

**LOST EINSTEINS: LACK OF DIVERSITY IN PATENT
INVENTORSHIP AND THE IMPACT ON
AMERICA'S INNOVATION ECONOMY**

HEARING

BEFORE THE
SUBCOMMITTEE ON COURTS,
INTELLECTUAL PROPERTY, AND THE INTERNET
OF THE

COMMITTEE ON THE JUDICIARY
HOUSE OF REPRESENTATIVES

ONE HUNDRED SIXTEENTH CONGRESS

FIRST SESSION

—————
MARCH 27, 2019
—————

Serial No. 116-12

Printed for the use of the Committee on the Judiciary



Available <http://judiciary.house.gov> or www.govinfo.gov

—————
U.S. GOVERNMENT PUBLISHING OFFICE

36-359

WASHINGTON : 2019

COMMITTEE ON THE JUDICIARY

JERROLD NADLER, New York, *Chairman*

ZOE LOFGREN, California	DOUG COLLINS, Georgia,
SHEILA JACKSON LEE, Texas	<i>Ranking Member</i>
STEVE COHEN, Tennessee	F. JAMES SENSENBRENNER, Jr.,
HENRY C. "HANK" JOHNSON, Jr., Georgia	Wisconsin
THEODORE E. DEUTCH, Florida	STEVE CHABOT, Ohio
KAREN BASS, California	LOUIE GOHMERT, Texas
CEDRIC L. RICHMOND, Louisiana	JIM JORDAN, Ohio
HAKEEM S. JEFFRIES, New York	KEN BUCK, Colorado
DAVID N. CICILLINE, Rhode Island	JOHN RATCLIFFE, Texas
ERIC SWALWELL, California	MARTHA ROBY, Alabama
TED LIEU, California	MATT GAETZ, Florida
JAMIE RASKIN, Maryland	MIKE JOHNSON, Louisiana
PRAMILA JAYAPAL, Washington	ANDY BIGGS, Arizona
VAL BUTLER DEMINGS, Florida	TOM McCLINTOCK, California
J. LUIS CORREA, California	DEBBIE LESKO, Arizona
MARY GAY SCANLON, Pennsylvania,	GUY RESCHENTHALER, Pennsylvania
<i>Vice-Chair</i>	BEN CLINE, Virginia
SYLVIA R. GARCIA, Texas	KELLY ARMSTRONG, North Dakota
JOE NEGUSE, Colorado	W. GREGORY STEUBE, Florida
LUCY McBATH, Georgia	
GREG STANTON, Arizona	
MADELEINE DEAN, Pennsylvania	
DEBBIE MUCARSEL-POWELL, Florida	
VERONICA ESCOBAR, Texas	

PERRY APELBAUM, *Majority Staff Director & Chief Counsel*
BRENDAN BELAIR, *Minority Staff Director & Chief Counsel*

SUBCOMMITTEE ON COURTS, INTELLECTUAL PROPERTY, AND THE INTERNET

HENRY C. "HANK" JOHNSON, Jr., Georgia, *Chair*

LOU CORREA, California, *Vice-Chair*

THEODORE E. DEUTCH, Florida	MARTHA ROBY, Alabama,
CEDRIC RICHMOND, Louisiana	<i>Ranking Member</i>
HAKEEM JEFFRIES, New York	STEVE CHABOT, Ohio
TED LIEU, California	JIM JORDAN, Ohio
GREG STANTON, Arizona	JOHN RADCLIFF, Texas
ZOE LOFGREN, California	MATT GAETZ, Florida
STEVE COHEN, Tennessee	MIKE JOHNSON, Louisiana
KAREN BASS, California	ANDY BIGGS, Arizona
ERIC SWALWELL, California	GUY RESCHENTHALER, Pennsylvania
	BEN CLINE, Virginia

JAMIE SIMPSON, *Chief Counsel*
THOMAS STOLL, *Minority Chief Counsel*

CONTENTS

MARCH 27, 2019

OPENING STATEMENTS

	Page
The Honorable Henry C. Hank Johnson, Jr., a Representative in the Congress from the State of Georgia, and Chairman, Subcommittee on Courts, Intellectual Property, and the Internet	1
The Honorable Martha Roby, a Representative in the Congress from the State of Alabama, and Ranking Member, Subcommittee on Courts, Intellectual Property, and the Internet	3
The Honorable Jerrold Nadler, a Representative in the Congress from the State of New York, and Chairman, Committee on the Judiciary	4

