The Innovator-Inventor Gap: Evidence from Engineers*

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ABSTRACT

We study intellectual property (IP) development by surveying engineers from high-tech firms and interviewing patent professionals, focusing on under-represented groups (URGs). We document the opt-in, competitive nature of inventing within firms: only a third of respondents submitted an idea, with half advancing to patent application, a drop-off that we validate with company invention databases. Despite similar training, women, though not under-represented minorities, are disadvantaged across the stages of invention. Next, we offer guidance on factors contributing to the innovator-inventor gap. While the inventor's identity and internal disclosure processes are important, the top three factors are even-handed management practices (e.g., project assignment), balance between extrinsic and intrinsic motivation, and corporate culture. Consequently, we discuss strategies for inclusive innovation and maximizing R&D returns.

JEL classification: O31, O32, O34, M14, M53

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Innovation and technological change are critical to economic growth (Schumpeter, 1942; Aghion and Howitt, 1992), and even successful firms need to innovate to ensure that their products and services will not get displaced by the next disruptive technology (Teece, 1986; Christensen, 1997). Researchers have long relied upon patent applications and research expenditures to study the invention process within firms as markers of success (Lerner and Seru, 2022), and on inventor records as a proxy for understanding and tracking talent flows (Kerr et al., 2016). However, because innovator activity before the point of patent filing is not readily observable from outside the firm, little is known empirically about the dynamics and decisions that lead to a patent application being filed or not.

Is the process from innovation to invention disclosure uniform across inventors and firms? If not, which factors help facilitate involvement in the process, and which factors work against it? Are these factors different for engineers from under-represented groups (URGs[1])? On the one hand, studies show that wealth, ethnicity, gender, and proximity to innovative companies play significant roles in one's likelihood of becoming an inventor (Bell et al., 2019). It is also the case that the "invention capital," stemming from networks and shared tacit knowledge needed to invent, is not equally available to all demographics (Chien, 2022). Yet, once diverse engineers join an innovative company, it is possible that inventive parity could be achieved within the company. If inventive parity does not hold and engineers from URGs remain underrepresented as named inventors on patents, it is important to explain why this "innovator-inventor" gap exists (Martinez et al., 2016; Chien, 2024).

Our research seeks to make progress in understanding the potential "innovator-inventor" gap by investigating the research and development (R&D) process *before* the filing of a patent through a detailed survey of 3,989 engineers at five high-technology firms and in-depth interviews with thirteen patent professionals. Importantly, this sample includes many engineers who self-identify as members of URGs.[2] The firms were surveyed sequentially, with 75% of responses coming from

[1]In the context of inventors, this is defined as a gender that is not male or an ethnicity that is not white and not Asian.

[2]In our survey, 77% self-identify as male, 22% as female, and 0.5% as non-binary, closely mirroring broader industry demographics, while ethnic composition varies geographically—dominantly Asian (77%) globally

a survey sent to all engineers at the first firm and the remaining sent to small but representative samples of engineers at the other four firms.[3] Beyond the core questions, the surveys varied by firm, leading to an unequal number of respondents to each question. The interviews with patent professionals helped ensure we covered relevant features of the invention process.

Our study began by talking to patent professionals across various high-tech firms to investigate variations in the innovation to invention process. These interviews uncovered meaningful variations both in how an idea is collected from engineers and technical staff and how an idea is reviewed and selected for intellectual property (IP) protection, a costly endeavor. During our interviews, patent professionals also expressed that they believed that some ideas worthy of IP protection were not getting submitted as invention disclosures due to factors like perfectionism or lack of time. They also discussed strategies to convert early ideas into fully developed invention disclosures. As illustrated in Figure 1, we use these insights to build a stylized depiction of the innovation to invention process within firms as a highly competitive, opt-in process in which only certain ideas are submitted for consideration, and certain submitted ideas advance to be filed for a patent application.

Another important insight to emerge from our interviews is the notion that converting R&D investments into IP protection is not only competitive but far more nuanced and fraught with friction than traditional models of invention acknowledge. This warrants carefully accounting for the various external and internal frictions in the innovation to invention process beyond just the technical learning undertaken by engineers or the acknowledgement that there are multiple steps to go from invention to development to commercialization. Models could explicitly consider the effects of culture, managerial practices, and the patent review process on R&D outcomes. For instance, a more conservative patent review board may require more substantial evidence of an

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but balanced between white and Asian (45% each) within the U.S., which accounts for 33% of respondents. Professionally, the modal respondent is on an engineering team, has been at their current firm 7 years, is 41 years old and partnered (splitting work equally with their partner), and follows a hybrid work schedule.

[3] Considering that the sampled firms share significant technological similarities, it's important to note that differences in technology are not the underlying cause of the variation in the invention process. The sampled firms are similar to and diverge from the average public patenting firm on other observable dimensions. For instance, our sampled firms generate six times more revenue, have two times more employees, 16 times more R&D expenditures, and 17 times more patents, but they are similar to the average public patenting firms in terms of profitability, Tobin's Q, patent value, and patent citation patterns (Kogan et al., 2019).

idea's potential inventive merits, leading to more original patents that are easier to develop into commercially viable products and services that garner greater private value.

We provide one such stylized model, which presents an approach for a systematic way of thinking about going from innovation to invention despite being a very nuanced idea. Specifically, we combine key ideas from the interviews into a model of how engineers optimally allocate time and effort to inventive tasks. To keep the model parsimonious, we focus only on two costs: (i) acquiring invention capital and (ii) reducing the uncertainty surrounding patent-worthiness. The cost of acquiring "invention capital" can be higher for diverse engineers, leading to less effort toward inventive tasks. Crucially, our model also emphasizes the relationship between effort and the increasing probability of success with more effort. Consider early-stage exclusionary practices such as not including diverse engineers on projects likely to yield patents or providing inadequate feedback on their early-stage ideas; these practices increase the cost of reducing the uncertainty surrounding the patent-worthiness of an inventive idea. This has a compounding influence, potentially leading diverse inventors to rationally reduce the amount of effort they allocate toward inventive tasks due to the reduced ability to gauge success accurately.

To assess the model's merits and help determine where along the inventive path diverse engineers may withdraw, we turn to our survey data, which provides several insights. First, the survey data brings clarity to the seemingly black-box IP process, revealing that it is best described as a competitive, opt-in one that resembles other contexts where URGs are underrepresented (He et al., 2021). Participation is meaningfully reduced at each stage in the innovation to invention path. While more than half of innovators have had an idea they believe is patentable, less than one-third have participated in their firm's IP process. Further, compounding the need to get innovators off the bench, only half of the ideas that are submitted as invention disclosures get filed as patent applications, and even fewer of the applications become granted patents. This suggests many potentially valuable ideas, supported by R&D expenditures, do not become inventions.[4]

Second, the survey data allows us to unpack the origins of the innovator-inventor gap by gender

[4] We asked about internal designation as trade secrets, and we learned that most invention disclosures are closed rather than designated as trade secrets.

and ethnicity. An interesting finding from the survey is that females and URMs face distinct experiences within their companies, leading to a disparate innovator-inventor gap for each group. Women, but not URMs, are disadvantaged across all stages of invention, from being assigned to patentable projects to submitting new ideas to having that idea turned into a patent application, and ultimately to the idea being granted. In fact, being female is associated with a nine percentage point decrease in advancing to the next step, whereas URMs are statistically indistinguishable from the most representative engineers.

Next, we triangulate across survey questions to determine which factors contribute the most to the innovator-inventor gap, creating a relative pecking order of factors. In developing the questions testing potentially influential formal, informal, and personal factors, we rely on the precedent set in prior studies, replicating exact wording to avoid introducing more ambiguity into topics already seen as amorphous.[5] The hierarchy among factors contributing to the innovator-inventor gap as revealed by engineers is management, motivation, culture, the invention review process, and last personal characteristics, including exposure to innovation. Even within this revealed pecking order, though, we observe that women and URMs perceptions of the factors facilitating invention or not are distinctive.

It's evident that across all firms that leadership and management practices influence the innovation-invention gap. Better management is the top factor that would increase idea submission. The manager's contribution to the innovator-inventor gap is readily apparent across various questions and framing techniques. Women are significantly less likely to perceive managers as "supportive of women's representation in the inventing process" and less likely to perceive that "men and women are equally assigned to projects that lead to inventive disclosures." The finding that project assignment is where the disparity starts is critical because a notable survey finding is that once assigned to projects, engineers' allocation of time toward tasks likely to lead to inventions is consistent across all demographics, as is the riskiness of the inventive ideas. Project mismanagement also serves as a unifying explanation for the factors engineers cited as preventing them from submitting more

[5] For instance, we draw from Graham et al. (2022) for questions on effective culture and cultural norms. We replicate generalized trust questions from Guiso et al. (2006), and the framework for high-performance leadership competencies developed by Schroder (1989).

inventive ideas: 45% indicate "I don't feel the work I do is likely to yield patentable inventions," and 31% indicate "I'm too busy with other work." Finally, when asked how participation in idea submission could be increased, especially for engineers from URGs, "better management" was the most common answer.

Second, we find the origin of the engineers' motivations contribute to the innovation-invention gap. Extrinsic motivation (i.e., motivation that is driven by external rewards like prize money for receiving a patent) is the top factor influencing idea submission out of 12 potential factors. Specifically, 41% of engineers perceive pecuniary awards as influential, and significantly more URMs do (54%). But the second most common factor influencing idea submission is tied to intrinsic motivation; specifically, 38% of engineers indicate that "knowing that I'm solving a problem for the greater good" influences them. Interestingly, though, only 23% of URMs cite intrinsic motivation, suggesting a big motivation gap. This motivation gap is consistent with a model by Bénabou and Tirole (2003) that predicts that motivation increases when employees feel empowered, especially for complex tasks (e.g., new idea generation), but battles for dominance can foster negative feelings and detract from empowerment (e.g., no collaboration). Gaps in motivation by gender and ethnicity and the type of inventions that engineers are likely to pursue as a result of such motivations appear to be an important part of the innovator-invention gap.

Rounding out the top three factors influencing idea submission is corporate culture. Isolating the specific elements of culture (Gorton et al., 2022), collaboration and integrity are two cultural values that come to the forefront that leaders could invest time and resources to make more effective. Specifically, we see that URMs indicate that information sharing is the top cultural norm helping innovators to invent, and it is statistically significantly higher based on relative ranking. Yet females are considerably less likely to experience managers explaining important details (76% male, 63% female). Without information sharing as a norm, this suggests women are left out of the loop when it comes to going from innovative ideas to inventions. Supporting this argument, women are significantly more likely to indicate that they do not have people with whom to collaborate (11% male, 22% female). This lack of team mentality is a more significant deterrent for females on the innovation to invention path.

Second, we find that the cultural value of integrity also appears to be holding back engineers with innovative ideas from actually converting them to invention disclosures. All URGs say holding employees accountable for unjust actions is a cultural weakness working against invention. Notably, females report significantly lower levels of trust (i.e., women think that most of the time, people at [Company] are just looking out for themselves rather than trying to be helpful). Females are significantly less likely to experience leadership in making ethical, fair decisions (82% male, 64% female). Finally, rounding out the hierarchy of factors contributing to the innovator-inventor gap, we observe that the patent submission process, peer recognition, mentoring, and personal characteristics such as identity, early life experiences, and exposure all matter but to a lesser extent. That is, while we find some support for all of these factors, they do not rank as highly from innovators' perspectives. Nevertheless, it is important to note that these factors may rank higher on a return on investment (ROI) basis as they can be less costly to change, and thereby are worth taking seriously.

Next, we interpret the revealed pecking order from the survey in the context of our theoretical model. Management practices and corporate culture are revealed by engineers to have a prominent position in the hierarchy of factors influencing idea submission. Notably, these highly influential factors increase both types of costs faced by engineers from underrepresented groups. Specifically, management behaviors such as uneven information sharing or biased project assignment by gender make it much more costly for female engineers to acquire the invention capital necessary to invent and reduce the uncertainty surrounding the patent-worthiness of their innovation. Conversely, factors that rank lower in the revealed pecking order, such as personal traits linked to confidence, predominantly affect the cost of reducing uncertainty alone. Thus, the model, which presumes engineers are rational and optimally allocate their time given these costs, predicts outcomes consistent with our survey. Namely, that the gap from innovation to invention is more likely due to changeable aspects of companies, rather than unique individual behavioral factors.

One key advantage of using a survey to study the innovation process is that we can directly ask questions of the engineers working on tasks that will produce inventions each day, whether or not a patent is submitted. Our survey thus provides unique data about the largely unobservable pre-invention process, especially the steps before a patent application is filed. This is important as we observe meaningful variation here, which suggests attempting to make inferences from observable outcomes related to granted patents may need to be modified. Yet as with any survey, one may be concerned about the reliability of the data. That is, to what extent are the high internal rejection rate of female inventive ideas and the fallout along the invention path an artifact of well-known survey critiques? We address three primary concerns with survey data, namely: (i) that the respondents may be a selected sample of engineers, (ii) that survey answers could be self-serving, and (iii) that observed correlations may be driven by some unobserved common characteristic (e.g., the success of the company).

In a series of robustness checks, we provide evidence that the engineers' survey responses are reliable and consistent with external data. First, we use external invention disclosure databases from three collaborating firms to validate that female inventors face higher rejection rates and a diminished likelihood of progressing through the various stages of the invention process. In fact, across different regression specifications, our estimates imply that the presence of a female inventor correlates with a 10 percent reduction in the probability of an idea advancing to be filed as a patent application and granted. We also repeat a question at one of our sampled firms via their employee engagement survey, avoiding IP or diversity framing. We find statistically indistinguishable results for participation in the IP process. Finally, we repeat the survey with students to verify that it is something about the perceived experience in the company rather than in society driving the results.

The remainder of the paper is organized as follows. Section 1 describes the related literature. Section 2 presents a theoretical model of the invention. Section 3 describes the survey and interview data. Section 4 presents the results. Section 5 includes responses to common survey critiques, robustness, and placebo tests. Finally, Section 6 concludes.

1 Literature Review

This study provides new information about how engineers view the invention process, gauges their perceived identity, confidence, aspirations, and objectives of inventing, and discerns how formal and informal practices inside the firm work for and against an inclusive invention process.

Thus, our research is primarily related to other research that examines inventors, and the unique contribution of our study is to evaluate the experiences of potential and established inventors to help determine the extent to which established inventors are or are not representative of all potential innovators. Our finding that potential inventors appear meaningfully different has important policy implications. For example, to support inclusive innovation, firms need not inadvertently to ignore the particular needs of the non-inventor population.

Prior surveys have explored strategic and operational dimensions of firm-level patenting (Cohen et al., 2000; Graham et al., 2009), but no study has delved into diverse engineers' experiences with the invention process. This omission is understandable given that the decision to patent often reflects firm-, rather than individual- level priorities, and that inventions over ideas devised on the job belong to employers, not employees, under the hired-to-invent doctrine. But participation in inventing, even conditional upon presence in the workplace, matters for a few reasons: at the inventor level, the invention is associated with compensation, retention, and psychic and social benefits (Kline et al., 2019; Bell et al., 2019; Chien, 2024); who invents also influences what inventions get commercialized, and for whose benefit (Koning et al., 2020; Koffi and Marx, 2023). Further, if underrepresented individuals patented at the same rate as rich white men, it is estimated that there would be four times as many inventions (Bell et al., 2019). Thus, our focus on engineers rather than management or executives' viewpoints is unique, and we believe it provides a meaningful contribution to the literature by providing their perceptions of the invention process and unique suggestions on how the process can be more inclusive.

There have been a few surveys of inventors and potential inventors. The relevant inventor surveys from the EU are the PatVal-EU survey and the European Commission's Community Innovation Survey, carried out biannually. PatVal-EU was a one-time retrospective survey of inventors who had been granted a patent by the European Patent Office (EPO) with a priority date between 1993 and 1997. The survey was carried out nearly a decade after the inventor filed for the patent (2003-2004) and focused on rewards to the inventor from patenting (e.g., monetary rewards), research collaborations in the innovation process (e.g., developing the patent with an external co-inventor), and the subsequent patent use by the inventors' employers (e.g., licensing).

While the administrators received a large number of responses at 8,963 responses, only 2.8% of the survey respondents identified as female, and no questions about ethnicity were asked on the survey (Giuri et al., 2007). Similarly, the Community Innovation Survey is a periodic survey that provides information on statistics about enterprises with product and business process innovations, their strategies, knowledge management, and innovation activities, as well as about factors that facilitate or hamper innovation (Commission', 2019).

One relevant inventor survey in the United States is Jaffe et al. (2000), which focuses on inventors' contributions to knowledge spillovers rather than inclusive innovation processes. The survey closest to ours is Ross et al. (2022), which seeks to explain the well-documented gap between the observed number of scientific publications produced by women and men in science. Basic scientific research is often a precursor to patent applications and commercialization but is usually conducted in university settings. Ross et al. (2022) survey 2,660 scientists regarding how credit is allocated for research done, and they find exclusion from authorship is common and differs significantly by gender, with 43% of women and 38% of men experiencing exclusion. We view our study that surveys high-tech engineers working in the private sector as a complement to their survey of scientists working in the public sector.

Our study contributes more broadly to several other important strands of literature. We contribute to research on innovation, inventorship, and the requisite need for "invention capital" (e.g., role models, networks, and other tacit knowledge) to take advantage of inventing (Chien, 2022). While other studies show that socioeconomic status, immigration status, education, IQ, and personality (Bell et al., 2019; Akcigit et al., 2017; Kerr et al., 2017; Aghion et al., 2019; Celik, 2023) all play a role in becoming an inventor, we identify through self-reported rankings a relative ordering of these factors influence on inventorship. We add to a large body of research that explores how gender and ethnicity affect the production and recognition of novel ideas (Ding et al., 2006; Cook, 2014, 2018; Hofstra et al., 2020; Ross et al., 2022; Waldfogel, 2023), and draw upon and extend work on the impact of competition and confidence on women's labor market outcomes (Kamas and Preston, 2018).

The question of who, within a work setting, goes for promotions and asks for raises is related to the question of who seeks to have one's ideas promoted and commercialized. Given the outsized impact of innovation and the influence of who innovates on what products get developed and made, the welfare consequences are substantial (Celik, 2023). Moreover, our finding that corporate culture and management practices have highly consequential and real effects on innovative outcomes is consistent with a rich literature showcasing their role in value creation (Bloom and Reenen, 2007; Guiso et al., 2015; Gorton et al., 2022; Graham et al., 2022; Grennan and Li, 2023; Grennan, 2023; Cullen and Perez-Truglia, 2023). Finally, our work speaks to research into optimally incentivizing firms to engage in invention (Lerner, 2005; Arora et al., 2018; Bloom et al., 2019) and optimally motivating individuals trained in science, technology, engineering, and mathematics ("STEM") to invent (Manso, 2011; Toivanen and Väänänen, 2012; Ederer and Manso, 2013; Toivanen and Väänänen, 2016; Bianchi and Giorcelli, 2020).

In addition, we contribute to the law and IP literature on what constitutes sound practices in developing and protecting IP (Chien, 2019; Mezzanotti, 2021; Abrams et al., 2023). Our results are consistent with the view that patent professionals, attorneys, and examiners all play a role in making innovation more inclusive, but so does sound public policy (Moser et al., 2014; Farre-Mensa et al., 2019; Pairolero et al., 2022). By describing the challenges in converting from the innovator to the inventor stage, we help shed light on some of the root causes that may need to be addressed to achieve parity benchmarks for commercialization and entrepreneurial aspects of invention (Ewens and Townsend, 2020; Koffi and Marx, 2023).

2 Model

In this section, we present a static model to understand better how engineers decide to allocate their time and effort between two types of tasks: (i) working on invention disclosures, which can potentially lead to payoffs for the inventor and firm, and (ii) other tasks both technical and non-technical which yield a fixed wage. In making these decisions, engineers face uncertainty regarding the quality of the ideas they could submit as potential invention disclosures. The model allows the engineer to put effort into gathering feedback to reduce this uncertainty. By examining how different factors, such as the potential payoff of an invention, the wage earned from other tasks, and the effort required to reduce uncertainty, affect the engineers' decisions concerning their time and effort, we seek to learn more about the factors influencing the inventive process. While we do not know of specific models examining engineer's optimal allocation of time and effort toward inventive tasks, this model does draw upon insights thinking about how would-be entrepreneurs decide to form a new venture (Evans and Jovanovic, 1989; Levine and Rubinstein, 2017), academics choose new research projects (Azoulay et al., 2011), and novelists create content (Waldfogel, 2023). Next, we summarize the various factors in our model.

- Total time (T) that is available for the engineer to work on tasks during the period. The engineer chooses to spend their time on technical or engineering tasks likely to lead to inventions (T_i) or on other tasks both technical and non-technical that are unlikely to lead to inventions (T_o)
- Probability of successful invention disclosure (p), which represents the likelihood that the invention disclosure will be successfully filed as a patent application.
- Cost of invention (C_i): This cost of invention abstracts away from the cost of equipment and resources and instead focuses on the mental cost. Mental costs associated with the inventive process include mental expenditures to gain tacit knowledge about the inventive process and invention-specific costs. The full cost of invention is expressed as $C_{tk} + \alpha * S$. Where C_{tk} is the cost required to obtain tacit knowledge about the inventive process, $\alpha * S$ is an invention-specific cost and α represents the overall importance for the noisy signal in the cost of invention.
- The noisy signal S is a linear function of effort (E) and represents the engineer's perception of the quality of the idea or the potential payoff from an invention disclosure as $S = \mu - \beta E$. Where $\beta > 0$ represents the reduction in noise per unit of effort. In this case, the more effort the engineer puts in (higher E), the less noise in the signal. The cost of effort is linear and represented by kE where $k > 0$. The engineer's noisy signal encompasses their internal and external perceptions. Internal perceptions include self-identifying as an inventor or problem-

solver and believing one's idea is worthy. External perceptions stem from formal and informal elements such as formal feedback from management, peers, and patent professionals and informal lessons learned from the corporate culture.

- Within the noisy signal, Sm μ is a parameter that indicates the baseline quality of the idea before the engineer puts in any effort to reduce the noise. A high μ would represent a strong initial perception of the idea's quality or a high potential payoff, while a low μ would indicate a weaker initial perception of the idea's quality or a lower potential payoff. For example, suppose an engineer is evaluating two ideas for invention disclosures. Idea 1 has a high μ, meaning that the engineer perceives it as a high-quality idea with a large potential payoff even before putting in any effort to reduce the noise. Idea 2, on the other hand, has a low μ, meaning that the initial perception of its quality and potential payoff is not as strong. As the engineer tries to reduce the noise, the quality signal for both ideas will become more accurate. However, the difference in the inventor's initial quality will still be relevant to the engineer when deciding how to allocate effort and time.

Having described the various factors in the model, we can express the engineer's objective function. Implicit in our setup are the constraints that $T_i \geq 0$, $T_o \geq 0$, and $E \geq 0$.

$$\max_{\substack{T \geq T_i + T_o \\ 0 \leq p \leq 1 \\ 0 \leq \alpha \leq 1}} U(T_i, E) = (p_0 + \gamma E)(w_b T_i) + (1 - p_0 - \gamma E)(w_f(T - T_i)) - (C_{tk} + kE + \alpha(\mu - \beta E))T_i$$

To find the optimal allocation of time and effort, we take the partial derivatives of the objective function for T_i and E and set them to zero. Then, we solve for T_i. There are two potential solutions. Since one of the solutions, $T_i = 0$ means that the engineer spends no time on the inventive tasks, we focus on the second solution. We then also use that solution to solve for E. We see that:

$$T_i = \frac{(p_0 + \gamma E)(w_b - w_f)}{C_{tk} + kE + \alpha(\mu - \beta E)}$$

$$E = \frac{\gamma(w_b - w_f) - k + \alpha\beta}{\gamma^2}$$

2.1 Key Trade-offs Engineers Face

The equation for E shows that engineers face a few key trade-offs that drive their optimal effort. First, wage differences matter. Effort is proportional to the wage difference between inventive and other tasks. Larger, faster wage differences incentivize engineers to invest effort in reducing the noise signal. By putting in more effort, the engineer can reduce the uncertainty surrounding the idea's potential payoff. However, this comes at the cost of time and resources that could be spent on other tasks. Second, the success rate matters. Effort is positively related to the rate at which the probability of success increases with effort (i.e., γ). A high value incentivizes the engineer to allocate more effort to this task. The final trade-off is cost. The costs associated with the effort play a role in determining the optimal level of effort. As costs increase, especially those associated with gaining tacit knowledge like "invention capital," effort will decrease.

