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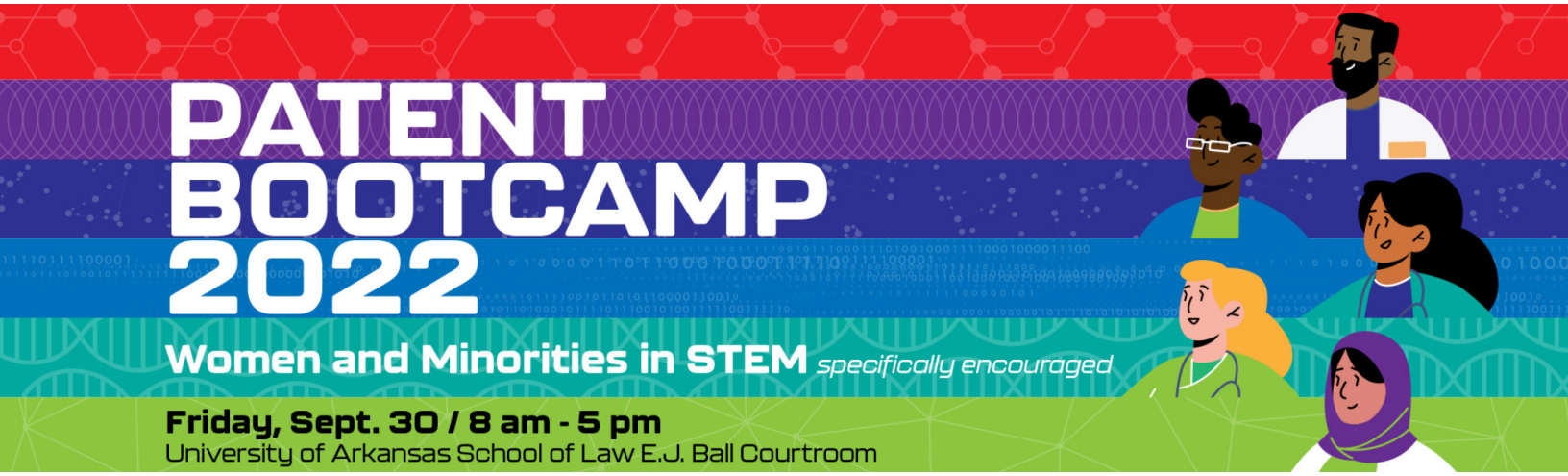

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TECH LAW
WRIGHT LINDSEY JENNINGS

UNIVERSITY OF ARKANSAS SCHOOL OF LAW

PATENT BOOTCAMP

SCHEDULE OF EVENTS

Friday, September 30, 2022

Program

8:00 – 8:30 a.m.	***Check-in. Registration. Continental Breakfast.***
8:30 – 8:40 a.m.	***Welcome and Introductory Remarks***
	Professor Cynthia Nance, Dean & Nathan G. Gordon Professor of Law. University of Arkansas School of Law
	Uche Ewelukwa Ofodile, E.J. Ball Professor of Law, School of Law, University of Arkansas.
8:40 – 9:00 a.m.	State of Innovation and Patenting at the University of Arkansas
	David Hinton, Associate Director, Technology Ventures, University of Arkansas
9:00 –10:00 a.m.	**Panel 1: Intellectual Property Law & Rights: A Primer**
Panelists:	Jane A. Kim, Partner, Wright Lindsey Jennings (**Trade Secrets**)
	Debby Winters, Cascade Law Group (**Copyrights**)
	Rashauna Norment, Rashauna Norment Law Firm, PLLC (**Trademarks**)
	Uche Ewelukwa Ofodile, E.J. Ball Professor of Law, School of Law, University of Arkansas (**Patents**)
Moderator:	Professor Sarah Gosman, Associate Professor, School of Law, University of Arkansas School of Law
10:00 –10:40 a.m.	**Keynote Address: Molly Kocialski, Regional Director, Rocky Mountain United States Patent and Trademark Office**
	Introduction by: Raquel de Castro, Treasurer, Hispanic Law Student Association
	Response and Q&A: Katie Thompson, Director, Science Venture Studio, Fayetteville, AR
10:40 – 10:50 a.m.	*Tea/Coffee Break (10 minutes)*

10:50 – 11:40 am **Breakout Session 1: *Acquiring A Patent: The Nuts and Bolts***

Session A: Pre-filing Considerations & Due Diligence. Patent Application Requirements, Finding an Affordable Patent Attorney, Filing a Provisional Patent Application and More

- Meredith Lowry, Partner, Wright Lindsey Jennings LLP, Fayetteville, AR.
- Rashauna Norment, Rashauna Norment Law Firm, PLLC.

Session B: Your Patent Application: From Claims Drafting to Submitting Your Patent Application. Common Mistakes to Avoid

- David Pieper, Founding Member, Keisling & Pieper PLC.
- Tammy VanHeyningen, PhD, Partner, Quarles & Brady LLP; Registered Patent Agent

Session C: Innovation and Patenting at the University of Arkansas: Prospects, Processes, Problems and Challenges. Agenda for Inclusivity and Diversity.

- Lisa C. Childs, PhD, Assistant Vice President for Technology Commercialization, University of Arkansas System Division of Agriculture, Patent Attorney
- Heather Nachtmann, Ph.D., Associate Dean for Research, College of Engineering & Earl J. and Lillian P. Dyess Endowed Chair in Engineering

11:40 – 12:10 p.m. ***Break for Lunch***

12:10 – 12:40 p.m. **Lunch Address: Jade Laye, Partner, Haynes & Boone LLP.**

Introduction by: Mr. Jammie Cush, President of the Black Law Students Association

12:40 – 1:30 p.m. **Panel 2*:* Creating a Legal Support Resource for Innovators and Entrepreneurs in NWA: Best Practices. Working Cost-Effectively with Patent Attorneys**

Panelist Mary Beth Brooks, Director, Small Business Development Center, Fayetteville, AR

Sarah Goforth, Executive Director, Office of Entrepreneurship and Innovation

Molly Kocialski, Regional Director, Rocky Mountain United States Patent and Trademark Office

Yoon Chae, Partner, Baker & McKenzie LL.P., Dallas

David Snow, Patent Agent; President of the University of Arkansas Technology Development Foundation

Moderator: Jane A. Kim, Partner, Wright Lindsey Jennings

1:30 – 2:30 pm **Breakout Session 2:** ***Acquiring A Patent: The Nuts and Bolts***

Session A: Pre-filing Considerations & Due Diligence: Patent Application Requirements. Finding An Affordable Patent Attorney. Filing a Provisional Patent Application and More.

- Meredith Lowry, Partner, Wright Lindsey Jennings
- Rashauna Norment, Rashauna Norment Law Firm, PLLC

Session B: Putting Together the "Perfect" Patent Application: From Claims Drafting to Submitting Your Patent Application. Common Mistakes to Avoid

- David Pieper, Founding Member, Keisling & Pieper PLC.
- Tammy VanHeyningen, PhD, Partner, Quarles & Brady LLP; Registered Patent Agent

Session C: Innovation and Patenting at the University of Arkansas: Prospects, Processes, Problems and Challenges. Agenda for Inclusivity and Diversity.

- Heather Nachtmann, Ph.D., Associate Dean for Research, College of Engineering
- Lisa C. Childs, PhD, Assistant Vice President for Technology Commercialization, University of Arkansas System Division of Agriculture, Patent Attorney

2:30 – 3:30 p.m. **Break Out Session 3.** ***Patent Prosecution. Patent Counseling. Landmines in Patenting***

Session D: Patent Prosecution and Patent Prosecutor Ethics: Key Steps. Major Challenges. Common Mistakes**.**

- Dr. Kimberlynn Davis, Partner, Kilpatrick Townsend, LLP, Atlanta
- Tammy VanHeyningen, PhD, Partner, Quarles & Brady LLP, Patent Attorney
- David Snow, Patent Agent; President of the University of Arkansas Technology Development Foundation
- Moderator: Margie Alsbrook, Visiting Assistant Professor, University of Arkansas School of Law

Session E: Patent Infringement and Patent Litigation. Common Mistakes Innovators and Start-ups Can Avoid.

- Yoon Chae, Partner, Baker & Mckenzie LLP, Dallas

3:30 – 4:30 p.m. **Panel 3. Innovation, Patents, Entrepreneurship: Special Focus on Small, Women-owned and Minority-owned Businesses – Prospects, Problems, and Challenges**

Panelists Jade O. Laye, Partner, Haynes Boone, LLP., Houston

Justin Urso, Director, McMillon Innovation Studio, University of Arkansas
David Hinton, Director, Technology Ventures, University of Arkansas

Katie Thompson, Science Venture Studio, Fayetteville, AR

Moderator Meredith Lowry, Partner, Wright Lindsey Jennings

4:30 – 4.50 p.m. **Closing Address: Dr. Kimberlynn Davis, Partner, Kilpatrick Townsend LLP, Atlanta**

Introduction by: Women's Law Student Association

4:50-5:00 p.m. Closing Remarks. Professor Uche Ewelukwa Ofodile

University of Arkansas School of Law

Patent Bootcamp 2022

A one-day patent bootcamp that will offer participants training on the basics of intellectual property law, patent law, and the patent application process. The goals of the patent bootcamp are: (i) to identify and discuss the challenges women/minorities/indigenous communities face with regards to protecting their inventions and innovation; and (ii) to provide intense training about the U.S. patent system and the patenting process.

This one-day program will focus on teaching the basics of intellectual property law in general and patent law in particular, as well the basics of the patent application and prosecution process. Overall, with an eye towards successful patent application, prosecution and enforcement, attendees will learn how to prepare a patent application that satisfies the statutory requirements for patentability.

The target audience is: innovators, entrepreneurs, individuals in STEM (science, technology, engineering, and mathematics), small, women-owned and minority-owned businesses, patent attorneys and patent agents.

The patent bootcamp faculty will offer presentations and lectures on the following topics:

- What is a Patent?
- What is a Trade Secrets?
- What is a Copyright
- What is a Trademark?
- Patents vs Trade Secrets: What is the Difference?
- Patents vs Trade Secrets: Which Option is Right for You?
- What Are the Stages of the Patent Application Process?
- Applying for a Patent: Pre-filing considerations
- Patent Search 101: The Basics of Patent Searching
- The Pros and Cons of a Provisional Patent Application
- Initial Steps of a Patent Invention Disclosure
- Preparing Your Patent Application: The Basics of Patent Claim Drafting
- An Overview of Patent Prosecution
- Patent Prosecutor Ethics
- Patent Infringement and Patent Litigation: Issues, Challenges, Strategies
- Patent Claim Chart Review
- Post-grant Proceedings at the United States Patent and Trademark Office.

PATENT BOOT CAMP 2022

Description of Panels

Panel I*:* Intellectual Property Rights – A Primer

This panel will provide an overview of the principal modes of intellectual property protection in the United States and around the world: patents, trademarks/trade dress, copyrights, trade secrets. The panel will help participants appreciate the importance and value of intellectual property rights (IPRs) in today's economy, grasp the general intellectual property law landscape and understand how the different modes of intellectual property operate and interact with one another. Questions asked and addressed will include: What is a patent? What rights are conferred by a patent? What is a trademark? What is a copyright? What is a trade secret? Patents vs trade secrets: which option is right for you?

Panel 2*:* Creating a Legal Support Resource for Innovators and Entrepreneurs in NWA: Best Practices. Working Cost-Effectively with Patent Attorneys

Obtaining a patent can be expensive. According to the law firm Forsgren Fisher, "A patent attorney will usually charge between $8,000 and $10,000 for a patent application, but the cost can be higher. In most cases, you should budget between $15,000 and $20,000 to complete the patenting process for your invention." The panel will look at the challenges innovators and entrepreneurs face finding affordable legal representation as far as protecting their intellectual property rights is concerned. The panel will discuss cost effective ways that small businesses and innovators can use to protect their intellectual property rights. The panel will also grapple with the issue of how to create legal support for innovators and entrepreneurs in Arkansas and will examine emerging best practices in other states.

Panel 3. Innovation, Patents, Entrepreneurship: Special Focus on Small, Women-owned and Minority-owned Businesses – Prospects, Problems, and Challenges

Women-owned and minority-owned businesses are less likely to participate in the patent process than their white male counterparts. While this disparity is decreasing, it will take more than 100 years to reach gender parity in the U.S. patent process and longer for most minority groups. This the panel will look at the aspects of the U.S. patent system that encourage patent acquisition and accelerate entrepreneurial activity and those aspects that act as impediments to women and minority entrepreneurs. The panel will also look more broadly at the prospects and challenges of commercializing a patent. Topics to be addressed include: What is the relationship between patents and entrepreneurship? What role do patent rights play in investors' decisions to invest in start-ups? What is the current state of involvement of women and minorities in the patent process? How do women-owned and minority-owned businesses currently participate in the entrepreneurship ecosystem in the United States and in Northwest Arkansas (NWA)? What challenges do small, women-owned and minority-owned businesses face commercializing their patents? How do we achieve a more diverse and inclusive innovation-patent-entrepreneurship ecosystem in NWA?

Sessions: Description

Session A: Pre-filing Considerations & Due Diligence. Patent Application Requirements, Finding an Affordable Patent Attorney, Filing a Provisional Patent Application and More

With a focus on patent law, this session will look at some of the basic, yet important considerations, that an innovator must consider and address prior to filing his or her patent application. The session will address a host of issues including: (i) the requirements of patentability; (ii) how to conduct a patent search; (iii) preparatory steps that can help reduce cost and possibly strengthen the quality of a patent application and the patent that is ultimately issued; (iv) finding an affordable patent attorney; (v) dangers of a fast and "low cost" patent; (vi) filing a provisional patent application. Questions that will be explored include: What can and cannot be patented? How long does patent protection last? How much does it cost to get a patent? Should I hire a patent attorney or agent? Can I afford a patent attorney? What if I cannot afford a patent attorney? When should I file a provisional patent application? When startups do not opt for patents, what other forms of protection do they rely on and what goes into the calculation about whether to apply for a patent?

Session B: Your Patent Application: From Claims Drafting to Submitting Your Patent Application. Common Mistakes to Avoid

This session will get deeper into the patent application process. A startup typically wants its patents fast and cheap, but is that really possible? From the standpoint of a researcher/inventor, Session B will examine (i) the pros and cons of filing a patent application without the help of a patent attorney; (ii) establishing and maintaining a good working relationship with your patent attorney; (iii) tell-tale signs that your patent attorney does not know what he or she is doing; (iv) getting down to the business of actually drafting and putting together a patent application. Using practical, real-world examples, the session will explore a host of questions related to the patent application process. Questions to be explored include: How do I know if my invention is patentable? What exactly is a claim and how do you draft an optimal claim? What is a specification? What is a written description? Is there such thing as a "perfect" patent application? Do startup companies face unique problems when getting patents? What are some common mistakes patent attorneys and patent agents make with respect to patent applications? Should I be worried about foreign patents? Can I file my application by myself (*pro se*).

Session C: Research, Innovation and Patenting at the University of Arkansas: Prospects, Processes, Problems and Challenges. Agenda for Inclusivity and Diversity.

This session is structured as a lively conversation around the state of the research-innovation-patenting eco-system at the university of Arkansas and in Northwest Arkansas. The session will also discuss the agenda, if any, for diversity and inclusivity in this eco-system. The session will explore questions such as: How do professors, scholars, and students go from research to innovation and patenting? What processes and partnerships are in place to encourage or promote inclusivity and diversity with respect to STEM-related research, innovation, and patenting at the University of Arkansas? Are conversations happening with local/international partners? At what point does a scholar or student start to think about talking to a patent attorney or patent agent?

Session D: Patent Prosecution and Patent Prosecutor Ethics: Key Steps. Major Challenges. Common Mistakes.

This panel will delve deeper into the patent application process by focusing on patent prosecution and the ethical issues and challenges involved. Patent prosecution costs and nightmares will be discussed as well the keys to effective patent prosecution. Topics to be addressed will include: What is patent prosecution? Why is patent prosecution important? What can I expect during the patent prosecution process? What could go wrong during the patent prosecution process? The session will also look at patent prosecution ethics by examining common mistakes patent attorneys and patent agents make in the course of prosecuting a patent. How to salvage a patent prosecution process that has gone horribly wrong will also be discussed.

Session E: Patent Infringement and Patent Litigation. Common Mistakes Innovators and Start-ups Must Avoid.

"You have a patent: now what?" This session is about challenges startups and small businesses face asserting and defending their patent. Start-ups are especially vulnerable when it comes to patent infringement and patent litigation and many are embroiled in costly litigation. An old joke: "How does a patent attorney tell the difference between a good invention and a bad invention: it is whether the check clears" comes to mind. This session is about learning how to avoid infringing on patents owned by others and knowing how to assert and defend one's patent. With a focus on small, women-owned and minority-owned businesses, this session will examine common mistakes start-ups make as far as asserting and or defending their patents is concerned. It will also discuss how start-ups can avoid infringing patents belonging to others. When to get a patent opinion letter and helpful approaches on patent opinion drafting will also be discussed. Other questions to address include: Could my patent be invalidated? Should I be worried about infringing a foreign patent? Should I be worried if my patent is infringed overseas? Time permitting, the panel will also discuss post-patent proceedings at the United States Patent and Trademark Office (USPTO).

2022 Patent Bootcamp for Women and Minorities in STEM

Speakers, Panelists, and Moderators

Speakers

Kimberlynn Davis

Kimberlynn B. Davis Ph.D. is a Partner at Kilpatrick Townsend. Kim focuses her practice on prosecuting foreign and domestic patent applications in pharmaceuticals, polymers, the chemical arts, materials, and metallurgy, due diligence and freedom to operate analysis, and client counseling and portfolio strategy for companies, universities and research institutions. With a background in organic and medicinal chemistry, Dr. Davis has pursued a career supporting life science innovators in all of their patent needs, including strategic patent counseling, portfolio development, and prosecution services. Dr. Davis provides litigation support in an array of technologies, including pharmaceuticals, polymers, drug and chemical formulations, and drug delivery systems. In particular, she has extensive experience in preparing non-infringement and invalidity opinions and in performing freedom-to-operate analyses and due diligence for pharmaceutical and chemical clients. While attending graduate school, she designed and synthesized nucleoside analogues as HIV-1 reverse transcriptase inhibitors and also focused on developing methodology to improve the regioselectivity of nucleoside base couplings under advisor Dr. Dennis Liotta. Dr. Davis also served as an intern in the Emory University Office of Technology Transfer, where she assessed the marketability and patentability of technologies. While attending Xavier University of Louisiana, Dr. Davis worked as a summer intern in medicinal chemistry at Eli Lilly and Company. Dr. Davis has co-authored scientific and legal journal manuscripts and presented at several scientific meetings. She is a recipient of Apex Society's Power 30 Under 30™ Award, was recognized as a Superwoman of the Future Services Asset Creation - Prosecution & Counseling Intellectual Property Market Protection - Opinions & Dispute Avoidance Patents Industries Health & Life Sciences Kimberlynn B. Davis Ph.D. Partner 1100 Peachtree Street NE Suite 2800 , Atlanta , GA USA 30309 t 404.541.6815 | f 404.547.4764 kbdavis@kilpatricktownsend.com 1 by Atlanta Tribune Magazine, and has been profiled by Rolling Out Atlanta Magazine. During law school, Dr. Davis received the GSU

College of Law Intellectual Property Scholarship and served as a graduate research assistant for the GSU Intellectual Property Advisory Board. Dr. Davis was recognized in 2018, 2019 and 2021 as a Georgia "Rising Star" in the area of Intellectual Property by Super Lawyers magazine. She was recognized in 2022 and 2023 as one of the "Best Lawyers: Ones to Watch" for Patent Law by The Best Lawyers in America®. Dr. Davis is a recipient of the National Bar Association's "40 Under 40 Nation's Best Advocates" Award in 2021 and was named a 2021 Georgia Legal Award honoree as an attorney "On the Rise" by The Daily Report. She was also named a "40 Under 40 Leader" by Emory University Alumni Association in 2020. Dr. Davis serves as the co-chair of KT Voice, Kilpatrick's resource group focused on promoting the interests of Black attorneys.

Education: Georgia State University, College of Law J.D. (2013) magna cum laude Emory University Ph.D. (2008) Organic Chemistry Xavier University of Louisiana B.S. (2004) Biochemistry, *summa cum laude.*

Lilybeth (Molly) Kocialski

Is the Director of the Rocky Mountain Regional United States Patent and Trademark Office. As the Regional Director of the Rocky Mountain Regional United States and Trademark Office, since January 2016, Mollybeth (Molly) Kocialski carries out the strategic direction of the Under Secretary of Commerce for Intellectual Property and Director of the USPTO, and is responsible for leading the Rocky Mountain regional office. Focusing on the nine states within this region and actively engaging with the community, Ms. Kocialski ensures the USPTP's initiatives and programs are tailored to the region's unique ecosystem of industries and stakeholders.

Ms. Kocialski brings more than 20 years of intellectual property experience to the USPTO. Most recently, Ms. Kocialski was the Senior Patent Counsel for Oracle America, Inc., where she was responsible for managing an active patent prosecution docket and was also responsible for all of the post-grant procedures and patent investigations for Oracle and its subsidiaries. Prior to Oracle, she worked at Qwest Corporation and was also in private practice in both New York and Colorado focusing on intellectual property litigation for multiple high-tech companies while maintaining an active prosecution docket.

Ms. Kocialski is a recognized IP leader in the Rocky Mountain region. Ms. Kocialski currently serves on the Colorado Federal Executive Board's Executive committee. Ms. Kocialski is the vice President of the Colorado IP Inn of Court and was previously the Chair of the Planning Committee and a member of the Planning Committee for the Rocky Mountain Intellectual Property Institute, an annual two-day conference on intellectual property that attracts over 500 attendees. She was the Chair of the Intellectual Property Section of the Colorado Bar

Association and served on the Colorado Bar Association's Board of Governors. Ms. Kocialski served as the head of the IP Committee and was a member of the Board of Directors for the Colorado Chapter of the Association of Corporate Counsel and served on the national IP Committee of the Association of the Corporate Counsel. In 2015 Ms. Kocialski was recognized by ManagingIP magazine as one of its North American Corporate IP Stars.

Ms. Kocialski is a graduate of the State University of New York at Buffalo School of Law as received a Bacelor of Science in Chemical Engineering from the University of New Mexico. Ms. Kocialski is a registered patent attorney and is admitted to the U.S. Patent and Trademark Office, the New York and Colorado state bars as well as the United States Courts in those jurisdictions.

Jade O. Laye (J.D. '04)

Jade O. Laye is a partner at Haynes and Boone LLP in Houston. A registered patent attorney, Jade Laye focuses his practice on intellectual property law, with an emphasis on patent prosecution, opinions, and counseling, as well as the acquisition, licensing, and divestiture of patent rights.

He is a former Patent Examiner with the United States Patent and Trademark Office (USPTO) in its telecommunications division. While at the USPTO, his technical focus was in the areas of video and data distribution systems, networks, electronic programming guides, and related technology, such as video recording devices, modems, and hand-held communications devices.

Clients benefit from Jade's experience with a range of technologies, including electrical and mechanical oil field devices, automotive technology, optical computing devices, electromagnetic logging tools, software, semiconductors, fracturing methods, e-commerce, and telecommunications. In addition to his law degrees, Jade holds a B.S. in Electrical Engineering.