WITNESSES

The Honorable Michelle Lee, Former Under Secretary of Commerce for Intellectual Property and Director U.S. Patent and Trademark Office	
Oral Testimony	13
Prepared Statement	16
Professor Lisa D. Cook, Associate Professor of Economics and International Relations, Director, American Economic Association Summer Training Program, Department of Economics, Michigan State University	
Oral Testimony	21
Prepared Statement	23
Professor Ayanna Howard, Professor and Chair, School of Interactive Computing, Georgia Institute of Technology	
Oral Testimony	40
Prepared Statement	42
Ms. Susie Armstrong, Senior Vice President, Engineering, Qualcomm, Inc.	
Oral Testimony	45
Prepared Statement	47

LETTERS, STATEMENTS, ETC., SUBMITTED FOR THE HEARING

Prepared statement for the record from the Honorable Doug Collins, a Representative in the Congress from Georgia, and Ranking Member, Committee on the Judiciary	73
--	----

APPENDIX

MATERIAL SUBMITTED FOR THE HEARING RECORD

Questions to witnesses for the Record from the Honorable Martha Roby, a Representative in the Congress from the State of Alabama, and Ranking Member, Subcommittee on Courts, Intellectual Property, and the Internet	78
Response to questions for the Record from The Honorable Michelle Lee, Former Under Secretary of Commerce for Intellectual Property and Director U.S. Patent and Trademark Office	80
Response to questions for the Record from Professor Lisa D. Cook, Associate Professor of Economics and International Relations, Director, American Economic Association Summer Training Program, Department of Economics, Michigan State University	83

IV

	Page
Response to questions for the Record from Professor Ayanna Howard, Professor and Chair, School of Interactive Computing, Georgia Institute of Technology	87
Response to questions for the Record from Ms. Susie Armstrong, Senior Vice President, Engineering, Qualcomm, Inc.	88

**LOST EINSTEINS: LACK OF DIVERSITY IN
PATENT INVENTORSHIP AND THE IMPACT
ON AMERICA'S INNOVATION ECONOMY**

WEDNESDAY, MARCH 27, 2019

HOUSE OF REPRESENTATIVES

SUBCOMMITTEE ON COURTS, INTELLECTUAL PROPERTY, AND THE
INTERNET, COMMITTEE ON THE JUDICIARY

WASHINGTON, DC.

The subcommittee met, pursuant to call, at 10:00 a.m., in Room 2141, Rayburn House Office Building, Hon. Henry C. "Hank" Johnson, Jr. [Chairman of the Subcommittee] presiding.

Present: Representatives Johnson of Georgia, Nadler, Deutch, Jeffries, Stanton, Lofgren, Correa, Roby, Chabot, Jordan, Reschenthaler, and Cline.

Staff Present: Jamie Simpson, Chief Counsel; David Greengrass, Senior Counsel; Madeline Strasser, Chief Clerk; Rosalind Jackson, Professional Staff Member; Thomas Stoll, Minority Chief Counsel; and Andrea Woodard, Minority Professional Staff Member.

Mr. JOHNSON of Georgia. Good morning, everyone. The subcommittee will come to order. Without objection, the Chair is authorized to declare recesses of the Subcommittee at any time.

We welcome everyone to this morning's hearing on "Lost Einsteins: Lack of Diversity and Patent Inventorship and the Impact on America's Innovation Economy."

I will now recognize myself for an opening statement.

Good morning, everyone. Welcome to the first hearing in the 116th Congress of the House Judiciary Committee's Subcommittee on Courts, Intellectual Property, and the Internet. I am proud that we begin our Committee's work on a topic that is of paramount importance to the future of our country, ensuring that everyone has the same equality of opportunity to participate in our Nation's innovation economy, a right so important that it is guaranteed by the U.S. Constitution. Our long-standing commitment to the innovation economy has made the United States a world super power. We have a duty to ensure that everyone has an equal chance to participate fairly in this vibrant part of our economy without misuse or abuse. Women, minorities, and other underrepresented groups of people should not be excluded from the patent system or face unnecessary barriers. Moreover, if we are to stay the world leader, we cannot afford to leave innovative talent behind.

