

Comments Submitted to USPTO Re:
National Strategy for Expanding American Innovation
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I. General

1. Inventors and entrepreneurs come from all walks of life and are not always employed by a large corporate or educational institution. How can people and organizations in the innovation ecosystem better support them?

Federal investment in two-year community colleges, four-year colleges and universities, cooperative extension services at land-grant universities, and public libraries across the nation can help inventors and entrepreneurs access the knowledge and skills needed to earn a living wage and to benefit from technological advancements. Community colleges also play an important role in entrepreneurship education, and are an integral part of state and local economic development efforts through certificate and degree programs. The rapid rate of technological change taking place in today's world places new demands on these public institutions. Knowledge and skills not commonly taught outside four-year colleges and universities with robust research programs must now be extended to the public at large, affording opportunities for Americans to compete locally and globally in the innovation economy. Investment to support public entities promoting and offering resources for invention and intellectual property protection could be advanced by the establishment of a virtual resource center. The virtual center could offer live staff support for those seeking assistance—including technical mentoring—and could act in partnership with the entities noted above so that people could receive in-person assistance. A combination of paid staffing and volunteers, similar to strategies used by public libraries to offer STEM programming and the Small Business Administration's SCORE program, could help to contain or share costs of a virtual resource center that also offers consultations.

2. Women and some minorities have not participated proportionally in the patenting of inventions. What barriers to innovation inclusion are specific to underrepresented groups? What supporting role should government organizations play in helping underrepresented groups overcome these barriers?

A recent report containing findings from the Lemelson-MIT Program's review of the literature surrounding the gender gap in patenting (Couch & Estabrooks, 2020) offered seven ideas for policy initiatives to support women's engagement in the development of novel solutions to problems and for the commercialization of their intellectual property through the creation of start-up companies. The recommendations were:

1. Incentives for patent-intensive industries in the private sector to hire more women in research and development focused on team-based projects with patent and commercialization potential.
2. Incentives for faculty inventors and private-sector partners to recruit, mentor, and continuously support women who enroll in college in fields prone to patenting, for which they are underrepresented.
3. Support for female faculty to further develop as inventors and to encourage the commercialization of their inventions.
4. Resources and policy changes at the K–12 level to allow for deliberate efforts as part of public schooling to support the development of young inventors and to increase interest in STEM college and career pathways among young women. Also, engagement of parents and others in the community in support of this effort.
5. Dual-enrollment options for high school students in which courses jointly offered by high schools and community colleges would focus on engaging students in project- and problem-based learning. Projects would involve the development of a working prototype of an invention that solves a problem student teams identify, offered for dual credit so the course has the same bearing as an Advanced Placement course on the calculation of grade-point averages used for college admissions.
6. Provision of legal services and waivers of filing fees for women seeking to protect their intellectual property.
7. Longitudinal studies of the efforts described above to determine what works, under what conditions, and for whom.

The full report is available at <https://lemelson.mit.edu/node/4367>.

Recommendations 2 and 3—pertaining to female faculty—are supported by research studies being conducted by Professor Mercedes Delgado of the Copenhagen Business School and Professor Fiona Murray of the MIT Innovation Initiative. Delgado and Murray’s (2020) analysis of patent data for the top 25 universities in the United States between 2000 and 2015 showed that university patents are produced by a small number of top academic inventors, with 6% of inventors contributing to 59% of the patents generated by the 25 universities. Female students were more likely to be listed on patents for the first time if they worked with a top inventor (holding seven or more patents). Delgado and Murray’s recommendations for accelerating change in the inclusion of women in patenting were as follows:

1. Develop metrics to induce change.
2. Document and celebrate top inventors who are inclusive.
3. Offer other targeted interventions to increase female top inventors.

High school course-taking data for young women suggested that women were enrolling and passing advanced coursework in STEM subjects. Many young women, however, did not choose to pursue degree paths in college in fields prone to patenting, with the exception of the life sciences. This suggests the need for more collaboration among colleges, universities, and STEM-oriented companies to engage with young women before their last year of high school to allow and encourage exploration of exciting career opportunities that exist in other fields/disciplines.