Jade is involved in Haynes and Boone's attorney diversity efforts, where he focuses on advancing the hiring, retention, and promotion of diverse lawyers within the firm. He also serves as a founding member of the Houston Minority IP Lawyers Association and was admitted into the 2016 class of the Leadership Council on Legal Diversity (LCLD) Fellows Program. In addition, he serves on the Board of Directors for the Bridge Preparatory Academy in Sugar Land, Texas.

Cynthia Nance

Cynthia E. Nance is the Dean and Nathan G. Gordon Professor at the University of Arkansas School of Law. Her teaching and scholarship focus on labor and employment law, workplace legislation, and poverty law.

Nance holds a Bachelor of Science, *magna cum laude,* from Chicago State University and a Master of Arts from the University of Iowa College of Business. She earned a Juris Doctor, with distinction, from the University of Iowa College of Law.

She has received various awards for her outstanding service and will receive the Association of American Law Schools' Women in Legal Education's annual Ruth Bader Ginsburg Lifetime Achievement Award in January. The recipient is someone who has impacted women, the legal community, the academy, and the issues that affect women through mentoring, writing, speaking, activism, and by providing opportunities to others.

Uché Ewelukwa Ofodile

Professor Uché Ewelukwa Ofodile holds the E. J. Ball Endowed Chair at The University of Arkansas School of Law and is an Affiliated Professor of the Department of Political Science and of African and African American Studies at The University of Arkansas' J. William Fulbright College of Arts and Sciences. Professor Ofodile is a lifetime member of the Council on Foreign Relations. From 2021-2022 she was a Senior Fellow of the Mossavar-Rahmani Center for Business and Government at Harvard University's Kennedy School of Government.

Professor Ofodile's teaching, research, and scholarship focuses on intellectual property law, technology and the law, international investment law, international trade law, international dispute settlement, as well as corporate social responsibility. Featured in *Law360* ('Breaking IP Barriers'), Professor Ofodile has advised numerous governments, international organizations, businesses, and nongovernmental organizations on issues relating to intellectual property law and emerging technologies. She is an active member of the American Bar Association Section of International law and has served the organization in numerous leadership positions including as Vice-Chair of the International Intellectual Property Committee. From 2014 – 2017 she served as the Co-Chair of the Intellectual Property Interest Group of the American Society of International Law. Professor Ofodile has authored numerous book chapters, articles, and essays. Her articles have appeared in refereed and policy-oriented

journals. Her recent articles and essays include: Uche Ewelukwa Ofodile, *Will Washington Ever Get Around to Regulating Artificial Intelligence*? JURIST (10 January 2022); Uche Ewelukwa Ofodile, *Businesses and the EU's Proposed Artificial Intelligence Act: Major Points of Controversy*, JURIST (17 December 2021); Uche Ewelukwa Ofodile, *The Intersection of FinTech (Cryptocurrency) and Trademark Law*, 53 U.C. Davis L. Rev. Online 141 (2020).

Professor Ofodile has certificates of training from the World Intellectual Property Organization for 'Workshop for Mediators in Intellectual Property Disputes,' 'Certificate, Advanced Workshops for Mediators in Intellectual Property Dispute,' 'Advanced Workshop on Domain Name Dispute Resolution,' and 'Intellectual Property Arbitration Workshop.' Professor Ofodile is the founder and convenor of 'Patent Bootcamp for Women and Minorities in STEM.'

Panelists

Mary Beth Brooks

Bringing 28 years of banking experience to the position, Mary Beth Brooks became director of the Arkansas Small Business and Technology Development Center at the University of Arkansas, Fayetteville in August 2018. She served as president and CEO of The Bank of Fayetteville from 2004 to 2015, followed by a private consulting practice. Earlier in her banking career, she held executive roles at Arvest Bank Group.

Active in the community, Mary Beth has served on the Arkansas Economic Development Commission, Northwest Arkansas Council, Fayetteville Chamber of Commerce board, Fayetteville Public Education Foundation board, Yvonne Richardson Community Center board, and the University of Arkansas for Medical Sciences, UAMS Northwest boards and helped found the Walton College Alumni Society.

A graduate of the University of Arkansas, she also holds a Master of Business Administration in Finance and Banking degree from the University of Wisconsin.

Yoon Chae

Yoon Chae is a partner in Baker McKenzie's Intellectual Property & Technology Practice, where he advises clients on diverse intellectual property and technology matters. He serves as an innovation ambassador of the Firm, a member of Texas Offices' Recruiting and Diversity & Inclusion Committees, and the Dallas representative of Baker Asian Lawyer Network (BALN). Yoon has extensive experience in all stages of IP litigation and has worked on cases in front of the Federal Circuit, the International Trade Commission, the Court of Federal Claims, and numerous federal district courts. He has also played critical roles on proceedings in front of the Patent Trial and Appeal Board and the American Arbitration Association. Yoon regularly writes about IP and regulatory issues relating to AI and autonomous systems, including the highly cited "Artificial Intelligence Collides with Patent Law" that he co-authored while serving as the Firm's first fellow at the World Economic Forum's Centre for the Fourth Industrial Revolution.

He was a recipient of the Firm's Excellence in Innovation Award (2018) and Texas Lawyer's On the Rise Award (2019). And he has been recognized by Texas Super Lawyers as a Rising Start in

IP litigation (2018-2022), the Best Lawyers in America for patent litigation (2022-2023), and the Best Lawyers in America as an attorney on their Ones to Watch list for IP litigation and patent litigation (2021-2022).

Lisa C. Childs

Lisa C. Childs is a patent attorney and the Assistant Vice President for Technology Commercialization for the University of Arkansas System Division of Agriculture and manages all aspects of the division's intellectual property portfolio. Before joining the University of Arkansas in 2006, she practiced patent law as a partner with Michael Best and Friedrich LLP in Chicago.

Childs is admitted to practice in Arkansas, Illinois, and the United States Patent and Trademark Office and is interested in making it easier for others to find technology-based jobs in Arkansas. She earned a Bachelor of Arts in biochemistry from Rice University, Doctor of Philosophy in genetics from North Carolina State University, and Juris Doctor, *cum laude*, from Loyola University.

Sarah Goforth

Sarah is the Executive Director of the Office of Entrepreneurship and Innovation at the University of Arkansas and an Adjunct Professor at the Sam M. Walton College of Business.

Goforth oversees the university's interdisciplinary Graduate Certificate in Entrepreneurship and teaches the New Venture Development course sequence. She has also held senior roles at the Discovery Channel and the Howard Hughes Medical Institute, where she was part of a core team that established a new science documentary startup, Tangled Bank Studios.

Goforth holds a B.A. in biology from Hendrix College and an M.A. in science journalism from the University of Wisconsin-Madison. Her research has been published in *The Journal of Neuroscience*, and her science writing has been published in *The Scientist*, *Popular Science*, *Science*, Discovery.com, *Smithsonian* magazine, *Madison* magazine, and *The Dallas Morning News*.

David Hinton

David J. Hinton, M.B.A, Ph.D. serves as Associate Director of Technology Ventures at the University of Arkansas, Fayetteville. David accelerates the process of transferring innovative solutions outside the walls of the university and into the marketplace. David leads all aspects of the university's intellectual property commercialization pipeline. David works with faculty, staff, and students to protect intellectual property that arises out of their research and work at the university.

Jane Kim

Jane A. Kim is a partner at Wright Lindsey Jennings LLP. A Chicago-area native, Jane has been practicing in the employment law field since 2007, when she moved to Little Rock to start her legal career at Wright Lindsey Jennings. She maintains an active litigation practice, primarily defending a wide range of clients in state and federal court actions—including class and collective actions—involving claims under the various civil rights and wage and hour laws, and claims related to employment agreements, covenants not to compete, and trade secrets. Jane also regularly provides advice and training on employment law compliance and represents employers in state and federal government agency investigations. Jane serves as Chair of the firm's Committee on Associates and is fluent in Korean.

Meredith Lowry

Meredith Lowry is a partner at Wright Lindsey Jennings LLP whose practice principally involves various aspects of intellectual property related to retail and e-commerce, including intellectual property acquisition, data and privacy, manufacturing, marketing, and distribution. She has assisted a variety of companies in their efforts to obtain patent, trademark, and copyright protection and has also worked with clients to protect those assets through online and in-store infringement. Since 2019, Meredith has spearheaded WLJ's initiative Woman-Run, a group dedicated to creating a network and education opportunities for women running businesses.

Heather Nachtmann

Dr. Heather Nachtmann is the Earl J. and Lillian P. Dyess Endowed Chair in Engineering and a Professor of Industrial Engineering at the University of Arkansas. She serves as the Director of the Maritime Transportation Research and Education Center and the Mack-Blackwell Transportation Center. She received her Ph.D. in Industrial Engineering from the University of Pittsburgh.

Dr. Nachtmann's current research program focuses on economic and decision analysis of the transportation systems, focusing on inland waterways and multimodal transportation networks, cost quality issues in the healthcare supply chain, and advanced methods for engineering economic analysis.

Rashauna Norment

Rashauna Norment is a registered patent attorney and the founding member of Rashauna Norment Law Firm, PLLC, an intellectual property law firm in Little Rock, Arkansas. Ms. Norment has been admitted to practice before the United States Patent and Trademark Office, courts in the State of Arkansas, and the Eastern and Western District Courts of Arkansas. She has over 13 years of experience in intellectual property law and handles patents, trademarks, copyrights, licensing, research, and litigation.

She has represented businesses, independent inventors and entrepreneurs, and other institutions based not only in Arkansas, but also in New York, Texas, California, and overseas concerning their patent, trademark, copyright, and business needs. She was also an adjunct law professor at the University of Arkansas at Little Rock William H. Bowen School of Law, teaching intellectual property law courses.

David Pieper

David B. Pieper is originally from Murfreesboro, TN and graduated from Vanderbilt University with a degree in electrical engineering. He is a registered patent attorney and founding member of Keisling & Pieper PLC, an intellectual property law firm in Fayetteville, Arkansas, where he has prosecuted hundreds of issued patents ranging from children's toys to quantum dot nanocrystals. David is also an adjunct professor at the University of Arkansas School of Law where he teaches classes in Intellectual Property Law and Entertainment Law.

David Snow Ph.D., CLP, Patent Agent

Dr. Snow currently serves as the Executive Director of Technology Ventures, with responsibility over intellectual property management and licensing activity for the University of Arkansas, and President of the University of Arkansas Technology Development Foundation (UATDF). The combined mission and vision of these organizations works to grow a diverse and engaged entrepreneurial community focused on driving innovation to impact, breaking poverty cycles, creating new sources of wealth in our community, and building safe innovation districts where anyone can belong

Katie Thompson

Katie Thompson is the Executive Director of Science Venture Studio at Startup Junkie, and CEO of Rooted Startups. She has a passion for working directly with entrepreneurs to help bridge the gap between the responsibilities of leadership, employees' interests, and areas for financial growth so that the company can optimize at its highest level of productivity.

The Science Venture Studio aims to support science and technology companies on their journey to developing their technology through non-dilutive federal research programs.

Justin Urso

Justin Urso is the director of the McMillon Innovation Studio, an interdisciplinary facility and set of programs housed in the Sam M. Walton College of Business at the U of A serving students from across campus and industry partners across the state.

Urso has a diverse background that includes working with startups and helping companies expand by harnessing their data. He also brings to the studio a wealth of experience mentoring and coaching student teams on product strategy, software and app development and business model design.

Tammy VanHeyningen

Tammy VanHeyningen, Ph.D., is a partner and registered patent attorney in the Intellectual Property Group of Quarles & Brady LLP. Her practice includes all areas of intellectual property counseling, with a focus on domestic and international patent prosecution, strategic patent portfolio development, licensing, non-infringement and invalidity opinions, and freedom to operate advice. Her technology concentrations are in biotechnology, biologics, and pharmaceuticals.

Tammy is recognized by the *IAM Patent 1000* as a top patent practitioner in Wisconsin. She has authored several scientific research articles and written and presented on many aspects of intellectual property law.

Debby Winters

Debby Winters puts her years of work as an intellectual property attorney and a Ph.D. in biochemistry and molecular biology at Cascade Law Group, offering clients assistance in handling a wide variety of intellectual property and business matters, including patents, trademarks, copyrights, trade secrets, and licensing. It is critical that businesses protect their intellectual property, and Debby is dedicated to helping clients do just that.

Dr. Winters has a varied background that includes teaching at the college level and practicing intellectual property and business law. She has practiced in an intellectual property law firm, served as in-house counsel for emerging start-up companies and most recently ran a sole legal practice focusing on the startup community.

Moderators

Margie Alsbrook

Margie is a visiting professor of Legal Research & Writing for the University of Arkansas School of Law. She has extensive experience advising companies, non-profits, and individuals on food, trade, and land use issues.

Sara Gosman

Professor Gosman is an Associate Professor at the University of Arkansas School of Law who teaches and writes in the areas of environmental and energy law. Her courses include environmental law, energy law and policy, and natural resources law, as well as Torts. Her research explores the ways in which uncertainty about risk creates both challenges and opportunities for policy. She is also the President of the Board of Directors for the Pipeline Safety Trust, a non-profit organization devoted to pipeline safety. Prior to joining the University of Arkansas School of Law in 2014, Professor Gosman was a lecturer at the University of Michigan Law School. She taught courses in toxics, Supreme Court environmental litigation, environmental justice, and oil and gas law. She has also practiced as a water resources attorney at the National Wildlife Federation and as an Assistant Attorney General in the environmental division of the Michigan Department of Attorney General. Professor Gosman received an A.B. with high honors from Princeton University and a J.D., *cum*

laude, from Harvard Law School, where she was senior editor of the Harvard Environmental Law Review. She also holds a Master's degree in public administration from the John F. Kennedy School of Government at Harvard University.

State of Patenting in the United States: Facts and Figures

Professor Uche Ewelukwa Ofodile

Global

- In 2020, 3,276,700 patent applications were filed worldwide.
    - WORLD INTELLECTUAL PROPERTY INDICATORS 2021

- Of the 3,276,700 patent applications filed worldwide in 2020, 1,497,159 applications were filed through the National Intellectual Property Administration of the People's Republic of China and 597,172 applications were filed through the United States Patent and Trademark Office.
    - WORLD INTELLECTUAL PROPERTY INDICATORS 2021

- In 2020, the United States ranked No. 2 (after China) in terms of ranking of total (resident and abroad) patents and trademarks filing activity by country of origin.
    - WORLD INTELLECTUAL PROPERTY INDICATORS 2021

- Of the top 20 patent offices (in terms of number of patent applications received), nine were located in Asia, six in Europe, two each in North America and Latin America and the Caribbean (LAC), and one in Oceania.
    - WORLD INTELLECTUAL PROPERTY INDICATORS 2021

United States

- In terms of the number of patent grants in the United States in FY 2021, by state: California ranked No. 1 (46,564 patents granted), Arkansas ranked No, 39 (384 patents granted).
    - Statista.com

United States: Gender Gap in Patenting

- In 2010, 18.8 percent of all patents had at least one female inventor, up from 3.4% in 1977. "[A]t the current rate of change since 2000 women will not see parity in patenting until the year 2092"
    - INSTITUTE FOR WOMEN'S POLICY RESEARCH, 'EQUITY IN INNOVATION: WOMEN INVENTORS AND PATENTS' (2016)

- "Women inventors made up only 12 percent of all inventors on patents granted in 2016."

    - USPTO, 'PROGRESS AND POTENTIAL: A PROFILE OF WOMEN INVENTORS ON U.S. PATENTS,' (2019)

- "American businesses have the lowest women inventor rates among the various categories of U.S. patent owners."
    - Information Technology and Innovation Foundation (ITIF), 'THE DEMOGRAPHICS OF INNOVATION IN THE UNITED STATES' (2016).

- "Women represent just 12 percent of U.S. innovators. The average male born in the United States is nine times more likely to contribute to an innovation than the average female." Innovators defined as "include people who have won national awards for their inventions, people who have filed for international, triadic patents for their innovative ideas in three technology areas (information technology, life sciences, and materials sciences), and innovators who have filed triadic patents for large advanced-technology companies."
    - THE DEMOGRAPHICS OF INNOVATION IN THE UNITED STATES (2016)

- According to the United States Patent and Trademark Office report: PROGRESS AND POTENTIAL 2020 UPDATE ON U.S. WOMEN INVENTOR-PATENTEES:

    - Patenting by U.S.-based women grew between 2016 and 2019. Patents with at least one woman inventor accounted for 21.9% of patents through 2019, up from 20.7% in 2016.

    - The women inventor rate (WIR)—that is, the share of women among all U.S. inventor-patentees—grew from 12.1% in 2016 to 12.8% by 2019.

    - The percentage of new women inventor patentees rose from 16.6% in 2016 to 17.3% by 2019.

    - The gender gap in the number of inventor patentees that stay active by patenting again is decreasing. In 2014, 46% of women patented again within five years of their first patent (by 2019), versus 52% of men. In 1980, the gap was 28% for women versus 38% for men.

United States: Racial Gap in Patenting

- U.S.-born minorities (including Asian Americans, African Americans, Hispanics, Native Americans, and other ethnicities) represent just 8 percent of U.S.-born innovators.
    - THE DEMOGRAPHICS OF INNOVATION IN THE UNITED STATES (2016)

- Immigrants comprise a large and vital component of U.S. innovation: 35.5 percent of U.S. innovators were born outside the United States.
    - THE DEMOGRAPHICS OF INNOVATION IN THE UNITED STATES (2016)

- "Men-owned businesses are twice as likely as women-owned businesses to have either a granted patent (1.5 percent compared with 0.7 percent) or a pending patent (0.9 percent compared with 0.6 percent)
    - Institute for Women's Policy Research, INNOVATION AND INTELLECTUAL PROPERTY AMONG WOMEN ENTREPRENEURS' (2018)

- "From 1970 to 2006, African American inventors were awarded just six patents per million people, compared to more than 235 patents per million for all U.S. inventors. Today, African Americans and Hispanics apply for patents at only half the rate of whites, and African American and Hispanic college graduates similarly hold just half as many patents as white college graduates."
    - Holly Fechner, Partner, Covington & Burling.

- "Considering only [those] born in the United States, 92.3 percent [of innovators] were White, 3 percent were Asian, and 2.1 percent were Hispanic. Despite representing 13.2 percent of the U.S. population, only two U.S.-born innovators reported as Black, representing less than half a percent of the U.S.-born group of innovators. Multiracial or "Other" respondents had 1.4 percent, with eight responses, as did Native American respondents."
    - THE DEMOGRAPHICS OF INNOVATION IN THE UNITED STATES (2016)

- "Blacks and Hispanics born in the United States account for 22.8 percent of the population, yet just 1.7 percent of responding innovators."
    - THE DEMOGRAPHICS OF INNOVATION IN THE UNITED STATES (2016)

Supplemental Materials

UNIVERSITY OF ARKANSAS SCHOOL OF LAW

SECOND ANNUAL PATENT BOOTCAMP

Friday, September 30, 2022

Training Packet

Professor Uche Ewelukwa Ofodile, SJD
Convenor, Patent Bootcamp 2022

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- Study of Underrepresented Classes Chasing Engineering and Science Success Act of 2018 (Public Law 115-273), available at: https://www.congress.gov/115/plaws/publ273/PLAW-115publ273.pdf

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- United States Patent and Trademark Office, Progress and Potential: 2020 Update on U.S. Women Inventor-Patentees (2020)
- Institute for Women's Policy Research, The Gender Patenting Gap, July 2016. https://iwpr.org/iwpr-general/the-gender-patenting-gap/ (Excerpts).
- Elyse Shaw and Cynthia Hess, *Closing the Gender Gap in Patenting, Innovation, and Commercialization: Programs Promoting Equity and Inclusion* (July 2018). https://iwpr.org/iwpr-general/closing-the-gender-gap-in-patenting-innovation-and-commercialization-programs-promoting-equity-and-inclusion/ (excerpts).

Appendix L Consolidated Patent Laws — March 2021 update

United States Code Title 35 - Patents

[Editor Note: Current as of July 1, 2020. The Public Laws are the authoritative source and should be consulted if a need arises to verify the authenticity of the language reproduced below.]

United States Code Title 35 - Patents
PART I — UNITED STATES PATENT AND TRADEMARK OFFICE

CHAPTER 1 —ESTABLISHMENT, OFFICERS AND EMPLOYEES, FUNCTIONS

CHAPTER 2 —PROCEEDINGS IN THE PATENT AND TRADEMARK OFFICE

CHAPTER 3 —PRACTICE BEFORE PATENT AND TRADEMARK OFFICE

CHAPTER 4 —PATENT FEES; FUNDING; SEARCH SYSTEMS

United States Code Title 35 - Patents
PART II — PATENTABILITY OF INVENTIONS AND GRANT OF PATENTS

CHAPTER 10 —PATENTABILITY OF INVENTIONS

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United States Code Title 35 - Patents

PART V — THE HAGUE AGREEMENT CONCERNING INTERNATIONAL REGISTRATION OF INDUSTRIAL DESIGNS

CHAPTER 38 —INTERNATIONAL DESIGN APPLICATIONS

SELECTED PROVISIONS OF OTHER TITLES OF THE UNITED STATES CODE

SELECT PROVISIONS OF TITLE 18, UNITED STATES CODE

UNCODIFIED LAW

SELECT UNCODIFIED AIA PROVISIONS

United States Code Title 35 - Patents

PART I — UNITED STATES PATENT AND TRADEMARK OFFICE

CHAPTER 1 — ESTABLISHMENT, OFFICERS AND EMPLOYEES, FUNCTIONS

Public Law 115–273
115th Congress

An Act

To direct the Under Secretary of Commerce for Intellectual Property and Director of the United States Patent and Trademark Office, in consultation with the Administrator of the Small Business Administration, to study and provide recommendations to promote the participation of women, minorities, and veterans in entrepreneurship activities and the patent system, to extend by 8 years the Patent and Trademark Office's authority to set the amounts for the fees it charges, and for other purposes.

Oct. 31, 2018
[H.R. 6758]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Study of Underrepresented Classes Chasing Engineering and Science Success Act of 2018.
15 USC 1 note.

SECTION 1. SHORT TITLE.

This Act may be cited as the "Study of Underrepresented Classes Chasing Engineering and Science Success Act of 2018" or the "SUCCESS Act".

SEC. 2. FINDINGS; SENSE OF CONGRESS.

(a) FINDINGS.—Congress finds the following:

(1) Patents and other forms of intellectual property are important engines of innovation, invention, and economic growth.

(2) Many innovative small businesses, which create over 20 percent of the total number of new jobs created in the United States each year, depend on patent protections to commercialize new technologies.

(3) Universities and their industry partners also rely on patent protections to transfer innovative new technologies from the laboratory or classroom to commercial use.

(4) Recent studies have shown that there is a significant gap in the number of patents applied for and obtained by women and minorities.

(b) SENSE OF CONGRESS.—It is the sense of Congress that the United States has the responsibility to work with the private sector to close the gap in the number of patents applied for and obtained by women and minorities to harness the maximum innovative potential and continue to promote United States leadership in the global economy.

SEC. 3. REPORT.

(a) STUDY.—The Director, in consultation with the Administrator and any other head of an appropriate agency, shall conduct a study that—

(1) identifies publicly available data on the number of patents annually applied for and obtained by, and the benefits of increasing the number of patents applied for and obtained

by women, minorities, and veterans and small businesses owned by women, minorities, and veterans; and

(2) provides legislative recommendations for how to—

(A) promote the participation of women, minorities, and veterans in entrepreneurship activities; and

(B) increase the number of women, minorities, and veterans who apply for and obtain patents.