As the Subcommittee on Intellectual Property, we come at this question from a particular angle, looking at who is named as inven-

tors on U.S. patents. Because the first Patent Act passed in 1790, shortly after this country's founding, we have a large documentary history of data to use. The good news is that this data shows that the patent system has long played a role in enabling marginalized but ambitious and inventive people the ability to participate in the innovation economy through the receipt of a patent. For example, while the majority of African Americans were still enslaved, the first patent believed to be awarded to an African American was in 1821 to Thomas L. Jennings for his new method of dry cleaning clothes. Another example: well before women obtained the right to vote, the first patent believed to be awarded to a woman was in 1793 to Hannah Wilkinson Slater for her new method of producing cotton sewing thread.

The bad news, however, is that, in modern times, data shows that there has not been a good track record of progress towards having equal protection from these groups in the patent system. The USPTO's recent report on gender diversity shows that, even today, the total number of inventors who are women in the United States is only 12 percent. It has not substantially increased over the last 15 years.

For other underrepresented groups, collecting data on patenting has been more challenging. The USPTO does not collect demographic data on who applies for patents. In the gender space, researchers have often relied upon algorithms to estimate if an inventor's name is male or female. This is not a perfect approach, but it is even harder for researchers to associate inventor data with other demographics such as race or ethnicity.

I am pleased that one of our witnesses today, Professor Lisa Cook, has nonetheless conducted research on how many African Americans are named as inventors on patents. This body of work, including Professor Cook's research, documents that there is underrepresentation here as well.

I look forward as well to hearing from the rest of the accomplished witnesses on this panel about their own stories of being a woman or minority in fields where they might have had few peers who look like them. I want to understand the challenges they faced and their ideas for improvement and, indeed, where they have already taken steps to improve participation, like former USPTO director Michell Lee's All in STEM initiative to address gender diversity.

Congress has certainly taken notice of this issue before. I was proud in the last Congress to work with the gentleman from Ohio, Mr. Chabot, and other Members of this Committee on the passage of the SUCCESS Act, which called for the USPTO to put together a comprehensive survey on patenting by women, minorities, veterans, and low-income individuals.

But it also seems that there is much more that we can do, and I hope to learn more about potential steps we can take from our witnesses as well.

I have often heard, for example, that many from underrepresented groups leave STEM fields once they are in them because they find themselves in an unwelcoming work environment. Research shows that this is just one of many reasons why there might

be underrepresentation. And there is no doubt that this is a complicated issue, but it is also critically important.

I think the title of the hearing speaks directly to this, “Lost Einsteins.” When women and minorities are not in the innovation pipeline or if they leave because they don’t feel welcome, we are losing sources for increased innovation. We are leaving talent on the table, and, frankly, we are leaving talent behind. The lack of diversity calls into question whether there is an equal opportunity for all of these underrepresented groups to live up to their full potential if being an inventor or an innovator is what they want to do. I believe we can and should do better.

Thank you, and I look forward to your testimony.

And it is now my pleasure to recognize the Ranking Member of the Subcommittee, the gentlewoman from Alabama, Mrs. Roby, for her opening statement.

Mrs. ROBY. I thank the Chairman, and I thank all of the witnesses for being here with us today.

Patents are one of the key drivers of innovation in this country. And by protecting inventions from theft, they provide the incentive necessary for individual inventors and small and large companies alike to invest the time and resources needed to develop lifesaving and life-enhancing products and helps the United States maintain its position in the world as the world’s undisputed innovation leader.

To realize our full potential, America needs to tap into the inventive genius found in the great minds of all our citizens, great minds like that of NASA chemist Barbara Askins, a graduate of the University of Alabama and a Huntsville resident, who, in 1978, was recognized as the first national inventor of the year. Ms. Askins invented the autoradiograph technology to create very high contrast images used in space photography and to vastly improve X-ray images. She was the sole inventor on the project and alone received a patent.

Unfortunately, while U.S. women earn almost half of all the undergraduate degrees in science and engineering and 39 percent of all new Ph.D.s in this field, even today they are not receiving a proportionate share of patents. The USPTO’s recent study on the issue found that, in 2016, a woman was named on only 21 percent of all patents granted, and women inventors made up only 12 percent of all inventors. It concluded that gains in participation in science and engineering occupations and entrepreneurship are not leading to significant increases in women inventors receiving patents. We have to do a better job of unlocking this potential to both help all of our citizens enjoy the fruits of their labor while also helping the U.S. to maintain its position as the technology leader.

To that end, just last year, this committee passed a bill that was signed into law with that goal in mind. The SUCCESS Act instructed the USPTO to work with the Small Business Administration to study the issue and report to Congress on recommendations for promoting the participation of women, minorities, and veterans both in entrepreneurship and in applying and obtaining patents. I look forward to receiving that report and its recommendations.