Importantly, all of these effort drivers have the potential to differ by gender and ethnicity. Consider an engineer with a single idea for an invention disclosure with some uncertainty in its quality. The engineer also has the option to work on other technical tasks that yield a fixed wage. If the fixed wage for the other technical tasks is high, the engineer might be less inclined to invest effort into reducing the noise for the invention disclosure idea. The increased wage from other tasks could make it more attractive to focus on those tasks rather than spending resources on refining the concept for the invention disclosure. In contrast, if the fixed wage is low, the engineer may find reducing the noise for the invention disclosure idea more worthwhile. The potential payoff from the invention disclosure becomes more attractive relative to the low wage from the other technical tasks, making it rational for the engineer to put more effort into refining the idea. From the hypothetical examples, it is clear that engineers must weigh the benefits of better understanding the idea's quality against the costs of the effort required to reduce the uncertainty.

Similarly, consider the fundamental trade-off that is the payoff vs. wage trade-off. The trade-off is between working on an invention disclosure with a potentially bigger payoff and working on other technical tasks that offer a fixed wage. When the potential payoff of an invention disclosure is high, engineers might be more inclined to allocate their time and effort to that invention disclosure, anticipating a greater reward. On the other hand, when the fixed wage for other technical tasks is high, engineers might prioritize those tasks over working on invention disclosures, especially if the potential payoff from the invention disclosure is uncertain or not high enough to justify the effort.

2.2 Extending the model

We acknowledge that many factors could be relevant to the innovator's optimal allocation of effort toward inventive tasks likely to lead to inventive disclosures and that we only present one highly stylized static model. In fact, by focusing on pecuniary rewards solely, we may miss meaningful interactions between pecuniary and non-pecuniary factors. However, we believe one could reinterpret the above derivation by broadening the framework to incorporate considerations of both social and private value. Engineers from diverse backgrounds might be inclined to dedicate time to innovative activities, particularly if the invention disclosure holds significant social value pertinent to their respective communities. The payoff could include intrinsic or social benefits, which only come from a high-quality disclosure. While this model is meant to provide some basic intuition for thinking about the trade-offs engineers face, we believe many factors are at play. For this reason, in the survey, we ask about many potential motivators and obstacles to invention to help refine exactly what makes acquiring tacit knowledge ("invention capital") and refining one's signal on patent-worthiness so costly. To better understand the many factors that we consider, please see Figure 2, which illustrates many factors at the firm (external) and innovator (internal) levels that shape the decision to submit invention ideas. The boxes along the top of Figure 2 show that firm-level factors are grouped into informal and formal institutions such as culture and management practices. Individual-level traits are grouped into individual traits, early-life experiences, and career-life balance. The blue, yellow, and red dot indicate which facts are likely to influence individual ideas (blue), group ideas (red), and idea submission (yellow).

3 Data

To better understand the potential trade-offs that engineers face and other barriers to patenting, we survey engineers from high-tech firms. In this section, we explain how we quantify the step in the patenting process where engineers drop off and their perceptions about the invention process.

3.1 Interview and survey methods

To better understand the steps in the invention process prior to filing a patent application, we interviewed thirteen patent professionals, mostly patent counsels or people involved in inventorship diversity efforts at the firm. The firms included private firms, firms that recently went through an initial public offering (IPO), and well-established firms. In doing so, we sought to broadly understand the patenting process at firms across their lifecycle stages; the firms also varied in terms of their culture and reputation for diversity and inclusion, with two firms in particular chosen for their broader reputation as good and bad places, respectively, for individuals from URGs. The patent professionals that we spoke to primarily work at technology or manufacturing firms.

Figure 1 is our attempt to illustrate the many strategies that firms use to harvest inventive ideas into fully-realized invention disclosures that warrant IP protection. For an idea to be submitted as an official invention disclosure, some firms have patent professionals reach out to inventors to see what they are working on to harvest any ideas that may be worthy of applying for intellectual property (IP) protection. At other firms, there are inventor portals into which inventors submit their invention disclosure and then wait a few weeks for feedback. Firms also commonly collect ideas through group events such as roundtables, hack-a-thons, brainstorming, or jam sessions. Such collecting sessions can be led either by patent professionals or senior engineers. These prevalent strategies are encapsulated in the figure and in the ensuing survey, we delve deeper into engineers' perceptions of how effectively these collecting strategies encourage participation in the invention process.

Once invention disclosures are tendered, the differences in evaluation approaches among firms continues as the figure demonstrates. Several firms use a two-stage assessment, where inventors receive preliminary feedback at the first stage. This intermediary step provides a conducive environment for refining disclosures before they are escalated to a patent review board. Conversely, some firms adhere to a singular, streamlined process wherein the disclosure is assessed immediately by the patent review board. The varying expertise of these committees and the possibility of blind reviews add layers of complexity to this evaluative stage. Moreover, we also heard IP legal review may further complicate the decision by considering factors beyond novelty and non-obviousness such as IP budgetary constraints, alignment with R&D priorities, subjective assessments of the patent prosecution success, estimated ease of detecting infringement, etc. Worthy ideas may be the subject of defensive publications or trade secrets, although we heard anecdotally among our firms that such designations based on patent idea submissions were rare. After the idea is collected and reviewed by the board and the IP legal team, it can be put closed, put on hold, or a patent application filed. When a patent is applied for the process can also vary in terms of the degree to which outside counsel is hired and back-and-forth in the patent prosecution process.

Figure 4 elaborates on the milestones in the innovation-to-inventin process by further separating the factors that influence the submission of an idea into firm-level (external) and innovator-level (internal) factors. In the top half of Figure 4 are firm-level factors such as those just discussed that are particular to inventing, including the mechanics and processes of idea submission and invention, as well as IP training and IP-specific mentorship programs. Also influential, however, are firm-level traits not particular to inventing such as, whether the firm has a collaborative culture, and management supports affinity groups as part of its diversity, equity, and inclusion process? In contrast, innovator-level factors and assets include characteristics of the person including their awareness of IP, identity as an inventor and individual sense of motivation and confidence in inventing decisions, collectively, a person's invention capital. However, a person's social network, including potential collaborators, mentors, and those knowledgeable about the inventing process, as well as a person's professional relationships, for example, with patent personnel, or lack thereof, also are what a person brings to the patenting process and further shape the context of a person's decision to engage or not in the patenting process.

We incorporate the knowledge gained from our interviews about the invention disclosure process and what influences it into the design of our survey instrument. In each case, we also worked with human resources (HR) or internal teams responsible for surveying employees to further refine the survey to match company-specific terminology or processes. In all but one case, an employee of the company sent a solicitation email on our behalf that included a link to our survey. For one company, we sent the solicitation email. We include examples of the emails in Appendix A. Our response rate varied across settings, ranging from a low of 7% to a high of 16%, which is comparable to previous surveys in corporate finance (Graham and Harvey, 2001; Graham, Grennan, Harvey, and Rajgopal, 2022). We include additional survey details in Appendix A. For example, details such as how we randomly scramble the order of choices within a question to mitigate potential order-of-presentation effects are explained, why we use a combination of positively and negatively worded questions to mitigate acquiescence bias, and our use of open-ended questions.

3.2 Benchmarking

Following the recommendation of List (2007), we compare the characteristics of firms in our sample with the broader population of patenting firms and Compustat firms. In Appendix Table A.1 shows, the firms in this sample are much more similar to patenting firms than the broader sample of Compustat firms. But even in comparison to patenting firms, our sample comes from engineers working at larger firms with more assets and employees, more revenue, and more R&D expenditures. The sample and the patenting firms are statistically indistinguishable on more standard financial metrics such as tangibility, revenue growth, asset growth, investment, market-to-book ratio, profitability, and leverage. In terms of their patents, the patents, on average, are indistinguishable in terms of citations and value per patent using the methodology from Kogan et al. (2017). However, our sample of firms are granted more patents per year than the average patenting firm in Compustat. Thus, it is essential to recognize that the inventive output from the sampled firms includes thousands of patents and many more invention disclosures before the patents are granted. While the firms are selected, they comprise a set of firms that contribute meaningfully to the U.S. economy and its competitive positioning worldwide.

To better understand, the exact nature of the patenting, we further benchmark our sample to the broader set of patents issued to public firms. Appendix Figure A.1 plots the frequency of patents in various technology subcategories over the past five years for both the sample firms and the broader sample of patenting firms in Compustat. The most common technology subcategories represented by the sample of firms are digital communication, audio-visual technology, computer technology, telecommunications, and optics. Relative to the broader population of patenting firms, the sample underrepresents engineers working on projects likely to lead to medical technologies, biotechnology, and pharmaceutical patents. Appendix Figure A.2 plots the percentage of patents from the sampled firms. The two largest subcategories (digital communication and audio-visual technology) each represent more than 10% of the granted patents in the last five years for the sampled firms. Despite that tilt toward high technology, the sampled firms cover over 30 technology subcategories.

3.3 Demographics of respondents

In Table 1, we summarize the details of the demographic information collected from the full sample of 3,989 survey respondents. Confidentiality was ensured to promote honest answers, and a "Prefer not to answer" option was available for sensitive questions. For instance, among the 3,758 respondents who responded to the gender question, 77% self-identify as male, 22% as female, and 0.5% as non-binary. However 231 respondents (5.8% of respondents) indicate that they "Prefer not to answer." When we conduct our analyses, we provide separate tabulations for those who prefer to provide their self-identified gender and ethnicity. The lack of female representation (22%) is confirmed by HR departments as being slightly below the actual percentage in surveyed firms, indicating that females may have felt more comfortable selecting "Prefer not to answer." Overall, gender-wise, our demographics are similar to numbers reported by policymakers[6]

For ethnicity, 3,714 respondents chose to answer. A dominant 77% identified as Asian, followed

[6] A 2021 report found that 28% of engineering graduates are women, but the gender imbalance varies across subdiscipline (Bello et al., 2021). Women are even less represented in digital information technology, computing, and physics. Given that our sample comes from engineers driving the digital revolution, this may explain the slightly lower percentage.

by 20% white, 2% Latinx, 1% multi-racial, 0.5% black, and 0.2% as American Indian, Alaska Native, or Native Hawaiian. This ethnic breakdown coincides neatly with the geographic distribution of the respondents. With 38% hailing from North America, 28% from East Asia, 23% from Southeast Asia, 7% from South Asia, 3% from the Middle East, and 1% from Europe. Additionally, less than 1% reported from Australia, Africa, and South America. When considering the U.S. demographic, which accounts for 33% of the total respondents, there is a shift in ethnic composition. The data reveals a balanced 45% each for white and Asian respondents, followed by 5% Latinx, 3% multi-racial, 1% black, and 0.4% American Indian, Alaska Native, or Native Hawaiian.

On the professional front, respondents predominantly belong to the engineering sector, accounting for 49% of the 3,746 who answered this question. This is followed by data science (24%), manufacturing (13%), products (10%), and business (5%). Consistent with global patterns of economic activity, in the U.S., we observe a higher concentration in data science (31%) and products (18%) and a lower presence in manufacturing (8%). Regarding the work environment, 70% operate in a hybrid setting, 20% are fully remote, and 10% work in-office, a pattern maintained both domestically and internationally. The average tenure at the respondents' current firm is 7 years, and the mean age is 41, which slightly shifts to 44 years in the U.S. context. Educational attainment shows that most international engineers have an undergraduate degree (47%), whereas, in the U.S., 39% possess a graduate degree. Lastly, regarding non-work life, 80% of the 309 respondents are partnered, with 73% of those having working partners. A significant 71% share household responsibilities equally with their partners.

3.4 Advantages of Survey Approach

The paper relies on an original survey of engineers to assess the importance of different aspects of the IP collecting process in firms. The strengths of our survey include its breadth and depth. We capture the views of engineers. Relatively few surveys of engineers have been conducted in the academic literature. Our survey approach offers two advantages to previous studies. First, our survey guaranteed anonymity, encouraging more honest responses, mainly when asking about potentially sensitive topics such as workplace dynamics, discrimination, and personal beliefs. Second, the detail of our survey and the inclusion of open-ended questions allow us to quantify aspects of the invention process that are essentially a black box right now. We break down the early steps of the IP process into understandable chunks that can be especially valuable when exploring complex subjects such as invention. Finally, through a series of four detailed questions, we can explore the factors that influence invention submission by employing question multiplicity, thereby mitigating bias and enhancing reliability.

4 Survey Results

4.1 Awareness of the IP Process

Table 2 provides descriptive statistics for engineers' general awareness of the IP process. Columns 1 to 2 present the number of observations and mean for the full sample of engineers. Columns 3 to 8 report the number of observations and means for those that self-identify gender and ethnicity broken into important subgroups. First, we compare those that represent the majority demographic of engineers (Asian or White males), which we label the Representative Group ("RG") with URGs. Second, we compare those who self-report their gender as male and female. Finally, in the last column, we report on URMs. The results are based on a sample of 3,912 engineers, of which 3,633 respondents specified a self-reported race and gender. Filtering to the demographic subgroup comprising most engineers, 2,724 are Asian or White males. The stars in the table denote the significance level from a *t*-test, indicating the likelihood that the observed differences in group means for URGs, females, and URMs are not due to chance.

The first question in Panel A quantifies the percentage of engineers affirming awareness of the invention process and tools ("yes"), disaggregated into various demographic categories. Panel A shows that 40% of all respondents and 40% of those identified as Asian or white males are aware of the process for submitting a patentable idea. Among engineers from URGs, this awareness stands at 39%, and among underrepresented minorities (URM), the figure rises to 45%. These percentages are statistically indistinguishable across demographics. This suggests information alone is unlikely to encourage greater participation in the invention process. For a subset of firms, the engineers report on their attendance at IP trainings. Consistent with overall awareness levels, the percentage remains consistent across demographics and is statistically indistinguishable. Overall, 45% of engineers indicate having attended an IP training. URMs showed the lowest participation rate at 40% while females show the highest participation at 47%. One explanation could be that some firms offer trainings through affinity groups and women are significantly more likely to report that they attended a training through an affinity group (e.g., Women in Engineering) whereas Asian and white men (the demographic majority) are significantly more likely to indicate that they attended a regular IP training.

Panel B summarizes engineers' perceptions of their participation in the early steps of the invention process. Among all the 556 engineers who answered these questions, 55% believe they have had an idea that might be patentable. The number is highest at 58% for Asian or white males and lowest at 47% for females. These percentages are statistically significantly different at the 5% level. However, interestingly, URMs outperform other demographic groups with 62% indicating that believe they have had a patentable idea. This could indicate bias in the hiring process such that URM engineers must be at a higher level even to be considered for the job.

For the question regarding participation in the early steps of the IP process, we spoke to patent professionals at each company to isolate potentially meaningful early indicators for invention. Engineers taking the survey then responded to bespoke questions that reflected their company's specific process. For example, participating in invention creation meetings, authoring engineer documents, or regularly working on projects with patents as key performanc indicators (KPIs) are company-specific early participation steps. Here, we begin to observe statistically significant differences of a meaningful magnitude across demographic subgroups. Specifically, 74% of Asian and white male engineers report participating in the early steps int he IP process while only 54% of women do. This 20 percentage point gap early on is potentially consistent with managerial bias in temrs of the projects and tasks engineers are assigned to.

For the question regarding participation in the later steps of the company's patent process, with a scale of 0 = no Invention Disclosures submitted, 1 = Invention Disclosure submitted but patent not filed and 2 = Invention Disclosure submitted and patent filed, the mean score for all 3,630 respondents was 0.49, but again there are significant differences across demographics. Female engineers self-report significantly less participation and engineers from underrepresented ethnicities report significantly higher participation. Regarding the submission of Invention Disclosures, 32% of Asian and white males have submitted whereas only 28% of engineers from URGs have submitted. This 4 percentage point (p.p.) gap continues into the filing stage with 15% of Asian and White males reporting a patent has been filed and 11% of engineers from URGs having a patent filed. These application rates are consistent with women's participation in the patenting process more broadly (Carpentier and Raffo, 2023). The survey also provided insights into how these Invention Disclosures are submitted. With most engineers submitting through digital inventor portals, about 20% through brainstorming sessions, and the remainder with the assistance of a patent professional. Women, however, are statistically more likely to use the anonymous digital inventor portals than male engineers.

Figure 3 helps to visualize the steps in the inventor's path from ideation to patent application. The figures show six steps: (1) inventive ideas, (2) assigned early-stage IP work, (3) sought advice, (4) sought training, (5) submitted an IDF, (6) patent application filed. Step 3 through 6 are all conditional on having an inventive idea or being assigned early-stage IP work. The upper figure showcases the disparities between Asian or white male engineers and female engineers, and Figure 3 explores the differences relative to being an engineer from an underrepresented ethnicity. Here, we see that there is meaningful fallout across each step. While 63% of Asian and white male engineers report having an inventive idea or being assigned to projects with IP-related output, the percent drops to 33% for actually submitting an invention disclosure among the surveyed engineers. We see participation taper off in the two steps where one could help get help to go from ideation to submission (i.e., seek advice or attend a training). As we can see in the upper figure, Asian and white males are at a persistent advantage – although across the steps the gap narrows – up to the point of submitting an IDF but then widens again for the idea being filed as a patent. Of note, the males, however, are more likely to have a patent application filed on their behalf (15% vs. only

11% of females).

To visualize the how this positioning changes in the inventor's path from ideation to patent, Figure 4 plots the cumulative positioning across the steps by gender and ethnicity. The upper figure focuses on gender and the lower figure on underrepresented engineers. Each bar is relative to path of well-represented engineers (i.e., Asian or white male engineers). Of note for females is that they are behind both in inventive ideas and are further behind in terms of being assigned IP work. They do make up for these disparities somewhat by seeking out advice and training. So much so, that females close about half the gap to 3.3. p.p. difference by the time they submit ideas despite a 7.7 p.p. difference early on. In contrast, when one considers by ethnicity, URM engineers are actually at an advantage because they appear to be more likely to be pulled into early-stage IP tasks such as brainstorming sessions or being assigned patent KPIs. This advantage persists in that they are also more likely to submit an idea and for that idea to be filed into a patent application. This again suggests that the path and lived experience of diverse engineers may not be the same for women and those from underrepresented ethnicities. In fact, in our sample of survey responses, those from URM engineers indicate that they are more likely to have their ideas filed as patent applications (22%) as opposed to Asian and white male engineers (15%). Given the drop-offs reported, though, this again showcases that more than half of all ideas submitted never actually get filed as a patent application.

In summary, two initial survey results that stand out relative to existent research on innovation is how high the internal rejection rates are for Invention Disclosures and the meaningful variation not in awareness but in early participation in the invention process across different demographic groups. Specifically, engineers self-report that more than half of all Invention Disclosures submitted are rejected. Later, we externally validate such conversion ratios conducting detailed analyses on company's internal Invention Disclosure databases. In addition, that female engineers are already at a disadvantage early on in the IP process (e.g., by not working on projects with patent KPIs or participating in invention meetings) point toward potential areas for targeted interventions.

4.2 Engineers' Self-identity, Confidence, and Aspirations

Understanding the psychological and behavioral dimensions of invention is critical for removing barriers to patenting. The survey data presented in Table 3 draws from three different panels: self-identity (Panel A), confidence in inventive ideas (Panel B), and time and aspirations for inventing (Panel C). The data in Panel A illustrates a stark gap between Asian or white male engineers and other demographic groups in self-identifying as inventors. While 49% of Asian or white male engineers identify themselves as inventors, only 35% of engineers from underrepresented groups (URGs) and females, and 36% of underrepresented minorities (URMs) do so. These differences are statistically significant at the 1% and 5% levels, respectively. However, almost all engineers, regardless of demographics, see themselves as problem-solvers (96% overall). This discrepancy between the broad agreement on being a 'problem-solver' and the specific identity of being an 'inventor' challenges traditional economic models that often conflate the two terms. Moreover, the life impact score of becoming an inventor is fairly consistent across demographics, with a mean score of 1.23. This suggests that framing activities associated with the invention process, such as brainstorming or idea collecting sessions, as problem-solving activities may induce greater participation in the patenting process, especially for members of underrepresented groups.

Engineers, on average, show low confidence in deciding the worthiness of an idea for invention disclosure, with a mean score of just 0.10. However, Asian or white male engineers are slightly more confident (0.17) compared to URGs and females, who show negative confidence scores (-0.12 and -0.13 respectively). These findings may provide an empirical explanation for disparities in invention submissions across demographics. Moreover, when uncertain, a large majority (80%) would seek advice. While advice-seeking is consistent across demographics, URGs and females show a slightly higher propensity to seek advice (85%), which is statistically significant at the 1% level. Interestingly, though, engineers from URGS are more likely to seek advice from someone else rather than a patent professional. One potential explanation is that there may be a perception among this group that the emotional cost of consulting with a patent professional is high due to systemic biases and stereotyping from experts relative to less formal advice channels. This combined with less extensive inventor networks to receive quality feedback and risk aversion in submitting all help to explain lower participation rates by women in the IP process.

Finally, in Panel C, we can better understand time use and aspiration for invention. The belief that engaging in the patent process is a "good use of time" was not overwhelming across any demographic, with 48% of all engineers affirming this. In terms of time allocation, engineers on average spend 15% of their workweek on tasks likely to lead to inventions, and a striking 61% on tasks unlikely to do so. Interestingly, URMs spend a statistically significant lower amount of time (51%) on tasks unlikely to lead to inventions. One explanation for different allocations of time across demographics could stem from the projects assigned (e.g., not being regularly assigned projects with patent KPIs). Therefore, we ask engineers their perception of the gender equality in projects assigned. Consistent with prior self-reported participation, there were significant variations by demographic groups. Asian or white males perceive more equality (1.08) compared to URGs and females (0.86). These differences are significant at the 1% level. Finally, the general interest in increasing the number of invention disclosures is positive (mean score 0.62), but with URGs and females showing less interest compared to their Asian or white male counterparts.

Overall, the differences in self-identity, confidence, and aspiration across demographic groups has important implications for how companies and policymakers approach the task of fostering inclusive innovation ecosystems. In particular, Table 3 begins to highlight how internal management practices may serve as a barrier to more inclusive patenting even if the company had a more demographically representative set of engineers.

4.3 Objectives, Feedback, and Perceptions of the Inventive Process

Table 4 describes the objectives engineers prioritize when working on inventions, as well as the feedback they receive and experiences they perceive others to have. The set of questions in Panel A elicit responses from engineers related to the self-reported amount of risk they take with their inventive tasks. It derives from work by Kerr et al. (2014); Chien (2014); Abrams et al.

(2023) recognizing the various types of patents inventors may pursue. If engineers from URGs take lower risks, overcoming the challenging, non-obviousness requirement for obtaining a patent may be harder to achieve. Here we observe that the majority of engineers (58%) report working on incremental changes as solutions to problems, 23% work on experimenting with risky changes, 12% work on defensive patents, and 6% focus on other activities such as translating academic research into a patent for commercialization. While the mix is slightly different from engineers from URGs, the results are not statistically distinguishable. Importantly, the self-reported risk-taking across demographic groups is indistinguishable. This suggests that the riskiness of the inventive idea is unlikely to differ by demographics.