(b) REPORT.—Not later than 1 year after the date of the enactment of this Act, the Director shall submit to the Committees on the Judiciary and Small Business of the House of Representatives and the Committees on the Judiciary and Small Business and Entrepreneurship of the Senate a report on the results of the study conducted under subsection (a).

SEC. 4. EXTENSION OF FEE-SETTING AUTHORITY.

Section 10(i)(2) of the Leahy-Smith America Invents Act (Public Law 112–29; 125 Stat. 319; 35 U.S.C. 41 note) is amended by striking "7-year" and inserting "15-year".

SEC. 5. DEFINITIONS.

In this Act:

(1) ADMINISTRATOR.—The term "Administrator" means the Administrator of the Small Business Administration.

(2) AGENCY.—The term "agency" means a department, agency, or instrumentality of the United States Government.

(3) DIRECTOR.—The term "Director" means the Under Secretary of Commerce for Intellectual Property and Director of the United States Patent and Trademark Office.

Approved October 31, 2018.

LEGISLATIVE HISTORY—H.R. 6758:

HOUSE REPORTS: No. 115–966 (Comm. on the Judiciary).
CONGRESSIONAL RECORD, Vol. 164 (2018):
Sept. 25, considered and passed House.
Oct. 11, considered and passed Senate.
DAILY COMPILATION OF PRESIDENTIAL DOCUMENTS (2018):
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Approved October 31, 2018.

LEGISLATIVE HISTORY—H.R. 6758:

HOUSE REPORTS: No. 115–966 (Comm. on the Judiciary).
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○

Congressional Research Service

Informing the legislative debate since 1914

Patent Law: A Handbook for Congress

September 16, 2020

Congressional Research Service
https://crsreports.congress.gov
R46525

CRS REPORT
Prepared for Members and
Committees of Congress

Congressional Research Service
Informing the legislative debate since 1914

SUMMARY

R46525

September 16, 2020

Kevin T. Richards
Legislative Attorney

Patent Law: A Handbook for Congress

A patent gives its owner the exclusive right to make, use, import, sell, or offer for sale the invention covered by the patent. The patent system has long been viewed as important to encouraging American innovation by providing an incentive for inventors to create. Without a patent system, the reasoning goes, there would be little incentive for invention because anyone could freely copy the inventor's innovation.

Congressional action in recent years has underscored the importance of the patent system, including a major revision to the patent laws in 2011 in the form of the Leahy-Smith America Invents Act. Congress has also demonstrated an interest in patents and pharmaceutical pricing; the types of inventions that may be patented (also referred to as "patentable subject matter"); and the potential impact of patents on a vaccine for COVID-19.

As patent law continues to be an area of congressional interest, this report provides background and descriptions of several key patent law doctrines. The report first describes the various parts of a patent, including the specification (which describes the invention) and the claims (which set out the legal boundaries of the patent owner's exclusive rights). Next, the report provides detail on the basic doctrines governing patentability, enforcement, and patent validity.

For patentability, the report details the various requirements that must be met before a patent is allowed to issue. These requirements include the following:

- **Patentable Subject Matter.** The claimed invention must be directed to one of the statutorily defined categories of patent-eligible subject matter.
- **Definiteness.** The patent claims defining the invention's legal boundaries must be sufficiently clear.
- **Written Description.** The specification must adequately describe the invention.
- **Enablement.** The specification must enable a person in the field of the relevant technology to make and use the invention.
- **Novelty.** The invention cannot be the same as something known in the "prior art" (i.e., public knowledge in the field of relevant technology at the time of invention).
- **Nonobviousness.** The invention cannot be an obvious extension of the prior art.

The report then explains how the rights granted by a patent are enforced, including issues relating to patent infringement (such as direct infringement, infringement under the doctrine of equivalents, induced infringement, and contributory infringement). Also addressed are issues relating to litigation in federal district court and before the International Trade Commission (ITC), including the specialized dispute procedures governed by the Drug Price Competition and Patent Term Restoration Act of 1984 (Hatch-Waxman Act) and the Biologics Price Competition and Innovation Act of 2009 (BPCIA).

Finally, the report explains how a patent owner may lose their patent. This includes discussions of ex parte reexamination, post-grant review, inter partes review, and covered business method review.

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The patent system has long been viewed as important to encouraging American innovation. Abraham Lincoln, in a speech before he became President, argued that the patent system "added the fuel of interest to the fire of genius, in the discovery and production of new and useful things."[1] In Mark Twain's *A Connecticut Yankee in King Arthur's Court*, the titular Connecticut Yankee related that "the very first official thing I did, in my administration—and it was on the very first day of it, too—was to start a patent office; for I knew that a country without a patent office and good patent laws was just a crab, and couldn't travel any way but sideways or backways."[2] Upon commencing patent infringement litigation against Kodak, Polaroid founder Edwin Land, inventor of the instant camera, explained that "[t]he only thing that keeps us alive is our brilliance. The only way to protect our brilliance is our patents."[3]

Patents and intellectual property (IP) remain important today. In 2019, the U.S. Patent and Trademark Office (PTO) issued 354,507 new patents—the most in its history.[4] In 2016, a joint report from the Economics and Statistics Administration and the PTO estimated that patent-intensive industries added 3.9 million jobs to the U.S. economy.[5] The same report estimated that patent-intensive industries added $881 billion in value to the U.S. gross domestic product (GDP), comprising 5.1% of the U.S. GDP.[6]

Patents also are an important aspect of technology and health care in the United States. It has been estimated that a single smartphone may be protected by as many as 250,000 patents.[7] New pharmaceuticals are often protected by patents;[8] indeed, intellectual property rights, including patent rights, are generally considered to play an essential role in encouraging the research and development necessary to create new pharmaceutical products.[9] For example, one recent study of the top twelve drugs by gross U.S. revenue found that pharmaceutical manufacturers obtained an average of seventy-one patents on each of these drugs.[10] Whether and to what extent any

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[1] Abraham Lincoln, *Second Lecture on Discoveries and Inventions* (Feb. 11, 1859) *in* 3 COLLECTED WORKS OF ABRAHAM LINCOLN 356, 363 (Roy P. Basler, ed. 2001).

[2] MARK TWAIN, A CONNECTICUT YANKEE IN KING ARTHUR'S COURT 107 (Charles L. Webster & Co. 1889).

[3] Victor K. McElheny, *Polaroid Is Suing Kodak, Charges Patent Violation*, N.Y. TIMES (Apr. 28, 1976), at https://www.nytimes.com/1976/04/28/archives/polaroid-is-suing-kodak-charges-patent-violation-polaroid-is-suing.html. Polaroid and Kodak eventually settled their dispute in 1991, with Kodak agreeing to pay Polaroid $925 million. Reuters, *Kodak Settles With Polaroid*, N.Y. TIMES (July 16, 1991), at https://www.nytimes.com/1991/07/16/business/kodak-settles-with-polaroid.html. Land had died earlier that year. Eric Pace, *Edwin H. Land Is Dead at 81; Inventor of Polaroid Camera*, N.Y TIMES (March 2, 1991), at https://www.nytimes.com/1991/03/02/obituaries/edwin-h-land-is-dead-at-81-inventor-of-polaroid-camera.html.

[4] Dennis Crouch, *How Many Patents Issued in 2019?*, PATENTLYO (Dec. 31, 2019), at https://patentlyo.com/patent/2019/12/many-patents-issued.html.

[5] Robert Rubinovitz et al., *Intellectual Property & the U.S. Economy: 2016 Update*, at ii, ECONOMICS & STATISTICS ADMINISTRATION and U.S. PATENT & TRADEMARK OFFICE, at https://www.uspto.gov/sites/default/files/documents/IPandtheUSEconomySept2016.pdf.

[6] *Id.* at 22.

[7] Steve Lohr, *Apple-Samsung Patent Battle Shifts to Trial*, N.Y. TIMES, (July 29, 2012), at https://www.nytimes.com/2012/07/30/technology/apple-samsung-trial-highlights-patent-wars.html. Notably, not all of the patents covering aspects of a smartphone are owned by the same entity. *Id.*

[8] *See generally* CRS Report R46221, *Drug Pricing and Pharmaceutical Patenting Practices*, coordinated by Kevin T. Richards, at 9-10, 16-20, 24-28.

[9] Henry G. Grabowski et al., *The Roles of Patents and Research and Development Incentives in Biopharmaceutical Innovation*, 34 HEALTH AFF. 302, 302 (2015) ("Patents and other forms of intellectual property protection are generally thought to play essential roles in encouraging innovation in biopharmaceuticals.").

[10] *See Overpatented, Overpriced: How Excessive Pharmaceutical Patenting Is Extending Monopolies and Driving Up Drug Prices*, I-MAK 6-8 (Aug. 2018), at https://www.i-mak.org/wp-content/uploads/2018/08/I-MAK-Overpatented-

countermeasures against COVID-19 should be patented has also been a subject of congressional interest.[11]

As patents and IP remain a subject of congressional interest, this report provides an overview of U.S. patent law. It begins by describing the various parts of a patent to provide context and background for the legal discussion. It then describes the legal requirements that must be met in order to obtain a patent and how the rights granted by a patent may be enforced. Finally, the report closes with a description of how patent rights may be lost, either through litigation or through administrative proceedings before the PTO's Patent Trial and Appeal Board.

What Is a Patent?

The Constitution empowers Congress to "promote the Progress of Science and useful Arts, by securing for limited Times to ... Inventors the exclusive Right to their respective ... Discoveries."[12] Since 1790, Congress has enacted patent laws pursuant to this power, granting inventors certain exclusive rights in their inventions for a period of time.[13] Broadly speaking, those exclusive rights are granted in return for the inventor's public disclosure of the invention.[14] Thus, patents represent a "quid pro quo": in return for the inventor's public disclosure, the inventor receives those time-limited exclusive rights.[15] Many of the specific doctrines underlying patent law can be explained by that rationale.

Parts of a Patent

Before describing the exclusive rights granted by a patent and related issues (such as how to obtain, enforce, and lose a patent), it is helpful to understand the basic parts of a patent.[16] For example, before describing the legal requirements for patent claims,[17] it is important to understand what patent claims *are*. Recently issued U.S. Patent No. 10,000,000 (the '000 patent) provides a good illustration of a patent's format.[18]

Overpriced-Report.pdf.

[11] *See, e.g.*, Press Release, Office of Representative Jan Schakowsky, Congressional Progressive Leaders Announce Principles On COVID-19 Drug Pricing for Next Coronavirus Response Package (Apr. 15, 2020), at https://schakowsky.house.gov/media/press-releases/congressional-progressive-leaders-announce-principles-covid-19-drug-pricing.

[12] U.S. CONST. art. I, § 8, cl. 8.

[13] *See, e.g.*, 35 U.S.C. § 271 (setting forth how patents may be infringed).

[14] J.E.M. Ag Supply, Inc. v. Pioneer Hi-Bred Int'l, Inc., 534 U.S. 124, 142 (2001) ("The disclosure required by the Patent Act is 'the quid pro quo of the right to exclude.'" (quoting Kewanee Oil Co. v. Bicron Corp., 416 U.S. 470, 484 (1974))); *see also* Universal Oil Prod. Co. v. Globe Oil & Ref. Co., 322 U.S. 471, 484 (1944) ("As a reward for inventions and to encourage their disclosure, the United States offers a ... monopoly to an inventor who refrains from keeping his invention a trade secret. But the quid pro quo is disclosure of a process or device in sufficient detail to enable one skilled in the art to practice the invention once the period of the monopoly has expired; and the same precision of disclosure is likewise essential to warn the industry concerned of the precise scope of the monopoly asserted.").

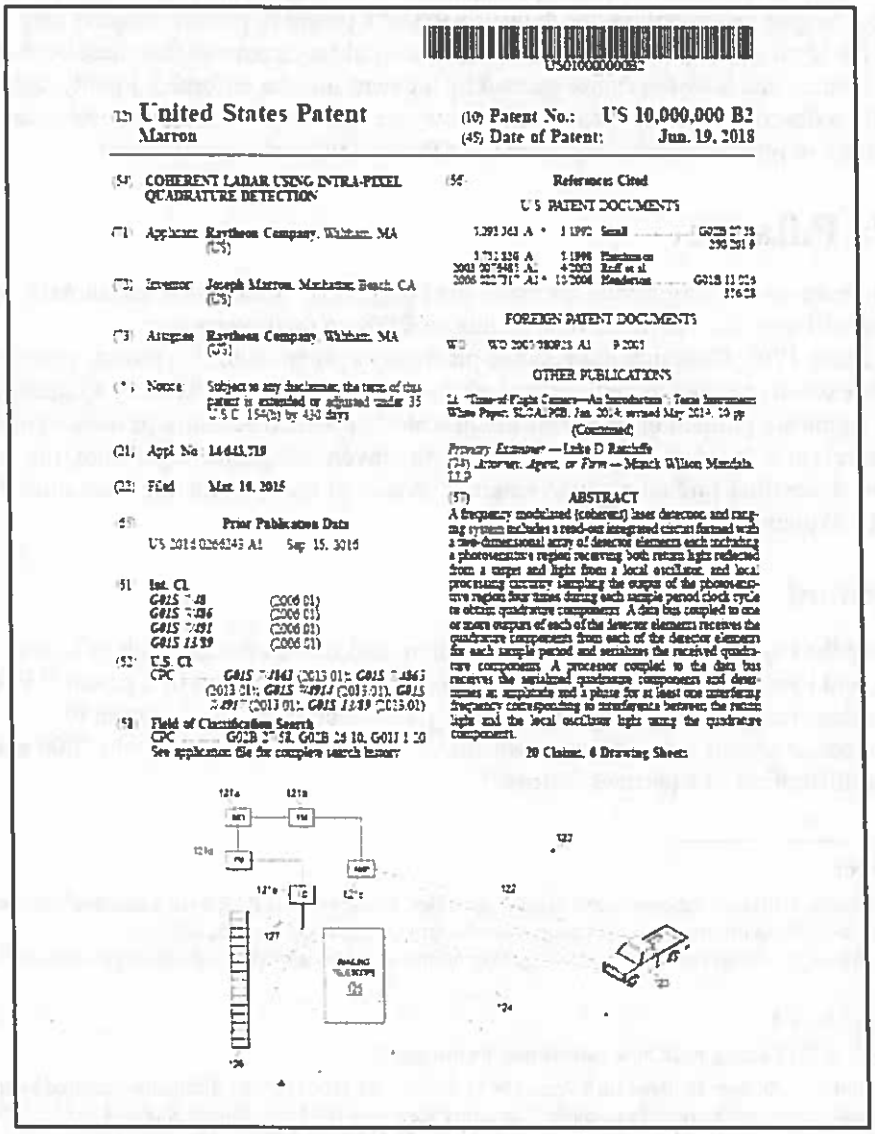
[15] *J.E.M. Ag Supply*, 534 U.S. at 142.

[16] The following description and legal requirements relate only to utility patents. Design patents, which protect a "new, original and ornamental design for an article of manufacture," *see* 35 U.S.C. §§ 171-73, and plant patents, which protect "any distinct and new variety of plant," *see id.* §§ 161-64, are beyond the scope of this report.

[17] *See* discussion *infra* in "Patent Application Requirements."

[18] U.S. Patent 10,000,000 was issued, with much fanfare, on June 19, 2018. U.S. Patent No. 10,000,000; *United States Issues Patent Number 10,000,000*, U.S. PAT. & TRADEMARK OFF. (June 19, 2018), at https://www.uspto.gov/about-

As shown below, a patent's cover page provides basic information about the patent, including the name(s) of the inventor(s), the title of the patent, the date that the patent issued, an abstract briefly summarizing the invention,[19] and a representative drawing:



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(12) **United States Patent**
Marron

(10) Patent No.: US 10,000,000 B2
(45) Date of Patent: Jun. 19, 2018

(54) COHERENT LADAR USING INTRA-PIXEL QUADRATURE DETECTION

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 430 days.

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(22) Filed: Mar. 10, 2015

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G01S 7/48 (2006.01)
G01S 7/486 (2006.01)
G01S 7/491 (2006.01)
G01S 17/89 (2006.01)

(52) U.S. Cl.
CPC *G01S 7/4863* (2013.01); *G01S 7/4865* (2013.01); *G01S 7/4914* (2013.01); *G01S 7/491* (2013.01); *G01S 17/89* (2013.01)

(58) Field of Classification Search
CPC G02B 27/58, G02B 26/10, G01J 1/20
See application file for complete search history.

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(57) ABSTRACT

A frequency modulated (coherent) laser detection and ranging system includes a read-out integrated circuit formed with a two-dimensional array of detector elements each including a photosensitive region receiving both return light reflected from a target and light from a local oscillator and local processing circuitry sampling the output of the photosensitive region four times during each sample period clock cycle to obtain quadrature components. A data bus coupled to one or more outputs of each of the detector elements receives the quadrature components from each of the detector elements for each sample period and serializes the received quadrature components. A processor coupled to the data bus receives the serialized quadrature components and determines an amplitude and a phase for at least one interfering frequency corresponding to interference between the return light and the local oscillator light using the quadrature components.

20 Claims, 6 Drawing Sheets

The cover page is followed by drawings illustrating background technology; various aspects of the invention; or different implementations of the invention. For example, Figure 4 of the '000 patent illustrates use of the invention in an exemplary environment:[20]

us/news-updates/united-states-issues-patent-number-10000000; *U.S. Patent 10 Million*, U.S. PAT. & TRADEMARK OFF., at https://10millionpatents.uspto.gov/patent-10-million.html.

[19] Because the purpose of this discussion and description is to familiarize the reader with the various parts of a patent, rather than specifically familiarize the reader with the innovations underlying the '000 patent, description of the relevant technological background and specific advance claimed by the '000 patent are omitted from this report.

[20] '000 patent, col. 6 ll. 7-59.

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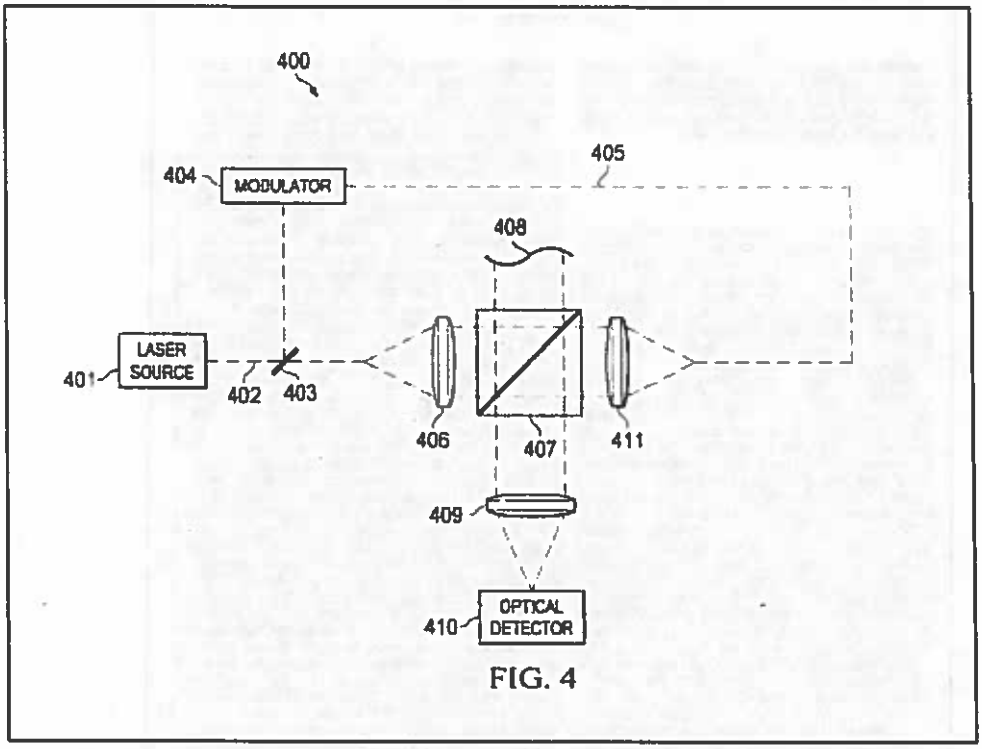

FIG. 4

Following the drawings is the *specification*, a textual description of the invention set out in two-column pages. As shown in the excerpt below, the description relating to Figure 4 appears in column six beginning at line seven (annotated with a red box):

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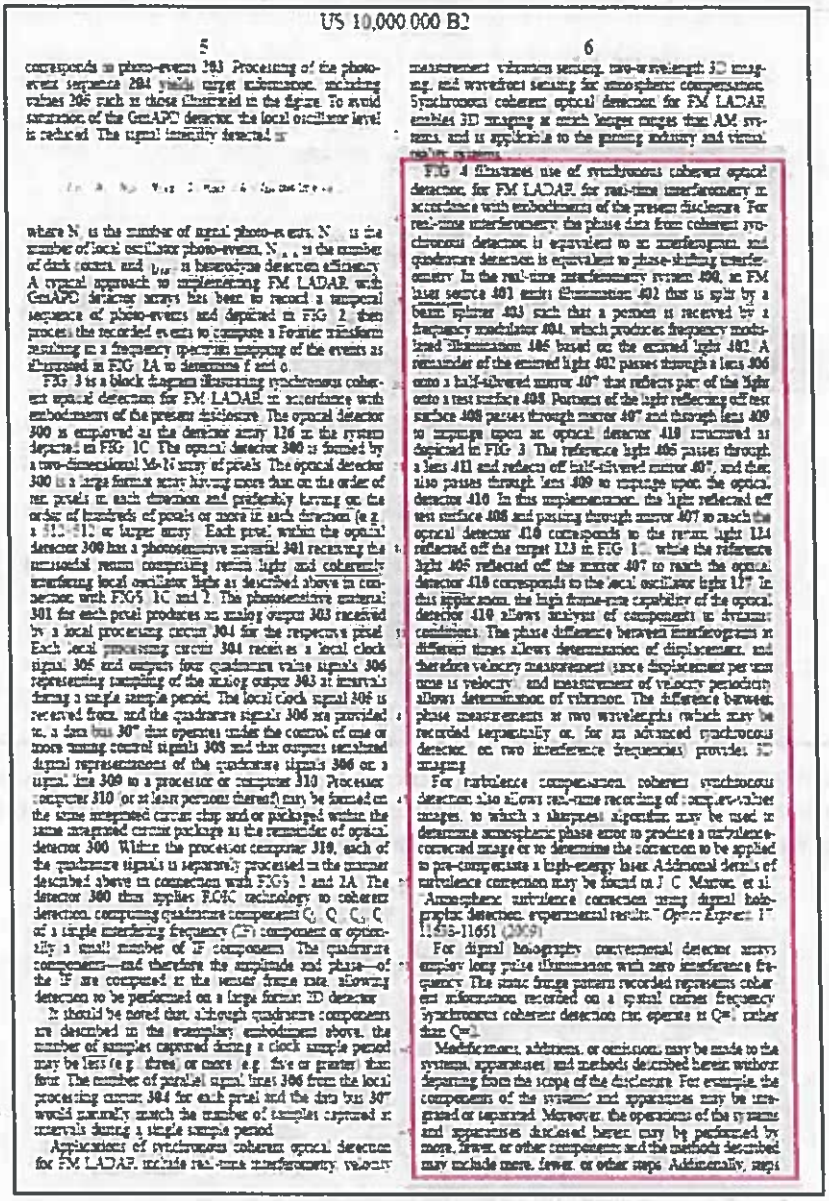

US 10,000,000 B2

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corresponds to photo-events 293. Processing of the photo-event sequence 284 yields range information, including values 295 such as those illustrated in the figure. To avoid saturation of the GmAPD detector, the local oscillator level is reduced. The signal intensity detected is

where N_s is the number of signal photo-events, N_{LO} is the number of local oscillator photo-events, N_{dark} is the number of dark counts, and η_{det} is heterodyne detection efficiency. A typical approach to implementing FM LADAR with GmAPD detector arrays has been to record a temporal sequence of photo-events and depicted in FIG. 2, then process the recorded events to compute a Fourier transform resulting in a frequency spectrum mapping of the events as illustrated in FIG. 2A to determine f and σ.