Today, we all look forward to hearing from our esteemed witnesses on their experiences with the patent system and how our

great female minds value the patent system but have experienced challenges fully participating in it and their recommendations on what can be done to promote the creation of new inventions by women and minorities in the patenting of those inventions.

So, again, I thank you, Mr. Chairman.

And I thank you again, all of the witnesses, for appearing here today. And we look forward to not only your testimony but having the opportunity to engage with each of you.

Thank you. I yield back.

Mr. JOHNSON of Georgia. Thank you, Representative Roby.

I am now pleased to recognize the Chairman of the Full Committee, the gentleman from New York, Mr. Nadler, for his opening statement.

Chairman NADLER. Thank you, Mr. Chairman. And thank you for holding this important hearing to investigate why there is a lack of diversity among patent holders in the United States.

Unlike many issues in Congress, there is bipartisan agreement on the need to protect American intellectual property and to foster innovation. So many entrepreneurs today rely on intellectual property to fuel their businesses, and these businesses are increasingly the engine of economic growth in our Nation. Statistics underscore how important IP is to our economy.

In 2016, the U.S. Commerce Department reported that IP-intensive industries contributed more than \$6 trillion of value to the U.S. gross domestic product. With so much of our economy dependent on IP-related industries, it is critical that everyone share in the economic opportunities that these industries offer. Promoting greater inclusion in the innovation ecosystem is good for our economy, good for underserved communities, and good for all Americans.

Unfortunately, research shows that many segments of our society continue to be underrepresented as inventors on patents. The U.S. Patent and Trademark Office's recent report on gender diversity finds that women are very much underrepresented as patent holders. Analyzing data on U.S. patents granted between 1976 and 2016, the report shows that women comprised only 12 percent of the named inventors on patents in 2016, representing an increase of only 2 percent over the last 16 years. Clearly, whatever progress is being made is happening far too slowly, and much needs to be done to promote greater gender diversity among inventors.

Moreover, the USPTO's research shows that the underrepresentation in patenting is not solely a function of women entering science and engineering fields at lower rates than men, although that continues to be a problem. In 2015, women comprised nearly 28 percent of the total science and engineering workforce but only 12 percent of inventors granted patents.

Even when women are in the fields most associated with patenting, they are patenting at the same rate as their male colleagues. This shows that the gender gap in patenting is likely to be caused by many factors, not just because there are fewer women scientists and engineers. Unfortunately, because the USPTO does not collect demographic data on inventors, it has been more challenging to study racial and ethnic diversity among U.S. inventors.

Nonetheless, the studies that have been done also show significant disparities in patenting rates along racial and ethnic lines.

I hope to learn more from the witnesses about how we can improve data collection on this issue and learn more about the causes of these disparities since the first step toward solving the problem is understanding its scope and root causes. For example, one study found that exposure to innovation during childhood has a major impact on an individual's desire to become an inventor, that a child's likelihood of becoming an inventor increases if he or she grows up in one of our country's technology hubs. I am proud that New York City, where my district is located, counts as one of these hubs, and I hope we can figure out how to replicate this sort of inventive environment elsewhere throughout the United States.

As the title of this hearing suggests, there may be many lost Einsteins in our country. The loss in economic value and innovation to say nothing of the missed opportunities for these individuals who are left behind presents a significant challenge that must be addressed.

I look forward to hearing from our witnesses not just about the barriers that underrepresented groups may face in the innovation ecosystem but also about how we can begin to address this serious problem. We can and we must do better, and that starts with hearings like this.

Thank you, Mr. Chairman. I yield back the balance of my time.
[The statement of Chairman Nadler follows:]

**Statement of the Honorable Jerrold Nadler, Chairman,
Committee on the Judiciary, for the
Hearing on “Lost Einsteins: Lack of Diversity in Patent
Inventorship and the Impact on America’s Innovation
Economy,”
Before the Subcommittee on Courts, Intellectual Property, and
the Internet**

**Wednesday, March 27, 2019, at 10:00 a.m.
2141 Rayburn House Office Building**

Thank you, Mr. Chairman, and thank you for holding this important hearing to investigate why there is a lack of diversity among patent holders in the United States.

Unlike many issues in Congress, there is bipartisan agreement on the need to protect American intellectual property and to foster innovation. So many entrepreneurs today rely on intellectual property to fuel their businesses, and these businesses are increasingly the engine of economic growth in our nation.