One aspect of the inventive process beyond risk that my vary by demographics is the importance an inventor places on private versus social value[7] From an economic perspective, striking the right balance between private economic gains from patenting activity and social welfare is vital. Too much focus on private value may lead to social inequality and restricted access to essential services and products. On the other hand, ignoring the private value may reduce the incentives for innovation, hindering societal progress in the long run. The first noteworthy result is that the inventions engineers work on are considered more valuable to direct users (mean = 1.24) than to society at large (mean = 0.46), indicating a market-oriented approach to invention. Second, we see that engineers from URGs are more likely to believe that invention should focus on social value (18% versus just 10% of Asian and white male engineers). This is consistent with consumer welfare gains from diverse inventorship. For instance, members of social groups are more likely to patent inventions targeted toward their own group's needs and interests, so lack of representativeness by inventors translates into a lack of breadth in inventions (**?**).

Panel B examines the nature and effectiveness of the feedback received during the invention process. One startling revelation is that 25% of engineers were unaware they could receive advice or feedback, a statistic that can be improved with more transparent internal processes. Engineers in our survey indicate a preference for peer and mentor feedback (18%) over other forms, with females

[7]For instance, Bloom et al. (2013) and Lucking et al. (2020) find that the social returns to R&D are about three times higher than private returns in the United States from 1980 to 2015, but less is known about which inventors focus on which values.

showing a significantly higher reliance (27%). This could be consistent with anecdotes suggesting that non-dominant demographics receive lower-quality feedback that is often unrelated to issues of substance. In fact, there is a statistically significant 12 p.p. lower level of satisfaction (44%) with feedback reported by engineers from URGs. In contrast, the majority (56%) of Asian and white male engineers were satisfied, and satisfaction even drops to 37% among underrepresented minorities (URM). This divergence could indicate a structural bias or shortfall in mentoring and guidance for URM engineers, an issue that warrants further investigation.

Panel C delves into perceptions related to gender equality and management support in the invention process. The data shows that the majority of the 3,115 engineers (mean score of 1.04) believe that men and women are equally likely to be named as inventors. This belief is significantly higher among Asian or white males, with a mean score of 1.09, than among engineers from URGs, with a mean score of 0.92. Similarly, most engineers feel that men and women are equally likely to submit an invention disclosure, albeit the score is slightly higher among Asian or White males (mean score of 1.01). When it comes to managerial encouragement and support for submissions, the mean score stands at 0.65 for all engineers, but it drops to 0.28 among URM. This significant and considerable drop highlights the potential for a managerial gap in fostering a more inclusive innovation environment.

Overall, perceptions about the equality and supportiveness of the invention environment vary across demographic subcategories and these findings point to areas where corporate culture and support mechanisms from patent professionals and managers can be improved.

4.4 Factors Influencing Invention

Before delving into the tables exploring the factors influencing invention, it is worth explaining the rationale for our approach. A common criticism often levied against survey-based research is the potential for bias, which can emanate from various sources such as the wording of questions, the sampling method, and even the medium in which the survey is administered. In the context of our research, which aims to explore the various factors that affect invention submission within corporate settings, mitigating this bias is crucial for deriving actionable insights. A cornerstone of our approach to ensure reliable and valid findings is the utilization of question multiplicity: asking the same underlying question in multiple ways.

Fowler (2014) demonstrates that survey questions phrased differently can sometimes yield significantly different responses and encourage question multiplicity as a solution to capture the full depth and nuance of the respondent's opinion. Moreover, question multiplicity has been noted to combat "response set bias," wherein respondents provide similar answers to a series of questions without necessarily engaging with the content. In the context of our research, we employed this approach in examining the barriers and facilitators to invention submission. For instance, we asked, "What prevents invention submission?" "What would facilitate greater involvement in invention?" "What has been most influential in encouraging idea submission?" and used open-ended text questions to ask, "How can participation in invention submission be increased?"

Table 5 summarizes the factors working for and against participation in the submission of Invention Disclosures. In Panel A, which focuses on the factors that engineers perceive to be preventing them from submitting more Invention Disclosures, we group each potential factor into three broad categories: (i) individual inventor characteristics, (ii) formal characteristics such as management practices and the invention process, and (iii) informal characteristics such as corporate culture. Broadly speaking, individual traits are the most commonly cited, but both informal and formal characteristics are frequently mentioned.

Across all demographic groups, the most cited factor inhibiting invention disclosures was "Too busy," with 51% of engineers affirming this. However, Asian or White male engineers cited being "Too busy with other work" at a significantly lower rate (24%) compared to underrepresented minorities (URM) (32%). This finding is consistent with the engineers previous self-reported numbers. Specifically, that engineers from URGs are less likely to participate in early or later steps of the invention process.

On the other hand, the next most cited factor preventing invention is that 45% of all engineers felt their work is unlikely to yield patentable inventions, with this number rising to 50% among Asian or White males. Interestingly, this belief was significantly less prevalent among URMs, at 33%.

This could just be a hiring selection effect whereby engineers from URMs must be more talented just to get the job. Examining other individual characteristics, we see confidence in deciding if one's idea is worthy (28%) matters more than perfectionism (13%). This suggests some perceived fear among engineers, often stemming from cultural norms associated with implicit bias. Given this fear, one suggestion may be to highlight alternative channels such as brainstorming sessions for overcoming such barriers. In fact, in Panel B we see that URM engineers are more likely to suggest this factor. Finally, it is interesting to note that there are no demographic differences in the perceived effects of lack of confidence, even if one demographic group is more likely to be comfortable deciding the worth of their idea.

Turning to the formal and informal characteristics, insufficient encouragement by management, and not having people with whom to collaborate on inventions as the greatest barriers to invention. Interestingly, females are twice as likely to report having nobody to collaborate with (22%) relative to their Asian and white male colleagues (11%). This is echoed by the perception of engineers from URMs that the culture is not supportive of inventing (11%) and is much higher than rates reported by Asian and white male engineers (4%).

Panel B provides insights into what factors could facilitate greater involvement in the IP process. While 61% of all engineers believed that offering more training could facilitate greater involvement in the IP process, this belief was less prevalent among URMs at 54%. This is inconsistent with literature that often assumes gaps in skills or knowledge can explain inventive differences. It is, however, consistent with the results on IP awareness that indicated no difference in awareness or attendance at IP training events across demographic groups.

What is probably most salient about Panel B, however, is the stark differences between what Asian and white males think will facilitate greater involvement and what engineers from URGs think. For example, women are 15 p.p. more likely to say encouragement from management could facilitate greater involvement. Another intriguing data point is the role of cultural norms in facilitating innovation. Specifically, URM engineers are 7 p.p. more likely than Asian and white males to believe that strengthening the innovation culture would make a significant difference. This supports the idea that cultural factors disproportionately affect URGs. Similarly, 25% of the

URM engineers, who often have smaller networks, indicate that having more brainstorming sessions would help whereas only 7% of Asian and white males think so. Yet 29% of Asian and white males want one-on-one sessions with patent professionals whereas that number is 11 p.p. lower for URM engineers. Finally, in terms of management practices, "inventor recognition" like plaques or t-shirts is significantly more likely to be suggested by URMs (12%) than by Asian or White males (4%). The multitude of differences in beliefs about what would help suggest that motivation for invention (external versus intrinsic factors) might have differing levels of impact across demographic groups.

Taken together, the findings about the factors working for and against participation in the IP process suggest that systemic constraints on inventor's time and how projects are allocated among engineers are likely universal obstacles to inclusive innovation. However, when it comes to facilitating greater involvement in the IP process, different demographics have very different desires: Asian and white males want to simplify the process, women want more encouragement from management and collaborators, and URMs want brainstorming sessions and a culture more supportive of innovation.

In the next table, we ask engineers to create a pecking order of the factors that actually have been the most influential in encouraging idea submission. The pecking order shows the top three most influential are: patent awards, knowing that I'm solving a problem for the greater good, and the culture of innovation. Other factors that rank highly are peers, recognition inside the company and mentors. What is not included is also informative. Famous inventors, training, management, and patent professionals all rank at the bottom. Interestingly, females and males do not differ in their relative rankings. But we do see significant differences between engineers from URMs and others. Engineers from URMs are significantly more likely to say that management and awards matter and significantly less likely to say that they are motivated by knowing that they are solving a problem for the greater good. The relative difference in weight placed on extrinsic relative to intrinsic motivation could be the byproduct of early interactions with the patenting system as we explore in our discussion of theory.

Finally, in Panel B we ask in an open-ended question that we performed textual analysis of to classify answers, how participation in idea submission could be increased, especially for employee from URGs? The pecking order is similar to prior findings but does exhibit marked differences of opinion by demographic subgroups. The top three suggestions on how participation in idea submission can be increased for URGs among all engineers include (1) better management, (2) more brainstorming sessions, and (3) improve the culture. The order is different for engineers from URGs, who offer advice consistent with (1) better management, (2) improve the culture, and (3) assign engineers from URGs to projects more likely to yield patentable inventions. In fact, 16% of female engineers in their open-ended responses suggest this whereas only 8% Asian or white male engineers perceive and report a problem with how tasks are allocated. Interestingly, despite the general finding that time constraints seem to matter, when asked in an open-ended way, only 4% of engineers suggested providing more time for invention as the solution. Finally, it is worth noting again that engineers from URMs differ from female engineers. The top response by engineers from URMs is anonymize the patent process (29%) suggest this whereas only 8% of female suggest it.

4.5 Mentorship

Mentorship is a potentially potent lever for encouraging innovation and fostering. Table 7 summarizes the perceived impact of patent mentorship on engineers, particularly in relation to the patenting process. Panel A highlights no difference in informal mentorship rates across demographics. We do see a divergence in formal patent mentorship experiences among demographic groups, attributable to some company's having mentorship programs associated with affinity groups (e.g., Women in Engineering). Yet, even with these programs, only 24% of engineers have participated in a formal patent mentorship program and only 38% have received informal mentorship. Asian or White males reported a slightly higher rate of informal mentorship at 42%, which could signify different networking dynamics.

Panel B explores why engineers have not sought mentorship. Interestingly, 79% simply hadn't thought about seeking mentorship. Not having the time for mentorships seems to be a more limiting factor for URMs at 17% compared to just 11% for all engineers. These figures provide a mixed narrative. On one hand, they support economic theories that time constraints hinder mentorship. On the other, they question the widely held belief that URGs avoid mentorship due to a fear of exposing weaknesses; almost no engineers cited this as a reason. Panel C delves into the perspective of those with a mentor and the perceived impact of mentorship. The frequency of meeting is consistent across demographic groups, with mentees suggesting their mentor provides advice, suggestions, or support around twice a month. The initiation of mentorship relationship differs significantly between demographic groups. A large percentage of URGs and females (93% and 95% respectively initiated contact by joining formal mentoring programs), while 29% of Asian or White males reported that the mentor initiated the relationship.

When looking at the perceived benefits, across the board mentored engineers reported benefits from the mentorship received. Mentees indicate a desire to work on more inventions, greater confidence in their ability to incorporate their mentor's tips into their work process, having the social connections necessary to get their invention ideas accepted by patent professionals, and having more social connections from introductions to new inventors that they anticipate working with. Females' perceptions of mentorship are more positive. Females indicate a statistically significant increases in job satisfaction at 1.3, compared to 0.9 for Asian or White males. Females also perceive that they have benefited more in terms of learning about patenting. Overall, the data suggests that mentorship, particularly when formalized, could be a key mechanism for fostering greater inclusivity in the invention process within engineering sectors.

4.6 Management, Culture, and Leadership

Table 8 explores engineers' perspectives on corporate culture, leadership, and trust within their organizations, with an emphasis on inventive goals. Panel A specifically addresses corporate culture, identifying the top three cultural norms for helping achieve inventive goals as (i) employees feel empowered, confident, and healthy, (ii) information sharing and (iii) employees to feel comfortable in suggesting ideas, concerns, and critiques. These strengths are crucial for promoting inventiveness. Conversely, weaknesses indicated by engineers surround the urgency with which employees work and holding employees accountable for unjust actions. The cultural norms received more favorable ratings from Asian and white male engineers, thus corroborating theories in cultural economics about the disproportionate impact of actions inconsistent with aspirational cultural values falling on members of URGs.

Shifting the focus to managerial practices, Panel B illuminates that engineers broadly perceive management as supportive of their inventive goals. Noteworthy is the significant role of career development and clear expectations as the most positively perceived aspects of management. However, the experience varies drastically by demographic group, indicating a divergent impact on inventive activities. Female engineers are 18 p.p. less likely to experience managerial decisions as ethical and fair, 15 p.p. less likely to experience management communicative about important details, and 10 p.p. less likely to feel inspired to invent by their leaders. In contrast, URM engineers report an increased likelihood that management actively supports their career development and removes barriers to inventiveness.

Next, we asked if the company had an effective culture as in (Graham et al., 2022). As with the cultural norms, overall engineers indicate the corporate culture is effective, but Asian and white male engineers perceive the culture as more effective. To further understand the interpersonal dynamics, we adapted a question from the World Values Survey on generalized trust (**?**) to fit the corporate context. Specifically, we ask "Would you say that most of the time, people at [Company] are trying to be helpful, or that they are mostly just looking out for themselves? (-2 = Always looking out for themselves, 2 = Trying to be helpful)." While engineers overall expressed trust in their colleagues, engineers from URGs reported significantly lower levels of trust. This divergence in trust levels, which is statistically significant, may carry implications for collaborative inventive efforts within the organization.

Overall, our examining of culture, management, and trust indicate that these aspects of the organization are valued differently across demographic lines. This is particularly evident in management's role: what is perceived as a strength by one group may not hold for another. Moreover, the significantly lower levels of trust among engineers from URGs could potentially be a barrier to inclusive innovation. These findings underscore the necessity of tailoring mentorship programs, management practices, and even day-to-day corporate interactions to be more inclusive, aiming to bridge these demographic divides and foster an environment conducive to innovation for all.

5 Validating Survey Responses

By using a survey to quantify early steps in the invention process, we gain direct insights from the engineers who are creating new technologies about their perceptions of the process. Yet this unique benefit of surveys could be offset by three primary concerns: (i) that the respondents may be a selected sample of engineers very interested in patents, (ii) that survey answers could be self-serving, and (iii) that observed correlations may be driven by some unobserved common characteristic (e.g., the success or lack thereof at the firm). We consider each of these concerns below.

Concerning the first concern, by conducting a "invention survey," those who respond to the survey could be a selected sample of engineers who are very interested in invention and thereby more likely to view it and the patenting process favorably. To that extent, we worked with HR and leadership at these firms to ensure we pooled from a representative sample of engineers. Finally, we asked one firm that regularly surveys its employees to include a single invention question on the survey. The results from this separate engagement survey are consistent with the findings from the invention survey for that firm. Finally, our summary statistics from the demographic questions suggest that those answering the invention survey are broadly similar to the demographics human resources expected in terms of who has responded to internal surveys, which were not about invention.

A second common critique is that survey respondents may bias their responses by overweighting outcomes they think the researchers want to hear and underweighting less favorable outcomes. To ascertain whether there is an appreciable bias in the survey responses, we compare the survey responses to multiple external data sources. One firm gave us its whole invention disclosure database. We could then match the survey respondents to those in that database, and we find significant correlations not just for patent applications but for invention disclosures. We matched the engineers to their LinkedIn profiles and US PTO statistics for a second firm to validate the responses. Finally, we externally validate the engineers' perceptions of culture and management by matching the survey responses to data from crowd-sourced employee reviews from Glassdoor. This career intelligence website attempts to provide transparency about jobs, salaries, and companies.

5.1 External validation with invention disclosure databases

Three of the firms that we either interviewed or surveyed provided us with their invention disclosure databases. These databases are generally part of an IP lifecycle management software suite provided as a service to patent professionals. For instance, IPFolio is a common package. While each firm chooses to track a variety of bespoke factors, we obtain data on the gender of the inventors, the number of inventors, and any decisions made on the invention submission. For instance, if the idea was filed as a patent or eventually granted as a patent. Following the same procedure in the survey, we are able to assess the juncture at which participation in the IP process tapers off. Our primary regression specification is:

$$Step_{dft} = \alpha + \beta F\hat{emale}_{dft} + \mu X_{dft} + \gamma_f + \rho_t + \varepsilon_{dft} \quad (1)$$

Table 9 showcases the results of this process. Across three different firms, and in consolidated examinations of all three firms, it is evident that the progression of ideas with a female inventor is comparatively less frequent than other submitted ideas. This holds regardless of whether we consider the presence of a female inventor (Panel A) or the proportion of female inventors involved (Panel B). The amalgamated results for all firms incorporate year and firm fixed effects and additional controls, yielding statistical significance at the 99th percentile in each instance. The quantitative estimates imply, with all other variables held constant, that the presence of a female inventor correlates with a 10 percent reduction in the probability of an idea advancing through the subsequent stages. This conveys a noteworthy disparity in the progression of inventive concepts based on the gender of the inventor, underscoring a critical area for further exploration and potential rectification within firms.

5.2 Student survey responses

In Appendix B, we document our procedure for surveying students and the results of the student survey. The student survey findings are generally consistent with factors inside the firm that must change to facilitate all engineers' greater engagement in the patenting process. To reach this conclusion, we first analyze the student survey data by itself, testing for significant statistical differences for students from URGs. To match the context of the survey of professional engineers, URG is defined as self-reporting a gender that is not male or an ethnicity that is not White or Asian. We observe relatively few differences. Second, we compare the responses between students and engineers for the same or nearly identical questions.

Appendix Table B.1 presents unconditional averages of students' awareness, participation, and feedback received in the invention process. Two interesting patterns emerge. First, univariate t-tests do not indicate much significant evidence that the likelihood of students' awareness, participation, or even feedback varies depending on gender or ethnicity. Across the 20 questions we ask, we only observe one question with a statistically significant difference conditional on being a student from a URG. Second, conditional on being students from URGs, they perceive that their peers in their field of study are more familiar with the invention and patenting process than they are. This finding suggests overcoming false perceptions of self and redefining stereotypes through increased STEM activities and events are likely important for increasing inventor diversity.

Next, we explore self-identity and factors influencing the pursuit of a technical career in Appendix Table B.2 and Table B.3. The questions examine self-identity, confidence in inventive ideas, aspirations, and time for invention, as well as the perceived objectives of the invention process. Again, the two groups appear indistinguishable. Behavioral framing again matters for students. While in each group, 44% thought they had an idea that might be novel or patentable, only 35% to 37% self-identify as inventors. Yet, like engineers in firms, 94% and 92%, respectively, self-identify as problem-solvers. Aspirations for the invention are the same, yet expectations about the percent of time spent on tasks likely to lead to inventions as well as the focus when working on projects, are different. In particular, we observe that Students from URGs at 7 p.p. are less likely to say that when working on projects or products that may result in an invention, they focus on experimenting with big, risky ideas that may prove to be foundational. They are also 5 p.p. less likely to think that they will spend their time on technical tasks that are unlikely to lead to inventions.

The factors influencing invention are similar by demographic groups, with two exceptions. First, students form URGs indicate that having role models that they share the same race or gender with is in their top 3 most influential resources or initiatives, increasing their desire to pursue invention as part of their career. In fact, 47% of students from URGs rank it in their top 3, which is a statistically significant 10 p.p. higher. Second, students from URGs appear to be more intrinsically motivated – solving problems for the greater good – and less financially driven than their peers. In combination with the fact that the two subgroups are statistically indistinguishable in terms of their familiarity with the process of inventing a new product or technology and patenting an invention, this suggests information alone is not enough to improve inventor diversity.

Finally, in a comparison of students' and engineers' perceptions of the inventive process, it's noted that students claim heightened awareness of invention yet exhibit less engagement in related training and lower self-identification as inventors. The study reveals that framing and language play crucial roles in perceptions, indicating potential ease in rectification of misconceptions early in education. Self-identity and problem-solving framing appear critical, as students and engineers, especially from URGs, display indistinguishable rates when identified as problem-solvers rather than inventors. This uniformity extends to the comfort in navigating idea-impact processes. Additionally, students, more so from URGs, anticipate spending more time on inventive tasks than actual allocations by engineers, revealing a disparity possibly attributed to insufficient exposure to realistic engineering tasks and mentoring. Regarding the objectives of invention, both students and engineers exhibit a consistent risk tolerance in inventive tasks. However, there is a discernible divergence in the perceived goals of patenting, with a notable inclination of students, predominantly from URGs, prioritizing social value over private value, indicating a shift in value perception among the emerging workforce. This comprehensive analysis suggests a symbiotic interplay of self-identity, exposure, mentoring, and value perception in shaping inventive and patenting perspectives among students and engineers.

5.3 Survey-on-survey regression analyses

Our examination of external invention disclosure databases corroborates the survey findings, indicating a need to consider the impact of diverse intrinsic characteristics on the innovation-to-invention trajectory. While the inherent limitations of survey-based regression analysis preclude definitive causal inferences and the potential for unaccounted variables influencing our findings remains, we have conducted a thorough reassessment incorporating an extensive array of control variables, detailed in Appendix C. These supplementary analyses underscore the robustness of our initial conclusions, notably that the inclusion of varying control variables does not significantly alter certain outcomes, hinting at their potential applicability in broader contexts. Additionally, we have implemented placebo tests to address concerns about measurement errors, further reinforcing the validity of our results. These findings emphasize that for companies to effectively got from innovation to invention for all engineers, a focus on changing management practices, motivational drivers, and the prevailing corporate culture is essential. Therefore, we encourage future researchers to design diversity pilots (i.e., randomized control trials) such as those pioneered by diversitypilots.org.

6 Conclusion

By surveying engineers and interviewing patent professionals, our study offers several insights into the invention process within high-tech firms. We found that the invention process is not uniform across firms, with meaningful variations in how ideas are collected, submitted, and reviewed for patenting. We also found that engineers' involvement in innovation is significantly influenced by factors such as management, culture, feedback on inventions, mentorship, role models, and incentives for invention. Importantly, our findings point towards a noticeable disparity for engineers from URGs regarding awareness, participation, and self-identity in the invention process.

Our study reveals that only 39% of engineers are familiar with the IP process at their firms, which is four percentage points lower for engineers from URGs. Despite no difference in the propensity to have a patentable idea, these engineers from URGs were less likely to be involved in projects that could yield patentable inventions, to have patent key performance indicators, and to be a part of meetings where new technologies were being created. Additionally, we found that engineers from URGs are significantly less likely to self-identify as inventors and are less comfortable deciding if their ideas are worth submitting for patent consideration.

Our investigation also points to a distinct role played by self-perception and internal and external perceptions of the benefits of being an inventor. The analysis indicates that engineers from URGs are more likely to spend time on non-technical tasks and less likely to engage in tasks they believe will lead to inventive disclosures. Furthermore, a quarter of these engineers believed that social value should be prioritized when developing inventions, aligning with their reported efforts towards inventions of "significant value to society at large." That the engineers who do invent focus on inventions with greater non-pecuniary benefits to themselves is consistent with our simple, static model in which the perceived benefits must be higher to outweigh the many additional costs engineers from URGs face (e.g., from lack of tacit knowledge, role models, networks, etc.).

Lastly, we addressed potential critiques with our survey methodology, including concerns about a selected sample of engineers, the possibility of self-serving responses, and unobserved factors driving correlations. Although our study cannot conclusively establish causal relationships, our findings provide critical insights for firms to encourage innovation, especially amongst URGs. Encouragingly, our study suggests that simple reframing, such as focusing on the term "problem-solvers" rather than "inventors," may facilitate greater participation. Similarly, cultural changes within firms, such as improving the transparency of the patent review process and fostering mentorship programs, could also be critical enablers of increased engagement in the patenting process. As firms seek to maximize innovation, fostering inclusive and encouraging environments for all engineers will be crucial to harnessing the full potential of their diverse workforce.