It also suggests the need to make explicit the opportunity other fields of study offer for helping people with particular types of problems. The connection between the needs of people that can be addressed by someone with a degree in life sciences, for example, may be more readily understood by young people than the human benefits derived from work undertaken by chemical or mechanical engineers. Making explicit the connection between the needs of people and improving lives through various fields of engineering may result in more female students opting to pursue particular fields that are prone to patenting.

The Lemelson-MIT Program had an opportunity to co-design and co-deliver an online offering in the summer of 2020 in partnership with a life sciences company specializing in the development of drug therapies for people with neurological diseases. Four hundred students—with an enrollment emphasis on students underrepresented in STEM—were engaged in the 28-hour program, which offered opportunities to learn from corporate employees and leading researchers at MIT as well as from high school and college student inventors with working prototypes. The program succeeded in developing students' knowledge of biology and life science as well as lab techniques, their knowledge of STEM careers and career-related skills, and interest in learning biosciences. A summary of the program effort and outcomes generated by the evaluation research study is available at <https://lemelson.mit.edu/node/4694>.

Data reviewed for the gender gap report regarding the performance of young women in STEM during the high school years showed that Black and Latinx students were not proportionately represented in Advanced Placement coursework in high school, and therefore may not be as academically prepared for fields of study that lead to patenting or as competitive for college admissions. This data suggests that Black and Latinx students may not have access to opportunities for learning that are beneficial to the development of young inventors. Important perspectives on this problem are discussed by Omotola McGee (2020), who postulates that STEM instruction in higher education “maintains gross inequities that are illustrative of structural racism, which both informs and is reinforced by discriminatory beliefs, policies, values, and distribution of resources,” leading to an argument for a critical examination “of the structural racism omnipresent in STEM.”

The Lemelson-MIT Program is collaborating with the California Community College Chancellor's Office and four community colleges in that state on an effort known as the Invention and Inclusive Innovation Initiative (I³). I³ addresses the inclusion challenge through community college courses, workshops, and event offerings that teach integrated STEM through the lens of invention and entrepreneurship. Almost half of the students enrolled in California community colleges during Spring semester 2020 were Hispanic and 5% were African American (California Community Colleges Chancellor's Office, 2020). Dual enrollment in I³ coursework by high school students may generate better-prepared students with higher grade-point averages. Such offerings may allow Black and Latinx students to then access coursework that also transfers to a four-year college or university. The I³ coursework may also allow others to learn what is needed to develop invention prototypes that can be protected and commercialized successfully without the need for further college study, but rather through workshops and certificates. Educational research will inform understandings of the short- and long-term outcomes from I³. The National

Science Foundation's Broadening Participation in STEM Entrepreneurship and Innovation could support efforts to research programs like I³ if there are additional grant opportunities in future years.

3. Mentoring and networking have been shown to be effective tools in supporting and encouraging underrepresented inventors and entrepreneurs. How can organizations and intellectual property practitioners in the innovation ecosystem better connect underrepresented innovators to each other and to mentors, both internally and across organizations?

Being mentored by a top inventor, either male or female, is associated with higher rates of patenting by collegiate-level female students (Delgado & Murray, 2020). Federal incentives that augment research grants in fields prone to patenting, such as enhanced graduate fellowships, would help top faculty inventors expand their research to include greater numbers of female and other underrepresented students. The data indicates that this would lead to higher rates of patenting among STEM PhDs.

The Invention and Inclusive Innovation Initiative (I³), launched by the Lemelson-MIT Program (LMIT) in collaboration with the California Community College Chancellor's Office in January 2021, includes a focus on strengthening local STEM ecosystems in ways that ensure student teams working to invent have access to mentors with many different types of expertise. Mentors, recruited with the assistance of college administrators and the Lemelson-MIT Program, will offer expertise related to invention, entrepreneurship, sustainability, and intellectual property. The model for community colleges and resources being created builds on similar work by LMIT since 2003 at the high school level through an initiative known as InvenTeams. The benefits of the InvenTeams model for high school students, which includes a mentoring component, have been documented in several research studies (Couch, Skukauskaite, & Estabrooks, 2020; Couch, Skukauskaite, & Estabrooks, 2019; Couch, Estabrooks, & Skukauskaite, 2018; Estabrooks & Couch, 2018). The community college model will include an expanded focus on inventing, along with entrepreneurship and the commercialization of contrivances where intellectual property has been explored. The community college model will also be informed by best practices arising from other successful efforts that include mentoring and intellectual property protection components within the National Science Foundation's I-Corps program, VentureWell's E-Team Grant program, InventOR, MIT's Venture Mentoring Service, and Microsoft's Make What's Next Program.