Statistics underscore how important IP is to our economy. In 2016, the U.S. Commerce Department reported that IP-intensive industries contributed more than \$6 trillion of value to the U.S. gross domestic product. With so much of our economy dependent on IP-related industries, it is critical that everyone share in the economic opportunities these industries offer. Promoting greater inclusion in the innovation ecosystem is good for our economy, good for underserved communities, and good for all Americans.

But unfortunately, research shows that many segments of our society continue to be underrepresented as inventors on patents.

The U.S. Patent and Trademark Office's recent report on gender diversity finds that women are very much underrepresented as patent-holders.

Analyzing data on U.S. patents granted between 1976 and 2016, the report shows that women comprised only 12% of the named inventors on patents in 2016, representing an increase of only 2% over the last 16 years. Clearly, whatever progress is being made is happening far too slowly, and much needs to be done to promote greater gender diversity among inventors.

Moreover, the USPTO's research shows that the underrepresentation in patenting is not solely a function of women entering science and engineering fields at lower rates than men, although that continues to be a problem. In 2015, women comprised nearly 28% of the total science and engineering workforce, but comprised only 12% of inventors.

Even when women are in the fields most associated with patenting, they are not patenting at the same rate as their male colleagues. This shows that the gender gap in patenting is likely to be caused by many factors, not just because there are fewer women scientists and engineers.

Unfortunately, because the USPTO does not collect demographic data on inventors, it has been more challenging to study racial and ethnic diversity among U.S. inventors. Nonetheless, the studies that have been done also show significant disparities in patenting rates along racial and ethnic lines. I hope to learn more from the witnesses about how we can improve data collection on this issue and learn more about the causes of these disparities, since the first step towards solving the problem is understanding its scope and root causes.

For example, one study found that exposure to innovation during childhood has a major impact on an individual's desire to become an inventor and that a child's likelihood of becoming an inventor increases if he or she grows up in one of our country's technology hubs. I am proud that New York City, where my district is located, counts as one of these hubs and I hope we can figure out how to replicate this sort of inventive environment elsewhere throughout the United States.

As the title of this hearing suggests, there may be many "Lost Einsteins" in our country. The loss in economic value and innovation, to say nothing of the missed opportunities for these individuals who are left behind, presents a significant challenge that must be addressed.

I look forward to hearing from our witnesses, not just about the barriers that underrepresented groups may face in the innovation ecosystem, but also about how we can begin to address this serious problem.

We can—and we must—do better, and that starts with hearings like this.

Thank you, and I yield back the balance of my time.

Mr. JOHNSON of Georgia. Thank you.

I will now introduce today's witnesses.

Michelle K. Lee is the Former Director of the U.S. Patent and Trademark Office and Former Under Secretary of Commerce for Intellectual Property. In that role, Ms. Lee was the principal advisor to the President through the Secretary of Commerce on domestic and international intellectual property policy matters and is the first woman to serve as the Director of the USPTO in the country's 220-plus-year history. She is also a veteran of Silicon Valley experienced in scaling fast-growing companies with disruptive technologies and an expert in intellectual property. She was the Deputy General Counsel for Google and, before that, worked at the law firm of Fenwick and West LLP. She currently serves as a public company board of directors for alarm.com, a provider of a cloud-based software as a service solution. Before building her legal career, Ms. Lee worked as a computer scientist at Hewlett-Packard research laboratories as well as at the Massachusetts Institute of Technology Artificial Intelligence Laboratory. She holds a B.S. and also an M.S. in electrical engineering and computer science from MIT as well as a J.D. from Stanford law school.

Professor Lisa D. Clark teaches at both James Madison College and in the Department of Economics at Michigan State University. After receiving a B.A. from Spelman College, she was a Marshall Scholar at Oxford University, where she obtained a B.A. in philosophy, politics, and economics. She received a Ph.D. in economics from the University of California at Berkeley and was a Post-doctoral Fellow and Visiting Assistant Professor at the Kennedy School of Government and Deputy Director for Africa research at the Center for International Development at Harvard University. Her current research interests include the economics of intellectual property rights, economic growth, and development, financial institutions and markets, and economic history. Dr. Cook is the author of a number of published articles, books, chapters, and working papers, and has edited and contributed to the Harvard World Economic Forum Global and Africa Competitiveness Reports.