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Figure 1.

Variations in invention submission process across firms

This figure illustrates the diverse approaches and methodologies employed by firms in the invention submission process, showcasing the differences in idea collecting methods, phases of review, and chances to iterate on an invention disclosure filings (IDF) based on feedback. The figure encapsulates the heterogeneous practices across firms shedding light on the varying interactive dynamics between engineers, patent professionals, and patent review boards. Comparing these varied approaches underscores the importance of understanding intra-firm dynamics in analyzing innovation outputs and the inclusiveness of methods used to collect new ideas and transform those inventive ideas into patented technologies.

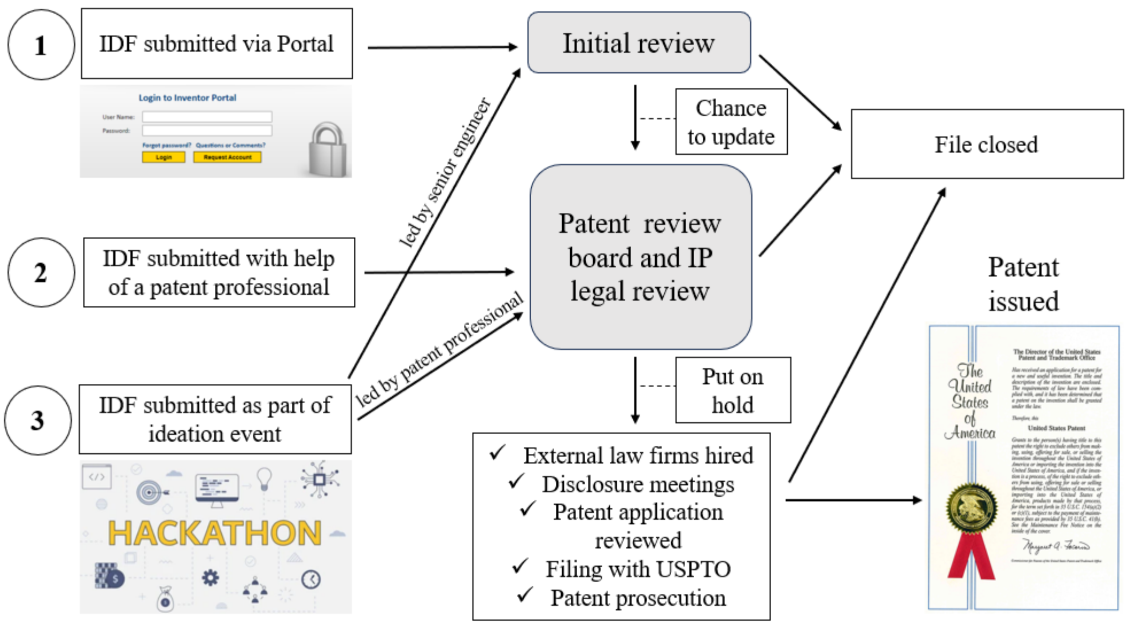


Figure 2.

Factors influencing the invention submission process

This figure illustrates the distinct factors at the firm (external) and innovator (internal) levels that shape the decision to submit invention ideas. The boxes along the top of the figure show that firm-level factors are grouped into informal and formal institutions such as culture and management practices. Individual-level traits are grouped into individual traits, early-life experiences, and career-life balance. The blue, yellow, and red dot indicate which facts are likely to influence individual ideas (blue), group ideas (red), and idea submission (yellow).

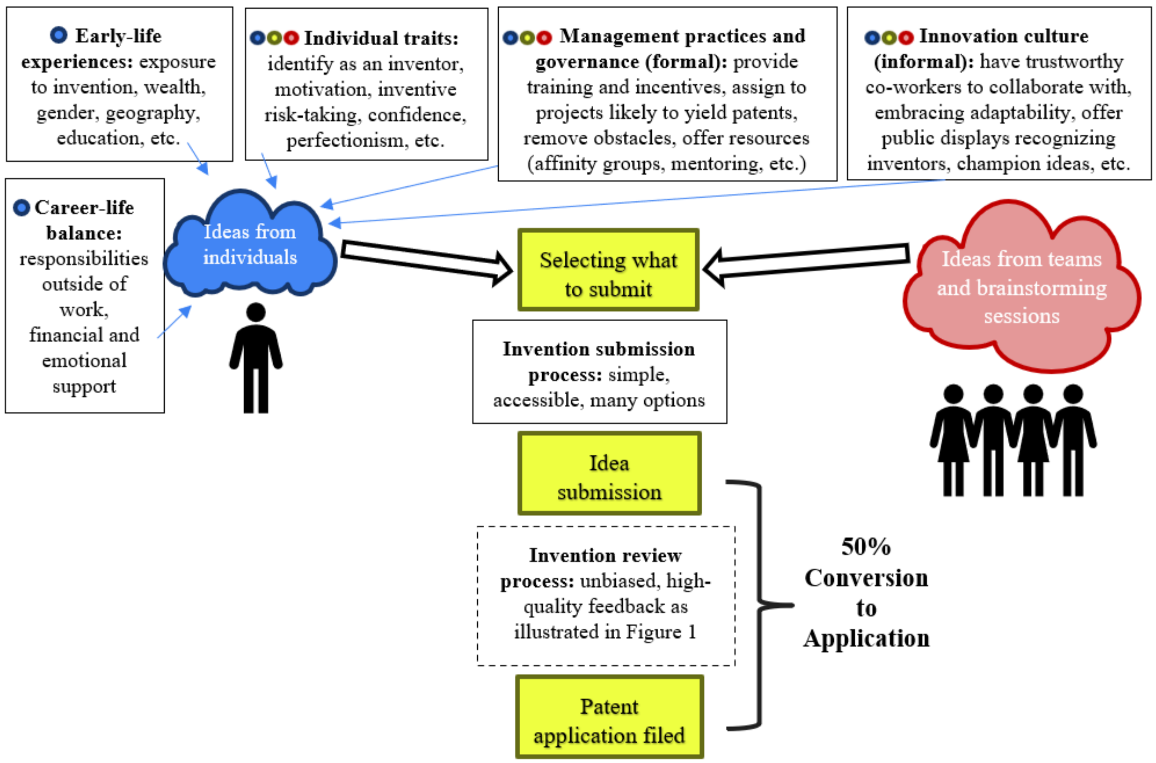
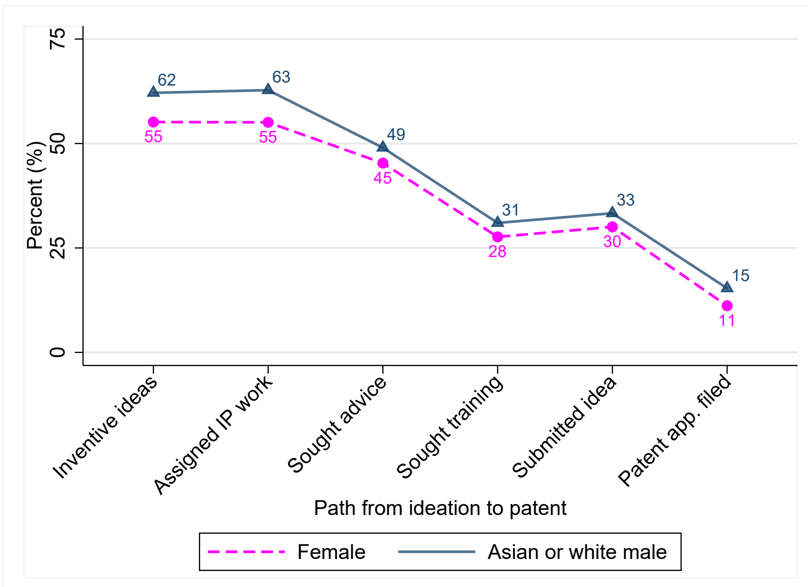


Figure 3.

Steps in the inventor's path from ideation to patent by gender and ethnicity

This figure illustrates the attrition of female engineers and engineers from underrepresented ethnicities ("URM") through various stages of the invention process, from ideation to patent application filing. The figure on the top focuses on gender and the figure on the bottom ethnicity. The dashed magenta line and circles represent the average for female engineers. The dashed cyan line and squares represent the average for engineers from URM. The navy line and triangles represent the average for Asian or white male engineers. The numbers mark the percent of engineers partaking in a specific step. It offers a detailed view into the journey from inventive idea to granted patent, pinpointing where engineers with potentially worthy ideas may fall off track.



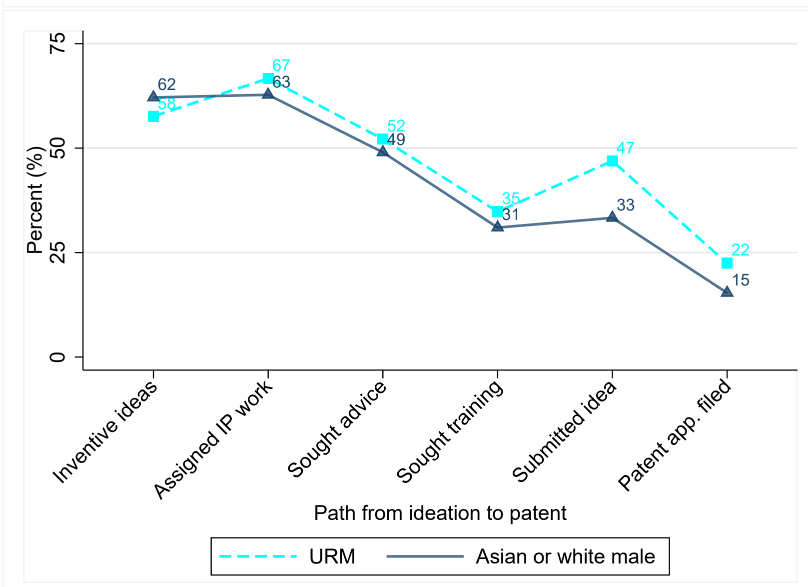


Figure 4.
Relative gains and losses in the inventor's path from ideation to patent
This figure illustrates the cumulative positioning of underrepresented engineers through various stages of the invention process relative to well-represented engineers (i.e., Asian and white males). The figure on top focuses on gender. The magenta bars represent the cumulative position of female engineers and the numbers represent the percentage point difference relative to Asian or white males. The figure on the bottom focuses on ethnicity. The cyan bars represent the cumulative position of engineers from under-represented ethnicities and the numbers represent the percentage point difference relative to Asian or white males.

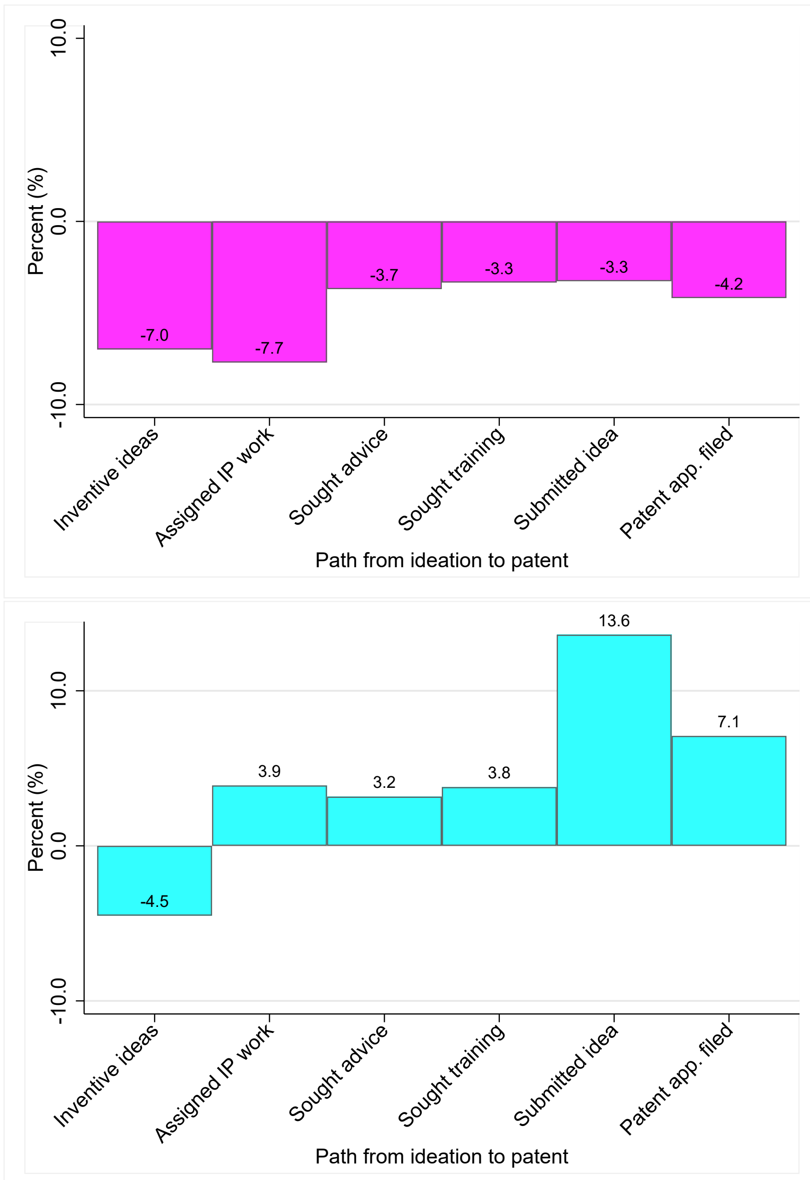


Table 1.

Summary statistics for demographic variables

This table provides descriptive statistics from the survey demographic variables questions for all survey respondents from engineers and technical staff. For a detailed description of each variable, see Appendix B. The survey questions are presented in Appendix A.

Panel A. Demographic characteristics	Obs. (1)	Mean (2)	USA Mean (3)	Male Mean (4)	Female Mean (5)
Gender					
Female	3758	22%	20%	0%	100%***
Male	3758	77%	80%	100%	0%***
Other (e.g., non-binary, transgender)	3758	0.5%	0.8%	0%	0%**
Ethnicity					
American Indian, Alaska Native, or Native Hawaiian	3714	0.2%	0.4%	0.2%	0.0%
Asian	3714	77%	45%	75%	83%***
Black	3714	0.5%	1%	0%	1%
Latinx	3714	2%	5%	2%	3%
Multi-racial	3714	1%	3%	1%	1%
White	3714	20%	45%	22%	14%***
Geographic Location					
East Asia	3989	28%	0%	31%	21%***
Europe	3989	1%	0%	1%	1%
Middle East	3989	3%	0%	3%	2%**
North America	3989	38%	100%	35%	35%
United States of America	3989	33%	100%	33%	28%**
South Asia	3989	7%	0%	7%	7%
Southeast Asia	3989	23%	0%	21%	33%***
Other (e.g., Australia, Africa)	3989	1%	0%	1%	0%
Business unit					
Business (e.g., sales, strategy, leadership)	3746	5%	7%	4%	6%**
Data science	3746	24%	31%	25%	18%***
Engineering	3746	49%	37%	47%	58%***
Manufacturing	3746	13%	8%	14%	10%***
Products	3746	10%	18%	10%	8%
Work environment					
In office	596	10%	9%	11%	7%
Hybrid	596	70%	72%	70%	66%
Fully remote	596	20%	18%	19%	28%**
Experience					
Time at [Company] (years)	3742	7.1	7.0	7.4	6.3***
Age (years)	3532	41.0	44.0	42.2	36.8***
Education [highest level completed]					
High school degree	3549	7%	7%	7%	9%*
College degree	3549	47%	35%	47%	46%
Graduate degree	3549	36%	39%	36%	38%
Doctorate degree	3549	9%	19%	10%	7%***
Non-work life					
I am single	309	20%	17%	18%	23%
I am partnered	309	80%	83%	82%	77%
My partner does not work	247	27%	25%	38%	9%***
My partner works	247	73%	75%	62%	91%***
My partner and I share equally in household and family duties	245	71%	75%	66%	79%**
My partner takes primary responsibility for household and family	245	17%	12%	25%	4%***
I take primary responsibility for household and family duties	245	12%	13%	10%	17%*

Table 2.

Engineers' awareness and participation in the IP process

This table provides descriptive statistics of the engineers' awareness and participation in the invention process segregated by demographic groups. Columns 1 to 2 summarize the frequency and mean for the full sample, while columns 3 to 8 report statistics for specific subgroups based on gender and ethnicity. Asian and white male engineers define the represented group (RG), while females and underrepresented minorities (URMs) define the underrepresented group (URG). The stars in columns 5, 7, and 8 denote the significance level from a t-test, indicating the likelihood that the observed differences in subgroup means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Full sample		Specific subgroups					
	Obs.	Mean	RG Obs.	RG Mean	URG Mean	Male Mean	Female Mean	URM Mean
Panel A. Awareness of invention process	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
I am aware of the process and tools where you can submit an idea for patenting. (1 = Yes, 0 = No)	3912	40%	2724	40%	39%	40%	39%	45%
Have you ever attended an IP training? (1 = Yes, 0 = No)	559	45%	259	46%	45%	45%	47%	40%
Yes, within the last 12 months	559	16%	259	21%	12%***	20%	12%**	19%
Yes, through an affinity group	339	21%	150	13%	28%***	12%	31%***	23%
Panel B. Participation in early steps of the invention process								
Have you ever had an idea that you thought might be patentable? (1 = Yes, 0 = No)	556	55%	259	58%	50%*	59%	47%**	62%
Are you regularly tasked with IP work? (e.g., participating in invention-creation meetings, authoring engineering documents, working on projects with patent KPIs) (1 = Yes, 0 = No)	747	65%	346	66%	62%	68%	55%***	73%*
Are you interested in working more on tasks that would lead to being a named inventor? (1 = Yes, 0 = No)	3128	61%	2345	62%	55%***	62%	55%***	58%
Have you ever sought help with navigating [Company's] patent process (e.g., by attending a training, talking to a patent professional, or patent mentor)? (1 = Yes, 0 = No)	750	47%	346	50%	45%	47%	50%	39%*
Panel C. Participation in later steps of the invention process								
How much have you participated in [Company's] patent process? (2 = Filed patent, 1 = Submitted but not filed, 0 = Did not submit)	3630	0.49	2611	0.49	0.42**	0.50	0.41***	0.69***
I have submitted Invention Disclosure(s) (1 = Yes, 0 = No)	3834	32%	2697	32%	28%**	33%	29%**	35%
An invention disclosure of mine has been filed as a patent application (1 = Yes, 0 = No)	3630	15%	2611	15%	12%**	16%	11%***	22%**
How many patent applications have been filed?	465	2.5	362	2.5	1.9	2.6	1.7	2.6
How was the Invention Disclosure submitted? Check all that apply.								
Via the inventor portal	586	38%	281	37%	40%	35%	52%***	28%*
Through a brainstorming or harvesting session	395	20%	194	20%	16%	21%	15%	22%
With the help of a patent professional	634	9%	301	10%	7%	9%	7%	5%
Patent professional reached out to me	354	5%	168	5%	5%	6%	5%	6%
I reached out to the patent professional	354	7%	168	6%	5%	7%	4%	9%

Table 3.

Engineers' self-identity and perceived impact of their inventive ideas

This table provides descriptive statistics of the engineers' self-identity and the perceived impact of their inventive ideas. Columns 1 to 2 summarize the frequency and mean for the full sample, while columns 3 to 8 report statistics for specific subgroups based on gender and ethnicity. Asian and white male engineers define the represented group (RG), while females and underrepresented minorities (URMs) define the underrepresented group (URG). The stars in columns 5, 7, and 8 denote the significance level from a t-test, indicating the likelihood that the observed differences in subgroup means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Full sample		Specific subgroups					
	Obs.	Mean	RG Obs.	RG Mean	URG Mean	Male Mean	Female Mean	URM Mean
Panel A. Self-identity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Do you self-identify as an inventor?	3874	46%	2700	49%	35%***	49%	35%***	36%**
Do you self-identify as a problem-solver?	561	96%	260	97%	95%	97%	96%	94%
Life impact of becoming an inventor	107	1.23	55	1.23	1.27	1.21	1.36	1.13
Panel B. Confidence in inventive ideas								
Are you comfortable deciding if your idea is worthy of submitting as an invention disclosure? (-2 = uncomfortable, 2 = comfortable)	3104	0.10	2332	0.17	-0.12***	0.17	-0.13***	-0.02
If you were unsure whether to submit an Invention Disclosure, what would you do next?								
Submit the Invention Disclosure anyway (and not seek advice)	3703	12%	2622	13%	9%***	13%	7%***	18%**
I will seek advice:	3512	80%	2535	79%	85%***	79%	85%***	82%
From someone else	413	50%	205	48%	59%*	49%	59%*	51%
From a patent professional	413	24%	205	24%	18%	24%	20%	19%
Not submit the Invention Disclosure (and not seek advice)	3512	10%	2535	10%	9%	10%	9%	5%
Panel C. Time for inventing								
Do you believe engaging in the patent process is a good use of your time? (1 = Yes, 0 = No)	191	48%	87	47%	51%	48%	50%	35%
In a typical work week, what percent (%) of your work time do you spend on the following tasks?								
Technical or engineering tasks that are likely to lead to inventons	238	15%	106	16%	12%	15%	13%	16%
Technical or engineering tasks that are unlikely to lead to inventions	238	61%	106	61%	60%	62%	60%	51%*
Other non-technical tasks	238	25%	106	23%	27%	23%	27%	34%
Men and women are equally assigned to projects that lead to inventive disclosures. (- 2 = Strongly disagree, 2 = Strongly agree)	3112	1.02	2341	1.08	0.86***	1.07	0.86***	0.50***

Table 4.

Engineers' perceived objectives, feedback, and subjectivity of the IP process

This table summarizes engineers' perceptions of the objectives of invention and their lived experiences of submitting ideas. Columns 1 to 2 summarize the frequency and mean for the full sample, while columns 3 to 8 report statistics for specific subgroups based on gender and ethnicity. Asian and white male engineers define the represented group (RG), while females and underrepresented minorities (URMs) define the underrepresented group (URG). The stars in columns 5, 7, and 8 denote the significance level from a t-test, indicating the likelihood that the observed differences in subgroup means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Full sample		Specific subgroups					
	Obs.	Mean	RG Obs.	RG Mean	URG Mean	Male Mean	Female Mean	URM Mean
Panel A. Perceived objectives of the invention process	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
When working on projects that may result in Invention Disclosure, I focus on:								
Defending products and inventions from competitive threats	371	12%	187	14%	9%	14%	9%	10%
Experimenting with big, risky ideas that may prove to be foundational	371	23%	187	25%	23%	25%	23%	23%
Incremental changes as solutions to the problems	371	58%	187	57%	60%	55%	61%	58%
Other	371	6%	187	3%	8%*	6%	8%	10%
The invention I worked on is primarily of value to individuals or businesses that use it directly (-2 = Strongly disagree, 2 = Strongly agree)	152	1.24	70	1.23	1.18	1.22	1.25	1.02
The invention that I worked on is of significant value to society at large, beyond its direct users (-2 = Strongly disagree, 2 = Strongly agree)	141	0.46	59	0.44	0.47	0.48	0.46	1.06**
In your view, what should be prioritized when developing an invention?								
Private value	223	5%	101	6%	0%**	5%	5%	0%
Social value	223	12%	101	8%	18%**	9%	17%*	24%
Both equally	223	18%	101	21%	17%	19%	17%	12%
It depends on context	223	65%	101	65%	64%	67%	61%	65%
Panel B. Feedback received from invention process								
I did not realize I could receive advice or feedback	326	25%	157	24%	28%	28%	21%	40%*
I receive better advice on submissions from peers and mentors	326	18%	157	18%	25%	17%	27%**	20%
I was satisfied with the feedback being offered	326	52%	157	56%	46%	52%	51%	37%*
I would rather focus on the future than feedback on what I cannot change	236	12%	111	14%	9%	13%	9%	10%
The feedback being offered is too negative	236	6%	111	4%	6%	6%	5%	5%
The feedback being offered is too vague	326	12%	157	10%	17%	11%	16%	13%
Panel C. Perception of the invention process								
For each of statement, indicate your level of agreement (-2 = Strongly disagree, 2 = Strongly agree)								
Men and women are equally likely to be named as inventors.	3115	1.04	2339	1.09	0.92***	1.08	0.93***	0.61***
Men and women are equally likely to submit an invention disclosure.	3116	0.95	2342	1.01	0.82***	1.00	0.83***	0.40***
My manager encourages the submission of invention disclosures.	3183	0.65	2381	0.68	0.62	0.66	0.63	0.28***
Mgmt. supports increasing women's representation in the inventing process.	3310	0.78	2431	0.82	0.68***	0.82	0.68***	0.60*
Invention process participants are positively and publicly recognized.	3123	0.81	2347	0.82	0.81	0.81	0.82	0.64

Table 5.