4. Developing organizational metrics to document the effectiveness of diversity and inclusion initiatives is necessary to track outcomes of action plans and initiatives. What are best practices that organizations can internally employ to measure their own progress, particularly in the area of intellectual property protection?

Invention education and patenting as an approach to protecting intellectual property (IP) go hand in hand. There is no IP to protect without the development of an algorithm or technological solution that is novel, useful, and unique, and not obvious to one skilled in the art. The Lemelson-MIT Program collects quantitative data to assess its strategies and activities

and to measure its contributions to the development of invention educators and students who are learning to invent. Quantitative measures include pre-and post-experience surveys and many other forms of data. The quantitative data allows us to track who was served (numbers, demographics, geography, and income), to identify changes in ways those we serve perceive their strengths and change the perception that they attribute to their experience, and to identify the number of patents generated in a given year. While high school students are not expected to generate a patent, 12 teams have earned patents for their work and many other teams have filed for patents (still pending). There are equity issues here, due to the difficulty in finding pro bono legal guidance and financial support. However, high school students can be taught how to apply for provisional patents, and this is a resource area that can be provided by the virtual resource center discussed earlier. It is important to note that patent data lags two to three years behind our students' program participation, given the length of time required for filings and awards. Thus, longitudinal tracking is necessary.

The LMIT program's understanding of the impact of our work on individual participants (mostly students and educators) has been greatly enhanced by the addition of ethnographic research studies. The studies have informed our understanding of ways particular components of our existing programs support the development of educators and students within invention education. Insights generated through this new component of our work guide continuous improvement and inform our work to design new programs for inventors at other ages and stages of development and to consider better ways to develop teachers as facilitators of the invention process. Additional information about ethnography in education is available in *Becoming an Educational Ethnographer* (Sancho-Gil & Hernández-Hernández, 2020).

Metrics or quantitative data other organizations could consider for evaluating their progress in supporting inventors is described as part of our answer to question #5.

5. Measuring national progress in realizing greater inclusion and diversity in Invention, entrepreneurship, and intellectual property may take years, and it will be critical to identify complementary short- and long-term metrics that are precursors to and indicators of expanding innovation. What are some specific, meaningful, and relevant measures that can be used to:

- a) Support year-over-year performance of action plans and initiatives in the short-term?*
- b) Demonstrate the long-term creation of diversity and inclusion in the innovation ecosystem while complementing short-term performance metrics?*

Research conducted by the Lemelson-MIT Program and by contractors working on our behalf has shown that inventors' capacity to invent develops across time and with exposure (Bell et al., 2019). Prolific inventors who have received the Lemelson-MIT Prize, collegiate inventors who have won our national Lemelson-MIT Student Prize, and high school InvenTeam members often cite experiences in their early years, family influences, and educators who made a difference. This has led us to understand that development as an inventor and the generation of a patent is intertwined with opportunities for learning (ways of finding and solving problems as an inventor, understanding of technologies, etc.). We use the term "pathway to invention" to describe the opportunities for learning that need to exist for people at different ages and stages

of development. The opportunities for learning must be coupled with access to other resources such as space to build, tools, materials, time in one’s day, mentors, intellectual property advice, patent filing fees, and venture capital.