Dr. Ayanna Howard is a Professor and Chair of the School of Interactive Computing at the Georgia Institute of Technology. She is also the Chief Technology Officer of Zyrobotics. She has made significant contributions in the technology areas of artificial intelligence, computer vision, and robotics. Her published research numbers over 250 peer-reviewed publications. Her accomplishments have been highlighted through a number of awards and articles as well as being named an MIT technology review top young innovator and recognized as one of the 23 most powerful women engineers in the world of Business Insider as well as one of the top 50 U.S. women in tech by Forbes. Prior to Georgia Tech, Dr. Howard was a Senior Robotics researcher and a Deputy Manager at NASA's Jet Propulsion Laboratory. Dr. Howard received her B.S. from Brown University, her MSEE from the University of Southern California, her Ph.D. in electrical engineering from the University of Southern California, and her M.A. from Claremont University Drucker School of Management.

Susan M. Armstrong is a Senior Vice President in Engineering at Qualcomm. She started at Qualcomm working on Globalstar and

then early CDMA base station projects. She was a pioneer in bringing internet protocols to the cellular industry resulting in the first web surfing on a cellular phone in 1997 and Qualcomm's commercialization of packet data in 1998. Since then, she has held various leadership positions, first as the head of software engineering in Qualcomm's mobile chipset division and then as the head of worldwide customer customer engineering, the group that integrates and commercializes the company's products and phones and other wireless devices. Recently, Ms. Armstrong has joined Qualcomm's government affairs group, where she brings an engineering and product background to policy work. Prior to joining Qualcomm in 1994, Ms. Armstrong worked for 10 years at the Xerox systems development department and the Xerox Webster Research Center. Ms. Armstrong holds a Bachelor's degree in Computer Science from California Polytechnic State University, San Luis Obispo. And, I hope that I have got that name right. Qualcomm?

Ms. ARMSTRONG. Qualcomm, yes.

Mr. JOHNSON of Georgia. Okay. Thank you.

We welcome all of our distinguished witnesses and thank you all for participating in today's hearing.

Before proceeding with testimony, I hereby remind each witness that all of your written and oral statements made to this Subcommittee in connection with this hearing are subject to penalties of perjury pursuant to 18 U.S.C., section 1001, which may result in the imposition of a fine or imprisonment of up to 5 years or both. Please note that each of your written statements will be entered into the record in its entirety.

Accordingly, I ask that you summarize your testimony in 5 minutes. To help you stay within that time, there is a timing light on your table. When the light switches from green to yellow, you have 1 minute to conclude your testimony. And when the light turns red, it signals your 5 minutes have expired.

Once again, I thank you all for being here.

And, Ms. Lee, you may begin.

Ms. LEE. Good morning.

Mr. JOHNSON of Georgia. And if you would turn on your microphone.

Thank you.

STATEMENTS OF THE HONORABLE MICHELLE K. LEE, FORMER UNDER SECRETARY OF COMMERCE FOR INTELLECTUAL PROPERTY AND DIRECTOR, U.S. PATENT AND TRADEMARK OFFICE; LISA D. COOK, ASSOCIATE PROFESSOR OF ECONOMICS AND INTERNATIONAL RELATIONS, DIRECTOR, AMERICAN ECONOMIC ASSOCIATION SUMMER TRAINING PROGRAM, DEPARTMENT OF ECONOMICS, MICHIGAN STATE UNIVERSITY; AYANNA HOWARD, PROFESSOR AND CHAIR, SCHOOL OF INTERACTIVE COMPUTING, GEORGIA INSTITUTE OF TECHNOLOGY; AND SUSIE ARMSTRONG, SENIOR VICE PRESIDENT, ENGINEERING, QUALCOMM, INC.

STATEMENT OF THE HONORABLE MICHELLE K. LEE

Ms. LEE. Good morning, Chairman Johnson, Ranking Member Roby, and Members of the Subcommittee. It is a pleasure to be

with you here today and thank you for hosting a hearing on such an important topic. Invention is a cornerstone of America's continued economic prosperity and well-being. Our world faces numerous challenges, including global warming, food insecurity, and cybersecurity, but also a number of attractive opportunities, including finding new cures for diseases and providing greater mobility for those with disability.

But solving those problems will require all the talent and all the ingenuity that we can muster. Yet when it comes to technological innovation, we are rowing with one hand behind our back. We have all seen the numbers. The percentage of women who are awarded patents in the U.S. is extremely low, anywhere from 12 to 21 percent, depending upon the study and depending upon how you count. And one recent study indicated that, at this rate, it would take 118 years for us to reach parity in gender in terms of patenting.