Factors working for and against participation in the IP process

This table provides descriptive statistics of the engineers' perceptions of the factors that are working against participation and that would encourage participation in the patenting process. Columns 1 to 2 summarize the frequency and mean for the full sample, while columns 3 to 8 report statistics for specific subgroups based on gender and ethnicity. Asian and white male engineers define the represented group (RG), while females and underrepresented minorities (URMs) define the underrepresented group (URG). The stars in columns 5, 7, and 8 denote the significance level from a t-test, indicating the likelihood that the observed differences in subgroup means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Full sample		Specific subgroups					
	Obs.	Mean	RG Obs.	RG Mean	URG Mean	Male Mean	Female Mean	URM Mean
Panel A. Factors preventing the submission of Invention Disclosures	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Individual inventor characteristics								
Discomfort with deciding if my idea is worthy of submitting	615	28%	292	30%	30%	27%	31%	26%
I don't feel the work I do is likely to yield patentable inventions	615	45%	292	50%	44%	48%	43%	33%**
I have not perfected my inventions to my satisfaction	615	13%	292	14%	15%	13%	13%	20%
Too busy	615	51%	292	55%	49%	55%	50%	51%
Too busy at home	566	29%	260	30%	32%	31%	37%	32%
Too busy with other work	566	31%	260	33%	26%	34%	21%***	32%
Management practices and the invention process								
Inventors are not positively and publicly celebrated	615	4%	292	5%	4%	4%	4%	4%
Not encouraged by management	615	14%	292	15%	14%	15%	12%	12%
The Invention Disclosure process needs improvement	264	9%	129	9%	7%	10%	8%	5%
Informal characteristics (e.g., cultural values and norms)								
Discomfort with disclosing my ideas to the patent review board	615	3%	292	3%	3%	4%	3%	6%
I do not have people with whom to collaborate on inventions	615	14%	292	11%	20%**	11%	22%***	13%
Inefficient workplace interactions	615	6%	292	6%	7%	5%	6%	3%
Our culture does not support inventing	566	6%	260	4%	7%	6%	5%	11%**
Panel B. Factors that would facilitate greater involvement in IP process								
Change management practices								
Being assigned to projects more likely to yield patentable inventions	3119	5%	2345	5%	6%	5%	5%	8%
Being given more time to work on patentable inventions	3069	5%	2313	5%	4%	5%	4%*	11%**
Inventor recognition, like a celebration, plaque, or limited-edition t-shirt	3614	5%	2556	4%	7%***	4%	6%**	12%***
Offer more training (in-person or virtual)	3661	61%	2596	62%	63%	61%	63%	54%*
Change the cultural norms								
Strengthen the innovation culture	3119	3%	2345	3%	3%	3%	2%	10%***
Encourage mentoring by senior engineers/scientists	3614	50%	2556	48%	59%***	47%	63%***	39%***
Change invention process								
Offer more brainstorming sessions to get early ideas	3614	9%	2556	7%	12%***	7%	11%***	25%***
One-on-one meeting with patent professionals	3614	28%	2556	29%	26%*	29%	27%	18%***
Simplifying and anonymizing the patent process	3661	20%	2596	21%	18%**	21%	18%*	19%

Table 6.

Factors influential in encouraging engineers to invent and ideas for underrepresented inventors

This table provides descriptive statistics of the engineers' perceptions of the factors most influential in encouraging engineers to submit Invention Disclosures. Columns 1 to 2 summarize the frequency and mean for the full sample, while columns 3 to 8 report statistics for specific subgroups based on gender and ethnicity. Asian and white male engineers define the represented group (RG), while females and underrepresented minorities (URMs) define the underrepresented group (URG). The stars in columns 5, 7, and 8 denote the significance level from a *t*-test, indicating the likelihood that the observed differences in subgroup means are not due to chance. ***, ** and * indicate *p*-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Full sample		Specific subgroups					
				RG	URG	Male	Female	URM
	Obs.	Mean	RG Obs.	Mean	Mean	Mean	Mean	Mean
Panel A. Most influential in encouraging idea submission	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Patent awards	410	41%	200	41%	43%	41%	43%	54%*
Knowing that I'm solving a problem for the greater good	410	38%	200	44%	34%*	43%	34%	23%**
Culture of innovation at [Company]	410	33%	200	37%	32%	37%	32%	37%
Peers	410	23%	200	25%	20%	25%	22%	17%
Recognition inside of the [Company]	410	23%	200	24%	24%	25%	24%	17%
Mentors at [Company]	410	20%	200	19%	25%	19%	24%	31%
Recognition outside of the [Company]	410	18%	200	17%	21%	17%	21%	17%
Performance reviews and firing and promotion decisions	410	11%	200	10%	12%	9%	14%	9%
Patent professionals	410	10%	200	11%	7%	11%	6%	11%
Management	410	9%	200	9%	13%	9%	11%	23%***
Internal trainings and policies	410	6%	200	7%	6%	6%	5%	9%
Famous inventors	410	5%	200	6%	3%	5%	5%	0%
Panel B. How can participation in idea submission be increased, especially for employees from under-represented groups?								
Better management	1568	20%	1173	19%	24%**	19%	25%***	13%
Offer more brainstorming sessions	1568	17%	1173	18%	15%	17%	16%	10%
Improve the culture	1568	14%	1173	13%	18%**	14%	18%*	23%
Simplify and anonymize the patent process	1568	13%	1173	13%	9%*	14%	8%***	29%***
Offer more training	1568	12%	1173	11%	14%	11%	14%	19%
Assign to projects more likely to yield inventions	1568	10%	1173	8%	15%***	8%	16%***	6%
Greater pecuniary incentives	1568	9%	1173	10%	7%*	10%	7%	3%
Provide more time for invention	1568	4%	1173	4%	5%	4%	6%	3%
More recognition, publicity, and appreciation	1568	4%	1173	4%	5%	4%	5%	3%
Create a mentoring program	1568	1%	1173	1%	1%	1%	1%	0%
One-on-one meetings with patent professionals	1568	0.2%	1173	0.1%	0.6%*	0.1%	0.6%**	0.0%
Require idea submission for career advancement	1568	0.1%	1173	0.0%	0.3%*	0.1%	0.0%	3.2%***

Table 7.

Mentorship and perceived impact

This table provides descriptive statistics of mentorship and the perceived impact of such relationships. Columns 1 to 2 summarize the frequency and mean for the full sample, while columns 3 to 8 report statistics for specific subgroups based on gender and ethnicity. Asian and white male engineers define the represented group (RG), while females and underrepresented minorities (URMs) define the underrepresented group (URG). The stars in columns 5, 7, and 8 denote the significance level from a *t*-test, indicating the likelihood that the observed differences in subgroup means are not due to chance. ***, ** and * indicate *p*-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Full sample		Specific subgroups					
			RG	RG	URG	Male	Female	URM
	Obs.	Mean	Obs.	Mean	Mean	Mean	Mean	Mean
Panel A. Mentorship in your time at [Company]	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Have you ever participated in a formal patent mentorship program?	251	24%	131	12%	44%***	12%	54%***	22%
Have you ever received informal patent mentorship?	354	38%	184	42%	38%	39%	46%	34%
Have you ever acted as a patent mentor?	140	39%	67	54%	18%***	53%	17%***	21%
Panel B. Perspective of those without a mentor								
What are the reasons you have no sought patent mentorship?								
I could not identify a potential mentor with overlapping interest	148	3%	77	3%	4%	3%	2%	8%
I did not believe patent mentorship would benefit me	148	7%	77	6%	8%	6%	10%	0%
I did not have time for patent mentorship	148	11%	77	12%	12%	12%	8%	17%
I did not think about it	148	79%	77	81%	78%	82%	78%	83%
I want to avoid activities that highlight my weakness to leaders	148	1%	77	1%	0%	1%	0%	0%
My co-workers already help me with IP so I don't need a mentor	148	3%	77	4%	2%	3%	4%	0%
Panel C. Perspective of those with a mentor and perceived impact								
How often would your patent mentor provide you with advice, suggestions, or support? (1 = Monthly, 6 = Several times a day)	115	1.7	54	1.7	1.7	1.7	1.7	1.6
Who first initiated the mentor-protégé like contact?								
Your mentor, by offering unsolicited advice, suggestions, or support	83	14%	35	29%	5%***	26%	5%***	13%
You, by asking the person for advice, suggestions, or support	83	7%	35	14%	2%*	15%	0%***	13%
You, by joining a formal mentorship program or an affinity group	83	78%	35	57%	93%***	59%	95%***	75%
To what extent do you disagree or agree with the statements about mentorship? (-2 = Strongly disagree, 2 = Strongly agree)								
I am planning to work on more invention disclosures at work	223	0.8	117	0.7	0.9	0.7	1.1**	0.7
I feel confident that I can incorporate my mentor's tips into my work process	221	0.7	116	0.7	0.6	0.6	0.8	0.4
I feel confident that I have the social connections necessary to get my invention ideas accepted by IP professionals	218	0.7	115	0.7	0.7	0.7	0.8	0.7
I learned a lot about patenting and become a better inventor	222	0.7	113	0.6	0.9*	0.5	1.1***	0.7
Being mentored increased my satisfaction at work	223	1.0	117	0.9	1.1	0.9	1.3***	0.8
Mentorship has helped me develop professionally and think broadly	89	1.2	34	1.2	1.2	1.1	1.3	1.0
I have benefited from my mentoring relationship	86	1.2	32	1.3	1.1	1.1	1.2	0.7*
My mentor introduced me to new inventors that I anticipate working with	86	1.1	31	1.0	1.1	1.0	1.2	1.1

Table 8.

The current state of management, culture, and trust

This table provides descriptive statistics of the engineers' perceptions of management, culture, and trust for their co-workers. Columns 1 to 2 summarize the frequency and mean for the full sample, while columns 3 to 8 report statistics for specific subgroups based on gender and ethnicity. Asian and white male engineers define the represented group (RG), while females and underrepresented minorities (URMs) define the underrepresented group (URG). The stars in columns 5, 7, and 8 denote the significance level from a t-test, indicating the likelihood that the observed differences in subgroup means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Full sample		Specific subgroups					
			RG	RG	URG	Male	Female	URM
	Obs.	Mean	Obs.	Mean	Mean	Mean	Mean	Mean
Panel A. Cultural norms	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Please evaluate the day-to-day interactions at [Company] and indicate which of these factors help us achieve our inventive goals (-2 = Weakness, which works against invention, 2 = Strength, key factor helping us to invent)								
Employees feel empowered, confident, and healthy	373	1.33	193	1.38	1.31	1.34	1.28	1.42
Information sharing among employees	376	1.32	195	1.34	1.29	1.33	1.22	1.66**
Employees' comfort in suggesting ideas, concerns, critiques	375	1.28	194	1.34	1.20	1.31	1.16	1.26
Trust among employees	371	1.25	193	1.28	1.25	1.24	1.27	1.34
New ideas develop organically	372	1.17	192	1.23	1.09	1.21	1.03	1.30
Broad agreement about goals	366	0.76	191	0.74	0.76	0.72	0.83	0.61
Willingness to hold employees accountable for unjust actions	358	0.21	189	0.31	0.09*	0.25	0.09	0.03
Urgency with which employees work	348	0.08	180	0.17	-0.08*	0.10	-0.03	-0.14
Average strength of cultural norms	381	0.94	195	0.98	0.87	0.95	0.87	0.94
Panel B. Management Practices								
I experience [Company] leadership to do the following: (0 = No, 1 = Yes)								
Give clear expectations	318	78%	172	80%	73%	80%	70%	85%
Provide coaching	307	61%	167	63%	36%	64%	48%	81%
Support my career development	332	80%	176	81%	79%	81%	76%	91%*
Gather multiple perspectives for decisions	325	65%	176	66%	61%	67%	57%	66%
Explain important details	321	73%	174	78%	67%*	76%	63%**	76%
Be pro-active about improving or removing barriers to inventiveness	282	59%	153	58%	57%	58%	54%	76%*
Inspire confidence, enthusiasm, and the courage to be inventive	289	70%	159	72%	63%	73%	62%*	78%
Be ethical and make fair decisions	322	77%	177	82%	69%**	82%	64%***	73%
Panel C. Effective culture and trust								
I believe [Company]'s corporate culture: (1 = Needs a substantial overhaul, 4 = is exactly where it should be)	377	3.16	197	3.25	3.14	3.21	3.09	3.20
Would you say that most of the time, people at [Company] are trying to be helpful, or that they are mostly just looking out for themselves? (-2 = Always looking out for themselves, 2 = Trying to be helpful)	375	1.52	194	1.65	1.34***	1.59	1.38**	1.48

Table 9.

External validation: analysis of invention disclosure databases by gender

This table provides a robustness check by comparing our survey measures of where engineers fall off the inventive path with actual invention disclosure databases sourced from three collaborating firms. The main variable of interest is step in the IP process, where 1 = invention submission, 2 = patent application, and 3 = patent granted. In Panel A and Panel B, the analysis concentrates on the diminishing prevalence of female inventorship along the inventive path. Panel C replicates Panel B but incorporates a control for the percentage of first-time inventors, ensuring that female is not simply a proxy for inexperienced engineers. Additional control variables include the number of inventors. Details of controls and fixed effects pertinent to all panels are listed beneath Panel C. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Dep. var. = Step in IP process				
	Firm 1	Firm 2	Firm 3	All firms	
Panel A.	(1)	(2)	(3)	(4)	(5)
Has a female inventor	-0.054	-0.120**	-0.145	-0.102***	-0.090***
	(0.037)	(0.052)	(0.093)	(0.033)	(0.032)
Observations	1149	1549	144	2842	2842
Adjusted R^2	0.230	0.108	0.231	0.123	0.186
Panel B.					
Pct. female inventors	-0.082	-0.302***	-0.138	-0.152***	-0.162***
	(0.053)	(0.102)	(0.116)	(0.055)	(0.053)
Observations	1149	1549	144	2842	2842
Adjusted R^2	0.230	0.111	0.225	0.122	0.187
Panel C.					
Pct. female inventors	-0.082	-0.270***	-0.135	-0.145***	-0.158***
	(0.053)	(0.102)	(0.118)	(0.055)	(0.053)
Pct. first-time inventors	0.058	-0.210***	-0.043	-0.108***	-0.082**
	(0.044)	(0.058)	(0.096)	(0.038)	(0.036)
Observations	1149	1549	141	2839	2839
Adjusted R^2	0.231	0.117	0.211	0.125	0.188
Control variables	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y
Firm fixed effects	N	N	N	N	Y

A Survey Questions and Logistics

Reliable surveys require careful design and sample planning. To minimize measurement error, we consulted experts to vet the survey design, including internal human resources (HR) teams responsible for designing and assessing employee survey measures throughout the calendar year. After receiving feedback from survey design specialists, the final survey contained different modules (e.g., familiarity with the IP process, mentoring, etc.). We randomized the modules received by survey respondents to reduce the time required to complete the survey. The median time to complete the survey is 8 minutes and 15 seconds. The average time to complete the survey is 29 minutes and 29 seconds. The surveys were all administered over the Internet, leaving the survey window and returning to complete it was possible. The survey is anonymous, does not require subjects to disclose their names, and is approved by the Institutional Review Board (IRB) at the authors' home institutions.

One advantage of online administration is the ability to randomly scramble the order of choices within a question to mitigate potential order-of-presentation effects. Specifically, the survey scrambled the order of answers when the respondent needed to assess various factors, or there were multiple choices. We did not reverse order the Likert scale, but we did repeat some aspects of the questions. From a survey design perspective, incorporating questions with both positive and negative biases is crucial as it mitigates acquiescence bias, ensuring that respondents are not merely agreeing with statements but are actively engaging with and considering each item. Further, the repetition of essentially equivalent questions framed differently enables the cross-verification of responses, enhancing the reliability and validity of the collected data by identifying inconsistencies and capturing a more nuanced understanding of respondents' perspectives. Finally, participants were allowed to skip questions if they did not want to answer them, so the number of observations varies across questions. Most multiple-choice questions included a free-text response option, so that survey takers could provide answers not explicitly specified in the question.

In addition, we use survey techniques that help attenuate the effect of noise attributable to potential respondent behavioral biases. To avoid engineers engaging in "cheap talk" about invention, we use a mix of questions that elicit hypothetical and real decisions. Neuroscience research suggests these two types of questions when asked in isolation, activate different parts of the brain. When the neuroscience researchers switched back and forth between hypothetical and actual choices, they discovered brain activity was stronger in the region associated with real choices, serving to reduce differences in response. Thus, by requiring respondents to switch back and forth between real and hypothetical decisions, our survey design tries to mitigate selection concerns.

Finally, invitations to take the survey followed different formats. A combination of HR professionals, patent professionals, and/or academics emailed the invitation. We know that framing a survey directly about invention or IP may deter some would-be inventors from taking the survey. For this reason, we iterated back and forth with HR departments on language that would be inclusive. Figure A.3 provides an example of a solicitation email used at one firm. Figure A.4 provides a second example. Similar language was used at the other firms as well. In each case the solicitation was sent to a diverse yet representative sample of engineers, and invitations were sent staggered. We worked directly with HR departments to ensure the representativeness of the sample. At one firm, female engineers were purposefully oversampled. At each firm, we sent the survey on a different initial date. We also sent reminder emails approximately two weeks after the initial invitation. In each case, the survey closed within six weeks of opening the survey.

Corporate accounting data are from the Compustat-CRSP fundamental annual database and are used to benchmark the surveyed and interviewed firms to a broader population of firms. Definitions are as follow.

Sales revenue = $REVT$

Revenue growth = $REVT/REVT_{t-1}$

Number of employees = EMP

Assets = AT

Firm size = $log(AT)$, in which AT is in real 2010 dollars.

R&D expenditures = $\log(1 + XRD)$ where missing values are set equal to 0

Is R&D active = indicator for $XRD > 0$

Intangible assets-to-total assets = $INTAN/AT$

Asset growth $= AT/AT_{t-1}$

Investment-to-Capital $= ((CAPX - SPPE) - (CAPX_{t-1} - SPPE_{t-1}))/PPENT_{t-1}$

Market Capitalization (MEQ) $= PRCC\_F \times CSHO$

Market Value of Assets $(MVA) = MEQ + DLC + DLTT + PSTKL - TXDITC$

Market-to-book ratio $= MVA/AT$

Profitability $= OIBDP/AT$

Debt-to-Assets $= (DLC + DLTT)/AT$

Some survey questions are combined to help illustrate a pattern. For instance, the stages of fallout in the inventor's path from ideation to granted patent combine similar but bespoke questions. Specifically, inventive ideas is "Yes, I have had an idea that I thought might be patentable" or "I am interested or very interested in inventing more." Assigned IP work includes those with an inventive idea or who had been assigned to an early-stage patent project. Sought advice is someone who indicated that yes they would seek advice if unsure conditional on being "Assigned IP work." Sought training is someone who attended training, has a mentor, or indicates an awareness of IP condition on being "Assigned IP work." Submitted idea is conditional on "Assigned IP work," as is patent application filed.

Table A.1.
Benchmarking responses to Compustat

This table provides descriptive statistics from the survey and interview firms relative to Compustat firms. Column 1 summarizes public firms from the survey and interview process, column 2 summarizes public firms from Compustat that have been granted a patent in the last 5 years, and column 3 summarizes all public firms from Compustat for the most recent fiscal year-end that occurred before the date of the survey and interviews. Panel A summarizes firm characteristics. Panel B summarizes patent characteristics. All samples are limited to North American firms. For a detailed description of each variable, see the definitions in Appendix A.

Panel A. Firm characteristcs	Survey and interview firms (1)	Patenting firms (2)	Compustat firms (3)
Sales revenue	66,813	11,878***	4,300
Revenue growth	14%	24%	70%
Number of employees	3.6	1.8***	1.1
Firm size	10.3	7.6***	6.8
Is R&D active	100%	81%*	42%
R&D expenditures	10,617	665***	243
Intangible assets-to-toal assets ratio	21%	23%	17%
Asset growth	5%	5%	6%
Net investment-to-capital raito	28%	20%	34%
Market-to-book ratio	2.8	2.1	3.7
Profitability	-8.4%	-1.1%	-10.7%
Debt-to-asset ratio	29.7%	29.4%	30.5%
Panel B. Patent characteristics			
Patents granted (2018-2022)	2670	162***	
KPSS value per patent	24.1	25.1	
KPSS citations per patent	0.4	0.5	

Figure A.1.
Benchmarking frequency of patents by technology subcategry
This histogram delineates the distribution of technology subcategories, as per the classification framework proposed by Schmoch (2008), for patents filed in 2018 or later and issued to public firms in North America. Frequencies of patents granted to the firms in our sample are superimposed on the histogram in mustard color for comparative analysis.

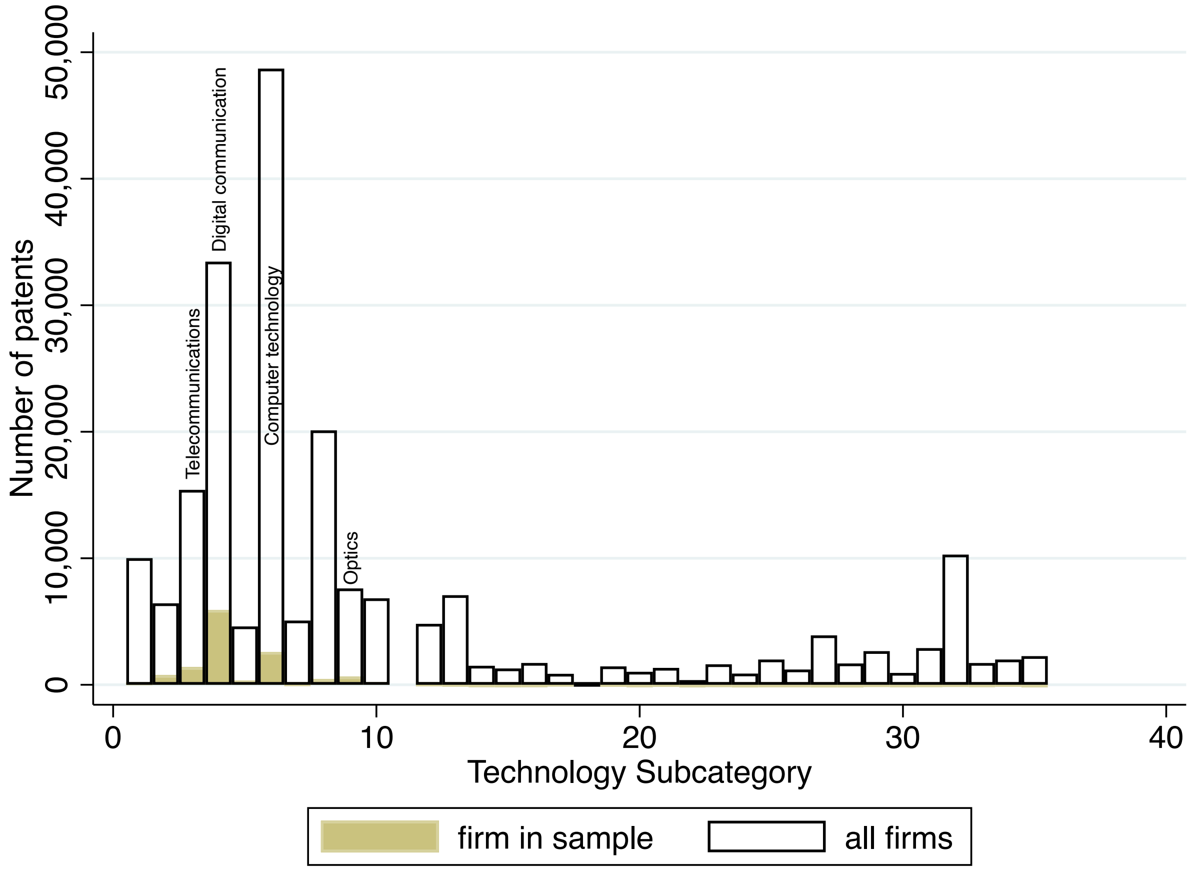


Figure A.2.