Measurements of national progress in creating more Inventors, entrepreneurs, and people who seek to protect intellectual property—including measures of participation by people from diverse backgrounds—should be sophisticated enough to measure progress at different levels of analytical scale (global, national, state, and local levels). The measures should generate data in the aggregate. Measures should also allow progress to be assessed for particular entities determined to have a major role to play in developing the capabilities of inventors, entrepreneurs, and people who file to protect intellectual property. The Lemelson-MIT Program’s work with inventors of all ages over the past 25 years has given us firsthand knowledge of the important work of four-year colleges and universities, cooperative extension programs, federal labs, community colleges, K–12 schools, afterschool programs, USPTO, and the private sector. Gathering data from all of these groups will be difficult. To avoid duplication of effort and confusion, data collection efforts will need to be coordinated across federal agencies such as the USPTO, the National Science Foundation, and the U.S. Department of Education.

The measures and data collected must align with the information we need to know for advancement. We recommend a focus on assessing:

- Patenting and trademark activity over time,
- Diversity in patent and trademark activity (gender, race/ethnicity, geography),
- Opportunities for diversity and students’ development as inventors
- Ratio of patenting and trademark activity by faculty and students in higher education,
- Breadth and impact of patenting activity (economic & social impact),
- Use of patents in products and services and resulting income received by patent owner (economic and social impact), and
- Types of support for students of all ages and numbers reached.

Examples of the types of entities who have a major role to play in invention, entrepreneurship, and IP, and the types of data that could be required from those receiving federal funding, appear in Table 1.

Table 1

Entities That Play a Major Role in Invention, Entrepreneurship, and IP, and Types of Data to be Collected From Them

Type of entity	Data	Why collected
Four-year college/university	# patents and trademarks applied for # patents pending # patent applications published # patents and trademarks issued	Assess patent and trademark activity change over time

Cooperative extension offices	<p>In each category:</p> <ul style="list-style-type: none"> # people listed on patents granted & demographics # females appearing first # females listed (in any order) # students listed first # students listed in any order (based on time of filing) # female students listed in any order (based on time of filing) <p>For patents granted:</p> <ul style="list-style-type: none"> # forward citations by category per the Web of Science index five years from date of issuance of a patent # citing organizations Four-digit International Patent Classification (IPC) codes assigned at time of patent application* <p>Has an entity on campus been designated as the lead for students who may have questions about intellectual property? If so, contact information</p> <p># and demographics of students at each grade level taking a course that includes invention and IP education</p> <p>Same data for course(s) on commercializing IP</p>	<p>Assess diversity in patent and trademark activity (gender, race/ethnicity, geography)</p> <p>Assess opportunities for developing as an inventor & gender diversity across sites. Assess ratio of patent and trademark activity by faculty and students</p> <p>Assess breadth and impact of patent activity (including social impact)</p> <p>Assess support for students</p>
Two-year colleges	Same as four year	Assess patent and trademark activity change over time
High schools/districts	# and demographics of students at each grade level taking a course that includes invention and IP education. Same data for course(s) on commercializing IP	Assess diversity in patent activity (gender, race/ethnicity)
Middle grades (6–8)/districts	# schools integrating STEM instruction and engaging ecosystem partners per federal STEM plan through the “lens” of inventing	Assess opportunities for developing as an inventor & diversity of

	<p># after-school programs/students served who participated in a local science fair, robotics competition, or invention conventions</p> <p>Note: Other useful data already collected</p> <p>Has an entity on campus been designated as the lead for students who may have questions about intellectual property? If so, contact information</p>	<p>those accessing opportunities</p> <p>Assess support</p>
Elementary grades/districts	<p># schools/students integrating STEM instruction and engaging ecosystem partners per federal STEM plan through the “lens” of inventing</p> <p># after-school programs/students served who participated in a local science fair, robotics competition, or invention convention</p> <p>Note: Other useful data already collected</p>	<p>Assess opportunities for developing as an inventor & diversity of those accessing opportunities</p>
USPTO	<p>Same as four year for minors under 18. Collect through virtual resource center that waives patent and trademark filing fees for minors</p> <p>Age of each person listed at time of filing</p>	<p>Examine growth over time among young people</p> <p>Examine decline in average age at first filing (proxy for effectiveness of invention education)</p>
Small business development centers/programs	Data	Why Collected
Public centers	<p># patents and trademarks applied for</p> <p># patents pending</p>	<p>Assess patenting activity and change over time</p>
Private sector businesses & corporations	<p># patent applications published</p> <p># patents and trademarks issued</p> <p>In each category: # people listed on patents granted & demographics</p>	<p>Assess diversity in patent activity (gender, race/ethnicity)</p>

females appearing first
females listed (in any order)