Why are the numbers so low? Number one, fewer girls and fewer women pursue STEM careers. And even those that do face high attrition rates. There are a myriad of reasons for this including differences in upbringing, societal expectations, fewer role models, unconscious bias, and even images in the media. Both these factors contribute to the low numbers in terms of women patent inventors.

If you think about it, in order to earn a patent, you have to have a pretty good understanding of your field, the technology, and how a product or process works. And then you have to come up with an insight that no one else has ever thought about on how to make it better, faster, cheaper, more cost-effective. And these insights don't often come to you in your first several years of practice in the profession. So, to the extent that women are leaving STEM careers earlier and at faster rates, that negatively impacts their patenting numbers.

Another contributing factor is the way organizations solicit invention disclosures. Based upon my experiences as in-house counsel, there are generally two ways: first, as a voluntary inventor-initiated submission and, second, as a manager-initiated brainstorming session inviting the relevant team members to brainstorm to harvest the inventions. The latter method, manager-initiated brainstorming sessions, tended to be much more productive in terms of getting invention disclosures from women.

Left to their own devices, women tended to discount the novelty and usefulness of their inventions and were less willing to dedicate the time to submit an invention disclosure and to process the patent application and viewed such activities as extracurricular professional activities. This has implications on our economy. IP-intensive industry support one-quarter of all jobs in the U.S. and make up one-third of our gross domestic product.

So what can we do? Personally, as a woman who has spent her career in tech and as the first woman head of the United States Patent and Trademark Office in our country's 200-plus-year history, I felt a heightened calling to address some of the problems I had seen. This led me to launch, as Chairman Johnson said, the first All-in-STEM initiative at the PTO. Its purpose: to encourage more girls and more women to pursue STEM education so that they could become inventors, STEM leaders, and entrepreneurs.

Programs included camp invention to teach our kids to design and build and create; a Girl Scout intellectual property patch to teach our young girls about IP and invention; workshops for women inventors and entrepreneurs so that they know of the resources and they have the support they need to carry out their work.

But there are ways that all of us can contribute. In-house patent counsel can measure and track the relevant statistics and be thoughtful on how invention disclosures are gathered. We can all be conscious of the disparate ways in which we raise our boys and girls, from the toys they play with, to the activities they pursue, to our expectations of them. We can broaden the image of inventors by sharing stories of successful women inventors, mentoring students in STEM to the maximum interest and potential of these individuals; and, within organizations that hire STEM talent, try to find ways to reduce unconscious bias and to recruit and retain these women and, if in alignment with your organization's priorities, including patenting as a factor to consider in the promotion and tenure decisions.

I am not advocating for gender parity in patenting numbers simply for the sake of achieving parity. Rather, I believe we need to nurture, develop, and harness all of our nation's technical, innovative talents in whatever shape, age, gender, background, or other demographic in which it may come.

As the title of your hearing suggests, our society and world cannot afford to leave behind any future Einsteins.

Thank you. I will be glad to answer your questions.

[The statement of Ms. Lee follows:]

**STATEMENT OF THE HON. MICHELLE K. LEE
FORMER UNDER SECRETARY OF COMMERCE FOR INTELLECTUAL
PROPERTY AND DIRECTOR OF THE U.S. PATENT AND TRADEMARK OFFICE**

Before the

**SUBCOMMITTEE ON COURTS, INTELLECTUAL PROPERTY AND THE
INTERNET COMMITTEE**

on

**“Lost Einsteins: Lack of Diversity in Patent Inventorship and the Impact on America’s
Innovation Economy”**

March 27, 2019

U.S. House of Representatives, Washington, DC

I. Introduction

Chairman Johnson, Ranking Member Roby and Members of the Subcommittee:

Good morning. Thank you for hosting this hearing on the important topic of diversity in patent inventorship and the impact on America’s innovation economy. I am Michelle Lee, the most recent, former Under Secretary of Commerce for Intellectual Property and Director of the United States Patent and Trademark Office, co-founder of ChIPs, a non-profit organization whose mission is to promote the development and retention of women in technology and intellectual property, an electrical engineer and computer scientist by training, an intellectual property lawyer, and a person who spent much of her childhood and career in and around technology. Thank you for inviting me to testify today.

Invention is a cornerstone of America’s continued economic prosperity and well-being. We are confronted by numerous pressing challenges including global warming, food insecurity, outbreaks of disease and cyber security. We also have many exciting opportunities such as finding cures for disease, gaining greater understanding of the human genome, replacing fossil fuels with renewable energy and more. Solving these problems requires using all of the talent, insights and ingenuity our society can muster. Yet, when it comes to technological innovation, we are rowing with one hand tied behind our back.

