuperscript{284} Chien, \textit{Inequalities, supra} note __, at Part III.

\textsuperscript{285} As described in Part II.C.3.A.
bias and work to make patent assistance available to under-resourced inventors.286 As the USPTO carries out innovator education, it also should continue to attend to gaps in awareness and uptake before the point of application, as well as gaps in the impact of patents, through citation, maintenance, and licensing;287 after the point of issuance. A periodic inventor-innovator survey, as described below, could help the agency better understand where gaps exist and how to address them.

2. Promoting “Progress” in the Dissemination of Information and Metrics about Inventors and Innovators

The second of the USPTO’s duties is to disseminate information about patents and trademarks to the public.288 But in contrast to metrics of invention, which the USPTO reports regularly,289 metrics of innovators and inventors are not regularly collected.290 In the spirit of measuring progress to make it, the USPTO should consider tracking and regularly reporting on metrics concerning applicants. 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. Reporting on the extent to which 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. The ability to report data by applicant demographic profile of course depends on the agency’s ability to collect such data.291

In order to understand the socio-economic outcomes of patenting, the Office should develop datasets on the economic profiles of patent applicants and recipients.292 Its capacity to access individual-level data of the kind offered by the Census or the IRS should be improved considerably if the agency gains CIPSEA “Confidential Information Protection and Statistical Efficiency Act” status, similar to a statistical agency.293

286 Suggestions for how to do so are described in Chien, Rigorous Policy Pilots the USPTO Could Try, supra note __, Part IV.
287 Studies suggest that the patents of women are cited, maintained, and commercialized less, as described in Part II.
289 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.
290 The PAR does include identify patent filers by country of origin and payment tier. Id.
291 The IDEA Act specifically contemplates the reporting of aggregate filing and related trends by demographic group. IDEA Act, supra note __
293 However, as of this writing, the Office of Management and Budget has not promulgated guidance on how it can do so.
3. Promoting “Progress” by Piloting Openly, Launching a Patricia Bath Diversity Scholars Program

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. The diversity interventions pursued by the USPTO thus far, like providing extra support to inexperienced filers, supporting diverse technical employees through affinity groups, and providing flexible work options, 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, the impact of policies such as the first-to-file system and fee discounts (Box 1), the opening of regional offices, and the relaxation of patent bar requirements have not been the subject of rigorous evaluation and study. They should be. To evaluate such information, the Office could launch a Diversity Scholars Program named after a diverse innovator, such as Patricia Bath. Such a program would invite researchers to propose and work on diversity projects. Following the example of other agencies, the USPTO could also solicit proposals for research to help the agency understand how its policies have reached underrepresented communities and innovators. With a highly trained technical workforce, the Patent Office itself may be able to offer insights into how to attract and retain a diverse set of technical workers, for example, by studying its own long-standing experiences with telework.

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

294 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.


296 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).

297 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.)

298 This would be similar to the Edison Visiting Scholars program the Office already hosts; described at Edison Visiting Scholar Program, USPTO (Jul. 22, 2022), https://www.uspto.gov/ip-policy/economic-research/edison-visiting-scholar-program.

299 See the Dept. of Labor’s program to do just this, in the context of labor programs, as described in Alexander Hertel-Fernandez, We’re Using Data to Better Understand Our Work and Create More Equitable Programs and Policies, U.S. Dep’t Lab. Blog (Feb, 2022), https://blog.dol.gov/2022/02/10/were-using-data-to-better-understand-our-work-and-create-more-equitable-program-s-and-policies.
Every year, 8,000 or so patents are issued that include a U.S. government owner or interest. 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.

**B. An Innovator Diversity Pilots Clearinghouse**

Numerous suggestions for making progress have been proposed and adopted, whether by Congress, the PTO, or companies. But determining whether reforms are effective is not easy. Policymakers may not know which reforms are likely to be effective, their cost, and how much progress they should realistically expect. Those charged with enacting these programs may lack the mandate to determine their effectiveness or share them more broadly. Those with the ability and motivation to evaluate, on the other hand, may not have access to the downstream 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 mentoring practices within companies are at risk of remaining largely unknown, hampering the path to progress.

A public-private “Innovator Diversity Pilots Clearinghouse” could address these gaps and supporting 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 – 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. 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 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,

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300 35 USC § 2A(9).
including research on diversity, equity, and inclusion in the technology sector.\textsuperscript{304}

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.\textsuperscript{305} 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.\textsuperscript{306} 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.\textsuperscript{307} 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.\textsuperscript{308}

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.\textsuperscript{__}) 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)

\textsuperscript{304} CHIPS and Science Act, supra note __ at Title III, Subtitle C (“Broadening Participation”) and Sec. 10326, Diversity in Tech Research.


\textsuperscript{306} Id. at 8.

\textsuperscript{307} 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).