Assess opportunities
for developing as an
inventor & gender
diversity

Note. *During the provisional patent and patent application process, patents are assigned International Patent Classification (IPC) codes by patent examiners to facilitate subsequent applicants search for prior art. The IPC codes thus allow a given invention to be classified in terms of the larger technological field in which it is located. When viewed in the aggregate, IPC codes allow for the characterization of the distribution of invention groups across technological fields (Miller et al., 2021).

There are many different roles within local, state, and national STEM/innovation ecosystems, carried out by individuals and organizations that are key to inventing and the commercialization of intellectual property. Technologies are available to assist with identifying human and other resources, as well as tracking participation and engagement in particular ecosystems. The use of these tools, coupled with quantitative research methods and more in-depth ethnographic studies, could generate new understandings of best practices. Mixed-method research studies could examine ways support for participants influenced their work as inventors and entrepreneurs. An emphasis could be placed on examining ecosystems producing inventors in greater numbers and business startups with intellectual property, while also assessing the percentages of those underrepresented in the innovation ecosystem.

6. Invention, entrepreneurship, and intellectual property protection have been shown to be concentrated in certain areas of the country and among individuals from higher socioeconomic groups. What new or existing channels could be created or utilized to more effectively deliver information and resources to prospective innovators from all demographic, geographic, and economic backgrounds?

Embedding invention education into the regular offerings of publicly financed education providers will ensure access to ways of learning how inventors find and solve problems that matter. Access to opportunities for learning, however, must be coupled with investment in resources for creating prototypes of inventions and in the preparation of educators to teach, facilitate the invention process, and assess student learning in new ways. Deliberate instruction in problem-oriented, open-ended, guided inquiry; the design of technical solutions to problems students identify through engagement with others; construction and testing of prototypes; submission of patent and trademark applications; and instruction on the commercialization of IP are not commonly taught as part of public schooling in the United States. A corresponding strand of teaching and learning is needed for learners of all ages and stages of development. Opportunities exist to infuse invention education into the offerings of K–12 schools, community colleges, and four-year colleges and universities.

II. Creating Innovators—Helping to prepare people to obtain the skills and develop the interests necessary to become innovators, problem solvers, and entrepreneurs

7. Research has shown that “invention education”—the infusion of transdisciplinary education in problem identification and problem solving—is critical to developing innovation skills in learners. How can educational institutions at all levels (pre-kindergarten through post-graduate) successfully infuse concepts of invention, entrepreneurship, and intellectual property education into curricula?

Research publications demonstrating what invention educators and collaborators have learned as they experimented with affording students an opportunity for learning to invent are limited. This prompted a number of researchers to examine the studies that do exist, to share what is currently known about invention education, and to articulate areas in need of further study. The document that invention education researchers created (Invention Education Research Group, 2019) is available at <https://lemelson.mit.edu/node/2511>. Additional investments are needed to expand efforts to document the models of teaching and learning that are emerging at each grade level for students at different stages of development. Research is also needed to understand how particular models support or constrain inventors’ development, as well as to inform instructional methods within each model and new ways of assessing both teaching and learning (i.e., students’ growth and development). Invention education is in its infancy, alongside the relatively new efforts to teach STEM subjects in an integrated manner with supports from community members in the broader ecosystem that surrounds educational institutions. Many approaches to invention education are emerging. Research studies are needed to document and assess the models, and to translate findings into new policies and practices that will allow successful models to flourish.

8. To supplement formal education, how can community institutions, particularly in rural and economically disadvantaged areas, build awareness of, and skills and interests in, invention, entrepreneurship, and intellectual property among students of all ages?