Distribution of technology subcategories for sampled firms

This figure illustrates the percentage composition of patents across various technology subcategories, as classified according to Schmoch (2008), and issued to the public firms in North America that our sample of engineers work at. The data pertains to patents filed in the year 2018 or subsequent years. For example, the "Digital Communication" subcategory constitutes the largest segment, accounting for 17% of the patents in the sample. Yet the data from the sampled firms exhibits a diverse technological landscape, featuring representation from over 30 distinct technology subcategories.

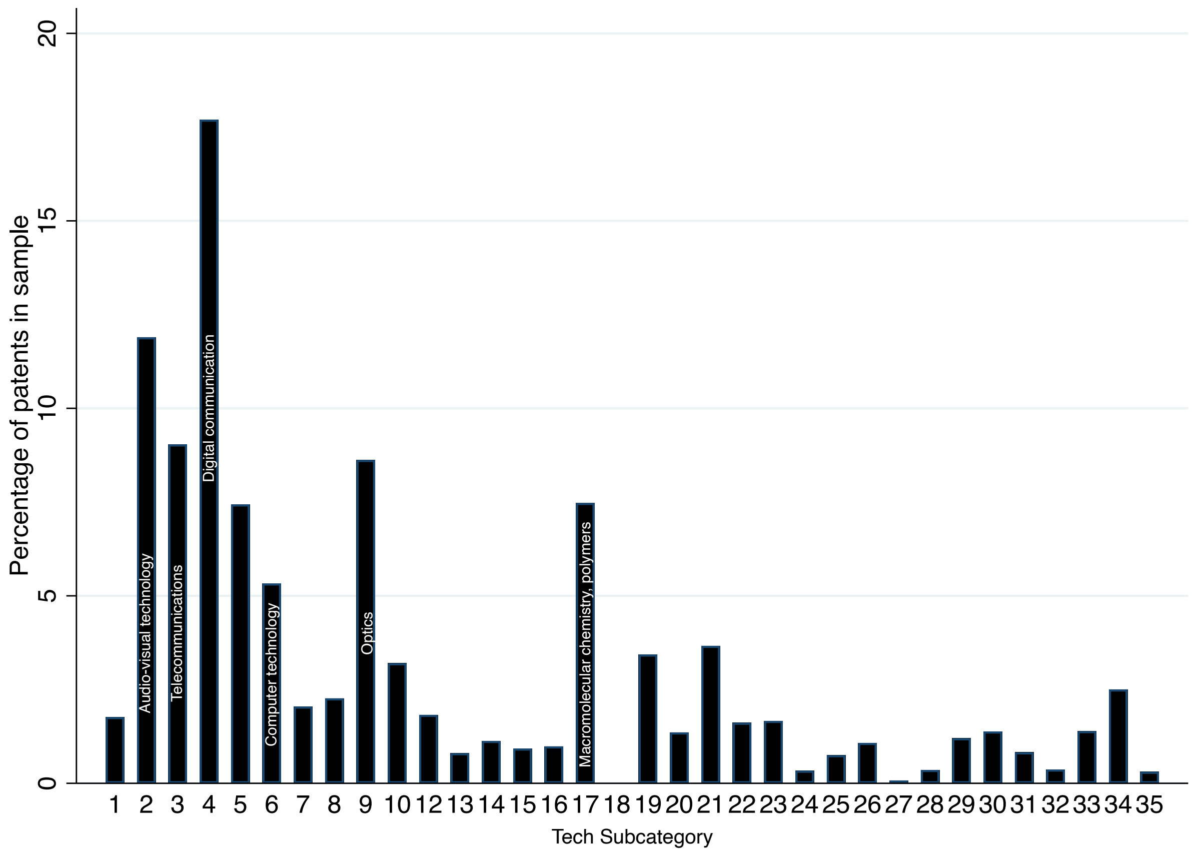


Figure A.3.

Example of non-biased survey solicitation email

This figure displays a representative survey solicitation email designed to avoid any respondent framing and ensure unbiased, genuine responses regarding innovation perspectives and experiences. The language within this email was crafted with the help of firms' HR departments to maintain neutrality, refraining from leading the potential respondent towards any predetermined conclusions or inducing any response bias. The objective of presenting this figure is to provide transparency in our data collection process and the integrity of the survey instrument.

Subject: Please Complete this Survey – We Need Your Help!

Dear X,

ABC strives to be an innovative company, and as a member of our community, your unique perspectives on the innovation process are invaluable to us. In partnership with researchers at the Diversity Pilots Initiative (diversitypilots.org), we are conducting a short, voluntary survey to understand the diverse range of experiences encountered by our employees. We would greatly appreciate your input.

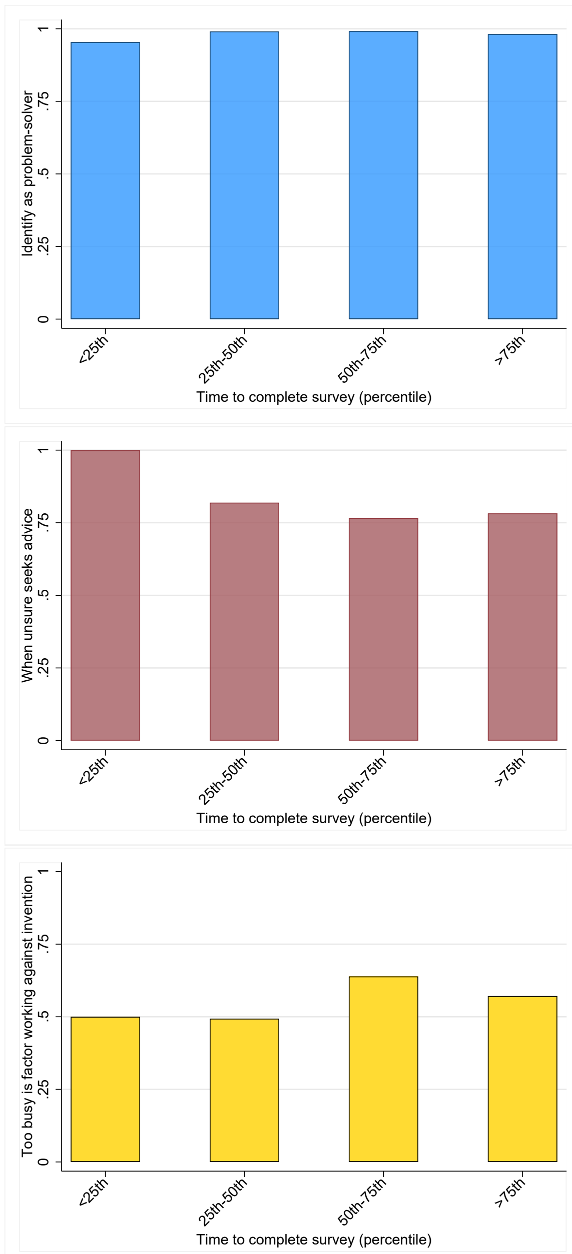
The survey aims to drive meaningful change and foster a more inclusive environment for all workers at ABC. Your contribution to this initiative would help us gauge the current innovation process and shape future strategies and practices.

Please don't worry; your responses will be kept confidential and used only for research and improvement at ABC. Here are the details of the survey:

- It should take approximately 10 minutes to complete.
- We have ensured that the survey is as simple as possible to navigate and can be completed at your own pace.
- **Follow this link to the Survey:** ${l://SurveyLink?d=Take the Survey}
- Or copy and paste the URL below into your internet browser: ${l://SurveyURL}
- Follow the link to opt out of future emails: ${l://OptOutLink?d=Click here to unsubscribe}

Your experiences are what we need to make this data collection genuinely representative. Even if you don't consider yourself to be an inventor, we want to hear from you and understand your insights. We look forward to your participation and greatly value your input. **Please take some time out of your busy days to complete the survey.**

Figure A.4.
Reliability of survey measures
The plot shows bar graphs for three survey questions from various modules (aspiration to invent, identity as an inventor, factors working against invention, etc.). Each bar represents the mean response by quartile of duration taking the survey. The responses are statistically indistinguishable by survey duration.



B Additional Tables

Table B.1.

Gender and the inventive path conditional on demographics, identity, and risk-taking

This table summarizes the extent to which female engineers' perceptions and experiences along the inventive path are distinct. The table uses survey data and ordinary least squares (OLS) regressions for the analyses. Details of controls and fixed effects pertinent to all panels are listed beneath Panel E. Each panel represents step(s) in the inventive path. Demographic controls include age, work experience, education, region, and business unit. Inventive risk controls for the focus of the invention process (defensive, experimental, incremental, or other). Self-identity controls for identifying as an inventor and the action taken if unsure whether to submit an Invention Disclosure. Culture controls include aggregate cultural norms, cultural effectiveness, and generalized trust. Management controls account for managerial encouragement. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

Panel A. Dep. var = Yes, I have had an idea that might be patentable.	(1)	(2)	(3)	(4)	(5)	(6)
Female	-0.092*	-0.107**	-0.029	-0.035	-0.114**	-0.045
	(0.047)	(0.054)	(0.055)	(0.048)	(0.056)	(0.054)
Observations	483	371	330	371	330	372
Adjusted R^2	0.062	0.104	0.083	0.259	0.096	0.065
Panel B. Dep. var = Yes, I am aware of the IP process and tools.						
Female	-0.056***	-0.052***	0.022	-0.019	-0.013	-0.055***
	(0.018)	(0.019)	(0.030)	(0.019)	(0.035)	(0.019)
Observations	3744	3464	331	3387	332	3585
Adjusted R^2	0.138	0.172	0.005	0.211	0.013	0.129
Panel C. Dep. var = Yes, I have submitted Invention Disclosure(s).						
Female	-0.083***	-0.073***	0.080*	-0.053***	0.011	-0.086***
	(0.017)	(0.018)	(0.045)	(0.018)	(0.051)	(0.018)
Observations	3678	3442	314	3364	313	3563
Adjusted R^2	0.142	0.184	0.027	0.195	-0.004	0.125
Panel D. Dep. var = Yes, an Invention Disclosure of mine has been filed as a patent.						
Female	-0.057***	-0.045***	-0.009	-0.029**	-0.067	-0.062***
	(0.014)	(0.014)	(0.060)	(0.014)	(0.061)	(0.015)
Observations	3515	3415	295	3335	288	3400
Adjusted R^2	0.049	0.128	0.117	0.138	0.097	0.052
Panel E. Dep. var = Step in IP process.						
Female	-0.143***	-0.119***	0.056	-0.083***	-0.062	-0.151***
	(0.029)	(0.029)	(0.081)	(0.029)	(0.087)	(0.029)
Observations	3515	3415	295	3335	288	3400
Adjusted R^2	0.127	0.193	0.064	0.210	0.045	0.122
Firm fixed effects	Y	Y	Y	Y	Y	Y
Demographics	N	Y	N	N	N	N
Inventive risk	N	N	Y	N	N	N
Self-identity	N	N	N	Y	N	N
Culture	N	N	N	N	Y	N
Management	N	N	N	N	N	Y

Table B.2.

Ethnicity and the inventive path conditional on demographics, identity, and risk-taking

This table summarizes the extent to which URM engineers' perceptions and experiences along the inventive path are distinct. The table uses survey data and ordinary least squares (OLS) regressions for the analyses. Details of controls and fixed effects pertinent to all panels are listed beneath Panel E. Each panel represents step(s) in the inventive path. Demographic controls include age, work experience, education, region, and business unit. Inventive risk controls for the focus of the invention process (defensive, experimental, incremental, or other). Self-identity controls for identifying as an inventor and the action taken if unsure whether to submit an Invention Disclosure. Culture controls include aggregate cultural norms, cultural effectiveness, and generalized trust. Management controls account for managerial encouragement. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

Panel A. Dep. var = Yes, I have had an idea that might be patentable.						
	(1)	(2)	(3)	(4)	(5)	(6)
Underrepresented minority (URM)	0.066	0.126	0.163*	0.147**	0.075	0.087
	(0.071)	(0.083)	(0.084)	(0.073)	(0.080)	(0.081)
Observations	458	342	311	345	312	347
Adjusted R^2	0.058	0.097	0.097	0.250	0.089	0.066
Panel B. Dep. var = Yes, I am aware of the IP process and tools.						
URM	-0.089**	-0.086*	-0.067	-0.036	-0.049	-0.097**
	(0.041)	(0.048)	(0.048)	(0.047)	(0.050)	(0.043)
Observations	3683	3398	312	3322	314	3525
Adjusted R^2	0.138	0.170	0.009	0.210	0.010	0.126
Panel C. Dep. var = Yes, I have submitted Invention Disclosure(s).						
URM	-0.089**	-0.064	-0.072	-0.040	-0.093	-0.085**
	(0.039)	(0.046)	(0.072)	(0.045)	(0.072)	(0.041)
Observations	3616	3378	296	3301	297	3505
Adjusted R^2	0.132	0.175	0.023	0.189	-0.002	0.114
Panel D. Dep. var = Yes, an Invention Disclosure of mine has been filed as a patent.						
URM	0.016	0.013	0.083	0.052	0.047	0.024
	(0.036)	(0.037)	(0.095)	(0.037)	(0.088)	(0.038)
Observations	3452	3353	277	3274	272	3341
Adjusted R^2	0.043	0.120	0.102	0.132	0.073	0.044
Panel E. Dep. var = Step in IP process						
URM	-0.042	-0.034	0.030	0.027	-0.004	-0.025
	(0.072)	(0.075)	(0.130)	(0.074)	(0.126)	(0.076)
Observations	3452	3353	277	3274	272	3341
Adjusted R^2	0.118	0.182	0.047	0.202	0.025	0.111
Firm fixed effects	Y	Y	Y	Y	Y	Y
Demographics	N	Y	N	N	N	N
Inventive risk	N	N	Y	N	N	N
Self-identity	N	N	N	Y	N	N
Culture	N	N	N	N	Y	N
Management	N	N	N	N	N	Y

Table B.3.

External validation: analysis of invention disclosure databases by gender

This table provides a robustness check by comparing our survey measures of where engineers fall off the inventive path with actual invention disclosure databases sourced from three collaborating firms. The main variable of interest is having a patent granted. In Panel A and Panel B, the analysis concentrates on the diminishing prevalence of female inventorship along the inventive path. Panel C replicates Panel B but incorporates a control for the percentage of first-time inventors, ensuring that female is not simply a proxy for inexperienced engineers. Additional control variables include the number of inventors. Details of controls and fixed effects pertinent to all panels are listed beneath Panel C. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Dep. var. = Patent granted				
	Firm 1	Firm 2	Firm 3	All firms	
Panel A.	(1)	(2)	(3)	(4)	(5)
Has a female inventor	-0.071**	-0.052*	-0.092	-0.078***	-0.078***
	(0.031)	(0.027)	(0.138)	(0.022)	(0.022)
Observations	1149	1584	154	2887	2887
Adjusted R^2	0.099	0.099	0.394	0.037	0.093
Panel B.					
Pct. female inventors	-0.098**	-0.108**	-0.114	-0.123***	-0.137***
	(0.044)	(0.052)	(0.171)	(0.036)	(0.035)
Observations	1149	1584	154	2887	2887
Adjusted R^2	0.099	0.100	0.394	0.036	0.094
Panel C.					
Pct. female inventors	-0.097**	-0.105**	-0.114	-0.121***	-0.136***
	(0.044)	(0.052)	(0.172)	(0.036)	(0.035)
Has a first-time inventor	0.022	-0.016	0.003	-0.025	-0.014
	(0.032)	(0.025)	(0.109)	(0.021)	(0.020)
Observations	1149	1584	154	2887	2887
Adjusted R^2	0.099	0.099	0.390	0.036	0.094
Control variables	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y
Firm fixed effects	N	N	N	N	Y

C Engineers in the United States

The United States, with its diverse mix of cultures, ethnicities, and histories, presents a particularly intriguing setting against which to analyze the barriers to patenting for high-tech engineers. Given the nation's rich diversity, with its long-standing challenges and progress in matters of race and gender, the experiences of U.S. engineers can offer distinct insights that might be less discernible in a global sample.

While our broader investigation, which encompassed survey responses from high-tech engineers and interviews with patent professionals, emphasized the experiences of URGs in multinational firms, it is essential to investigate the uniquely American context for two reasons. First, one cannot discount the possible nuances and complexities that arise due to the U.S.'s distinct historical trajectory, especially in matters of gender and racial dynamics. Thus, we are particularly interested in whether the opt-in, competitive ethos of innovation we observed within these firms is more or less evident in the United States.

A second reason to study the U.S. is its role in shaping innovation culture worldwide, given that its academic institutions and corporate behemoths serve as a foundational learning experience for young engineers (Bernstein et al., 2022). Thus, with their specific cultural and historical idiosyncrasies, American institutions could influence the emergence of certain behaviors and tendencies that subsequently manifest as factors working for or against the patenting process worldwide.

For these reasons, in this Appendix, we present tables and analyses that replicate our main findings but focus exclusively on engineers working in the United States. Through this narrowed lens, we look for any distinct patterns or insights that may further our understanding of the dynamics of the invention process within firms and any barriers to inclusive innovation in the high-tech engineering domain.

Table C.1.

Engineers' awareness and participation of the IP process

This table provides descriptive statistics of the engineers' awareness and participation in the invention process segregated by demographic groups. Columns 1 to 2 summarize the frequency and mean for the full sample, while columns 3 to 8 report statistics for specific subgroups based on gender and ethnicity. Asian and white male engineers define the represented group (RG), while females and underrepresented minorities (URMs) define the underrepresented group (URG). The stars in columns 5, 7, and 8 denote the significance level from a t-test, indicating the likelihood that the observed differences in subgroup means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Full sample		Specific subgroups					
	Obs.	Mean	RG Obs.	RG Mean	URG Mean	Male Mean	Female Mean	URM Mean
Panel A. Awareness of invention process	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
I am aware of the process and tools where you can submit an idea for patenting. (1 = Yes, 0 = No)	1297	50%	806	50%	45%	49%	50%	39%**
Have you ever attended an IP training? (1 = Yes, 0 = No)	308	46%	144	49%	41%	46%	47%	25%***
Yes, within the last 12 months	308	16%	144	22%	7%***	21%	9%**	13%
Yes, through an affinity group	132	13%	60	7%	17%*	6%	22%***	0%
Panel B. Participation in early steps of the invention process								
Have you ever had an idea that you thought might be patentable? (1 = Yes, 0 = No)	304	59%	143	60%	55%	62%	51%	63%
Are you regularly tasked with IP work? (e.g., participating in invention-creation meetings, authoring engineering documents, working on projects with patent KPIs) (1 = Yes, 0 = No)	473	71%	220	72%	71%	73%	64%*	76%
Are you interested in working more on tasks that would lead to being a named inventor? (1 = Yes, 0 = No)	833	63%	592	63%	61%	63%	60%	63%
Have you ever sought help with navigating [Company's] patent process (e.g., by attending a training, talking to a patent professional, or patent mentor)? (1 = Yes, 0 = No)	477	49%	221	53%	44%*	49%	51%	32%***
Panel C. Participation in later steps of the invention process								
How much have you participated in [Company's] patent process? (2 = Filed patent, 1 = Submitted but not filed, 0 = Did not submit)	1104	0.65	728	0.64	0.55	0.65	0.55	0.69
I have submitted Invention Disclosure(s) (1 = Yes, 0 = No)	1278	37%	800	38%	31%**	38%	34%	31%
An invention disclosure of mine has been filed as a patent application (1 = Yes, 0 = No)	1104	22%	728	22%	16%*	23%	16%**	24%
How many patent applications have been filed?	204	3.4	143	3.6	2.4	3.4	2.0	2.6
How was the Invention Disclosure submitted? Check all that apply.								
Via the inventor portal	382	36%	184	40%	28%**	36%	42%	18%***
Through a brainstorming or harvesting session	213	30%	107	32%	24%	32%	18%*	32%
With the help of a patent professional	420	11%	199	13%	7%*	12%	7%	7%
Patent professional reached out to me	172	8%	81	10%	6%	11%	4%	11%
I reached out to the patent professional	172	12%	81	11%	8%	13%	4%	17%

Table C.2.

Engineers' self-identity and perceived impact of their inventive ideas

This table provides descriptive statistics of the engineers' self-identity and the perceived impact of their inventive ideas. Columns 1 to 2 summarize the frequency and mean for the full sample, while columns 3 to 8 report statistics for specific subgroups based on gender and ethnicity. Asian and white male engineers define the represented group (RG), while females and underrepresented minorities (URMs) define the underrepresented group (URG). The stars in columns 5, 7, and 8 denote the significance level from a t-test, indicating the likelihood that the observed differences in subgroup means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively..

	Full sample		Specific subgroups					
	Obs.	Mean	RG Obs.	RG Mean	URG Mean	Male Mean	Female Mean	URM Mean
Panel A. Self-identity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Do you self-identify as an inventor?	1292	48%	804	52%	35%***	51%	35%***	33%***
Do you self-identify as a problem-solver?	309	96%	144	98%	96%	98%	96%	94%
Life impact of becoming an inventor	72	1.22	41	1.25	1.25	1.23	1.41	0.89
Panel B. Confidence in inventive ideas								
Are you comfortable deciding if your idea is worthy of submitting as an invention disclosure? (-2 = uncomfortable, 2 = comfortable)	815	0.26	582	0.39	-0.09***	0.36	-0.16***	-0.02*
If you were unsure whether to submit an Invention Disclosure, what would you do next?								
Submit the Invention Disclosure anyway (and not seek advice)	1254	17%	794	18%	14%*	19%	10%***	21%
I will seek advice:	1085	79%	717	76%	83%**	76%	86%***	80%
From someone else	276	50%	138	49%	60%	50%	60%	46%
From a patent professional	276	24%	138	23%	18%	23%	20%	21%
Not submit the Invention Disclosure (and not seek advice)	1085	8%	717	8%	8%	8%	9%	5%
Panel C. Time for inventing								
Do you believe engaging in the patent process is a good use of your time? (1 = Yes, 0 = No)	169	47%	77	43%	49%	43%	53%	26%
In a typical work week, what percent (%) of your work time do you spend on the following tasks?								
Technical or engineering tasks that are likely to lead to inventons	132	11%	60	14%	7%**	13%	9%	6%
Technical or engineering tasks that are unlikely to lead to inventions	132	62%	60	65%	58%	65%	58%	61%
Other non-technical tasks	132	26%	60	21%	35%***	22%	32%**	33%
Men and women are equally assigned to projects that lead to inventive disclosures. (- 2 = Strongly disagree, 2 = Strongly agree)	808	0.76	579	0.87	0.32***	0.85	0.24***	0.41**

Table C.3.