FIG. 3 is a block diagram illustrating synchronous coherent optical detection for FM LADAR in accordance with embodiments of the present disclosure. The optical detector 300 is employed as the detector array 126 in the system depicted in FIG. 1C. The optical detector 300 is formed by a two-dimensional M-by-N array of pixels. The optical detector 300 is a large format array having more than on the order of ten pixels in each direction and preferably having on the order of hundreds of pixels or more in each direction (e.g. a 512×512 or larger array). Each pixel within the optical detector 300 has a photosensitive material 301 receiving the incidental return comprising return light and coherently interfering local oscillator light as described above in connection with FIGS. 1C and 2. The photosensitive material 301 for each pixel produces an analog output 303 received by a local processing circuit 304 for the respective pixel. Each local processing circuit 304 receives a local clock signal 305 and outputs four quadrature value signals 306 representing sampling of the analog output 303 at intervals during a single sample period. The local clock signal 305 is received from, and the quadrature signals 306 are provided to, a data bus 307 that operates under the control of one or more timing control signals 308 and that outputs serialized digital representations of the quadrature signals 306 on a signal line 309 to a processor or computer 310. Processor/computer 310 (or at least portions thereof) may be formed on the same integrated circuit chip and/or packaged within the same integrated circuit package as the remainder of optical detector 300. Within the processor/computer 310, each of the quadrature signals is separately processed in the manner described above in connection with FIGS. 2 and 2A. The detector 300 thus applies FLOC technology to coherent detection, computing quadrature components C_0, $C_{\pi/2}$, C_π, $C_{3\pi/2}$ of a single interfering frequency (IF) component or optionally a small number of IF components. The quadrature components—and therefore the amplitude and phase—of the IF are computed at the sensor frame rate, allowing detection to be performed on a large format 2D detector.

It should be noted that, although quadrature components are described in the exemplary embodiment above, the number of samples captured during a clock sample period may be less (e.g. three) or more (e.g. five or greater) than four. The number of parallel signal lines 306 from the local processing circuit 304 for each pixel and the data bus 307 would naturally match the number of samples captured at intervals during a single sample period.

Applications of synchronous coherent optical detection for FM LADAR include real-time interferometry, velocity measurement, vibration sensing, two-wavelength 3D imaging, and wavefront sensing for atmospheric compensation. Synchronous coherent optical detection for FM LADAR enables 3D imaging at much longer ranges than AM systems, and is applicable to the gaming industry and virtual reality systems.

FIG. 4 illustrates use of synchronous coherent optical detection for FM LADAR for real-time interferometry in accordance with embodiments of the present disclosure. For real-time interferometry, the phase data from coherent synchronous detection is equivalent to an interferogram, and quadrature detection is equivalent to phase-shifting interferometry. In the real-time interferometry system 400, an FM laser source 401 emits illumination 402 that is split by a beam splitter 403 such that a portion is received by a frequency modulator 404, which produces frequency modulated illumination 405 based on the received light 402. A remainder of the emitted light 402 passes through a lens 406 onto a half-silvered mirror 407 that reflects part of the light onto a test surface 408. Portions of the light reflecting off test surface 408 passes through mirror 407 and through lens 409 to impinge upon an optical detector 410 constructed as depicted in FIG. 3. The reference light 405 passes through a lens 411 and reflects off half-silvered mirror 407, and then also passes through lens 409 to impinge upon the optical detector 410. In this implementation, the light reflected off test surface 408 and passing through mirror 407 to reach the optical detector 410 corresponds to the return light 114 reflected off the target 123 in FIG. 1C, while the reference light 405 reflected off the mirror 407 to reach the optical detector 410 corresponds to the local oscillator light 117. In this application, the high frame-rate capability of the optical detector 410 allows analysis of components in dynamic conditions. The phase difference between interferograms at different times allows determination of displacement, and therefore velocity measurement since displacement per unit time is velocity, and measurement of velocity periodicity allows determination of vibration. The difference between phase measurements at two wavelengths (which may be recorded sequentially or, for an advanced synchronous detector, on two interference frequencies) provides 3D imaging.

For turbulence compensation, coherent synchronous detection also allows real-time recording of complex-value images, to which a sharpness algorithm may be used to determine atmospheric phase error to produce a turbulence-corrected image or to determine the correction to be applied to pre-compensate a high-energy laser. Additional details of turbulence correction may be found in J. C. Marron, et al., "Atmospheric turbulence correction using digital holographic detection: experimental results," *Optics Express* 17, 11638-11651 (2009).

For digital holography, conventional detector arrays employ long pulse illumination with zero interference frequency. The static fringe pattern recorded represents coherent information recorded on a spatial carrier frequency. Synchronous coherent detection can operate at $\Omega=1$, rather than $\Omega=2$.

Modifications, additions, or omissions may be made to the systems, apparatuses, and methods described herein without departing from the scope of the disclosure. For example, the components of the systems and apparatuses may be integrated or separated. Moreover, the operations of the systems and apparatuses disclosed herein may be performed by more, fewer, or other components and the methods described may include more, fewer, or other steps. Additionally, steps

The textual description must meet specific legal requirements in order for the patent to be valid.[21]

Following this textual description (and concluding the patent) are the patent *claims*, a series of numbered paragraphs setting forth what the inventor regards as his invention.[22] These claims form the metes and bounds of the patent right; in other words, the claims define the scope of the

[21] Those requirements are explained in detail *infra*. *See* discussion *infra* in "Patent Application Requirements."

[22] 1 ROBERT A. MATTHEWS, JR., ANNOTATED PATENT DIGEST § 1:24 (2020) ("The end of each specification contains a series of numbered paragraphs [where] the patent applicant defines in concise terms the specific invention that the patent applicant particularly claims as his invention. These paragraphs are referred to as patent claims.").

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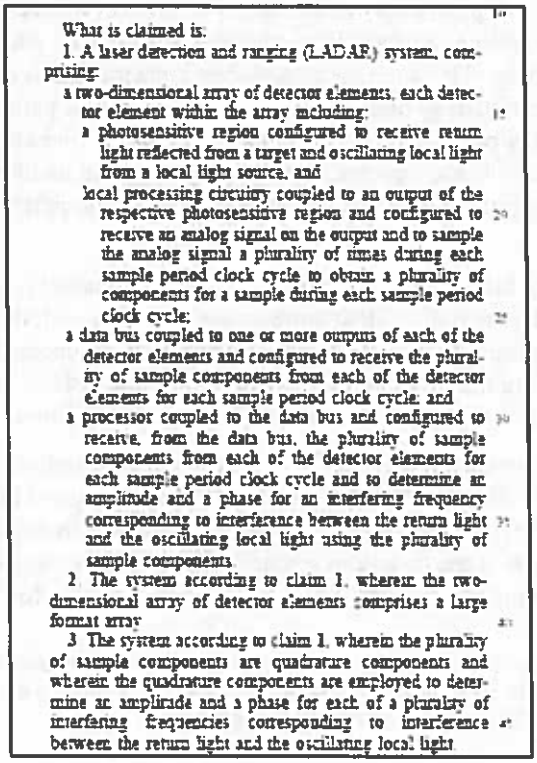
invention, and thus the scope of the legal rights granted by the patent.[23] Some of the '000 patent's claims appear below:



What is claimed is:

1. A laser detection and ranging (LADAR) system, comprising:

a two-dimensional array of detector elements, each detector element within the array including:

a photosensitive region configured to receive return light reflected from a target and oscillating local light from a local light source, and

local processing circuitry coupled to an output of the respective photosensitive region and configured to receive an analog signal on the output and to sample the analog signal a plurality of times during each sample period clock cycle to obtain a plurality of components for a sample during each sample period clock cycle;

a data bus coupled to one or more outputs of each of the detector elements and configured to receive the plurality of sample components from each of the detector elements for each sample period clock cycle; and

a processor coupled to the data bus and configured to receive, from the data bus, the plurality of sample components from each of the detector elements for each sample period clock cycle and to determine an amplitude and a phase for an interfering frequency corresponding to interference between the return light and the oscillating local light using the plurality of sample components.

2. The system according to claim 1, wherein the two-dimensional array of detector elements comprises a large format array.

3. The system according to claim 1, wherein the plurality of sample components are quadrature components and wherein the quadrature components are employed to determine an amplitude and a phase for each of a plurality of interfering frequencies corresponding to interference between the return light and the oscillating local light.

The individual clauses within each patent claim are *limitations* that serve to define the invention.[24] Those limitations, taken together, set forth what has been invented. *Independent claims* generally do not reference other claims; for example, claim 1 of the '000 patent is an independent claim. *Dependent claims*, on the other hand, reference and incorporate the limitations of previous claims;[25] for example, claims 2 and 3 of the '000 patent are dependent claims. Patent claims have specific legal requirements, which are explained in more detail later in the report.[26]

Rights Conferred by a Patent

A patent confers certain legal rights on its owner. Specifically, the patent owner may exclude others from making, using, importing, offering for sale, or selling the invention (collectively,

[23] Thorner v. Sony Ent. Am. LLC, 669 F.3d 1362, 1367 (Fed. Cir. 2012) ("It is the claims that define the metes and bounds of the patentee's invention." (citation omitted)).

[24] Hyatt v. Dudas, No. CIV A 04-1138 HHK, 2006 WL 2521242, at *1 (D.D.C. Aug. 30, 2006), *aff'd*, 551 F.3d 1307 (Fed. Cir. 2008) ("[A] single claim can be composed of multiple elements and/or limitations.... Limitations ... usually describe the claim's restrictions, or the interaction between or features of the claim's elements. An application may contain several claims, and each claim usually contains several limitations."); *see also* Bell Commc'ns Rsch., Inc. v. Vitalink Commc'ns Corp., 55 F.3d 615, 619 (Fed.Cir.1995) ("[T]he language of the claim defines the scope of the protected invention.").

[25] 35 U.S.C. § 112(d) ("[A] claim in dependent form shall contain a reference to a claim previously set forth and then specify a further limitation of the subject matter claimed. A claim in dependent form shall be construed to incorporate by reference all the limitations of the claim to which it refers.").

[26] *See* discussion *infra* in "Patent Application Requirements."

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"practicing the invention").[27] Notably, the patent includes only *negative* rights to *exclude* others from practicing the invention;[28] the patent grant does not include the positive right for the patent owner to do so.[29] In other words, a patent allows the owner to prevent others from making, using, importing, offering for sale, or selling the invention, but does not give the patent owner the power to perform those acts affirmatively.[30] In some circumstances, a patented invention when practiced in a particular manner may itself infringe another patent.[31] The infringed patent is referred to as a *blocking patent* because it blocks practice of the patented invention.[32] Blocking patents may arise, for example, when a patent's claims are directed to an improvement on another patented invention.[33] In that case, the original patent may "block" practice of the patent on the improvement.[34]

The exclusive rights granted by the patent begin on the date that the patent issues, and generally expire twenty years from the date that the patent application was filed with the PTO.[35] The patent term may be extended under certain circumstances; for example, to compensate for time spent in regulatory review (such as before the Food and Drug Administration (FDA) in the context of pharmaceutical patents)[36] or for delays due to certain PTO procedural failures.[37]

Patents "have the attributes of personal property."[38] Accordingly, although title in an invention initially vests with the inventor, that interest may be transferred or assigned to others.[39] It is common for employment contracts to include provisions under which an employee assigns his interest in any patents developed in the course of employment to the employer.[40] Similarly, patents may be sold from one party to another.[41] A patent owner may also form a contract with

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[27] 35 U.S.C. § 271(a). *See also* Bloomer v. McQuewan, 55 U.S. 539, 549 (1852) ("The franchise which the patent grants, consists altogether in the right to exclude every one from making, using, or vending the thing patented, without the permission of the patentee. This is all that he obtains by the patent.").

[28] *See Bloomer*, 55 U.S. at 549.

[29] Animal Legal Def. Fund v. Quigg, 932 F.2d 920, 935 (Fed. Cir. 1991) ("It should hardly need saying that the issuance of a patent gives no right to make, use or sell a patented invention ....").

[30] *Id.*

[31] *See* Robert Merges, *Intellectual Property Rights and Bargaining Breakdown: The Case of Blocking Patents*, 62 TENN. L. REV. 75, 80-82 (1994).

[32] *See id.*

[33] *Id.*

[34] *Id.*

[35] 35 U.S.C. § 154(a)(2). For patents whose application was filed before June 8, 1995, the patent term is seventeen years from the date of issuance; for patents whose application was filed after that date, the patent term is twenty years from the earliest date to which the application claims priority. Novartis Pharm. Corp. v. Breckenridge Pharm. Inc., 909 F.3d 1355, 1358 (Fed. Cir. 2018). Before the change in patent term, patent applications could remain pending for many years (in some cases, decades) before issuing and then disrupting developed industries because the term ran from the date of issuance. *See* Mark A. Lemley & Kimberley A. Moore, *Ending Abuse of Patent Continuations*, 84 B.U. L. REV. 63, 79-80 (2004).

[36] *See generally* 35 U.S.C. § 156.

[37] *Id.* § 154(b).

[38] *Id.* § 261.

[39] *See id.*; Beech Aircraft Corp. v. EDO Corp., 990 F.2d 1237, 1248 (Fed. Cir. 1993) ("[T]he patent right initially vests in the inventor who may then, barring any restrictions to the contrary, transfer that right to another, and so forth.").

[40] *See, e.g.*, Daniel F. Spulber, *Intellectual Contract and Intellectual Law*, 23 J. TECH. L. & POL'Y 1, 55 (2018); Robert P. Merges, *The Law and Economics of Employee Inventions*, 13 HARV. J.L. & TECH. 1, 2 (1999).

[41] *See, e.g.*, Steve Lohr, *Microsoft's AOL Deal Intensifies Patent Wars*, N.Y. TIMES (April 9, 2012), at https://www.nytimes.com/2012/04/10/technology/microsoft-to-buy-aol-patents-for-more-than-1-billion.html (describing Microsoft's purchase of more than 800 patents held by America Online for more than $1 billion).

another party permitting the other party to make, use, import, or sell a patented invention in return for compensation (e.g., a lump sum payment or a continuing royalty).[42] Such a contract is referred to as a *license*.[43]

Patent Appeals

Unlike most cases in federal court, appeals involving patent law are heard by a single appellate court—the U.S. Court of Appeals for the Federal Circuit (Federal Circuit).[44] (Appeals from decisions of U.S. district courts in most nonpatent cases are heard by the various U.S. Courts of Appeals for different geographical regions or circuits.) Sitting in Washington, DC, Congress created the Federal Circuit in 1982 in an effort to unify and standardize patent law.[45] Although the Supreme Court left the Federal Circuit's interpretations of patent law essentially undisturbed during the first two decades of the Federal Circuit's existence, in recent years the Supreme Court has taken more interest in patent law cases.[46] In many of those cases, the Supreme Court has reversed the Federal Circuit's interpretation of patent law.[47] Nevertheless, Federal Circuit decisions play a large role in the acquisition and enforcement of patent rights in the United States.

Patent Requirements

The process for receiving a patent begins with the filing of an application with the PTO.[48] A PTO patent examiner then reviews the application for compliance with the substantive requirements

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[42] Thomas R. Varner, *An Economic Perspective on Patent Licensing Structure and Provisions*, 47 LES NOUVELLES 28, 32 (2012) (finding, based on a study of nearly 1,500 licensing agreements filed with the Securities and Exchange Commission between 1994 and 2010, that 83% of licenses used a royalty with a rate based on percentage of sales, number of units sold, percentage of profits, or percentage of costs).

[43] MATTHEWS, *supra* note 22, at 5 § 35:28 ("In essence, a patent license is a permission, backed by a contractual promise not to sue, for a party to perform acts that without the license would be deemed acts of infringement."). *See also* 35 U.S.C. § 261 ("Applications for patent, patents, or any interest therein, shall be assignable in law by an instrument in writing. The applicant, patentee, or his assigns or legal representatives may in like manner grant and convey an exclusive right under his application for patent, or patents, to the whole or any specified part of the United States.").

[44] Daniel Kazhdan, *Beyond Patents: The Supreme Court's Evolving Relationship with the Federal Circuit*, 94 J. PAT. & TRADEMARK OFF. SOC'Y 275, 294 (2012) ("[U]nlike regional courts of appeals, because the Federal Circuit has exclusive jurisdiction over the questions of law that it decides, it can create uniformity.").

[45] MARION T. BENNETT, UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT: A HISTORY, 1982-1990 4-8, 10-11 (1991). *See also* Timothy R. Holbrook, *The Federal Circuit's Acquiescence(?)*, 66 AM. U. L. REV. 1061, 1065 (2017) ("When the Federal Circuit was created, it had a monumental task on its hands: creating uniformity from the morass of patent case law developed by the regional circuits."). The Federal Circuit has exclusive jurisdiction in a number of nonpatent areas as well, including appeals from the PTO, the U.S. Court of Appeals for Veterans Claims, the U.S. Court of Federal Claims, the U.S. International Trade Commission, and the U.S. Court of International Trade. 28 U.S.C. § 1295.

[46] Paul R. Gugliuzza, *The Supreme Court Bar at the Bar of Patents*, 95 NOTRE DAME L. REV. 1233, 1234-35 (2020); Peter Lee, *The Supreme Assimilation of Patent Law*, 114 MICH. L. REV. 1413, 1421-22 (2016); Timothy R. Holbrook, *The Return of the Supreme Court to Patent Law*, 1 AKRON INTELL. PROP. J. 1, 2 (2007); John F. Duffy, *The* Festo *Decision and the Return of the Supreme Court to the Bar of Patents*, 2002 SUP. CT. REV. 273, 274 (2002).

[47] Samuel F. Ernst, *A Patent Reformist Supreme Court and Its Unearthed Precedent*, 29 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 1, 5 (2018) ("Since the year 2000, the Supreme Court has reversed or vacated the Federal Circuit in patent law cases in 74% of the opinions it has issued reviewing that court ...."); H.R. Rep. No. 112-98, at 39 (2011) ("[T]he need to modernize our patent laws has found expression in the courts, as well. The Supreme Court has reversed the Federal Circuit in six of the patent-related cases that it has heard since the beginning of the 109th Congress.").

[48] *See generally* 35 U.S.C. § 111.

for receiving a patent.[49] If the examiner determines that the application does not meet one of the requirements, she will reject the application.[50] The applicant may generally then amend the application in an effort to overcome the examiner's rejection.[51] Once the examiner determines that an application meets all of the patentability requirements, she "allows" the application to issue as a patent.[52] *Patent prosecution* is the process of applying for a patent, addressing examiner concerns, and receiving the patent.[53] As PTO examiners are generally not lawyers,[54] but rather are subject specialists in the relevant science and/or technology area, the PTO issues the *Manual of Patent Examining Procedure* (MPEP) as guidance for examiners and practitioners.[55]

The following sections outline the requirements that a patent applicant must satisfy to receive a patent. The discussion begins with two preliminary explanations. First, a discussion of who may receive a patent—an area with some emerging issues in view of the rise of artificial intelligence (AI) in recent years. Second, a discussion of one of the core concepts in analyzing patentability: the "person of ordinary skill." The sections that follow then address the substantive requirements for patentability. Those substantive requirements broadly fall into two groups. First are requirements of the *patent application*; that is, requirements regarding the specification that describes the invention, and the level of clarity required in the patent claims. Second are the requirements of the *invention*; namely, that the claimed invention must be patentable subject matter and not be too similar to what has come before. Examiners may reject patent claims that fail to meet one or more of these requirements while the application is still pending.[56] If a patent claim issues as part of a patent and is later determined to fail one or more of these requirements, then that claim is generally "invalid" and subject to challenge if it is enforced.[57]

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[49] *See* JAMES E. HAWES & FREDERIC M. DOUGLAS, PATENT APPLICATION PRACTICE § 2:4 (2020) (providing an overview of the patent application process); *General Information Concerning Patents*, U.S. PAT. & TRADEMARK OFF. (Oct. 2015), at https://www.uspto.gov/patents-getting-started/general-information-concerning-patents.

[50] HAWES & DOUGLAS, *supra* note 49, § 14:2.

[51] *Id.* § 15.7-15.19.

[52] *Id.* § 21.1.

[53] Nick Cornor, *Are Changes to the U.S. Patent System Objectively Killing Innovation?*, 24 CURRENTS: J. INT'L ECON. L. 87, 90 (2020) ("Patent prosecution refers to the process of applying for a patent."). Although the foregoing discussion provides a high-level overview of the process, patent prosecution is governed by specific laws and regulations, the detailed discussion of which could fill its own report. *See generally* HAWES & DOUGLAS, *supra* note 49.

[54] Lital Helman, *Decentralized Patent System*, 20 NEV. L.J. 67, 89 (2019) ("PTO examiners are not lawyers."); Greg Reilly, *Decoupling Patent Law*, 97 B.U. L. REV. 551, 592 (2017) ("Inherently legal tasks—like parsing the wording of documents, analogizing and distinguishing precedent, and applying canons of document interpretation—are better suited for legally trained judges than legally limited patent examiners.").

[55] *See Manual of Patent Examining Procedure*, U.S. PAT. & TRADEMARK OFF. (9th ed. June 2020), at https://www.uspto.gov/web/offices/pac/mpep/index.html.

[56] HAWES & DOUGLAS, *supra* note 49, § 14:2.

[57] Steven Adamson, *Pharmaceutical Patent Wars, Reverse-Payment Settlements, and Their Anticompetitive Effects for Consumers*, 30 LOY. CONSUMER L. REV. 241, 267 (2018) ("[A]n invalid patent does not meet the statutory requirements."); Connell v. Sears, Roebuck & Co., 722 F.2d 1542, 1552 (Fed. Cir. 1983) ("No claim of a patent declared invalid can be enforced ....").

Inventorship Requirements

Under current law, only natural persons may be listed as an inventor on a patent.[58] However, it is common for inventors to assign their patent rights to their employers.[59] Further, anyone to whom the inventor has assigned or is under an obligation to assign patent rights may apply for a patent in the inventor's name.[60]

An emerging issue is whether an AI device may qualify as a patent's inventor. In a recent decision, the PTO rejected a patent application where the listed inventor was an AI device.[61] In that case, the application named an AI device called "DABUS" as the inventor.[62] The application further stated that "the invention was autonomously generated by artificial intelligence."[63] The PTO ruled that an AI could not be an inventor because, in its view, the relevant statutory provisions permitted only natural persons to be inventors.[64] For example, the PTO reasoned, the patent statutes repeatedly refer to the inventor as an "individual,"[65] and other provisions of the Patent Act state that "[w]hoever" creates a new invention may receive a patent, both of which suggested that the inventor must be a natural person.[66] Finally, the PTO reasoned that the Federal Circuit had indicated in the past under different circumstances that an inventor must be a natural person (although the Federal Circuit has not directly confronted the question whether an AI device may be an inventor).[67] The European Patent Office has similarly rejected patent applications naming DABUS as an inventor.[68]

The question of who invented a particular invention raises the question of what happens when two people claim to have invented the same thing. For applications filed prior to March 16, 2013, the first person to *invent* a particular invention was generally regarded as the inventor and given priority in obtaining a patent.[69] Congress changed that practice, however, when it passed and President Obama signed the Leahy-Smith America Invents Act (AIA).[70] For applications filed on

[58] MBO Labs., Inc. v. Becton, Dickinson & Co., 602 F.3d 1306, 1310 n.1 (Fed. Cir. 2010) ("Individuals, not corporations, create inventions."); *see also* Beech Aircraft Corp. v. EDO Corp., 990 F.2d 1237, 1248 (Fed. Cir. 1993) ("[O]nly natural persons can be 'inventors.'").