Students spend the vast majority of their waking hours outside formal education settings. Developing an invention is a time-intensive process that may be pursued as part of students’ formal schooling but will also need to be pursued during the hours they are not in a classroom. The work must be supported by both formal and informal educators who possess different types of expertise. Expertise needed by novice inventors can include knowledge of the problem, technical knowledge needed for a solution, knowledge of the invention process, IP protection, venture capital, and knowledge related to launching a new company. Many students may not have the knowledge, skills, or social networks needed to identify and/or access the support that they need to move a good idea forward. Technology tools can be used to provide greater transparency of local, state, and national resources. The tools must be attached to human ecosystem mapping efforts, and ecosystems of support require resources to manage and evolve across time and events as local conditions change.

9. More can be done to help teachers, even those with a formal science, technology, engineering, or mathematics (STEM) background, incorporate concepts of innovation into their teaching methods. What new or existing professional development opportunities, resources,

and programs could train teachers to incorporate invention education concepts into their instruction? How could these efforts be leveraged and scaled so that similar resources and opportunities are accessible to all teachers?

National consensus reports cite problem- and inquiry-based approaches to teaching and integrated approaches to teaching STEM as promising practices. Integrated STEM teaching can increase students' conceptual learning within the disciplines and can support the development of student interest in STEM (National Academies of Sciences, Engineering, & Medicine, 2018; National Academy of Engineering & National Research Council, 2014). The 2014 report by the National Academy of Engineering and National Research Council that calls for integrated STEM teaching also described the need for new forms of teacher preparation. They emphasized the importance of subject-specific content knowledge, knowledge of how to provide instructional supports that help students recognize connections between disciplines, and ways of supporting students' developing proficiency in individual subjects in ways that complement students' learning through integrated subjects.

The Lemelson-MIT Program has sixteen years of experience in helping high school educators develop the capacity to teach their students to invent. This work has generated many insights into ways of supporting teachers' growth and development. Preliminary findings from one study (Skukauskaite, Couch, & Estabrooks, 2019), for example, showed the strengths teachers brought to the program that may have originated from working in industry before becoming a teacher. Alumni who participated in our recent survey indicated that the InvenTeam year was transformational to their teaching practices. Funding is needed for additional research that examines specific actions taken by LMIT, ways teachers developed as a result of those actions, and work with teachers by many other groups supporting invention education. Findings from the studies can inform efforts to expand professional development offerings for educators, ensuring that the effective elements of existing approaches are maintained.

III. Practicing Innovation – Harnessing skills and interests to the act of innovation

10. Recent progress in developing STEM graduates from underrepresented groups has been documented. How can similar rates of invention and entrepreneurship be attained? How can organizations best recruit and retain innovators from diverse backgrounds?

Nearly 85% of USPTO patents issued in 2018 to U.S. assignees (those assigned rights of ownership) were assigned to businesses (National Science Board [NSB], 2020). Another 9% of patents were assigned to individuals (NSB, 2020). The data indicates that, because businesses account for the majority of U.S. patents, they have the greatest potential to make changes that will improve patenting outcomes for underrepresented groups. We recommend a tighter coupling of multi-year partnership efforts between educators and the private sector to help recruit, prepare, and support underrepresented inventors and innovators in fields prone to patenting. We envision collaborations across high schools, two- and four-year colleges, and industry representatives who are able to offer employment to students after graduation from

college. Collaborations would include co-teaching efforts for students as they pursue pathways to invention.

11. Inventors thrive when cultural and institutional barriers within workplaces are minimized or removed. What are examples of these barriers, and how can organizations remove them to create an inclusive, innovative workplace culture?

Colleges and universities can lead by example. A recent report containing findings from the Lemelson-MIT Program's review of the literature surrounding the gender gap in patenting (Couch & Estabrooks, 2020) noted that:

Women in academia patent at higher rates, compared to industry and government (Sohar et al., 2018; Sugimoto et al., 2015). Women in academia, however, are less likely to submit disclosures to their patent office, and are also less likely to have their patent cited by others if they do succeed in getting a patent (Sohar et al., 2018; Sugimoto et al., 2015). In fields like life sciences, known for higher percentages of female faculty and women who patent, female life scientists are patenting at 43% of the rate of their male peers (Ding et al., 2006; Sohar et al., 2018).