Engineers' perceived objectives, feedback, and subjectivity of the IP process

This table summarizes engineers' perceptions of the objectives of invention and their lived experiences of submitting ideas. Columns 1 to 2 summarize the frequency and mean for the full sample, while columns 3 to 8 report statistics for specific subgroups based on gender and ethnicity. Asian and white male engineers define the represented group (RG), while females and underrepresented minorities (URMs) define the underrepresented group (URG). The stars in columns 5, 7, and 8 denote the significance level from a t-test, indicating the likelihood that the observed differences in subgroup means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Full sample		Specific subgroups					
			RG	RG	URG	Male	Female	URM
	Obs.	Mean	Obs.	Mean	Mean	Mean	Mean	Mean
Panel A. Perceived objectives of the invention process	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
When working on projects that may result in Invention Disclosure, I focus on:								
Defending products and inventions from competitive threats	245	13%	126	15%	10%	15%	10%	13%
Experimenting with big, risky ideas that may prove to be foundational	245	24%	126	25%	22%	24%	24%	17%
Incremental changes as solutions to the problems	245	55%	126	55%	57%	54%	54%	57%
Other	245	8%	126	5%	12%*	7%	12%	13%
The invention I worked on is primarily of value to individuals or businesses that use it directly (-2 = Strongly disagree, 2 = Strongly agree)	85	1.23	41	1.23	1.04	1.24	1.19	0.90
The invention that I worked on is of significant value to society at large, beyond its direct users (-2 = Strongly disagree, 2 = Strongly agree)	78	0.48	35	0.31	0.56	0.45	0.53	0.94
In your view, what should be prioritized when developing an invention?								
Private value	126	5%	58	3%	0%	3%	8%	0%
Social value	126	11%	58	9%	18%	9%	14%	20%
Both equally	126	13%	58	10%	16%	11%	16%	10%
It depends on context	126	71%	58	78%	66%	77%	63%*	70%
Panel B. Feedback received from invention process								
I did not realize I could receive advice or feedback	185	24%	92	21%	40%	26%	26%	56%***
I receive better advice on submissions from peers and mentors	185	19%	92	18%	28%	18%	30%	17%
I was satisfied with the feedback being offered	185	56%	92	62%	40%***	54%	51%	33%*
I would rather focus on the future than feedback on what I cannot change	119	13%	61	15%	13%	14%	11%	10%
The feedback being offered is too negative	119	8%	61	7%	5%	10%	3%	10%
The feedback being offered is too vague	185	15%	92	14%	21%	15%	19%	11%
Panel C. Perception of the invention process								
For each of statement, indicate your level of agreement (-2 = Strongly disagree, 2 = Strongly agree)								
Men and women are equally likely to be named as inventors.	809	0.79	577	0.88	0.48***	0.87	0.41***	0.54
Men and women are equally likely to submit an invention disclosure.	809	0.66	577	0.77	0.28***	0.75	0.22***	0.28**
My manager encourages the submission of invention disclosures.	871	0.58	613	0.65	0.50	0.60	0.53	0.28**
Mgmt. supports increasing women's representation in the inventing process.	979	0.74	655	0.83	0.51***	0.81	0.44***	0.56*
Invention process participants are positively and publicly recognized.	813	0.75	580	0.80	0.69	0.77	0.68	0.66

Table C.4.

Factors working for and against participation in the IP process

This table provides descriptive statistics of the engineers' perceptions of the factors that are working against participation and that would encourage participation in the patenting process. Columns 1 to 2 summarize the frequency and mean for the full sample, while columns 3 to 8 report statistics for specific subgroups based on gender and ethnicity. Asian and white male engineers define the represented group (RG), while females and underrepresented minorities (URMs) define the underrepresented group (URG). The stars in columns 5, 7, and 8 denote the significance level from a t-test, indicating the likelihood that the observed differences in subgroup means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Full sample		Specific subgroups					
	Obs.	Mean	RG Obs.	RG Mean	URG Mean	Male Mean	Female Mean	URM Mean
Panel A. Factors preventing the submission of Invention Disclosures	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Individual inventor characteristics								
Discomfort with deciding if my idea is worthy of submitting	456	27%	217	29%	32%	26%	35%*	27%
I don't feel the work I do is likely to yield patentable inventions	456	46%	217	51%	46%	47%	49%	34%**
I have not perfected my inventions to my satisfaction	456	12%	217	11%	14%	11%	15%	18%
Too busy	456	51%	217	56%	45%**	56%	47%	48%
Too busy at home	407	26%	185	28%	28%	29%	31%	29%
Too busy with other work	407	33%	185	35%	27%	35%	24%*	37%
Management practices and the invention process								
Inventors are not positively and publicly celebrated	456	4%	217	5%	4%	4%	5%	4%
Not encouraged by management	456	15%	217	15%	15%	15%	13%	11%
The Invention Disclosure process needs improvement	171	8%	89	9%	5%	9%	5%	7%
Informal characteristics (e.g., cultural values and norms)								
Discomfort with disclosing my ideas to the patent review board	456	3%	217	3%	4%	4%	3%	7%
I do not have people with whom to collaborate on inventions	456	13%	217	10%	17%**	9%	22%***	9%
Inefficient workplace interactions	456	5%	217	5%	6%	5%	4%	2%
Our culture does not support inventing	407	6%	185	4%	7%	6%	6%	10%
Panel B. Factors that would facilitate greater involvement in IP process								
Change management practices								
Being assigned to projects more likely to yield patentable inventions	824	10%	584	9%	11%	10%	11%	10%
Being given more time to work on patentable inventions	774	8%	552	8%	8%	8%	8%	13%
Inventor recognition, like a celebration, plaque, or limited-edition t-shirt	1199	10%	746	9%	14%***	9%	15%**	12%
Offer more training (in-person or virtual)	1219	55%	763	57%	54%	57%	53%	55%
Change the cultural norms								
Strengthen the innovation culture	824	5%	584	4%	6%	5%	3%	12%**
Encourage mentoring by senior engineers/scientists	1199	39%	746	37%	50%***	36%	57%***	37%
Change invention process								
Offer more brainstorming sessions to get early ideas	1199	17%	746	15%	21%**	16%	22%**	24%**
One-on-one meeting with patent professionals	1199	18%	746	18%	17%	18%	16%	16%
Simplifying and anonymizing the patent process	1219	21%	763	22%	22%	22%	23%	21%

Table C.5.

Factors influential in encouraging engineers to invent and ideas for underrepresented inventors

This table provides descriptive statistics of the engineers' perceptions of the factors that have been most influential in encouraging engineers to submit Invention Disclosures. Columns 1 to 2 summarize the frequency and mean for the full sample, while columns 3 to 8 report statistics for specific subgroups based on gender and ethnicity. Asian and white male engineers define the represented group (RG), while females and underrepresented minorities (URMs) define the underrepresented group (URG). The stars in columns 5, 7, and 8 denote the significance level from a *t*-test, indicating the likelihood that the observed differences in subgroup means are not due to chance. ***, ** and * indicate *p*-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Full sample		Specific subgroups					
	Obs.	Mean	RG Obs.	RG Mean	URG Mean	Male Mean	Female Mean	URM Mean
Panel A. Most influential in encouraging idea submission	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Patent awards	276	47%	134	47%	55%	47%	55%	56%
Knowing that I'm solving a problem for the greater good	276	36%	134	43%	35%	42%	33%	26%
Culture of innovation at [Company]	276	30%	134	34%	29%	33%	30%	33%
Peers	276	26%	134	27%	22%	27%	25%	22%
Recognition inside of the [Company]	276	23%	134	25%	21%	25%	24%	11%
Mentors at [Company]	276	17%	134	15%	25%*	17%	24%	30%*
Recognition outside of the [Company]	276	18%	134	18%	22%	18%	22%	15%
Performance reviews and firing and promotion decisions	276	12%	134	13%	13%	12%	13%	11%
Patent professionals	276	11%	134	10%	4%*	10%	4%	11%
Management	276	8%	134	7%	13%	8%	9%	26%***
Internal trainings and policies	276	6%	134	7%	5%	7%	3%	7%
Famous inventors	276	6%	134	5%	4%	5%	7%	0%
Panel B. How can participation in idea submission be increased, especially for employees from under-represented groups?								
Better management	425	23%	299	23%	23%	22%	27%	14%
Offer more brainstorming sessions	425	17%	299	18%	17%	17%	19%	10%
Improve the culture	425	14%	299	12%	21%**	14%	19%	24%*
Simplify and anonymize the patent process	425	20%	299	19%	22%	20%	19%	31%*
Offer more training	425	15%	299	14%	17%	15%	16%	21%
Assign to projects more likely to yield inventions	425	15%	299	14%	16%	13%	19%	7%
Greater pecuniary incentives	425	8%	299	10%	6%	9%	8%	3%
Provide more time for invention	425	6%	299	6%	4%	5%	5%	3%
More recognition, publicity, and appreciation	425	2%	299	3%	1%	3%	0%	3%
Create a mentoring program	425	2%	299	2%	2%	1%	3%	0%
One-on-one meetings with patent professionals	425	0.2%	299	0.3%	0.0%	0.3%	0.0%	0.0%
Require idea submission for career advancement	425	0.2%	299	0.0%	1.2%*	0.3%	0.0%	3.4%***

Table C.6.

Mentorship and perceived impact

This table provides descriptive statistics of mentorship and the perceived impact of such relationships. Columns 1 to 2 summarize the frequency and mean for the full sample, while columns 3 to 8 report statistics for specific subgroups based on gender and ethnicity. Asian and white male engineers define the represented group (RG), while females and underrepresented minorities (URMs) define the underrepresented group (URG). The stars in columns 5, 7, and 8 denote the significance level from a t-test, indicating the likelihood that the observed differences in subgroup means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Full sample		Specific subgroups					
				RG	URG	Male	Female	URM
	Obs.	Mean	RG Obs.	Mean	Mean	Mean	Mean	Mean
Panel A. Mentorship in your time at [Company]	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Have you ever participated in a formal patent mentorship program?	171	13%	91	4%	29%***	5%	39%***	5%
Have you ever received informal patent mentorship?	299	41%	152	45%	41%	42%	49%	36%
Have you ever acted as a patent mentor?	93	45%	49	61%	13%***	57%	18%***	13%*
Panel B. Perspective of those without a mentor								
What are the reasons you have no sought patent mentorship?								
I could not identify a potential mentor with overlapping interest	108	4%	56	4%	6%	4%	3%	9%
I did not believe patent mentorship would benefit me	108	10%	56	9%	11%	8%	15%	0%
I did not have time for patent mentorship	108	13%	56	16%	11%	15%	9%	9%
I did not think about it	108	76%	56	77%	78%	79%	74%	91%
I want to avoid activities that highlight my weakness to leaders	108	0%	56	0%	0%***	0%	0%***	0%***
My co-workers already help me with IP so I don't need a mentor	108	5%	56	5%	3%	4%	6%	0%
Panel C. Perspective of those with a mentor and perceived impact								
How often would your patent mentor provide you with advice, suggestions, or support? (1 = Monthly, 6 = Several times a day)	65	1.7	34	1.6	1.6	1.6	1.7	1.5
Who first initiated the mentor-protégé like contact?								
Your mentor, by offering unsolicited advice, suggestions, or support	46	26%	23	43%	11%**	37%	11%**	33%
You, by asking the person for advice, suggestions, or support	46	13%	23	22%	6%	22%	0%**	33%
You, by joining a formal mentorship program or an affinity group	46	61%	23	35%	83%***	41%	89%***	33%
To what extent do you disagree or agree with the statements about mentorship? (-2 = Strongly disagree, 2 = Strongly agree)								
I am planning to work on more invention disclosures at work	143	0.8	75	0.7	0.7	0.7	1.0	0.4
I feel confident that I can incorporate my mentor's tips into my work process	142	0.5	74	0.6	0.4	0.5	0.6	0.1*
I feel confident that I have the social connections necessary to get my invention ideas accepted by IP professionals	139	0.7	74	0.8	0.4	0.7	0.6	0.3
I learned a lot about patenting and become a better inventor	140	0.6	73	0.4	0.7	0.5	0.9*	0.5
Being mentored increased my satisfaction at work	144	0.9	77	0.9	0.9	0.8	1.2**	0.7
Mentorship has helped me develop professionally and think broadly	41	1.0	16	0.8	1.2	0.8	1.3**	0.5
I have benefited from my mentoring relationship	40	1.1	15	1.0	1.0	1.0	1.2	0.0
My mentor introduced me to new inventors that I anticipate working with	40	0.8	15	0.7	0.6	0.8	0.8	0.5

Table C.7.

The current state of management, culture, and trust

This table provides descriptive statistics of the engineers' perceptions of management, culture, and trust for their co-workers. Columns 1 to 2 summarize the frequency and mean for the full sample, while columns 3 to 8 report statistics for specific subgroups based on gender and ethnicity. Asian and white male engineers define the represented group (RG), while females and underrepresented minorities (URMs) define the underrepresented group (URG). The stars in columns 5, 7, and 8 denote the significance level from a t-test, indicating the likelihood that the observed differences in subgroup means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Full sample		Specific subgroups					
				RG	URG	Male	Female	URM
	Obs.	Mean	RG Obs.	Mean	Mean	Mean	Mean	Mean
Panel A. Cultural norms	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Please evaluate the day-to-day interactions at [Company] and indicate which of these factors help us achieve our inventive goals (-2 = Weakness, which works against invention, 2 = Strength, key factor helping us to invent)								
Employees feel empowered, confident, and healthy	253	1.36	133	1.46	1.28	1.39	1.27	1.37
Information sharing among employees	255	1.38	134	1.40	1.37	1.37	1.31	1.70*
Employees' comfort in suggesting ideas, concerns, critiques	255	1.27	134	1.34	1.14	1.31	1.13	1.27
Trust among employees	252	1.24	133	1.26	1.23	1.23	1.26	1.37
New ideas develop organically	253	1.22	133	1.26	1.17	1.23	1.15	1.41
Broad agreement about goals	249	0.73	132	0.71	0.70	0.69	0.84	0.54
Willingness to hold employees accountable for unjust actions	242	0.24	129	0.32	0.11	0.26	0.15	-0.10**
Urgency with which employees work	237	0.03	124	0.10	-0.17	0.03	-0.08	-0.07
Average strength of cultural norms	259	0.95	134	0.99	0.86	0.95	0.89	0.95
Panel B. Management Practices								
I experience [Company] leadership to do the following: (0 = No, 1 = Yes)								
Give clear expectations	215	81%	113	82%	78%	83%	75%	88%
Provide coaching	207	65%	109	67%	36%	69%	52%	87%
Support my career development	228	83%	118	81%	84%	82%	80%	96%*
Gather multiple perspectives for decisions	224	71%	119	71%	68%	72%	63%	79%
Explain important details	219	78%	116	83%	73%	81%	69%*	85%
Be pro-active about improving or removing barriers to inventiveness	192	63%	103	62%	60%	63%	57%	82%*
Inspire confidence, enthusiasm, and the courage to be inventive	193	73%	105	74%	67%	75%	64%	89%*
Be ethical and make fair decisions	221	83%	119	89%	78%**	87%	72%***	80%
Panel C. Effective culture and trust								
I believe [Company]'s corporate culture: (1 = Needs a substantial overhaul, 4 = is exactly where it should be)	263	3.10	135	3.18	3.10	3.15	3.00	3.26
Would you say that most of the time, people at [Company] are trying to be helpful, or that they are mostly just looking out for themselves? (-2 = Always looking out for themselves, 2 = Trying to be helpful)	260	1.56	132	1.70	1.39***	1.62	1.44	1.48

D Student Survey

While our exploration into the factors that help facilitate involvement in the innovation process across firms reveals suggestive evidence, consistent with the existence of meaningful hurdles for engineers from URGs, it is also important to consider alternative explanations. For this reason, we explore the academic environment where foundational learning transpires for engineers. It is conceivable that the observed tendencies and behaviors manifesting as barriers to inclusive innovation within corporate environments may have their genesis in the educational experiences and institutional cultures of the universities.

Surveying STEM students thus becomes a critical parallel inquiry, as it permits an examination of whether these disincentives and biases are ingrained during the formative academic phase and subsequently carried into the professional realm. If this is the case, the locus of responsibility could potentially shift from the corporate entities to the academic institutions, necessitating a recalibration of policy interventions and institutional reforms aimed at fostering a more inclusive innovation ecosystem at the foundational level of post-secondary education.

Next, we describe the results from a survey of students enrolled in a set of core courses in the Physics department, Engineering department, Mathematics department, Computer Science department, and Leavey School of Business at Santa Clara University (SCU) in June of 2023. The response comes from a sample of students enrolled in core (i.e., required) courses for majors. Unlike the engineers, the students were incentivized to participate with the chance at a prize. Each student who completed the survey and provided their email address was entered in a drawing for $500. The student response rate was 21%, which is higher than for the sample of engineers.

D.1 Summary statistics

In Table D.1, we summarize the details of the demographic information collected from the student sample of 132 survey respondents. Confidentiality was ensured to promote honest answers, and a "Prefer not to answer" option was available for sensitive questions. For instance, among the student respondents, 52% self-identify as male, 44% as female, and 2% as other and 3% prefer not to provide their self-identified gender. Consistent with other studies suggesting women fall out at a later stage, the percentage of survey respondents self-identifying as female is double what it is among surveyed engineers in high-tech firms.

In terms of ethnicity, the percentage of Asian respondents is 48% which is similar to the 45% observed in the survey for engineers from the United States. SCU is a historically Hispanic-serving university and we do see that the percentage of student respondents indicating Latinx or multiple ethnicities is much higher than for the engineering sample. The gains to diversity appear to be primarily result in a lower sample of white respondents with only 29% of respondents indicating they are white as compared to 45% in engineers in high-tech firms. In terms of breakdown, all years are represented but the majority of students are sophomores (a common time to take required rather than elective courses). Twenty-two percent immigrated to the US to go to school or for a parent to take a job.

Most aspire to be engineers upon graduation (46%), some entrepreneurs (15%), some in science or technical roles (13%), and 26% are unsure. These numbers largely reflect the indicated majors with 35% declaring an engineering major, 33% a business major, 18% a math or science major, 5% a data science major, and 9% still undeclared.

Turning to Table D.2, we see that students indicate that they are somewhat familiar with the process of inventing a new product or technology, but less familiar with the process of patenting an invention. We then ask students how familiar they perceive themselves to be relative to their peers. Here, we see that students from URGs are more likely to indicate that they are familiar with the invention and patenting process. One-in-five students indicate that they have attended a workshop, seminar, or course that discussion invention of the patenting process, with most indicating that they had learned about patenting through coursework.

Among students 44% indicate that they have had an idea that they thought might be novel or patentable and the percentage is the same among students from URGs. Despite students having ideas, only 8% indicated that they acted on this idea b pursuing a patent for it. Given the small sample, it is hard to discern a statistical difference, but we do observe that students from URGs are more likely to have pursued the idea on their own relative to peers who are more likely to indicate pursuing the idea through a job or internship. Interestingly, when we asked about the feedback received on the idea, students from URGs are more likely to have sought advice from engineers, scientists, or professors, whereas their peers are less likely to have even tried to solicit advice.

Table D.3 begins to explore students' self-identity and the perceived impact of their inventive ideas. Here, we see no difference in the reported rates at which students self-identify as inventors or problem-solvers. We do, however, see much higher percentage of students identify as problem solvers (94%) which is similar to the levels we see with engineers. Interestingly, we see no difference in confidence in coming up with a new technical idea or in successfully navigating the process to bring the idea to impact. Unlike when we focus on engineers, when we ask students what they would do if they were unsure whether to submit an idea or not, students are much more likely to see advice and do so from someone experienced (e.g., inventor, mentor, or professor). We see that students from URGs are more likely to aspire to be a named inventor, and interestingly, they perceive differences in terms of the percentage of time that they think they will spend on technical tasks likely and unlikely to lead to invention in their first post-college job. This marks a difference from the engineers who did not have differences in expectations. This need for members of URGs to update their prior beliefs to a larger extent than their peers is intriguing and potentially consistent with the subsequent time and effort allocations discussed in the main body of the paper.

Finally, we ask the students about the perceived objective of the invention process. Here, we do see that students from URGs are less likely to indicate that they focus on experimenting with big, risky ideas that may prove to be foundational. Next, as with the engineers, we see that students from URGs are more likely to want to work on inventions that have meaningful social value in addition to private value, and they are more likely to believe that social value should be prioritized when developing an invention.

Table D.4 examines the factors influencing students to pursue a technical career. Here we see that money is less influence to students from URGs than it is to their peers. Money is the #2 most influential for any student but #5 for students from URGs. Whereas knowing that they are solving a problem for the greater good or solving a problem that they have personally experienced or been exposed to is more influential to students from URGs. Finally, to a lesser extent positive feedback received from others is more influential to members of URGs. The top three factors for students from URGs are knowing that I'm solving a problem for the greater good (48%), knowing that I'm solving a problem that I have personally experienced (40%) or been exposed to and work or internship experience (31%).

Next, we ask students "What resources or initiatives do you believe would increase your desire to pursue invention as part of your career?" Here again we see differences. The top 3 answers are mentoring from an engineer or scientist (53%), coursework (47%), and training and events focused on invention (39%). Yet for students from URGs, a top 3 answer is "having role models that I have an affinity with (e.g., race, gender) talk to me about careers involving invention." This need for role models may help to explain why students from URGs also have less accurate perceptions of the time they will be able to spend on inventive activities.

Table D.5 explores mentorship and its perceived impact. We see no difference in rates of mentorship among students based on ethnicity or gender. Three-in-ten students indicate that they have a mentor whom they can speak to about ideas for an invention. Similar to engineers, the most common reason for not having a mentor is that they had not thought about it. Interestingly, about 29% of students from URGs say they could not find a mentor, but this rate is similar to all students. The only answer that is statistically different for diverse students is their belief that their peers help plenty so they do not need mentors. If the students could choose, they would like to receive mentorship from professionals in their field of study rather than from academic advisors, peers, or even someone knowledgeable with an affinity (e.g., same race or gender). Finally, this table examines the perspective of those with a mentor and the perceived impact. The results are nearly identical across race and gender. Most strongly agree that they have benefitted from the mentoring relationship, and feel confident that they can incorporate their mentor's tips to develop inventions. Two results of note are that students from URGs with a mentor are much more likely to have a professor as a mentor (74% vs. 51% for any student), yet they also are less likely to agree that they are planning to pursue a career in invention and work on more inventions as a result of mentorship.

Table D.6 examines students participation in STEM activities to prepare for college. This, like our survey of students, helps us understand better the paths that led to becoming an engineer and how that may have shaped actions and perceptions toward inclusive innovation. Here we learn that gendered-extracurricular activities along with robotics club rank as the most influential in their decision to pursue a STEM degree. When asked what motivated them to attend a STEM event in the first place, we see that students from URGs are more motivated by "Practice - implementing real-life solutions." Skills development and networking are the other motivators in the top 3. Finally, consistent with anecdotes, the sample of students from URGs are more likely to indicate that "yes" they are the first person in their family to complete high school and to study STEM in college.

Panel A of Table D.7 echoes previous results and may serve as an explanation for the learned behavior and desire for recognition and encouragement by engineers from URGs. We see that students from URGs are significantly more likely to indicate that parent and teacher's encouragement as well as special recognition from being placed in advanced programs at school were important factors influencing their pursuit of a technical career. Here, as in previous questions, we see that both financial considerations and the ability to do meaningful work play a big role too. Panel B examines exposure to engineers and scientists. Here we learn that students pursuing a technical career are more likely to have had a parent who was also a scientist, suggesting exposure is important. Finally, Panel C explores sources of support. While there is no statistical difference by demographics, it is worth noting the relative ranking of which sources of support are most important. Here we learn that most important sources of support are financial support (3.8), emotional support (3.3), community support (3.0), network support (2.5), and finally childcare support (2.1).