[59] *See supra* note 40 and accompanying text.

[60] 35 U.S.C. § 118 ("A person to whom the inventor has assigned or is under an obligation to assign the invention may make an application for patent.").

[61] *In re* Application No. 16/524,350, Decision on Petition, 2020 WL 1970052, at *1 (Apr. 22, 2020).

[62] *Id.* DABUS is an acronym for "Device for the Autonomous Bootstrapping of Unified Sentience." Rebecca Tapscott, *USPTO Shoots Down DABUS' Bid For Inventorship*, IPWATCHDOG (May 4, 2020), at https://www.ipwatchdog.com/2020/05/04/uspto-shoots-dabus-bid-inventorship/.

[63] *Application No. 16/524,350*, 2020 WL 1970052, at *1.

[64] *Id.* at *3.

[65] *Id.* at *3 & n.8 (citing 35 U.S.C. §§ 100(a), 100(g), 115(a)).

[66] *Id.* at *3.

[67] *Id.* at *3-4.

[68] *EPO Refuses DABUS Patent Applications Designating a Machine Inventor*, European Patent Office (Dec. 20, 2019), at https://www.epo.org/news-events/news/2019/20191220.html.

[69] Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 3(n)(2), 125 Stat. 284, 293 (2011); *see also* Sanofi-Aventis v. Pfizer Inc., 733 F.3d 1364, 1366 n.3 (Fed. Cir. 2013).

[70] *See, e.g.*, Biogen MA, Inc. v. Japanese Found. for Cancer Rsch., 785 F.3d 648, 654 (Fed. Cir. 2015) ("The AIA changed the patent system, among other things, from a first-to-invent to a first-inventor-to-file regime for determining patent priority.").

or after March 16, 2013, generally the first person to *file* his application with the PTO is regarded as the inventor.[71]

The Person of Ordinary Skill

Many of the patentability requirements discussed below are analyzed from the perspective of a "person of ordinary skill in the art" ("POSITA," sometimes referred to as "a person having ordinary skill in the art" (PHOSITA), "a person skilled in the art," and the like).[72] For example, the question whether an invention would have been obvious is analyzed by determining what would have been known to a person of ordinary skill at the time of the invention under review.[73] The person of ordinary skill is a hypothetical construct, not a real person.[74] Instead, the person of ordinary skill is assumed to have the level of education and training common in the field of the invention, as well as all of the publicly available knowledge in that field.[75] Thus, for example, the legal question in determining whether an invention would have been obvious (and thus ineligible for patenting) is not whether an invention was *in fact* obvious to the inventor, but instead whether the invention would have been obvious to this hypothetical person of ordinary skill.[76]

Claim Construction

Both a patent's validity and the determination whether a particular patent is infringed upon may turn on the meaning and scope of particular patent claim terms.[77] For example, the Federal Circuit has reversed a jury verdict of infringement, and vacated the associated award of $85 million in damages, based on its conclusion that the trial court applied the incorrect meaning of a single claim term.[78] The process for determining the meaning of a disputed patent claim term is referred to as *claim construction*.[79]

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[71] *Id.*

[72] *See generally* MATTHEWS, *supra* note 22, at 3 § 18:35.

[73] 35 U.S.C. § 103. *See also* KSR Int'l Co. v. Teleflex Inc., 550 U.S. 398, 417 (2007).

[74] *In re* Rouffet, 149 F.3d 1350, 1357 (Fed. Cir. 1998) ("Obviousness is determined from the vantage point of a hypothetical person having ordinary skill in the art to which the patent pertains. This legal construct is akin to the 'reasonable person' used as a reference in negligence determinations. The legal construct also presumes that all prior art references in the field of the invention are available to this hypothetical skilled artisan." (citation omitted)).

[75] Takeda Chem. Indus., Ltd. v. Alphapharm Pty., Ltd., 492 F.3d 1350, 1363 (Fed. Cir. 2007) (stating that a "person of ordinary skill is a hypothetical person who is presumed to be aware of all the pertinent prior art") (quoting Custom Accessories, Inc. v. Jeffrey-Allan Indus., 807 F.2d 955 (Fed. Cir. 1986)).

[76] *KSR*, 550 U.S. at 420 ("The question is not whether the combination was obvious to the patentee but whether the combination was obvious to a person with ordinary skill in the art.")

[77] MPHJ Tech. Invs., LLC v. Ricoh Ams. Corp., 847 F.3d 1363, 1364 (Fed. Cir. 2017) ("[T]he first step in any validity analysis is to construe the claims of the invention to determine the subject matter for which patent protection is sought." (quoting Smiths Indus. Med. Sys., Inc. v. Vital Signs, Inc., 183 F.3d 1347, 1353 (Fed. Cir. 1999))); Nazomi Commc'ns, Inc. v. Nokia Corp., 739 F.3d 1339, 1343 (Fed. Cir. 2014) ("The first step of the infringement analysis is claim construction ...."). *See also* TVIIM, LLC v. McAfee, Inc., 851 F.3d 1356, 1362 (Fed. Cir. 2017) ("Claim terms must be construed the same way for the purpose of determining invalidity and infringement.").

[78] SimpleAir, Inc. v. Sony Ericsson Mobile Commc'ns AB, 820 F.3d 419, 421 (Fed. Cir. 2016).

[79] Netword, LLC v. Centraal Corp., 242 F.3d 1347, 1352 (Fed. Cir. 2001) ("'Claim construction' is the judicial statement of what is and is not covered by the technical terms and other words of the claims."). *See also* Abbott Labs. v. Sandoz, Inc., 544 F.3d 1341, 1358 (Fed. Cir. 2008) ("The first step in most infringement suits is the procedure called 'claim construction,' where the scope of the claim is defined by the court."); Pall Corp. v. Hemasure Inc., 181 F.3d 1305, 1308 (Fed. Cir. 1999) ("Analysis of patent infringement starts with 'construction' of the claim, whereby the court establishes the scope and limits of the claim, interprets any technical or other terms whose meaning is at issue, and

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WHO BECOMES AN INVENTOR IN AMERICA? THE IMPORTANCE OF EXPOSURE TO INNOVATION

Alexander M. Bell
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Who Becomes an Inventor in America? The Importance of Exposure to Innovation
Alexander M. Bell, Raj Chetty, Xavier Jaravel, Neviana Petkova, and John Van Reenen
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ABSTRACT

We characterize the factors that determine who becomes an inventor in the United States, focusing on the role of inventive ability ("nature") vs. environment ("nurture"). Using deidentified data on 1.2 million inventors from patent records linked to tax records, we first show that children's chances of becoming inventors vary sharply with characteristics at birth, such as their race, gender, and parents' socioeconomic class. For example, children from high-income (top 1%) families are ten times as likely to become inventors as those from below-median income families. These gaps persist even among children with similar math test scores in early childhood – which are highly predictive of innovation rates – suggesting that the gaps may be driven by differences in environment rather than abilities to innovate. We then directly establish the importance of environment by showing that exposure to innovation during childhood has significant causal effects on children's propensities to invent. Children whose families move to a high-innovation area when they are young are more likely to become inventors. These exposure effects are technology-class and gender specific. Children who grow up in a neighborhood or family with a high innovation rate in a specific technology class are more likely to patent in exactly the same class. Girls are more likely to invent in a particular class if they grow up in an area with more women (but not men) who invent in that class. These gender- and technology class-specific exposure effects are more likely to be driven by narrow mechanisms such as role model or network effects than factors that only affect general human capital accumulation, such as the quality of schools. Consistent with the importance of exposure effects in career selection, women and disadvantaged youth are as under-represented among high-impact inventors as they are among inventors as a whole. These findings suggest that there are many "lost Einsteins" – individuals who would have had highly impactful inventions had they been exposed to innovation in childhood – especially among women, minorities, and children from low-income families.

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FEATURE

The Colorblind Patent System and Black Inventors

By Shontavia Jackson Johnson

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Innovation and inventing have been critical to America's progress since its birth.[1] These concepts were so important that the Founding Fathers wrote them into the first Article of the U.S. Constitution, authorizing Congress to give inventors exclusive rights to their inventions for a limited time.[2] The Patent Act was one of the first pieces of legislation passed by the first U.S. Congress in 1790, and it revolutionized the global patent landscape.[3] By the end of the 1800s, America had catapulted itself to the top of the world's economic food chain, and the U.S. patent system was one of the reasons why.[4] Inventors with access to this system were, and still are, uniquely positioned to quite literally change the world.

From inception, our patent system recognized that American progress needs inventors and that inventors should own the fruits of their intellectual labor for some period of time when certain requirements are met. On paper, these constitutional ideals have always applied equally to the demographic tapestry of American inventors. The original law did not explicitly exclude certain races of inventors from participation in the patent system, unlike some of the other laws that

existed at that time. There were, however, practical legal barriers that excluded the earliest black inventors in the United States from obtaining patents.

The patent system simply was not available at that time to enslaved people—they were not considered American citizens, and the rights and provisions of the Constitution did not extend to them.[5] In addition, states enacted laws that prevented enslaved people from owning any kind of property, presumably including patents.[6]

For black inventors who were either born free or otherwise acquired their freedom, there were also legal barriers. After 1793, the Patent Act "included a 'Patent Oath,' which eventually required patent applicants to swear to be the 'original' inventor of the claimed invention and to their country of citizenship."[7] The U.S. Supreme Court's 1857 *Dred Scott* opinion held that black Americans could not be citizens of the United States.[8] Arguably, free blacks were precluded from patenting their inventions after *Dred Scott* because they did not have a country of citizenship and presumably could not swear to the Patent Oath.[9] Even after the *Dred Scott* opinion was superseded by the Thirteenth and Fourteenth Amendments after the Civil War, "the economic and educational conditions that many free blacks faced . . . simply were not conducive to pursuing whatever incentives and opportunities U.S. patent law provided."[10]

There was and continues to be a consistently wide gap between the colorblind American patent system and certain groups of inventors, especially black inventors.

This article will highlight black inventors from America's inception to now. It will also highlight past and present barriers faced by black inventors.

Early Black Inventors in a New America

Three months after President George Washington signed the Patent Act in April 1790, Samuel Hopkins, a white man from Philadelphia, received the first U.S. patent for "an Improvement in the making of Pot ash and Pearl ash by a new Apparatus and Process."[11] It would be 31 years—1821—before Thomas Jennings became the first black inventor to receive a U.S. patent for his dry cleaning methods.[12] Martha Jones, who is the first known black woman to obtain a U.S. patent, would not obtain one for her "Improvement to the Corn Husker, Sheller" until 1868,[13] while the first (white) woman received a patent 59 years prior in 1809.[14]

These gaps show the reality of the times—black inventors faced significant barriers whether free or enslaved.[15] This did not, however, kill their inventive spirit. People who were enslaved served as prolific inventors on Southern plantations. For example:

> At the turn of the nineteenth century, a Kentucky slave invented the hemp brake. In about 1800, a Massachusetts slave named Ebar invented a method of making brooms out of corn stalks. In about 1825, an Alabama slave named Hezekiah invented a machine for cleaning cotton. In 1831, a Charleston, South Carolina slave named Anthony Weston invented an improvement on a threshing machine invented by W.T. Catto .... And in 1839, a North Carolina slave named Stephen Slade invented a method of curing tobacco that enabled the creation of the modern cigarette.[16]

These unsung inventors never obtained patents or the financial gains of their inventions—though slave masters and other white men often did. Some would take undue credit for these inventions and/or secretly patent the inventions themselves, ignoring the true inventors.[17]

For example, there have long been suggestions that the cotton gin was actually conceived of by an enslaved man named Sam, not Eli Whitney, who is revered as one of America's great inventors.[18] In addition, not long after the invention of the cotton gin, plantation owner Cyrus McCormick received a patent for another invention that transformed farming and made him a multimillionaire—the mechanical reaper.[19] Today, most people also attribute the reaper's invention to Jo Anderson, an enslaved man owned by the McCormick family.[20] As a society deeply entrenched in slavery during this time period, these kinds of events were not uncommon.[21]

Some enslaved inventors *did*, however, acquire significant wealth. One quintessential example of early American ingenuity is the story of Benjamin Montgomery, who was born into slavery in Virginia in 1819 and later sold in Mississippi to Joseph Davis, the brother of Jefferson Davis. While enslaved in Mississippi, Montgomery invented a certain type of boat propeller with significant utility for those who depended on steamboats to deliver goods along the waterways.[22] Montgomery could not receive a patent for the invention as he was a slave and not considered a citizen. Nonetheless, Montgomery found success. He operated a general store on the plantation, built relationships, and continued to innovate. He eventually earned enough money to purchase his wife's freedom. After the Civil War ended, he also purchased the plantation he worked on as a slave and became one of the wealthiest planters in Mississippi. This positioned his son, Isaiah

Montgomery, to found Mound Bayou, a successful African American enclave in Mississippi in the early 1900s.[23]

During these early American years, free black Americans were also inventing and contributing to the country's transition into a land of innovation. Thomas Jennings, the first known black patentee, was born free and successfully patented a dry cleaning method in 1821.[24] This proved to be lucrative for him, as the ability to exclude others from making and selling his invention led Jennings to own one of New York City's largest clothing stores.[25] His success was passed along to his children, who all were successful in their professional pursuits.[26] In addition, Jennings's accomplishments extended far beyond his children—he used the profits from his patented invention to free the rest of his family from slavery.[27] His invention also improved the quality of life for customers and sparked later innovation that created the dry cleaning industry we are familiar with today.[28]

Another black inventor, Norbert Rillieux, revolutionized industry both domestically and abroad. Rillieux was born free in Louisiana in 1806 and studied engineering in France.[29] Because of his intelligence, he became the youngest person ever—at age 24—to serve as an applied mechanics instructor at L'École Centrale, a prestigious French institution.[30] Rillieux ultimately applied for and received four U.S. patents related to sugar refining once he returned to America.[31] His inventions transformed the industry, and he became the most celebrated engineer in Louisiana at the time.[32]

Unfortunately, all free black inventors were not created equal. According to Professor Brian Frye:

> Obtaining a patent was difficult and expensive [for free black inventors]. Some inventors could not afford to patent their inventions or could not obtain legal assistance. Some inventions were not worth patenting. And some patent applications were rejected, possibly based on racial discrimination. Accordingly, some patent applicants concealed their race from the Patent Office, in order to avoid potential discrimination. And others used their white partners as proxies, for the same reason.[33]

One such inventor was Henry Boyd, who purchased his freedom in 1826 prior to inventing a new type of bed frame. Boyd partnered with a white man who applied for the patent in his own name.[34] The patent was granted to Boyd's proxy in 1835, and within a decade Boyd's company was Cincinnati's premier manufacturer of bed frames and employed between 18 and 25 black and white men.[35]

These early inventors laid the groundwork for modern American inventors from all backgrounds, especially black inventors. Today's black inventors do not face the same legal and societal hurdles to the patent system, and many have found significant success. However, the number of black U.S. patentees is disproportionality low. The next section will highlight some of these inventors and the impact of low patent system involvement.

Modern Black Inventors in a Maturing America

America's ascent as the preeminent industrialized nation in the world was driven by the "golden age" of innovation and invention during the late nineteenth and early twentieth centuries.[36] Early black inventors were critical participants in the patent system during this time.

One of the most prolific inventors of the golden age was Granville T. Woods, a black man who received more than 60 patents in the fields of electricity and telegraphic communications.[37] Born in 1856, Woods viewed invention as both a means to acquire capital to invest in future projects and a way to implement the modernization of America.[38] Woods was self-taught, having left school at age 10 to work in an Ohio machine shop. He studied electronics, machining, and blacksmithing while working full time.[39] Woods received his first patent in 1884 for a steam boiler furnace.[40] He would travel between Cincinnati and New York inventing, raising venture capital for, and selling his inventions.[41] His inventions competed with those of highly regarded inventors like Alexander Graham Bell, Lucius Phelps, and Thomas Edison.[42] His patented inventions included technology that improved trains, streetcars, and electrical communication systems, among other things. Upon his death in 1910, Woods had realized his goal of helping to modernize America.

Along with Woods, Lewis Latimer was a premier black inventor at the end of the nineteenth century. Born free in 1848 to parents who had run away from slavery, Latimer learned about patent drafting as an office boy in a Massachusetts patent law firm.[43] Latimer rose in the firm's ranks to become a draftsman—a professional rarity for blacks during this period—and over time he not only helped others but also developed several of his own inventions.[44] His inventions included toilet systems for railroad cards, carbon filament light bulbs, and the now-common threaded light bulb socket, among other things.[45] Latimer worked with some of America's most well-known inventors, including Alexander Graham Bell and Thomas Edison.[46] His work helped make electric lights possible both in private homes and in public, and this transformed the way Americans lived and worked at that time.[47]

As the twentieth century was beginning, other black inventors were helping to make Americans safer with their inventions.

Garrett Morgan, for example, received patents for what would become the gas mask in 1914[48] and the traffic signal in 1923.[49] Morgan was formally recognized by the city of Cleveland in 1916 when he saved the lives of 24 men trapped in a tunnel beneath Lake Erie while wearing the mask he invented.[50] His traffic signal invention became an indispensable component of both national and global traffic models.[51] Morgan's traffic signal invention is the grandfather of the type we use today.

Charles Richard Drew, a doctor in Washington, D.C., helped make medical gains by inventing a method for preserving human blood in 1942.[52] Drew's work saved thousands of lives during World War II, and he became the founding medical director of the United States Red Cross Blood Bank.[53]

In the home safety space, Marie Van Brittan Brown invented the first home security system and obtained a patent for it in 1969.[54] She invented the system because police did not respond quickly to emergencies happening in her New York neighborhood.[55] Brown's invention allowed a homeowner to see a person at the door and hear their voice on a television set that was controlled by a wireless radio system.[56] Some iterations of Brown's home security are still being used in the twenty-first century.

These examples show that black American inventors have developed technology that not only advanced American technology but also saved and continues to save lives. These inventors improved our health and safety. Other black inventors created new ways for people around the world to enjoy themselves.

Dr. Lonnie Johnson, for example, changed water fights forever with his invention of the number one selling water toy of all time—the Super Soaker water gun. Johnson received a patent for a "squirt gun" in 1986 at a time when water guns essentially all followed the same design. Johnson's background as a NASA engineer led him to design a water gun that uses air pressure to create more forceful water streams.[57] To date, Johnson's water guns are approaching $1 billion in sales and are sold by Hasbro, the largest toy maker in the world.[58] Johnson currently holds more than 100 patents on everything from toys and consumer products to advanced energy devices and methods.[59] He has used the profits from his patented inventions to found and operate a research lab in Atlanta's inner city that stimulates economic development and creates jobs.[60]

Other modern American inventors have used their inventions to serve the world as humanitarians. Dr. Patricia Bath, an ophthalmologist and academic, received multiple patents related to cataract treatment between 1988 and 2003.[61] The technology she invented, including the Laserphaco Probe, is used around the world to painlessly treat cataracts.[62] Bath used her successes to found the American Institute for the Prevention of Blindness in Washington, D.C. She travels the world on humanitarian missions, restoring sight for those without access to adequate medical treatment.

Modern black inventors are also at the forefront of cutting-edge technology that improves both the public and private sectors. In the private sector, Marian Rogers Croak currently holds more than 135 patents primarily related to voice-over Internet protocol (VoIP) technology, which paved the way for VoIP systems like Skype and Google Hangouts.[63] Croak spent more than 30 years at AT&T, where she managed 2,000+ engineers and led AT&T to replace wired communications with Internet protocol.[64] She currently serves as a vice president of engineering at Google, where she is responsible for Google's global expansion of Internet access in emerging markets and elsewhere.[65]

Another such inventor is Janet Emerson Bashen, the founder and current CEO of Bashen Corporation, who became the first black woman to obtain an American software patent in 2006.[66] Early in her career, Bashen worked in the insurance industry and noticed that the industry needed private, third parties to investigate Equal Employment Opportunity (EEO) claims. She founded a company to meet this need and then coinvented a way to securely store information about EEO investigations.[67] Bashen went on to develop new software that facilitates EEO complaints and other Title VII adherence.[68]

In the public sector, there are esteemed inventors such as Dr. Robert G. Bryant of the National Aeronautics and Space Administration (NASA). Bryant has served as an inventor or coinventor on dozens of issued patents related to polymers and advanced composites during his career at NASA.[69] His work is highly regarded in the industry, having received numerous accolades over the years, including R&D 100 awards in 1994 and 1996 and the NASA Government Invention of the Year Award in 2006.[70]

These black American inventors illustrate the range of benefits associated with encouraging innovation and access to the American patent system. Those who can participate in it not only

receive the personal right to exclude others from making, using, offering for sale, or selling their invention, but they also receive a gateway to revolutionizing our country with their innovations.

Unfortunately, the reality remains that black patentees are woefully underrepresented in America. Recent studies show wide disparities between the number of U.S. patents issued to inventors of color and the total number of patents issued.[71] This is particularly true for black and Hispanic inventors. There is no reliable data on the actual number and proportion of black American patentees because the United States Patent and Trademark Office (USPTO) does not currently collect demographic data about patentees.[72] However, tangential and anecdotal research suggests that the rates are very low.[73]

For example, one 2010 study found that from 1970 to 2006, black American inventors received six patents per million people, compared to 235 patents per million for all U.S. inventors.[74] Another 2016 study found that black Americans "apply for patents at nearly half the rate of whites."[75]

A 2016 Information Technology & Innovation Foundation report, *The Demographics of Innovation in the United States*, found even more grim results.[76] The report surveyed "innovators," defined as people who have won national awards for their inventions; people who have filed for international, triadic patents[77] for their innovative ideas in three technology areas (information technology, life sciences, and materials sciences); and people who have filed triadic patents for large advanced-technology companies. This report identified only 0.3 percent of black American respondents as "innovators."

There are no easy answers to address these racial gaps. As some scholars have noted, any solutions are multifaceted and their success will rely on the creation and success of other solutions.[78] Some solutions include: (1) greater STEM exposure and education; (2) mentorship and social networking; (3) institutional changes in academia and industry so that black inventors have much-needed support; (4) greater exposure to inventors and innovation; (5) access to financial resources; and (6) public policy changes that prevent and remedy discrimination.[79]

The existing gaps must be addressed, however, and not merely for social parity reasons. There are economic imperatives: increasing the number of black American inventors will also increase America's GDP—by as much as 3.3 percent according to some estimates.[80] In addition, patent ownership is essential for acquiring venture capital and improving the success rates of startup companies.[81] Many early black inventors, like Granville Woods, used patents to raise the funds

necessary for continued innovation. Persistent gaps like these "result in the U.S. foregoing the opportunity for substantial economic growth and job creation."[82]

In addition, diversity broadens the continuum of experiences and perspectives to draw from, which will in turn lead to more creative solutions to the world's problems.[83] One Nigerian-American inventor, Jessica Matthews, invented a soccer ball in 2009 that doubles as a power generator. Matthews came up with the idea after attending a wedding in Nigeria as a teenager.[84] She later founded a company, Uncharted Play, that now owns 15 patents and broke records when it raised $7 million in a Series A funding round in 2016.[85] Matthews's life experiences and diverse background led to the emergence of this innovative solution to global access to power problems.