Researchers hypothesize that female faculty members' lack of opportunity (Murray & Graham, 2007), research-funding disparities, tendencies for women to be working "behind the scenes," the multiple demands on women, and a lack of motivation for making money as reasons for these types of statistics (Sexton & Ligler, 2018). Further research is needed to understand whether these differences experienced by female faculty and witnessed by female students influence young women's interest or perspectives in their own work as inventors. Policies that address the barriers faced by female faculty inventors, nevertheless, would contribute to closing the gender gap in patenting through higher rates of patenting and commercialization by females in academia. These policies could include legal support for filing patents, waivers of filing fees, and more intentional focus within universities and their technology transfer offices to support the development of female faculty as inventors and as mentors of female students through targeted education, support and initiatives to encourage engagement.

12. Access to information and resources is pivotal for the development of individual inventors and small businesses. How can the nation better support individual inventors and small businesses with resources so they can successfully translate their skills and creativity into the acts of invention, intellectual property protection, and entrepreneurship?

See answers to question #1.

13. Another important objective is increasing diversity in the entire intellectual property field. What are ways of promoting diversity in the corps of intellectual property attorneys and agents who represent innovators?

Less than 2% of IP lawyers are Black or Hispanic (1.7% and 1.8% of the profession, respectively; HBNA, 2019a; Lopez, 2020). This lack of diversity in the corps of intellectual property attorneys does not allow for mentors or exploration of the IP legal field as a career path. Just as it promotes female, Black, and Hispanic inventors, the USPTO can promote female, Black, and Hispanic intellectual property lawyers. The USPTO may do this by encouraging its 57 certified IP law school clinics to offer outreach programs introducing intellectual property and the study of law to support the protection of intellectual property in their surrounding communities. Similar to introducing young people to ways of helping others in fields of study prone to patenting, law school clinics can introduce young people to ways of helping others to protect their intellectual property. Additionally, the USPTO may consider creating videos to make visible role models of leading female, Black, and/or Hispanic intellectual property attorneys, such as:

- Nicole Morris with Emory University School of Law;
- Shontavia Johnson, an attorney and entrepreneur who serves as associate vice president for entrepreneurship and innovation at Clemson University;
- Justice Dalila Wendlandt on the Massachusetts Supreme Court: mechanical engineer and former partner with a firm in the intellectual property litigation group;
- Sharon Barner, Vice President, General Counsel, and Corporate Secretary for Cummins, Inc. in Indiana: former Deputy Undersecretary of Commerce for Intellectual Property and Deputy Director of the USPTO after serving a firm as chair of the intellectual property department;
- James Smith, Chief Intellectual Property Counsel at Ecolab, Inc. in Minnesota, and former Chief Administrative Patent Judge with the USPTO; and
- Law school participants in the IP law immersion program sponsored by the Hispanic National Bar Association (HNBA, 2019b).

More generally, the following activities may be considered within the field of law:

- Add outreach and mentoring programs from the diversity, equity, and inclusion sections of bar associations for K–12 students from diverse backgrounds;
- Promote the intellectual property specialty to diverse law school populations, to diverse higher ed populations in STEM fields, and to K–12 STEM students in invention education initiatives; and
- Clarify state bar requirements and the patent bar exam with learners in invention education (state bar requirements may not include STEM, whereas the patent bar requires education or training in science or engineering). This is important for the early trajectory planning of people into the corps of intellectual property attorneys and agents.

IV. Realizing Innovation – Reaping the personal and societal benefits of innovation

14. Financial support is a critical element in translating an innovation into commercial success. What organizations, programs, or other efforts help promote access to capital to an expanded group of inventors and entrepreneurs—demographically, geographically, and economically?

Prize programs, such as the Lemelson-MIT Student Prize, are a source of revenue that can help college students with costs related to their start-up efforts. The media attention generated through such programs is an additional benefit that can help inventors secure other investment. The Lemelson-MIT Program has a research study underway in partnership with researchers from the University of Massachusetts at Amherst to generate greater insights into young women's participation in the Lemelson-MIT Student Prize, in comparison to male participants. Pitch competitions offer another opportunity to obtain funding and to make a new technology or startup company visible to funders. Several new competitions have emerged, such as those offered by Chloe Capital and Equalize at Washington University St. Louis (<https://equalize.wustl.edu/>), which limit participation to inventors and entrepreneurs from underrepresented backgrounds.