\textsuperscript{308} 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. To advance its policy objectives, the federal government has supported clearinghouses in areas ranging from education and civic engagement, to family and child welfare programs. In the last year, for example, the White House launched a clearinghouse to support school reopenings across the country via Executive Order, and a best practices guide to diversity and inclusion in the federal STEM workforce. 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

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practices supported by “strong” evidence with those supported by “promising” or no evidence). As such, clearinghouses not only support the sharing of both operational (“how-to”) and evaluation (“does it work”) information across firm and sector boundaries, but also the measurement of success. Below I discuss a few other gaps an innovator diversity clearinghouse could address.

1. Supporting Data Disclosure and the Tracking of Progress

Though this Article has made the case for redefining “progress,” much of the data needed to make meaningful comparisons is not readily available. 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 can work to facilitate and standardize data access protocols with respect to data shared within companies as well as beyond them. For example, the community around a clearinghouse could provide input on how to regularize reporting of technical worker statistics through the EEOC-1 reporting process. It could also help advise the Security and Exchange Commission’s development of human capital reporting requirements. The establishment of a National Secure Data Service (NDSS) under the recently passed CHIPS and Science Act of 2022 will likely create additional opportunities. Supporting safe, privacy-respecting ways to share “locked up” data should also be a priority.

2. Supporting Implementation for Rigorous Evaluation

A second challenge with gauging the “impact” of diversity interventions is the need to specify a control group to whom the treated group can be compared. The gold standard is the 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

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314 IES, supra note ___; Soydan, supra note ___.
315 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.
316 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, Berk A. Sensoy, Joshua T. White, White, Human Capital Disclosure, Vand. Owen Grad. Sch. Mgmt. 1, 2 (Jan 11, 2022), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3991257#.

Electronic copy available at: https://ssrn.com/abstract=4213799
the outcomes of the remaining participants (the “control” group). In its examination of over half a million patents filed each year, the USPTO is well-positioned to randomize any number of variety of interventions and should do so where practicable and ethical. Companies should also consider working with academics or other evaluators to carry out rigorous trials using standard hypothesis testing approaches. Building capacity within firms and in the public sector to implement for evaluation could be another contribution of a Diversity Pilots Clearinghouse.

But even in the absence of randomization, public and private actors can be forthcoming about what they do and implement “quasi-experimental” evaluation, such as staging rollouts or using cutoffs to facilitate evaluation. When the USPTO makes a decision, for example, to open regional facilities, it can reveal not only the locations it did choose, but the locations that it didn’t choose, on the theory that they closely resemble the chosen locations and can form a control group. Developing standards for the documentation and disclosure of details about diversity interventions would also be a worthwhile task for a Diversity Pilots Clearinghouse.

3. Fostering Collaboration and Partnerships Through Transparency

A clearinghouse can also foster research partnerships and learning across disciplines and organizations. Innovator and inventor diversity problems are complex. 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.

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.

4. Proposing Pilots

A diversity pilots clearinghouse could also foster collaboration in designing and implementing pilots. Such pilot partnerships could form around common potential obstacles to progress. For example, the possibility of bias in evaluation, in both firm and Patent Office

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319 For example, in the case of oversubscription to a service for which there is limited capacity, as described in Chien, Rigorous Policy Pilots the USPTO Could Try, supra note ____.
320 As described in Chien, Rigorous Policy Pilots, supra note ____.
321 As suggested by Lisa Cook, supra note ___, at 15.
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. Experiments could be used to test the hypothesized mechanisms. 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.  

C. Surveying Diverse Innovators and Inventors

A final 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. 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, and even less is known about the relationship between them. Conducting a survey that specifically compares the experiences of the two groups can help ensure that policies to support all innovators are not inadvertently skewed towards much-studied inventors. Specific questions of interest could pertain to awareness and accessibility of government supports and programs as well as initiatives geared at new or under-resourced innovators.

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. In an online resource, I provide a list of previous relevant inventor and innovator surveys, namely the PatValEU and Community Innovation surveys of Europe, and where available, the survey  

322 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, 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.

323 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.

324 Available at https://drive.google.com/drive/folders/1M5bBZmcfLM3G4mvuUDA4qV0LlThlvz?usp=sharing.


instruments from them, to provide the starting point for further exploration of a survey.

While the PTO, as well as the scientific agencies that fund R&D, would be natural partners in an innovator-inventor survey due to their direct contacts with the relevant populations, 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.327

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.328 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: through the unique knowledge, approaches and motivation (novelty), as well as the unique combinations, conflict, and numerosity they bring to innovative processes. But it has also done so based 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 technical workforce. Focusing on the innovator-inventor gap can elucidate the obstacles to participation – including bias, power dynamics, time pressure, confidence levels and perfectionism, and differential responses to rejection. Interventions to address them deserve the same rigorous analysis and evaluation. Where successful, they should be elevated through a regular innovator-inventor survey, diversity pilots clearinghouse, and the enhanced ability of the USPTO to support progress, redefined.

328 Described at PatVal-EU, supra note __.