Conclusion

America's innovation landscape has long been considered among the best in the world, thanks in part to its 228-year-old patent system.[86] Black American inventors have consistently participated in it, despite many past and present barriers. From Thomas Jennings to Jessica Matthews and beyond, these inventors have contributed to the fabric of America's innovation ecosystem. As America looks forward, we would all be served well by creating an inclusive and diverse patent system that is not only colorblind, but accessible to all.

Endnotes

1. Even before the nation's founding, there were patents. The Massachusetts general court granted the first patent in the 13 colonies to Samuel Winslow in 1641. *See Salt Making, First Patent*, Cambridge Sentinel, Sept. 26, 1942, at 7.

2. Article I of the Constitution empowers Congress "[t]o promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries." U.S. Const. art. I, § 8, cl. 8. Article I forms the basis of both patent and copyright law in the United States.

3. President George Washington actually singled out the Patent Act as the law the first Congress should pass to vitalize the new nation. *See* John White, *The Day That Changed the World: April 10, 1790*, IPWatchdog (Apr. 9, 2015), https://www.ipwatchdog.com/2015/04/09/the-day-that-changed-the-world-april-10-1790/id=56422/. The law's passing was the third act of Congress. *Id.*

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Progress and Potential

2020 update on U.S. women inventor-patentees

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KEY FINDINGS

- More women are entering and staying active in the patent system than ever before.
- Patenting by U.S.-based women grew between 2016 and 2019. Patents with at least one woman inventor accounted for 21.9% of patents through 2019, up from 20.7% in 2016.
- The women inventor rate (WIR)—that is, the share of women among all U.S. inventor-patentees—grew from 12.1% in 2016 to 12.8% by 2019.
- The percentage of new women inventor-patentees rose from 16.6% in 2016 to 17.3% by 2019.
- The gender gap in the number of inventor-patentees that stay active by patenting again is decreasing. In 2014, 46% of women patented again within five years of their first patent (by 2019), versus 52% of men. In 1980, the gap was 28% for women versus 38% for men.
- The District of Columbia had the highest average WIR for 2007-2019 at 19.2%, while North Dakota had the lowest at 8.3%.
- Wyoming showed the largest improvement in its average WIR, up from 9.6% over 2007-2016 to 11.2% for 2007-2019.
- Among the top patenting organizations, Proctor & Gamble had the highest average WIR at 29.3% for 2007-2019.
- 3M Company showed the largest improvement in the participation of women inventor-patentees: Their average WIR increased from 15.2% over 2007-2016 to 16.6% for 2007-2019.

Introduction

The U.S. patent system improves the lives of Americans by encouraging and strengthening innovation. For this system to be most effective, all Americans must have the opportunity to reap the personal and commercial benefits of applying for and receiving patent protection. In a 2019 report, "Progress and Potential: A profile of women inventors on U.S. patents," the United States Patent and Trademark Office (USPTO) investigated the participation of U.S.-based women inventor-patentees in the U.S. patent system.[1] It examined the trends and characteristics of women's participation and found that women were underrepresented.

This update improves our understanding of women's participation as inventor-patentees in two ways. First, it updates the findings from the 2019 report using three years of new data, covering January 2017 through December 2019. Second, it provides an analysis of entry by women into the patent system. In particular, it looks at the number and share of new women inventor-patentees and the degree to which those women remain active by patenting again within the next five years. The updates and new information presented in this report rely heavily on PatentsView—a free, online platform for visualizing, disseminating, and promoting a better understanding of U.S. patent data supported by the USPTO's Office of the Chief Economist.[2]

There has been continued improvement in the participation of women inventor-patentees

The participation of U.S.-based women in the U.S. patent system can be evaluated using two indicators. The first is the share of patents that include at least one woman inventor. This indicator counts patents and provides an "output" perspective on participation, but it is also influenced by other factors, such as the gender composition of inventor-patentee teams and the total number of patents those teams produce. The second indicator—called the women inventor

1 See U.S. Patent and Trademark Office, Office of the Chief Economist, "Progress and Potential: A profile of women inventors on U.S. patents," IP Data Highlights, no. 2 (February 2019), www.uspto.gov/sites/default/files/documents/Progress-and-Potential.pdf. "Inventor-patentees" are inventors who choose to pursue patent protection for their invention(s).

2 PatentsView (www.patentsview.org) uses a machine learning algorithm to assign unique person-specific IDs to inventor-patentees, thus permitting the tracking of inventor-patentees in U.S. patent data since 1976.

rate (WIR)—calculates the share of women among all inventor-patentees in a given period of time.[3] The WIR indicates the proportion of unique women who are engaged in the patent system and provides an "input" perspective on participation. Unlike the first indicator, the WIR is independent of team gender composition and team production because it identifies the number of unique women inventors within a given time period.

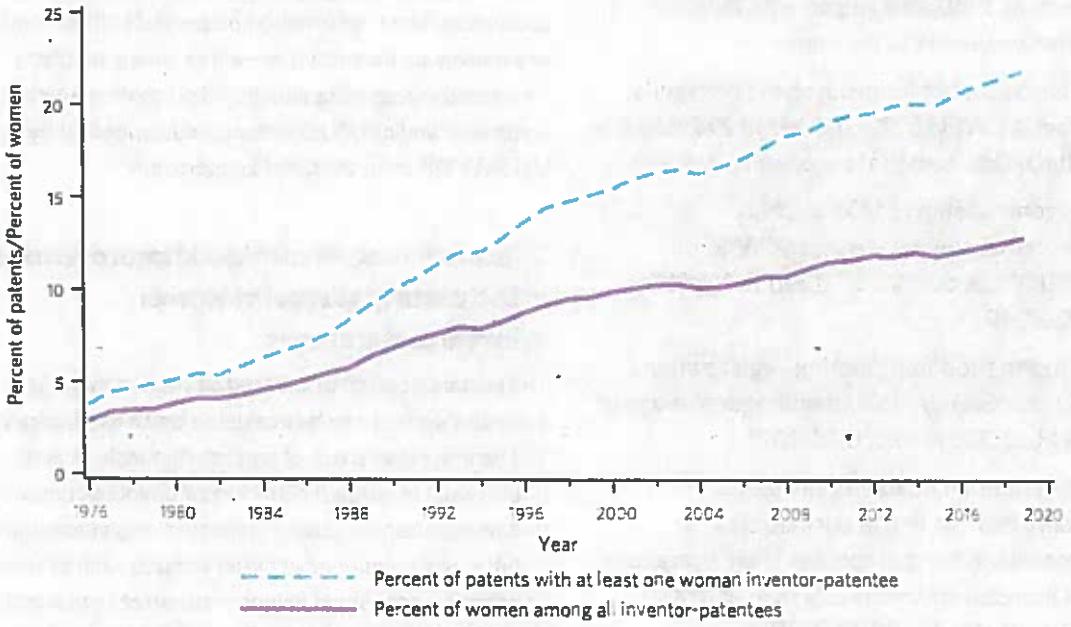
Both indicators have improved substantially since 1976 (Figure 1). The share of patents with at least one woman inventor grew from 20.7% in 2016 to 21.9% by the end of 2019 and is growing faster than in the prior period.[4] Observing faster growth in patent output is certainly positive, but it is unclear whether this trend reflects the contributions of women inventor-patentees because the dominant share of this output comes from mixed-gender teams.

The WIR improved from 12.1% in 2016 to 12.8% by 2019. This shows that more women are active as inventor-patentees. However, a WIR of 12.8% is substantially lower than other benchmarks of women's education and employment as scientists and engineers.[5] In 2017, women held about 2 million science and engineering jobs, but only 27,000 women were inventor-patentees in that year. The share of male science and engineering job holders who are inventor-patentees was three times higher. These data suggest that expanding the pipeline through education and science and engineering jobs, while necessary, is not sufficient to increase the participation of women as inventor-patentees.

More women are entering and staying active in the patent system

Bringing new women into the patent system is one of the most important channels for expanding women's participation as inventor-patentees. Using unique identifiers for inventor-patentees available through PatentsView, this

Figure 1: Patenting and participation by U.S.-based women inventor-patentees, 1976–2019



Source: Authors' analysis of PatentsView data, 1976–2019

3 WIR is calculated for a single year (such as 2019) as the number of unique women inventors divided by the total number of unique inventors for that year. The *average* women inventor rate (AWIR) is calculated over several years, such as 2007-2019, as the sum of unique women inventors in those years combined, divided by the sum of all unique inventors for those same years.

4 From 2010 to 2016, the share of patents with at least one woman inventor grew at an average annual rate of 1.3%. This rate increased to 2% for 2016 through 2019.

5 Recent figures from the National Science Board (NSB) show that women make up about 52% of the U.S. college-educated workforce and hold 29% of all U.S. science and engineering jobs (NSB 2020).

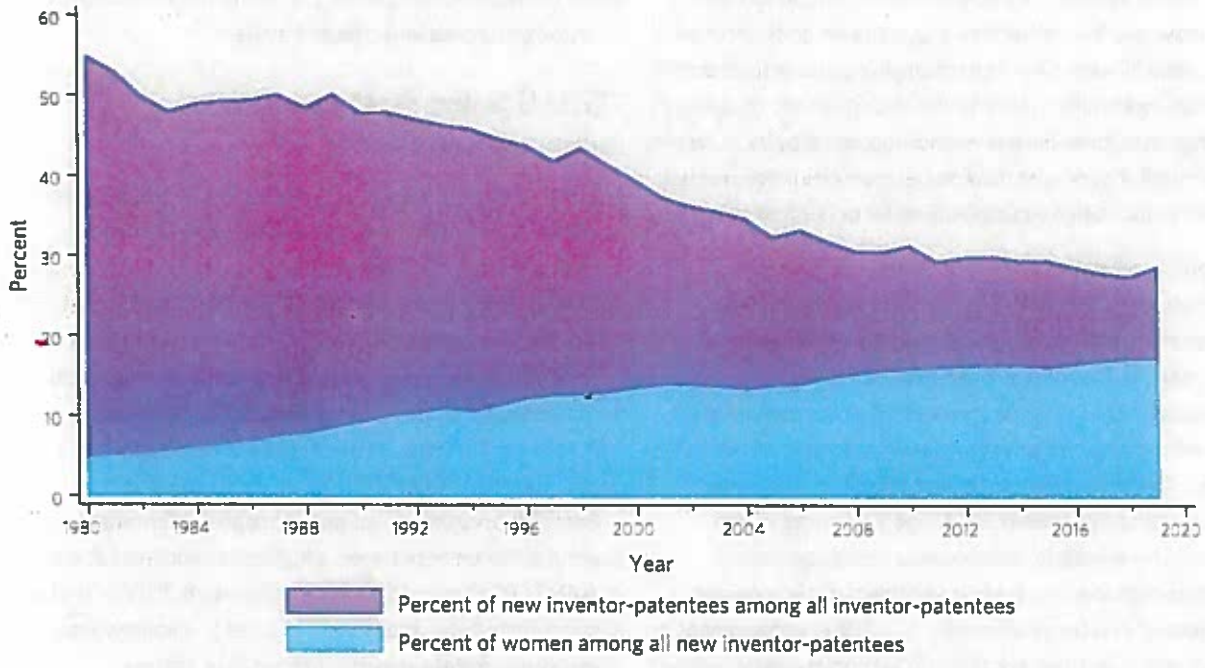
report extends the scope of the USPTO's 2019 "Progress and Potential" report by shedding light on the flow of new U.S.-based inventors into the patent system.

In 1980, there were approximately 44,550 unique inventor-patentees. This number grew to about 241,800 by 2019. During that same period, the share of new inventor-patentees among this group fell (the purple area in Figure 2). To some degree, this downward trend is expected, given that the number of inventor-patentees who patented again increased over time relative to the entry of new inventor-patentees. However, after growing at an average rate of 9.6% from 2009 to 2014, the number of new inventor-patentees grew at just 2.7% per year (on average) from 2014 to 2019. In 2019, there were about 69,080 new inventor-patentees.

Similar to the trend in the WIR, the share of women among all new inventor-patentees increased from about 5% in 1980 to 17.3% by the end of 2019 (the blue area in Figure 2). In the five-year period from 2009 to 2014, the number of new women inventor-patentees grew by an average of 10.8% each year. In the next five years ending in 2019, this growth slackened to 4% per year. Nevertheless, a 4% annual growth in the number of new women inventor-patentees is notably higher than the growth observed for new men inventor-patentees, which was 2.5% from 2014 through 2019. From 2014 to 2019, the average number of new women inventor-patentees per year was about 10,340.[6]

Similar to the trend in the WIR, the share of women among all new inventor-patentees increased from about 5% in 1980 to 17.3% by the end of 2019.

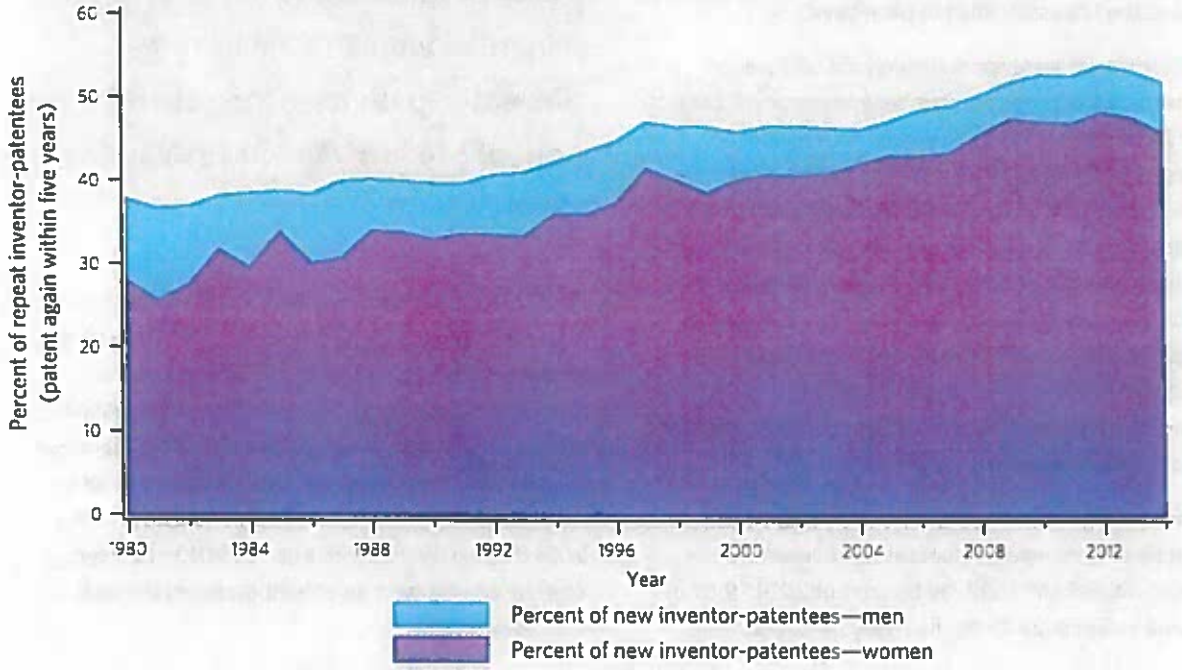
Figure 2: New inventor-patentees as a percentage of all inventor-patentees, and corresponding women's percentage, 1980–2019



Source: Authors' analysis of PatentsView data, 1976–2019

6 For top universities, Delgado and Murray analyze the participation of new female inventors. (See Delgado, M., and F. Murray, "Catalysts for Gender Inclusion in Innovation: The Role of Universities and Their Top Inventors," unpublished paper, Massachusetts Institute of Technology, February 2020.)

Figure 3: Percentage of new inventor-patentees who remained active in the patent system by patenting again within five years, by gender, 1980–2014



Source: *Authors' analysis of PatentsView data, 1976–2019.*
Note: *Cohorts were constructed by grouping inventor-patentees by the year they received their first patent and then following them for five subsequent years.*

Another aspect that characterizes participation as inventor-patentees is whether they stay active in or drop out of the patent system. One form of staying active is to patent multiple inventions over time. For this report, we measure engagement for each new inventor-patentee by assessing whether that person obtained at least one more granted patent in the five years following his or her first patent.

For groups of new inventor-patentees from 1980 through 2014, Figure 3 shows the percentage who remained active in the patent system within the next five years. For instance, of the group of new men inventor-patentees in 1980, about 38% of those individuals stayed active by patenting again within the next five years. This percentage rose over time. For new men inventor-patentees in 2014, about 52% remained active. The results for women inventor-patentees indicate that women are less continuously engaged in the patent system as inventors, but that engagement is improving over time. For the 1980 group of new women inventor-patentees, about 28% remained active within the next five years. By 2014, this percentage increased to nearly 46%. Although the factors driving these trends are not yet known, women inventor-patentees are decreasing the gender gap in the number of active inventor-patentees in the patent system.

The U.S. and most states show an improved AWIR

For the nation, women's participation as inventor-patentees improved. The average women inventor rate (AWIR) for 2007-2019 was 14.2%, up from 13.6% for 2007-2016. However, national-level improvements in AWIR do not reveal state level variation in women's participation (Figure 4). A strong national AWIR could be driven by a handful of states, potentially masking important differences in the geography of women's participation. The USPTO's 2019 "Progress and Potential" report revealed a more than 10 percentage point difference between the highest and lowest state AWIRs (Delaware 18.3%, North Dakota 8.2%). In that same time period, about 42% of all U.S.-based women inventor-patentees were located in four states: California, Massachusetts, New York, and Texas. Three states had fewer than 50 women inventor-patentees (Wyoming, North Dakota, and Alaska), four states had between 50 and 100, and 18 states plus the

Figure 4: Average women inventor rate (AWIR) by state, 2007–2019

Source: Authors' analysis of Patents View data, 2007-2019

About 41% of all U.S.-based women inventor-patentees are located in four states: California, Massachusetts, New York, and Texas.

District of Columbia had between 101 and 500 women inventor-patentees.[7]

With the updated data used in this report (2017–2019), the range of AWIR values across states increased slightly to 11%, underlining how geographic location shapes opportunities differentially for women to become inventor-patentees.[8] Among the four states with the most women inventor-patentees, Texas is the only one ranked below the national AWIR of 14.2%.[9]

Figure 5 illustrates how state AWIRs have changed since 2016. Forty-five states and the District of Columbia improved their AWIRs for 2007-2019 relative to 2007-2016. Wyoming (darkest purple in Figure 5) showed the largest improvement, rising from 9.6% to 11.2%. This is an increase of 1.6 percentage points.[10] However, because Wyoming has a small number of inventor-patentees, this change represents a relatively small increase in the absolute number of women inventor-patentees. The AWIRs for 15 states increased between 0.001 and 0.500 percentage points, while 30 states plus the District of Columbia improved between 0.501 and 1.500 percentage points. Alaska, Hawaii, North Dakota, Alabama, and Mississippi all experienced small reductions in their AWIRs.

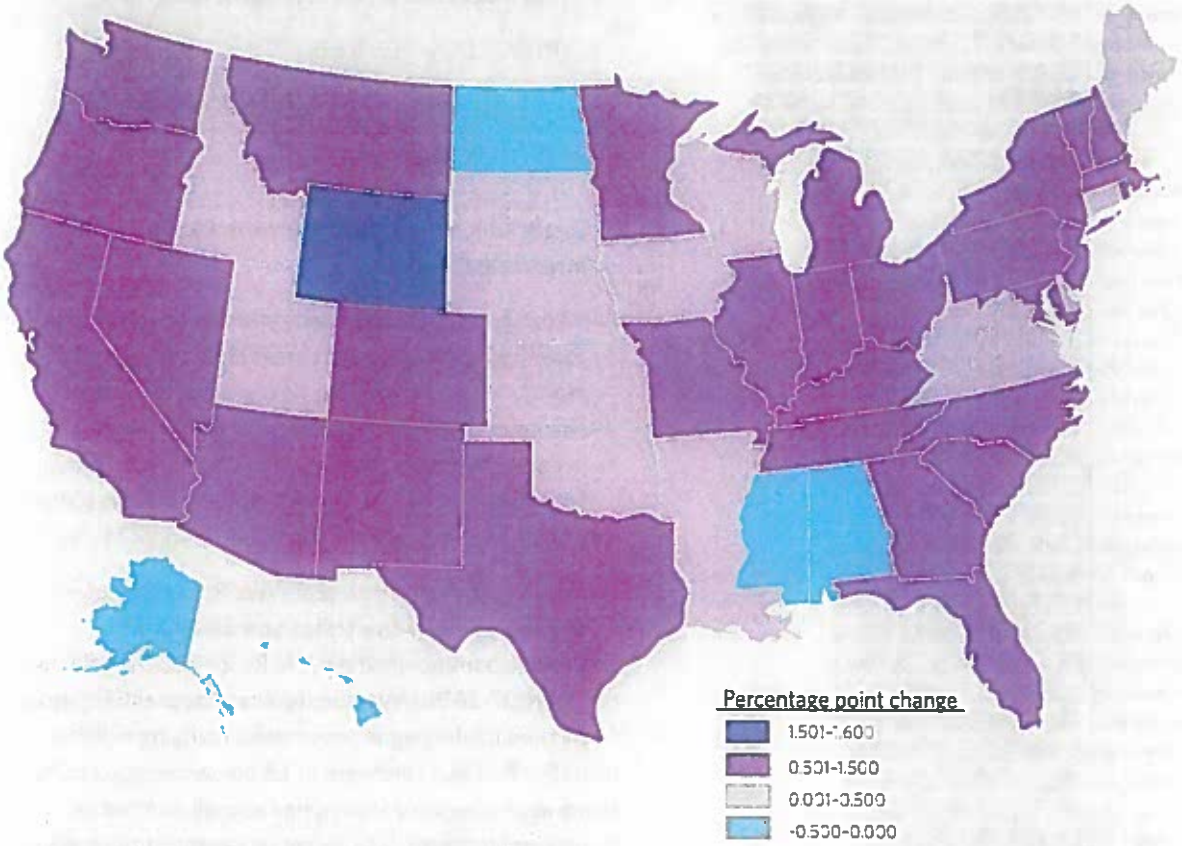
7 See USPTO, "Progress and Potential" (February 2019).

8 In this update, the period of coverage was expanded to include five earlier years of data preceding 2012, adding 2007–2011. This change was made to provide consistency with other figures in this report, but it does not influence the results in a meaningful way. Using an average over 2007-2019 helps to smooth year to year variation.

9 Note that the national AWIR of 14.2% is higher than all WIR values reported in Figure 1. This is due to the fact that the AWIR in Figure 4 is an average calculated over a longer time interval, from 2007 through 2019, and thereby retains unique inventor-patentees who may have patented in only one year. The WIR reported in Figure 1 only counts unique inventor-patentees appearing annually.

10 A change in percentage points is not equivalent to a percentage change. For instance, the percentage point change will be 5 when values go from 10% to 15% whereas the percentage change would be 50%.