15. Successfully commercializing an inventive product or concept requires in-depth knowledge about production processes, market forces, and other pertinent information. What types of mentoring initiatives could be implemented or expanded to help experienced entrepreneurs impart this specialized knowledge to diverse and novice inventors?

See answers to question #3.

16. Formalized partnerships like tech transfer offices/conferences, accelerators, and incubators can help streamline commercialization objectives such as product development, licensing, and distribution. What can be done to make these partnerships more accessible and effective at supporting all inventors and entrepreneurs?

See suggestions in answer to Question 1 for a virtual resource center to serve students, inventors, and entrepreneurs not employed at a research-intensive university with a tech transfer office.

V. Other

17. Please provide any other comments that you feel should be considered as part of, and that are directly related to, the development of a national strategy to expand the innovation ecosystem demographically, geographically, and economically.

In earlier comments, we noted that 85% of patents issued by the USPTO in 2018 to U.S. assignees (those assigned rights of ownership) were assigned to businesses, and another 9% were assigned to individuals (NSB, 2020). It is important to note that, while the share of patenting activity by universities may be small, the impact of university inventions and the commercialization of their intellectual property has a tremendous impact on the U.S. economy and on daily lives. A newly issued report by Miller et al. (2021) of 26 inventors who received the \$500K Lemelson-MIT Prize—almost all of whom were university inventors—estimated the social and economic impacts as follows:

Economic Impact of Invention:

- The 26 Lemelson-MIT Prize winners were affiliated with more than 180 companies and institutions, founding more than 140 of them to develop or commercialize new inventions.
- The independent companies founded by Lemelson-MIT Prize winners that are still in operation and report financial data collectively employ approximately 40,000 people and generate total annual revenues exceeding \$54 billion as of 2019.
- Two companies founded by Lemelson-MIT Prize winners were among the first biotechnology firms to achieve a market capitalization exceeding \$100 billion. Several other publicly traded firms founded by Lemelson-MIT Prize winners had market valuations between \$100 million and \$50 billion as of 2020.
- At least 35 of the companies affiliated with the 26 Prize winners were acquired or merged with other companies in deals valued at approximately \$7.5 billion (in 2019 dollars).

Technological Impact of Invention:

- The 26 winners, as of January 2020, held 3,871 patents for original inventions deemed to be “novel, non-obvious, and useful” by the U.S. Patent and Trademark Office.
- The patents were cited as prior art by over 40,000 subsequent patent applicants, which demonstrates that they served as material inputs to future inventions by others.
- 5,972 unique organizations were identified as having drawn on the winners’ original patents as they looked for citations for new patents.
- The winners’ patents spanned a wide range of technological classifications, with the greatest number falling in the “medical or veterinary sciences and hygiene” innovation category.

Scientific Impact of Invention:

- The 26 winners have published over 3,700 articles that have accumulated over 334,000 citations (as of March 2020).
- Winners’ articles were published in 682 different journals and were assigned 8,327 unique “Keyword Plus” keywords, demonstrating substantial breadth in the scientific content covered.

The Lemelson-MIT Prize is no longer being awarded. A strategic decision has been made to redouble efforts to help more young people learn to invent and to expand the invention education efforts in ways that help more people from underrepresented communities learn to invent and bring their inventions to intended audiences, thus creating a pipeline for inventors across ages and stages of development.

Another report, *Competing in the Next Economy* (2020) by the Council on Competitiveness, contains recommendations that are highly relevant to the questions asked in this federal notice. The council calls for “all hands on deck,” with a goal of increasing tenfold the number and diversity of Americans engaged in innovation.

One last recommendation we offer is for the USPTO and the Office of Science and Technology Policy to work more closely together to amplify the need for diversify among ranks of inventors, to help promote the understanding of invention education and the need to create a pathway for all, and to help celebrate young inventors through the renewal of White House Science Fairs.

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