D.2 Comparison to engineers

Some of the questions posed to students are nearly identical to those of engineers. In the next set of questions, we directly test whether students' answers and their perceptions of the invention process differ from those of the engineers. These tests help substantiate arguments that some of the barriers to patenting are firm-specific rather than an artifact of bias from educational experiences or related exposures earlier in life.

Table D.8 compares and contrasts engineers' vs. students' perceptions of the inventive process. Panel A focuses on awareness and familiarity with invention. Surprisingly, students claim to be more aware of the inventive process but have attended fewer trainings on or off-campus. When asked about a patentable idea, fewer students indicate that they have had one (44% of students vs. 55% of engineers). Interestingly, inventive ideation is statistically indistinguishable when focusing on engineers from URGs vs. students from URGs. This suggests that improved language and framing, even early in the educational process, may help get those with inventive ideas to recognize that they are, in fact, patentable ideas.

The importance of self-identity is reinforced in Panel B, which summarizes perceptions of self-identity and confidence as inventors among engineers and students. Students are less likely to identify as inventors than engineers, which is unsurprising given their experience. Interestingly though, the results are statistically indistinguishable when we look at students vs. engineers from URGs. As noted before, when the question is framed as a problem-solver rather than an inventor, the rates of self-identifying with the term are much higher for students and engineers from URGs. Like the perception of a patentable idea, this suggests language and more accurate renderings of inventors may help mitigate the fallout from an inventive concept to submitting it as a patent application. The comfort level in navigating the process of bringing ideas to impact is also statistically indistinguishable for students vs. engineers from URGs but significantly different when comparing as a whole. This tells us that self-identity early on is a factor, but it is not the only factor taken together with the rest of the results. In fact, the next question starts to point to where additional confusion may arise. Students from URGs are significantly more likely to indicate that they would seek advice if they were unsure whether to submit an idea. The question of mentoring and feedback then becomes a crucial consideration.

Another critical factor appears to be time. Panel C of Table B.8 shows meaningful differences in what students think their typical work well will look like in terms of time allocated to tasks relative to what actual engineers say. Students are much more likely to believe they will spend time working on tasks likely to lead to inventive disclosures and much less time on tasks unlikely to lead to inventive disclosures. The gap is much starker and larger when looking at engineers vs.

students from URGs. While we learned that engineers from URGs are being assigned tasks less likely to yield a patentable invention, this under-assignment is coupled with students from URGs believing that they will spend more time on tasks likely to lead to inventive disclosures than their peers. This could result from a lack of exposure to engineers or mentors, leading to a less accurate perception of reality.

Finally, in Panel D, we focus on the perceived objectives of the inventive process. Here a few comparisons stand out. First, there is no statistical difference to reject the hypothesis that students and engineers have the same tolerance for risk when approaching inventive tasks. This is important because if we see later on that they are failing to have patents granted, it should not be because their patents are riskier or of a different quality since everyone appears to have the same tolerance for risk. We see a divergence in the goals of the patenting process. Again, engineers and students from URGs strongly believe that the social value, or the significance to society at large, beyond the direct users of the product matters more. In different forms of the question (Likert scale and simple yes vs. no), students, especially those from URGs, prioritize social value over private value in invention. For example, 28% of students believe social value should be prioritized vs. 12% of engineers. On a Likert scale, students are 0.35 points less likely to think that the inventions they will work on should primarily be of value to individuals or businesses that use them directly.

Table D.1.

Students demographic statistics

This table provides descriptive statistics from the survey demographic variables questions for all student survey responses.

Panel A. Demographic characteristics	Obs. (1)	Mean (2)
Gender		
Female	132	44%
Male	132	52%
Non-binary	132	1%
Other	132	1%
Prefer not to say	132	3%
Ethnicity		
Asian	132	48%
African American/Black	132	2%
Hispanic/Latino	132	8%
Two or more ethnicities (not Hispanic/Latino)	132	6%
American Indian, Alaska Native, Native Hawaiian, or other Pacific Islander	132	2%
White/Caucasian	132	29%
Prefer not to say	132	5%
Immigrant status		
Immigrated to the US to go to school or for a parent to take a job	129	22%
Major		
Business	132	33%
Data science or analytics	132	5%
Engineering	132	35%
Math or science	132	18%
Undeclared	132	9%
Desired post-college job title		
Engineer	128	46%
Entrepreneur	128	15%
Scientist	128	6%
Technical staff	128	7%
Other	128	26%
Education (Current status)		
Freshman	131	14%
Sophomore	131	43%
Junior	131	17%
Senior	131	13%
Graduate student	131	14%

Table D.2.

Students' awareness and participation in the invention process

This table provides descriptive statistics of students' awareness and participation in the invention process. Observations are reported in column (1), and the percentages of students indicating "yes" are reported in column (2). Columns (3) and (4) repeat this exercise but only for students who self-identify as being a member of an underrepresented group ("URG"). To match the context of the survey of professional engineers, URG is defined as self-reporting a gender that is not male or an ethnicity that is not White and not Asian). The stars in the table denote the significance level from a t-test, indicating the likelihood that the observed differences in group means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Any student		Student from URGs	
	Obs.	Mean	Obs.	Mean
Panel A. Awareness of the invention process	(1)	(2)	(3)	(4)
How familiar are you with the process of inventing a new product or technology? (1 = Not at all, 5 = Very familiar)	144	2.63	68	2.72
How familiar are you with the process of patenting an invention? (1 = Not at all, 5 = Very familiar)	134	2.11	61	2.13
How familiar, compared to you, do you think your peers in your field of study are with the invention and patenting process? (-1 = less familiar, 0 = about the same, 1 = more familiar)	152	-0.04	71	0.06*
Have you attended a workshop, seminar, or course that discussed invention or the patenting process? (1 = Yes, 0 = No)	155	19%	72	18%
A course	155	10%	72	11%
An event organized on campus	155	5%	72	3%
An event organized off-campus	155	6%	72	4%
Panel B. Participation in the invention process				
Have you ever had an idea that you thought might be novel or patentable? (1 = Yes, 0 = No)	146	44%	72	44%
Did you act on this idea, for example, by pursuing a patent for this idea or invention? (1 = Yes, 0 = No)	146	8%	72	8%
On my own	146	4%	72	6%
Through the University	146	2%	72	3%
Through my job or internship	146	1%	72	0%
Panel C. Feedback received				
In the context of your inventive ideas, please check all factors that are relevant to any feedback you received.				
I did not realize I could receive advice or feedback	78	14%	39	18%
I did not try to solicit any feedback	78	29%	39	21%
I do not have inventive ideas	110	13%	44	16%
I received advice on my idea from my peers	78	45%	39	46%
I received advice on my idea from senior engineers, scientists, or professors	78	26%	39	31%
I was satisfied with the feedback being offered	78	21%	39	23%
The feedback being offered is too negative	78	1%	39	3%
The feedback being offered is too vague	78	13%	39	13%

Table D.3.

Students' self-identity and perceived impact of their inventive ideas

This table provides descriptive statistics of the engineers' self-identity, confidence, aspirations, and the perceived impact of their inventive ideas. Observations are reported in column (1), and the percentages of students indicating "yes" are reported in column (2). Columns (3) and (4) repeat this exercise but only for students who self-identify as being a member of an underrepresented group ("URG"). To match the context of the survey of professional engineers, URG is defined as self-reporting a gender that is not male or an ethnicity that is not White or Asian. The stars in the table denote the significance level from a t-test, indicating the likelihood that the observed differences in group means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Any student		Students from URGs	
	Obs.	Mean	Obs.	Mean
Panel A. Self-identity	(1)	(2)	(3)	(4)
Do you self-identify as an inventor?	154	37%	72	35%
Do you self-identify as a problem-solver?	154	94%	72	92%
Do you self-identify as a leader?	154	74%	72	78%
Panel B. Confidence in inventive ideas				
How confident are you in coming up with a new technical idea? (1 = Not at all confident and 5 = Very confident)	149	2.83	69	2.90
How confident are you in successfully navigating the process to bring this idea to impact?	141	2.64	65	2.69
What would you do next if you were unsure whether to submit an idea as an Invention Disclosure?				
Submit the idea anyway (and not seek advice)	145	1%	71	0%
I will seek advice:	145	92%	71	96%
From someone experienced (e.g., inventor, mentor, professor)	145	71%	71	76%*
From a patent professional	145	21%	71	20%
Not submit the idea (and not seek advice)	145	6%	71	4%
Panel C. Aspirations and time for inventing				
Do you aspire to be a named inventor? (1 = Yes, 0 = No)	178	54%	72	71%
In your first post-college job, what percent (%) of your time do you expect to spend on the following tasks:				
Technical tasks that are likely to lead to inventions	116	25%	59	28%
Technical tasks that are unlikely to lead to inventions	116	42%	59	37%*
Other non-technical tasks	116	32%	59	35%
Panel D. Perceived objectives of the invention process				
When working on projects or products that may result in an invention, I focus on:				
Expanding academic research into something patentable	133	17%	69	20%
Experimenting with big, risky ideas that may prove to be foundational	133	26%	69	19%**
Incremental changes as solutions to the problems	133	55%	69	58%
Other	133	2%	69	3%
The innovative or inventive tasks that I want to work on will be primarily of value to individuals or businesses that use it directly. (-2 = Strongly disagree, 2 = Strongly agree)	115	0.89	60	0.89
The innovative or inventive tasks that I want to work on will be of significant value to society at large, beyond its direct users.	111	0.87	59	0.95
The innovative or inventive tasks that I want to work on will be of significant value to people like me or in my community.	114	0.83	61	0.82
In your view, what should be prioritized when developing an invention?				
Private value	178	17%	72	19%
Social value	178	40%	72	51%
Value to people like me or in my community	178	31%	72	43%
It depends on the context	178	43%	72	64%

Table D.4.

Factors influencing students to pursue a technical career

This table provides descriptive statistics of students' awareness and participation in the invention process. Observations are reported in column (1), and the percentages of students indicating "yes" are reported in column (2). Columns (3) and (4) repeat this exercise but only for students who self-identify as being a member of an underrepresented group ("URG"). To match the context of the survey of professional engineers, URG is defined as self-reporting a gender that is not male or an ethnicity that is not White or Asian. The stars in the table denote the significance level from a t-test, indicating the likelihood that the observed differences in group means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Any student		Students from URGs	
	Obs.	Pct. indicating "Top 3" most influential	Obs.	Pct. indicating "Top 3" most influential
Panel A. Most influential in encouraging you to pursue technical	(1)	(2)	(3)	(4)
Chance to make money from an invention	128	34%	67	27%*
Courses, training, and events	128	12%	67	15%
Culture of innovation in the bay area	128	22%	67	22%
Famous inventors	128	3%	67	1%
Getting good grades in school	128	9%	67	7%
Knowing that I'm solving a problem for the greater good	128	44%	67	48%
Knowing that I'm solving a problem that I have personally experienced or been exposed to	128	34%	67	40%
Mentors	128	14%	67	13%
Peers	128	14%	67	15%
Positive feedback I've received from others	128	26%	67	30%
Public recognition	128	9%	67	9%
Work or internship experience	128	29%	67	31%
Panel B. What resources or initiatives do you believe would increase your desire to pursue invention as part of your career?				
Anonymize and simplify the invention process	128	13%	68	9%
Brainstorming sessions to get early ideas	128	34%	68	31%
Coursework focused on invention	128	47%	68	53%
Having role models that I have an affinity with (e.g., race, gender) talk to me about careers involving invention	128	37%	68	47%***
Having someone at the University reach out to me about my ideas	128	31%	68	32%
Inventor recognition, like a celebration or limited-edition t-shirt	128	9%	68	7%
Mentoring from an engineer or scientist	128	53%	68	49%
Training and events focused on invention	128	39%	68	40%

Table D.5.

Mentorship and perceived impact

This table provides descriptive statistics of mentorship received and the perceived impact of such relationships. Observations are reported in column (1), and the percentages of students indicating "yes" are reported in column (2). Columns (3) and (4) repeat this exercise but only for students who self-identify as being a member of an underrepresented group ("URG"). To match the context of the survey of professional engineers, URG is defined as self-reporting a gender that is not male or an ethnicity that is not White or Asian. The stars in the table denote the significance level from a t-test, indicating the likelihood that the observed differences in group means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Any student		Students from URGs	
	Obs.	Mean	Obs.	Mean
Panel A. Mentorship	(1)	(2)	(3)	(4)
Do you have a mentor whom you could speak to about ideas you might have for an invention? (1 = Yes, 0 = No)	130	32%	68	28%
Panel B. Perspective of those without a mentor	(1)	(2)	(3)	(4)
What are the reasons you have not sought mentorship?				
I was unable to find a mentor	88	33%	49	29%
I don't believe a mentor would benefit me	88	6%	49	4%
I don't have time or could only meet with a mentor at inconvenient times	88	16%	49	16%
I didn't know I should have one	88	59%	49	65%
My peers help me plenty, so I don't need a mentor	88	11%	49	18%**
Wanted to avoid activities that highlighted my weakness to others	88	9%	49	12%
If you could choose, who would you most like to receive mentorship from?				
Academic advisor	87	20%	49	20%
Professional in my field of study	87	51%	49	45%
Patent attorney	87	6%	49	6%
Fellow student or peer	87	7%	49	6%
Someone knowledgeable that I have an affinity with (e.g., race or gender)	87	17%	49	22%
Panel C. Perspective of those with a mentor and perceived impact	(1)	(2)	(3)	(4)
How many times per month have you met with your mentor?	39	2.3	18	2.4
Which of the following describes your mentor?				
Professor	41	51%	19	74%***
Professional in my field of study	41	54%	19	42%
Patent attorney	41	5%	19	5%
Fellow student or peer	41	27%	19	26%
Did you and your mentor have an affinity? (1 = Yes, 0 = No)	41	41%	19	53%
Same gender	41	27%	19	26%
Same age	41	27%	19	26%
Same ethnicity	41	22%	19	21%
Same major	41	22%	19	21%
To what extent do you disagree or agree with the statements about mentorship? (-2 = Strongly disagree, 2 = Strongly agree)				
I am planning to pursue a career in invention and work on more inventions	38	0.1	17	-0.1
I feel confident that I can incorporate my mentor's tips to develop inventions	38	0.8	18	0.8
I feel confident that I have the social connections to get my ideas accepted	34	0.3	15	0.3
I learned a lot about patenting, and I have become a better inventor	36	0.4	16	0.3
I have benefitted from my mentoring relationship	39	1.3	18	1.3
My mentor introduced me to new inventors that I anticipate connecting with	36	0.1	16	0.3

Table D.6.

Students participation in STEM activities to prepare for college

This table provides descriptive statistics of students' motivation and participation in STEM activities and events. Observations are reported in column (1), and the percentages of students indicating "yes" are reported in column (2). Columns (3) and (4) repeat this exercise but only for students who self-identify as being a member of an underrepresented group ("URG"). To match the context of the survey of professional engineers, URG is defined as self-reporting a gender that is not male or an ethnicity that is not White or Asian. The stars in the table denote the significance level from a t-test, indicating the likelihood that the observed differences in group means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Any student		1 =	2 =	3 =	4 =	5 =	Students from URG	
			Not at all important	Somewhat important			Very important		
	Obs.	Mean						Obs.	Mean
Panel A. STEM activities	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
If you participated in any of the following activities before enrolling in college, how influential were they on your decision to pursue STEM?									
Robotics club	62	2.1	58%	6%	15%	8%	13%	31	2.4
Math club	56	1.9	63%	7%	20%	4%	7%	31	2.1
Hackathon	63	2.0	59%	10%	10%	13%	10%	31	2.0
Gendered extracurricular STEM activity	59	1.9	64%	8%	5%	15%	7%	34	2.3**
STEM camp	58	2.1	57%	9%	9%	17%	9%	31	2.2
Programs/activities at the library	57	1.7	70%	11%	7%	5%	7%	34	1.7
Panel B. STEM activity motivation									
What is your motivation for attending STEM events? (Check all that apply)									
Fun - A creative outlet	52	54%						24	58%
Networking - Make industry connections	52	69%						24	75%
Practice - Implement real-life solutions	52	71%						24	88%**
Skills - Grow and learn advanced technical skills	52	77%						24	75%
Society - Help make progress on community-based goals	52	29%						24	29%
Teamwork - Collaborate with like-minded individuals	52	71%						24	63%
Winning - I love competitions	52	23%						24	21%
Panel C. Achieving a college education									
What kind of high school did you attend?									
Public school	130	48%						72	50%
Private school	130	54%						72	53%
School specializing in STEM	130	2%						72	4%
Please answer "yes" or "no" to the following questions. I was the first person in my family to:									
Complete high school	178	4%						72	8%
Complete college	178	5%						72	4%
To study STEM in college	178	15%						72	22%
Pursue a post-graduate STEM degree	178	13%						72	17%
Pursue a post-graduate STEM degree in another country	178	10%						72	11%

Table D.7.

Factors students perceive as influential in their pursuit of a technical career

This table provides descriptive statistics of the factors, role models, and sources of support that students perceive as influential in their pursuit of a technical career. Observations are reported in column (1), and the percentages of students indicating "yes" are reported in column (2). Columns (3) and (4) repeat this exercise but only for students who self-identify as being a member of an underrepresented group ("URG"). To match the context of the survey of professional engineers, URG is defined as self-reporting a gender that is not male or an ethnicity that is not White or Asian. The stars in the table denote the significance level from a t-test, indicating the likelihood that the observed differences in group means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	Any student		1 =	2 =	3 =	4 =	5 =	Students from URG	
			Not at all				Very		
	Obs.	Mean	important	Somewhat important			important	Obs.	Mean
Panel A. Factors influencing the pursuit of a technical career	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
How important have the following factors been in influencing you to pursue a technical career?									
Parent's encouragement	111	3.1	16%	17%	27%	16%	23%	61	3.4**
Teacher's encouragement	89	2.3	38%	18%	22%	15%	7%	49	2.7***
Role model	105	2.8	26%	14%	27%	20%	13%	56	2.8
Financial considerations	114	3.6	10%	11%	23%	25%	32%	62	3.6
Intrinsic love of science and technology	110	3.4	12%	16%	20%	19%	33%	60	3.4
Desire to solve global societal problems	109	3.1	19%	14%	26%	18%	23%	60	3.2
Desire to solve problems for people in my community	108	3.2	14%	13%	31%	21%	21%	58	3.3
I realized I had talent in math/science	106	3.1	18%	12%	29%	20%	21%	58	3.3*
Special recognition from being placed in advanced programs	78	1.7	56%	24%	10%	9%	14%	45	2.0**
I attended a specialized STEM school	108	3.2	21%	9%	23%	25%	21%	59	3.2
Ability to do meaningful work	111	3.5	8%	12%	30%	21%	30%	61	3.5
Ability to engage in citizen science	83	1.8	65%	8%	13%	11%	2%	46	1.7
Less discrimination than other fields	82	2.0	54%	13%	16%	10%	7%	45	1.9
Panel B. Exposure to engineers and scientists	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
How important was exposure to engineers or scientists in your pursuit of a technical career?									
One or both of my parents was a scientist	91	2.4	47%	10%	14%	14%	14%	52	2.7**
I had extended family members who were scientists	85	2.3	52%	5%	18%	11%	15%	48	2.5
I had a role model within my community that was a scientist	82	2.3	41%	16%	24%	11%	7%	46	2.2
I knew someone that was a scientist to whom I looked up to	84	2.6	31%	24%	18%	13%	14%	47	2.5
I was inspired by one or more books I had read	85	2.2	44%	24%	9%	13%	11%	49	2.1
I received encouragement from a role model	83	2.3	42%	14%	24%	13%	6%	46	2.3
Panel C. Sources of support in pursuit of a technical career	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Which of the sources of support have been important in your pursuit of a technical career?									
Financial support (e.g., scholarships or from family)	90	3.8	17%	6%	9%	23%	46%	48	3.8
Emotional support	84	3.3	23%	8%	20%	18%	31%	46	3.3
Network support (e.g., helped me get a job or find mentors)	65	2.2	45%	14%	25%	8%	9%	34	2.5
Childcare support	52	1.8	67%	6%	15%	2%	10%	24	2.1
Support from my community	76	2.8	26%	20%	24%	13%	17%	41	3.0

Table D.8.

Student vs. engineers: awareness, goals, and self-identity

This table compares and contrasts engineers vs. students perceptions of the inventive process. It summarizes familiarity with the invention process, the goals of the inventive process and careers, and self-identity in relation to invention. Observations are reported in column odd columns, the percent of students or engineers reporting "yes" are reported in even columns. Columns (1) to (4) explore the full sample, and Columns (5) to (8) focus on engineers and students that are members of underrepresented groups ("URG"). To match the context of the survey of professional engineers, URG is defined as self-reporting a gender that is not male or an ethnicity that is not White or Asian. The stars in the table denote the significance level from a t-test, indicating the likelihood that the observed differences in group means are not due to chance. ***, ** and * indicate p-values under the assumption of a single test of 1%, 5%, and 10%, respectively.

	All engineers		All students		Engineers from URG		Students from URG	
	Obs.	Mean	Obs.	Mean	Obs.	Mean	Obs.	Mean
Panel A. Awareness of invention process	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Awareness of invention and patenting process	3912	40%	134	69%***	904	39%	61	66%***
Have you ever attended a relevant training? (1 = Yes, 0 = No)	559	45%	155	19%***	183	44%	72	18%***
Have you ever had an idea that you thought might be patentable? (1 = Yes, 0 = No)	556	55%	146	44%**	182	49%	72	44%
Panel B. Self-identity and confidence								
Do you self-identify as an inventor?	3874	46%	154	37%**	891	35%	72	35%
Do you self-identify as a problem-solver?	561	96%	154	94%	183	95%	72	92%
How comfortable are you in navigating the process of bringing your idea to impact? (-2 = Not at all comfortable, 2 = Very comfortable)	3104	0.10	151	-0.29***	642	-0.12	70	-0.24
If you were unsure whether to submit an idea, what would you do next?								
Submit the invention anyway (and not seek advice)	3703	12%	145	1%***	838	9%	71	0%***
I will seek advice	3512	80%	145	92%***	770	85%	71	96%**
Not submit the invention (and not seek advice)	3512	10%	145	6%	770	9%	71	4%
Panel C. Time for invention								
In a typical work week, what percent (%) of your work time do you spend (expect to spend) on the following tasks?								
Technical or engineering tasks that are likely to lead to inventive disclosures	238	15%	116	25%***	97	12%	59	28%***
Technical or engineering tasks that are unlikely to lead to inventive disclosures	238	61%	116	42%***	97	60%	59	37%***
Other non-technical tasks	238	25%	116	32%***	97	27%	59	35%
Panel D. Perceived objectives of the invention process								
When working on projects or products that may result in an invention, I focus on:								
Experimenting with big, risky ideas that may prove to be foundational	371	23%	133	26%	113	22%	69	19%
Incremental changes as solutions to the problems	371	58%	133	55%	113	61%	69	58%
Other (e.g., defensive patenting or expanding academic research)	371	19%	133	19%	113	17%	69	23%
The invention I worked on is primarily of value to individuals or businesses that use it directly (-2 = Strongly disagree, 2 = Strongly agree)	152	1.24	115	0.89***	58	1.18	60	0.89**
The invention that I worked on is of significant value to society at large, beyond its direct users (-2 = Strongly disagree, 2 = Strongly agree)	252	0.64	111	0.87***	119	0.71	59	0.95**
In your view, what should be prioritized when developing an invention?								
Private value	223	5%	132	3%	92	0%	70	3%
Social value	223	12%	132	28%***	92	18%	70	27%
Both, it depends on context	223	83%	132	69%***	92	82%	70	70%*