Figure 5: Percentage point change in the average women inventor rate (AWIR) by state between the time periods 2007–2016 and 2007–2019



Source: Authors' analysis of PatentsView data, 2007–2019

Few top patent assignees surpass the national AWIR

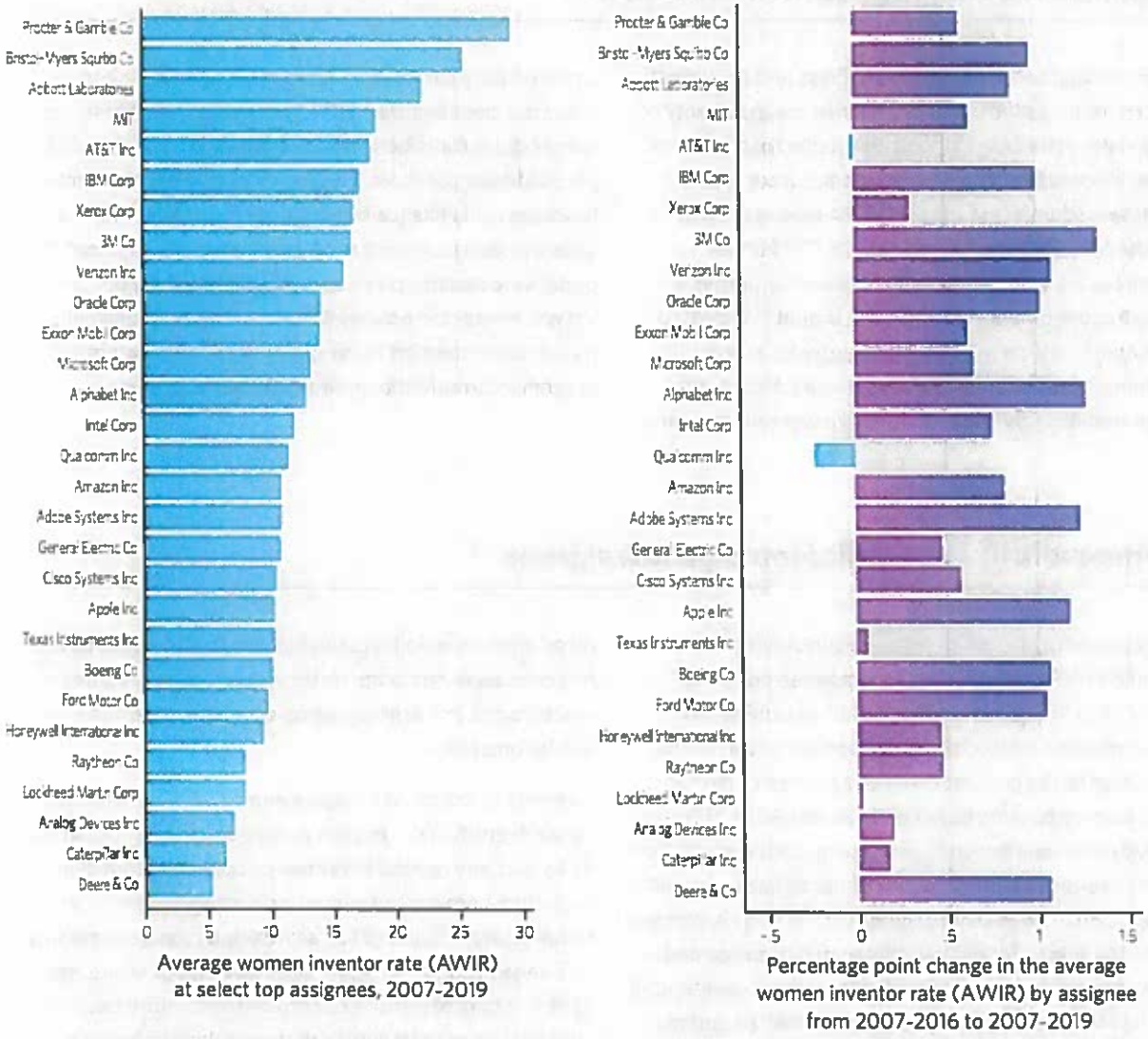
Due to the volume of annual patent filings, the organizations that are the top patent assignees have a disproportionate influence on women's participation in the U.S. patent system.[11] For the 29 top assignees listed in Figure 6 (left bar chart), only 11 had AWIRs above the 14.2% national AWIR. Continuing a long-running trend, Procter & Gamble led the group with over 29%. The three companies with the highest AWIR values produce diversified healthcare products and pharmaceuticals, which is consistent with the concentration of women in chemistry, biology, and related STEM (science, technology, engineering, and mathematics) fields and jobs.[12] In contrast, women make up the smallest share of inventor-patentees at companies more focused on electrical and mechanical engineering technologies, such as Deere & Co. (5%), Caterpillar (6%), and Analog Devices (7%).

Women's participation as inventor-patentees varies considerably across U.S. companies, both within and across industrial sectors.

11 When a patent is granted, a company or other entity is assigned ownership and identified as the "assignee" of the patent.

12 National Science Board, Science & Engineering Indicators, 2020. "The State of U.S. Science & Engineering." Washington, D.C.: NSB-2020-1. ncses.nsf.gov/pubs/nsb20201

Figure 6: Average women inventor rate (AWIR) at 29 top patent assignees



Source: Authors' analysis of PatentsView data, 2007–2019

Figure 6 (right bar chart) shows the percentage point changes in the AWIRs for top assignees between two time periods, 2007–2019 compared to 2007–2016. 3M Company showed the largest gain in women's participation, rising by 1.4 percentage points to 15.2% in 2007-2019. The increase for Procter & Gamble, which is first in the AWIR rankings, was about half as large (0.59 percentage points). The AWIR values for 9 of the top 29 assignees listed in Figure 6 increased by more than 1 percentage point, and 18 others exhibited some improvement. AWIR values were flat or slightly down for Qualcomm and AT&T.

Appendix I: Gender attribution validation

After publication of the 2019 "Progress and Potential" report, we undertook an evaluation of the quality of the gender attribution algorithm used in that report and in this update. The algorithm's accuracy was assessed on a test set of USPTO examiners whose genders are known from internal USPTO human resources data.[13] First, patent examiner names were extracted from public data on U.S. patents hosted by PatentsView (www.patentsview.org). Second, examiner genders were attributed to each patent examiner using the algorithm. There were more than 3 million patent-examiner pairs. For these, a gender was attributed in about 90% of the cases. For these successful attribution cases, the algorithm correctly predicted gender in 94.3% of the cases. This number, however, is likely a lower bound for the algorithm's accuracy due to instances of incomplete information or data inconsistencies. For example, some observations contained only the initials of the examiner's name rather than his or her first name, which is not enough information to infer the person's gender.

Appendix II: The AWIR for top patent assignees

To generate the set of organizations reviewed, we relied on the list of selected top assignees used in the 2019 "Progress and Potential" report.[14] We pre-processed the top patent assignee names[15] for matching to the population of all assignee names on U.S.-granted patents between 1976 and 2019.[16] Using software, we applied various fuzzy matching methods to the pre-processed names of top assignees and the population of all patent assignees.[17] The software generated scores for each potential match based on the co-occurrence of words, where words were weighted by their inverse frequency. We retained all potential matches with a score greater than or equal to 95 (out of a possible score of 100).

Next, manual reviews were performed to validate the accuracy of matched candidates. This process involved identifying matches to joint ventures, subsidiaries, or international branches of the companies and other entities in our sample. Inaccurate or low-quality matches were removed. Despite these efforts, some inaccuracies in the grouping of assignee names may still be present.

Two sets of matched assignee names were generated for each entity: (1) assignee names of the entity itself as well as any related IP branch or holding company, excluding joint ventures, subsidiaries, and international branches; and (2) all matching assignee names. The second set, while more expansive, does not represent a company's entire corporate structure because subsidiaries with names that are different from the corporate name could not be identified without comprehensive information on corporate ownership structures and any changes in those structures over time. For this reason, AWIR values may differ if the entire corporate structure is considered.

13 Appendix II of the USPTO's "Progress and Potential" (February 2019) report explains the gender attribution algorithm in detail.

14 Appendix III of the USPTO's "Progress and Potential" (February 2019) report provides more background.

15 We manually searched the patent assignee data for possible variants of the official name of each entity in our sample. An individual firm's name can appear in a variety of ways on different patents. For example, International Business Machines may be abbreviated as "IBM," or Massachusetts Institute of Technology as "MIT." We compiled a list of such name variants for each entity and then cleaned and standardized the variants using a firm name standardization software package (stnd_comp) in Stata.

16 We restricted the PatentsView assignee file to all organizational assignees (that is, no individuals) with at least one patent granted between 1976 and 2019 and then cleaned and standardized each assignee name using a firm name standardization software package (stnd_comp) in Stata.

17 We used the publicly available Doherr Search Engine to perform matching. See Doherr, Thorsten, "Inventor mobility index: A method to disambiguate inventor careers," ZEW Discussion Paper, no. 17-018 (2017).

For each of the two sets of matched assignee names, granted patents were linked and retained for the period of interest, 2007 through 2019. For each matched patent in sets 1 and 2, we retrieved PatentsView's unique inventor ID and associated gender to calculate the AWIR for the set of unique inventors. The AWIRs were consistent across the matched patents in sets 1 and 2 because the vast majority of matched patents fall into both groups. Given this similarity, throughout the report, we provide only the AWIR for the patents linked to assignees matched in set 1, which excludes joint ventures, subsidiaries, and international branches.

For Figure 6, we calculated the AWIR across two periods: 2007–2016 and 2007–2019. To ensure internal consistency, we reestimated the AWIR for the 2007–2016 period instead of relying on the data from the previous report. Analyzing these two periods allowed us to assess changes in the top assignee AWIRs. Although the methods remained largely the same as those in the previous report, the input data changed in several ways, leading to assignee-level differences between the AWIR in the previous report and the reestimated 2007–2016 AWIR in this report. Most notably, the assignee and inventor disambiguation algorithms were improved, which led to higher-quality data, but also to variations in the set of inventors and patents associated with each assignee. As a quality check, we manually compared the selected assignees' patent portfolios generated for both reports, including only those patents granted between 2007 and 2016, to ensure consistency. The differences in patent portfolio composition across reports was driven by the erroneously linked patents in the previous report because of a lower-quality disambiguation algorithm. Our results will also be influenced by differences in the share of inventors with missing gender attributions across assignees.

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INSTITUTE FOR WOMEN'S POLICY RESEARCH

Briefing Paper

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July 2016

The Gender Patenting Gap

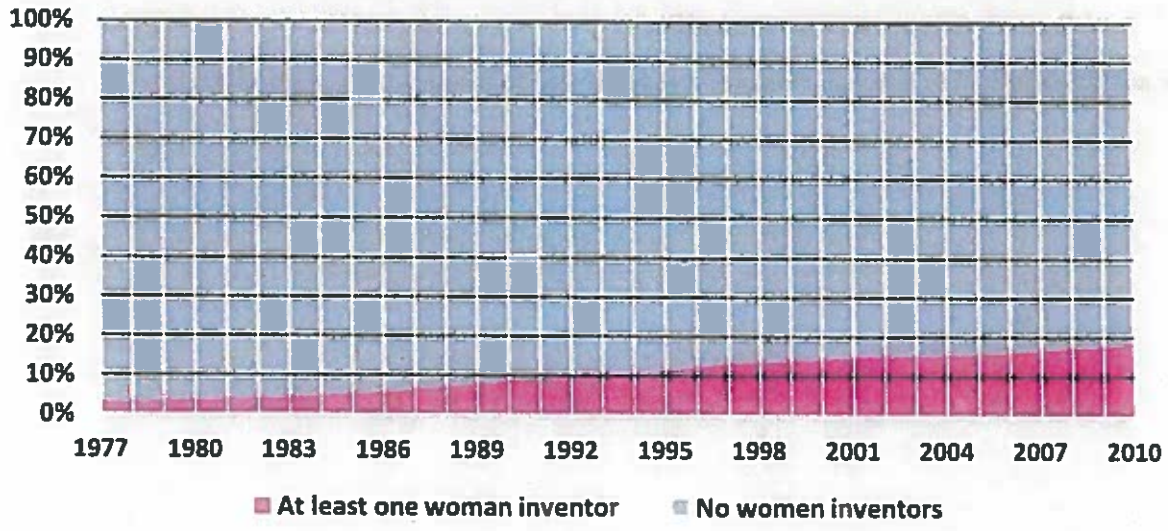
Jessica Milli, Ph.D., Barbara Gault, Ph.D., Emma Williams-Baron, Jenny Xia, and Meika Berlan

The Institute for Women's Policy Research reviewed and analyzed published data and literature on women and patenting, finding that women hold an extremely small share of patents, and that at the current rate of progress, gender equity is more than 75 years away. This briefing paper presents a snapshot of the data and related recommendations.

Women's Small Share of Patents

Although women have more than quintupled their representation among patent holders since 1977, only 18.8 percent of all patents had at least one woman inventor in 2010, compared with 3.4 percent in 1977 (Figure 1).[1]

Figure 1. Share of Patents with Any Women Inventors, 1977-2010



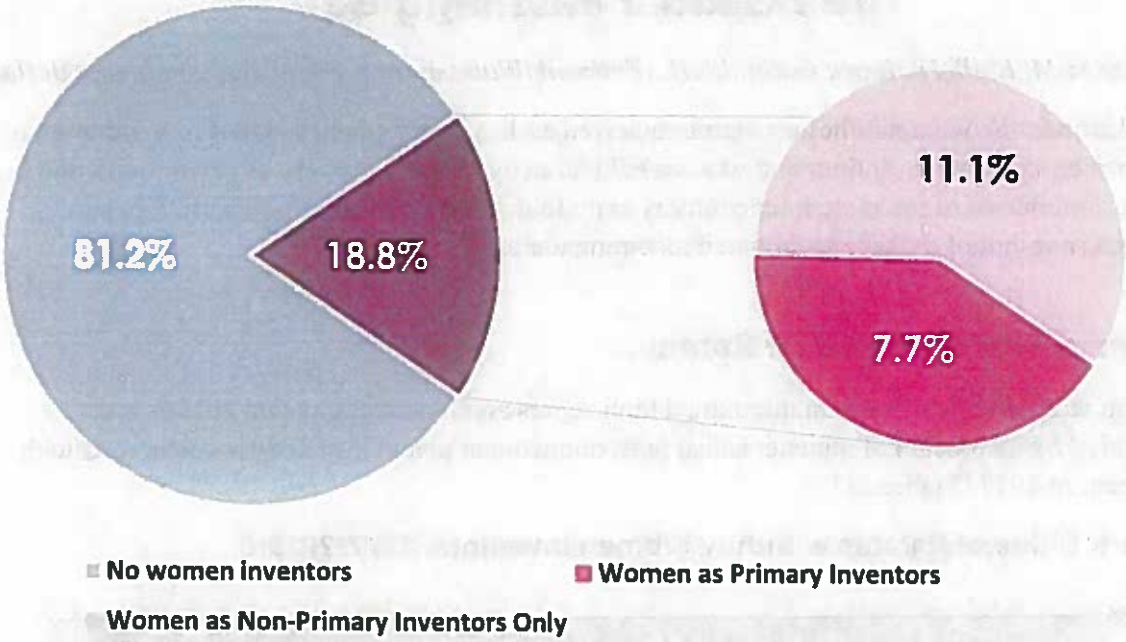
Source: IWPR analysis of Delixus, Inc. and National Women's Business Council (2012) and United States Patent and Trademark Office (USPTO) (2016a).

[1] Unfortunately, due to data limitations, recent information on the representation of women of color among patent holders is unavailable.

Women Underrepresented as Primary Inventors

Only 7.7 percent of all patents listed a woman as the ***primary*** inventor (Figure 2).

Figure 2. Share of Women as Primary and Non-Primary Inventors on Patents, 2010

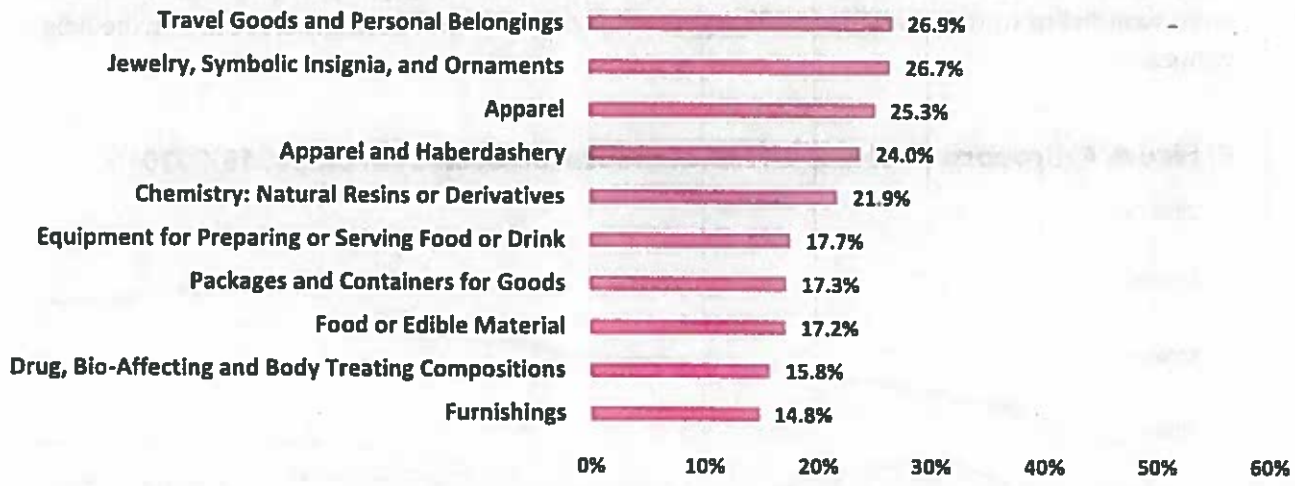


Source: IWPR analysis of Delixus, Inc. and National Women's Business Council (2012) and USPTO (2016a).

Female Silos of Science

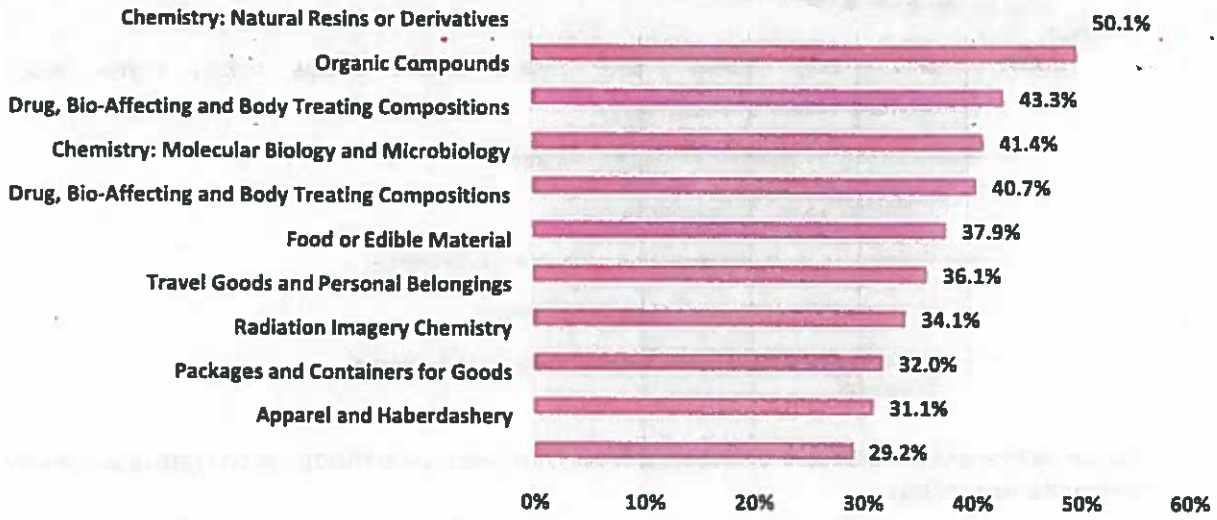
Women are rarely the "Primary Inventor" on a patent and among those who are, most are concentrated in patent technologies associated with traditional female roles, such as jewelry and apparel. Patents that have any women inventors, however, span a greater variety of patent classes (Figures 3a and 3b).

Figure 3a. Top 10 Patent Classes by Share with a Woman as the Primary Inventor, 2010



Note: Data represent total patent grants of U.S. origin only and do not include patent grants of foreign origin.
Source: Delixus, Inc. and National Women's Business Council (2012).

Figure 3b. Top 10 Patent Classes by Share with any Women Inventors, 2010

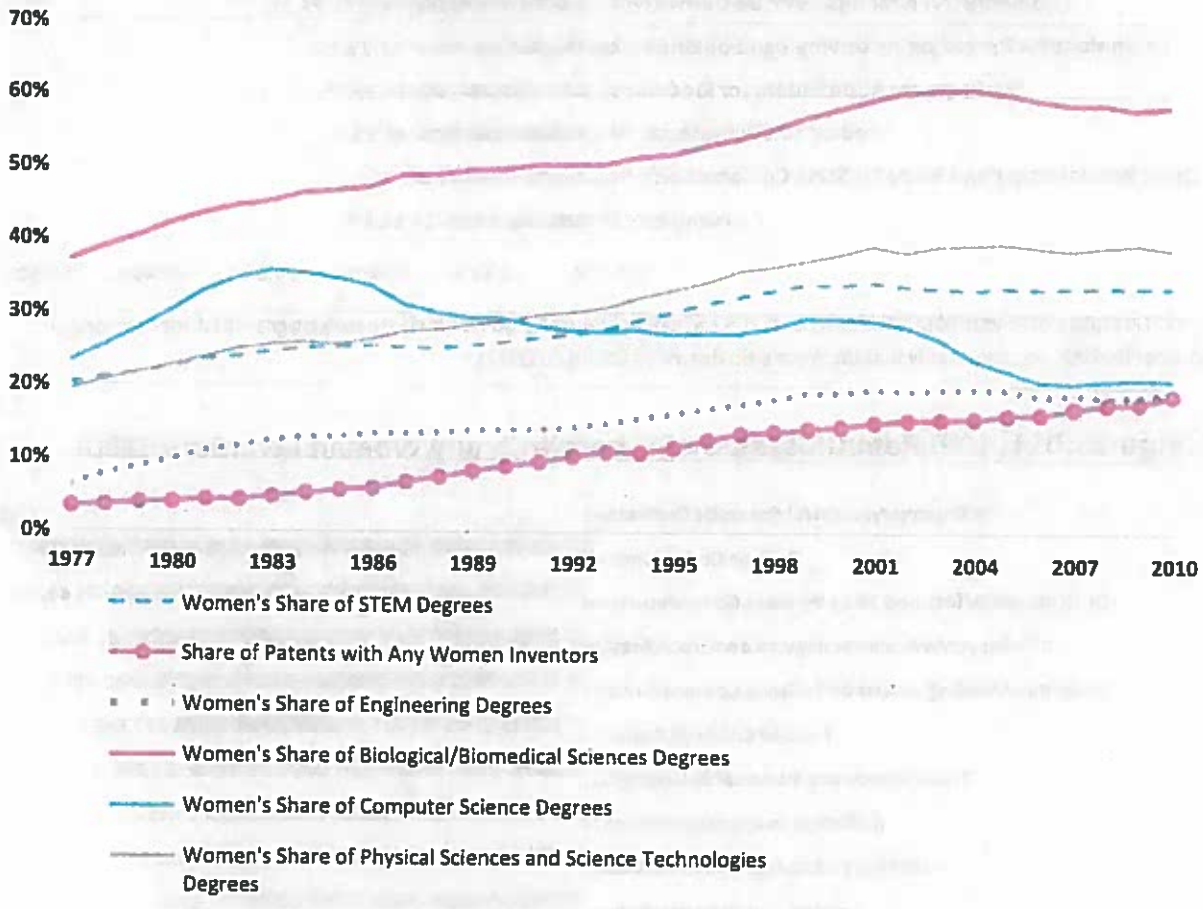


Note: Data represent total patent grants of U.S. origin only and do not include patent grants of foreign origin.
Source: Delixus, Inc. and National Women's Business Council (2012).

The Pipeline is Part of the Problem

Women's low representation in Science, Technology, Engineering, and Math (STEM) fields plays a role in their low patenting rates, and Black, Hispanic, and Native American women are especially underrepresented among STEM degree holders (Hess, Gault, and Yi 2013). While increases in women's patenting are associated with increases in the share of STEM degrees awarded to women, women continue to be grossly underrepresented in some patent-intensive STEM fields, such as engineering and computer science (Figure 4). The ongoing scarcity of women in these specific fields may play a larger role in the patenting gap than women's representation in STEM overall (Hunt et al. 2012). In 2010, only 19.1 percent of engineering degrees, 20.9 percent of computer science, and 38.7 percent of degrees in the physical sciences were awarded to women, whereas 58.3 percent of degrees in the biological sciences were held by women.

Figure 4. Proportion of Key STEM Degrees Received by Women, 1977-2010

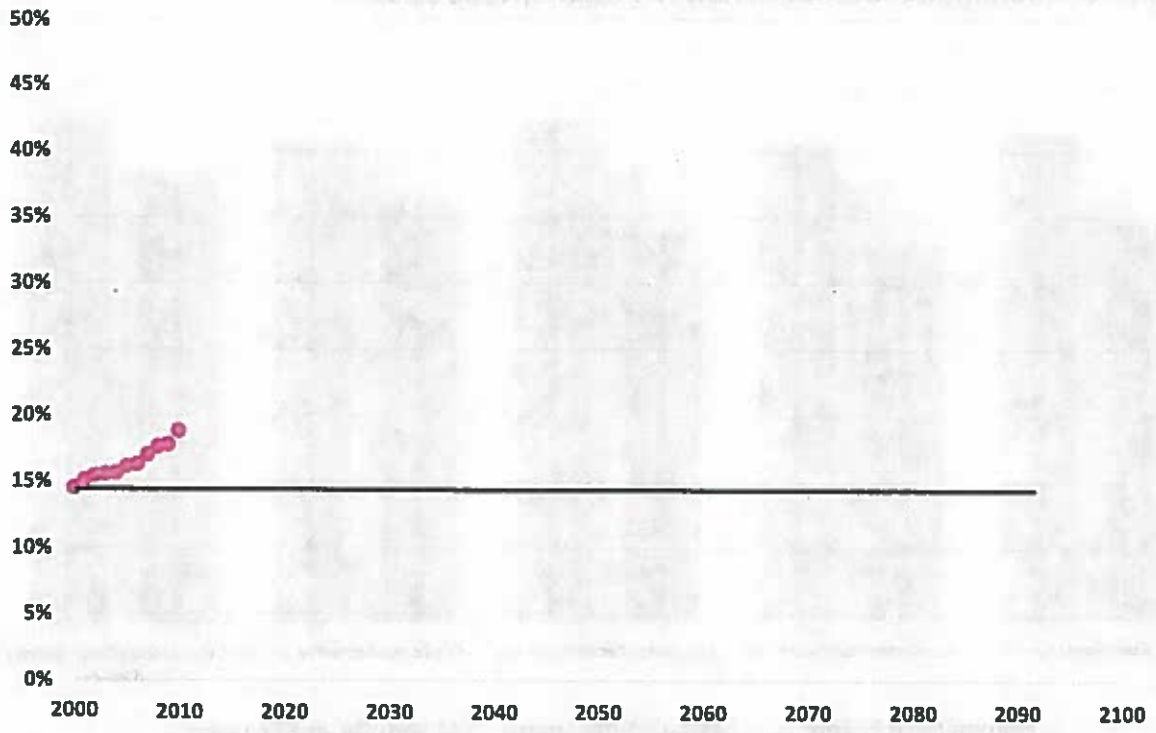


Source: IWPR analysis of Delixus, Inc. National Women's Business Council (2012); USPTO (2016a); and Snyder, Brey, and Dillow (2016).

How Far Do Women Have to Go to Reach Parity?

At the current rate of progress in recent years (since 2000), women are not expected to reach parity in patenting until 2092 (Figure 5).

Figure 5. Share of Patents with any Women Inventors, 2000-2010, with Projection to Parity in 2092



Source: IWPR analysis and projection based on Delixus, Inc. and National Women's Business Council (2012) and USPTO (2016a).

Gender Diverse Teams Succeed

A study published by the National Center for Women and Information Technology found that IT patents with mixed-sex teams are cited more often than those with single-sex teams in later patent applications (Figure 6), suggesting that greater diversity may lead to the development of patents that are more useful and successful (Ashcraft and Breitzman 2012).[2]

Figure 6. Citation Index: U.S.-Invented IT Patents, 1980-2010

Note: The citation index developed by Ashcraft and Breitzman (2012) first normalizes individual patent citation counts by technology class and year granted in order to account for the fact that some technologies have higher average citation counts than others and that older patents have had a longer period of time over which to accrue citations. These normalized citation counts were then compared with expected citation counts based on an individual patent's technology class and age to calculate the citation index.
Source: Ashcraft and Breitzman (2012).

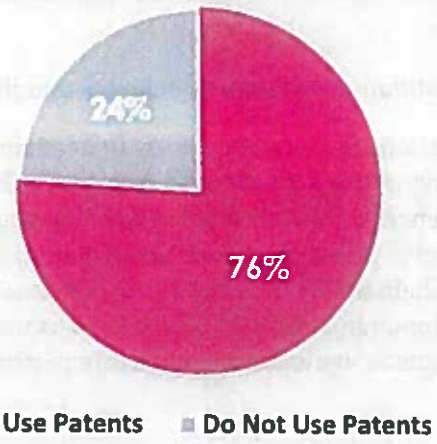
[2] Mixed sex teams in the study were also substantially larger than single sex teams, which could point to an alternate explanation for the teams' higher citation count. The study authors suggest that further research would be needed to assess the relative importance of diversity and/or team size (and other factors potentially associated with team size, such as invention complexity).

Securing Support

Women entrepreneurs' access to venture capital funding is likely to be affected by their low rates of patenting. While 36.3 percent of all businesses in the United States are women-owned (National Women's Business Council n.d.), only three percent of venture capital funding went to businesses with a woman CEO between 2011 and 2013 (Brush, Greene, Balachandra, and Davis 2014). Men are four times more likely to have received outsider equity to finance their businesses than women—in 2010, outsider equity made up 12.8 percent of men-owned businesses' total financial capital compared with only 3.0 percent in women-owned businesses (Robb 2013).

Start-up managers report that 76 percent of venture capital investors consider patents in funding determinations (Figure 7). Patent applications signal quality for new projects and aid venture capital investors in their decision making process (Haeussler, Harhoff, and Muller 2009).

Figure 7. Percent of Venture Capital Investors that Use Patents in Funding Determinations, 2008



Source: Graham, Merges, Samuelson, and Sichelman (2009).

Research-Based Recommendations for Increasing Women's Patenting

- Develop systems and data tools to better track women's progress in patenting.

  The U.S. Patent and Trademark Office (USPTO) does not collect demographic information on inventors as a part of the patent application, so researchers typically use name-matching software to try to identify the gender or race/ethnicity of the inventors. The National Survey of College Graduates, which gathered data on patenting among college graduates in the past, has not provided data on the topic since 2003.

- Employers can offer women assistance with patenting costs.

Fees associated with filing a patent can pose a substantial barrier for women and underrepresented communities of color, since they earn less, on average, than white men (Hegewisch and DuMonthier 2016). In addition, women entrepreneurs are less likely than comparable men to have access to start-up capital (U.S. Census Bureau 2016) or to receive venture capital funding (Brush, Greene, Balachandra, and Davis 2014) that can contribute to costs of obtaining new patents.

According to one leading patent attorney, patenting expenses can include: the costs of legal help with a patent search; legal fees associated with filing any provisional application and a non-provisional application; USPTO filing fees; and the costs of professional drawings. The attorney fees just for filing a non-provisional application can range from $5,000 to $16,000, not including any of the other associated costs (Quinn 2015).

- Support efforts to improve gender diversity in STEM.

  Hunt et al (2012) found that gender segregation within STEM fields accounts for 31 percent of the commercial patenting gap, so initiatives that encourage inclusion of women and girls into STEM, at all levels of the pipeline, can contribute to closing the gender patenting gap.

- Encourage women's cultivation of industry contacts and higher-power networks.

  Meng (2016), using data from a national study of academic scientists in the United States, finds that having industry contacts is the most influential factor in patenting involvement for women. Interview studies with life scientists find that women have smaller and lower-level professional networks than men (Ding, Murray, and Stuart 2006; Murray and Graham 2007). Employers, supervisors, and mentors can take affirmative steps to open high-powered networks to women, and to value time spent developing such contacts in evaluating women's performance.

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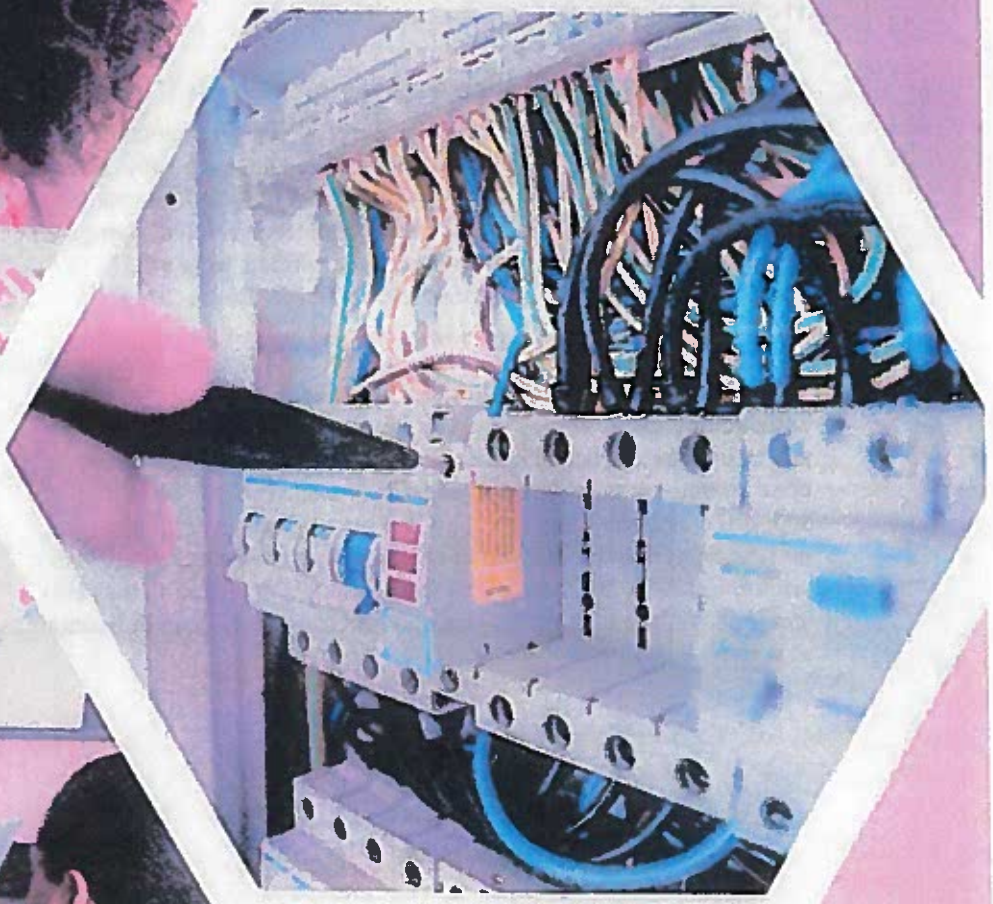
Closing the Gender Gap in Patenting, Innovation, and Commercialization



Programs Promoting Equity and Inclusion

INSTITUTE FOR WOMEN'S POLICY RESEARCH

About This Report

This report profiles programs designed to increase gender diversity in patenting, innovation, and entrepreneurship in a variety of settings, including academic institutions, corporations, and government and nonprofit organizations. Drawing on a program scan and interviews of selected program leaders and participants, it describes seven programs in depth and highlights how they were developed, their successes and lessons learned, and their results in promoting gender diversity. The report aims to provide an accessible resource that can help others seeking to increase the number of women who patent and commercialize their inventions. It is one of a series of IWPR research reports examining the underrepresentation of women, including women of color, among patent holders and in science, technology, engineering, and mathematics (STEM) disciplines and occupations. The report was produced with support from Qualcomm, Inc.

About the Institute for Women's Policy Research

The Institute for Women's Policy Research (IWPR) conducts and communicates research to inspire public dialogue, shape policy, and improve the lives and opportunities of women of diverse backgrounds, circumstances, and experiences. The Institute's research strives to give voice to the needs of women from diverse ethnic and racial backgrounds across the income spectrum and to ensure that their perspectives enter the public debate on ending discrimination and inequality, improving opportunity, and increasing economic security for women and families. The Institute works with policymakers, scholars, and public interest groups to design, execute, and disseminate research and to build a diverse network of individuals and organizations that conduct and use women-oriented policy research. IWPR's work is supported by foundation grants, government grants and contracts, donations from individuals, and contributions from organizations and corporations. IWPR is a 501(c)(3) tax-exempt organization that also works in affiliation with the Program on Gender Analysis in Economics at American University.

IWPR #C471

Closing the Gender Gap in Patenting, Innovation, and Commercialization: Programs Promoting Equity and Inclusion

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Executive Summary

Greater diversity of perspectives among inventors and entrepreneurs can speed progress in addressing society's most serious problems. Women and many communities of color, however, remain significantly underrepresented within the innovation ecosystem in the United States. Recent research indicates that women are less likely than men to enter into and advance in the fields of science, technology, engineering, and mathematics, and less likely to patent and commercialize their inventions when they do. As of 2010, only 18.8 percent of all patents granted had at least one woman inventor listed.

A number of programs across the nation are addressing the gender gap in patenting, innovation, and commercialization. This report describes some of these efforts, based on a scan of programs and in-depth interviews with leaders of notable programs across the country. IWPR queried dozens of experts to identify promising programs, and conducted interviews with program leaders and participants to identify and profile a subset of seven programs selected according to criteria related to program longevity, outcomes tracking, and other factors.

Featured Programs

The programs profiled in this report were all created to address female underrepresentation in innovation. They operate in different settings (e.g., universities, nonprofit organizations, corporations), target different audiences (e.g., professional women, women faculty, women patent holders), and often tailor their approaches to address specific challenges or issues experienced in their communities. The programs engage in a variety of activities, such as helping participants broaden their networks or obtain funding, connecting them to mentors, offering women individual guidance to help them advance in the patenting or commercialization process, and educating the broader community on the importance of increasing diversity in patenting, innovation, and commercialization. The seven programs selected for in-depth interviews are listed below.

1. **Accelerating Women And underRepresented Entrepreneurs (AWARE)** program is located at the University of Illinois Urbana-Champaign. AWARE is a program for faculty and graduate students who are interested in patenting and commercializing their innovations. The program hosts seminars and networking events at the University to connect participants with mentors and investors and also employs an Entrepreneur in Residence (EIR) who works one-on-one with participants to guide them through the patenting and commercialization process. The program also provides small proof of concept and/or seed grants to participants.

2. **BioSTL's Bioscience & Entrepreneurship Inclusion Initiative** works to increase diversity in the bioscience technology industry in the greater St. Louis region. The Inclusion Initiative partners with other organizations and companies to host seminars and workshops in addition to working one-on-one with innovators to connect them with resources and individuals to help them commercialize their innovations.

3. **Empowering Women In Technology Startups (EWITS®)** is a 10-week program offered at the University of Florida. It is a hands-on experiential learning program focused on helping professional women understand the process of commercializing an invention. The women in the program are split into teams and asked to develop a business model for a real technology (not their own) and develop the elements of a company to commercialize the innovation.

4. **MyStartupXX** is a student accelerator program run out of the Rady School of Management at the University of California San Diego. This semester-long program supports innovators who are

working to commercialize an invention and helps them build a business plan, develop a pitch plan for investors, and develop a working prototype of their invention.

5. **REACH for Commercialization™** works with female faculty, postdoctoral researchers, and graduate students at Ohio State University. The program runs a series of four workshops that discuss different aspects of the patenting and commercialization process in an academic setting. REACH also hosts networking events that help connect their participants with investors, entrepreneurs, and peers.

6. The U.S. Department of Energy's (DOE) Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) **Phase 0 Assistance Program** strives to increase diversity in DOE SBIR/STTR programs by helping women- and minority-owned small businesses field competitive applications for DOE SBIR/STTR Phase I awards. The program works one-on-one with participants, helping them develop their applications and connecting them with business mentors and industry experts who provide assistance on a range of topics.

7. **STEM to Market** is a two-part program run by the Association for Women in Science with cohorts based in three locations: Washington, DC; Chicago, Illinois; and the San Francisco Bay Area. The program provides entrepreneurial training and support to women working in science, technology, engineering, and math (STEM) fields, and works with key decision makers, investors, and funders to increase innovation and entrepreneurship among diverse groups of women through systems change.

The programs receive funding from an array of sources including the federal government, universities, and private foundations. Many have no dedicated staff or are run by one staff member; some rely on volunteers who donate their time and expertise.

Strategies for Promoting Women's Participation and Success in Patenting, Innovation, and Commercialization

Though each program has taken a different approach, some common strategies for increasing women's patenting, commercialization, and entrepreneurship emerged across the interviews.

- **Information-sharing and education**
  Education about patenting and commercialization is a significant component of programs profiled for this report. Educational activities and resources were provided in a variety of ways, including through a structured curriculum, one-on-one advice, and seminar-based instruction. A majority of the program leaders interviewed said that women in their communities are less likely than men to hear about the possibilities and benefits of pursuing patenting and entrepreneurship, and that women are less likely to view these activities as an achievable part of their career paths.

- **Network building and mentorship**
  All the programs profiled seek to help women cultivate the networks and sponsors needed to take an innovation from idea to market. Each program stresses the importance of networking among peers, which allows participants to learn from others' challenges, troubleshoot their own issues, and receive advice. In addition, the programs help participants network and develop connections with investors and venture capital firms who might assist them in securing funding. They use a variety of strategies to help women build networks, including hosting symposiums and

workshops, bringing experts into the program, and connecting innovators to mentors.

- **Changing the culture**
  The programs featured in this report actively work to foster cultural change by building awareness about the importance of diversity in patenting, commercialization, and entrepreneurship across a broad set of audiences, including students, faculty, and staff at universities; stakeholders in local communities; and investors. For example, BioSTL's Inclusion Initiative works with partner organizations and institutions to change the culture of the bioscience industry in St. Louis, and STEM to Market offers tools and interventions to help investors develop more inclusive policies and practices.

- **Tracking outcomes**
  Each program either formally or informally tracks its outcomes, and all measure their program's success at achieving concrete program goals. For example, EWITS® and REACH survey their participants to track experiences and outcomes, and EWITS® was evaluated by a Ph.D. student for their dissertation. Other programs have collected stories and anecdotes from participants to illustrate their program impacts for individual women.

Suggestions for Program Development and Support Based on Leader Interviews

The report offers insights on strategies for effective program development and implementation derived from the program leader interviews. In conceiving and planning their programs, for example, leaders said they spent considerable time and energy identifying and understanding their target audience and the kinds of partnerships and resources that would best serve them. Program leaders stressed the importance of defining a realistic scope of work by identifying key gaps in existing supports, working with other programs in the community, and avoiding duplication of other efforts.

The program leaders interviewed also emphasized the importance of ensuring stakeholder buy-in—such as from university leadership for programs in university settings—and establishing relationships with partners and other organizations within local communities. Such relationships help to ensure that the program receives ongoing support, both financial and otherwise, and connects program leaders to individuals and networks needed to run each program. Data on outcomes and feedback from participants can help programs garner support from stakeholders and enable them to make course corrections over time, continuously increasing their effectiveness.

The programs featured in the report often struggle to secure adequate funding to fully meet their programmatic goals. Almost all expressed a desire for additional staffing that they could not currently afford. The sustainability and scalability of programs, like the ones profiled in this report, would require greater investments from philanthropists, corporations, and other stakeholders to allow programs to compensate their leadership and expert participants for their time and efforts.

Rigorous external program evaluations, potentially comparing different approaches, could help ensure that organizations and supporters are investing in efforts that will make a measurable difference in closing the gender gap in patenting, innovation, and commercialization.

When asked how greater diversity would affect women and society, those interviewed for this study responded unequivocally: it would make the world a better place. Increasing diversity in inventing and entrepreneurship would help ensure that innovation addresses a more diverse set of challenges and that higher quality products and services are developed to tackle society's pressing issues.

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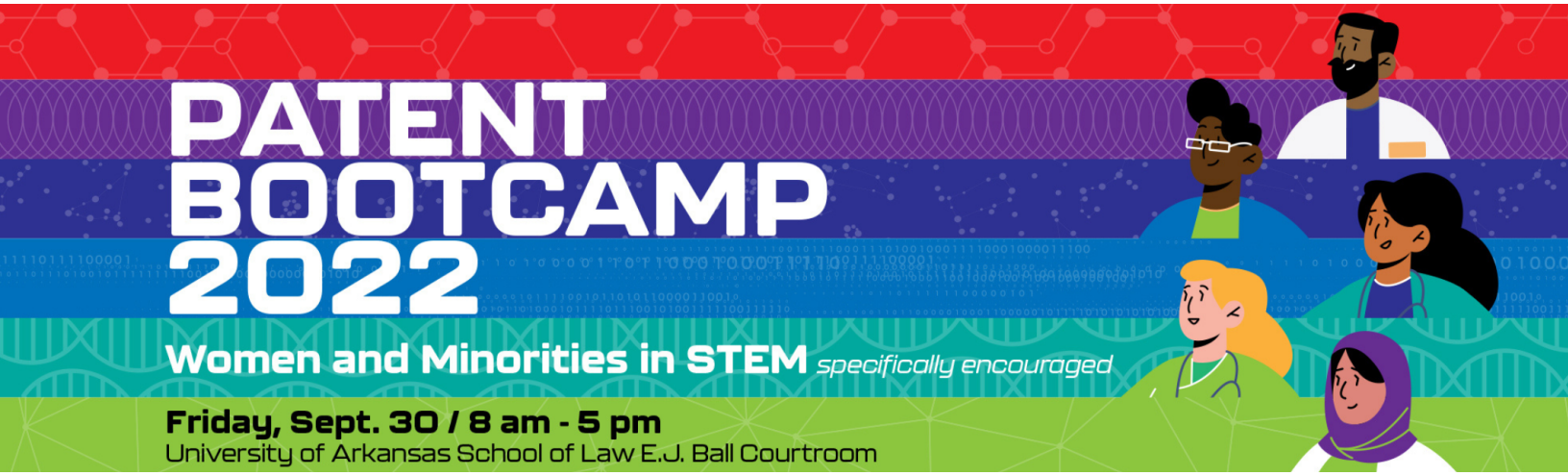

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