II. The Numbers

We have all seen the numbers on diversity and patent inventorship. In a recent report published by the United States Patent and Trademark Office,¹ which is consistent with other similar studies, there are a few key take-aways:

¹ See <https://www.uspto.gov/sites/default/files/documents/Progress-and-Potential.pdf>.

1. the vast majority of patents go to men;
2. while the numbers have been gradually improving, the percentage of patents granted to unique women inventors was only 12% in 2016; and
3. despite increases in the number of women in science, technology, engineering and math (STEM) fields, women inventor rates remain significantly below their share of science and engineering jobs.

III. Why?

There are numerous reasons for this gender disparity. The first is educational and occupational choices. Fewer girls and women pursue STEM fields when it comes to choosing majors in college and as careers than their male counterparts. The net result is women hold about a quarter of STEM jobs despite filling close to half of all jobs in the overall U.S. economy. Studies have found a myriad of reasons for the lower numbers of girls and women in STEM including differences in upbringing, societal expectations, images in the media, and fewer role models.

Furthermore, the attrition rate for women in STEM fields continues to remain high at every level. A 2013 study found that 50% of women working in STEM careers left their field for other occupations in the first twelve years of their career, compared to only 20% of professional women in non-STEM fields. This has impact on the patenting rates. The ability to invent something new, useful and nonobvious requires deep understanding of current technology and then the insight on how to achieve the desired goal faster, cheaper and/or more effectively. These insights may not come to a scientist in his or her first several years as a professional. To the extent women leave STEM careers at faster rates and earlier, there are fewer who remain with the expertise necessary to make the cutting edge innovations that our patent system rewards, thus exacerbating the disparity.

The pipeline and attrition problems of women in STEM are consistent with my observations and experiences growing up and moving through the ranks in my professional career. As a young girl, I had a strong interest in math and science. As I began my STEM journey, the number of boys and girls in my math and science classes was roughly equal and the girls did just as well as the boys, if not better. When I began studying calculus and advanced calculus in high school, the numbers of girls steadily decreased. By the time I went to college at MIT, the percentage of women who chose my selected major of electrical engineering and computer science was a small minority. Later, as a graduate student at the MIT Artificial Intelligence Lab, I was one of a few number of women in the program.

My own passion for technology and innovation led me to later study and practice intellectual property law; I wanted to help our most innovative inventors protect and commercialize their inventions. But as I joined the high stakes and technical world of litigating patents, the number

of women in our chosen field was again visibly small. So throughout my career in tech, I've often been one of a small number of women in the room, and an even smaller number at the table.

Another factor that might contribute to the gender disparity may be the way organizations solicit and generate invention disclosures from employees in order to submit and obtain patents. Based upon my experience as in-house counsel and as a patent attorney in private practice, invention disclosures were mainly generated through (1) voluntary, inventor-initiated submissions, or (2) periodically-held, manager-initiated, brainstorming sessions involving all the relevant team members on a project. I found the latter method more productive for generating invention disclosures from the women scientists and programmers than the former. The women who participated with their colleagues in manager-mandated brainstorming sessions generally made important contributions to the patent disclosure sessions leading to issued patents. Yet, these same women often did not submit invention disclosures through the patent department's voluntary submission process. In a number of instances, the women discounted the novelty and usefulness of their inventions and seemed less willing to dedicate the time to apply for a patent, viewing it more as an "extracurricular" professional activity.

IV. The Impact

These disparities have important implications for our innovators individually and for society as a whole. For these individual, patents are often crucial in creating and funding a business. As anyone who has watched the TV show "Shark Tank" knows, investors often want to know if you have a patent before they provide funding. According to one study published in 2009, seventy-six percent of venture capital investors consider patents in funding determinations. Funding leads to commercial opportunities for the innovator and job creation for our society.

Further, being named as an inventor on a patent often represents a milestone in a person's own life story. Being an author of a patent is validation of hard work, creativity and a significant professional accomplishment. This accomplishment often leads to enhanced career opportunities such as promotions, tenure, peer recognition, as well as collaboration, commercial and speaking opportunities.

Beyond the implications on the individuals, our society loses when we fail to harness the full innovative talents of our population across all demographics and geographic regions. Having diverse perspectives on teams can lead to more rigorous, productive problem solving, more effective decision making and products better suited to customer needs. And studies have shown the importance of patents to fuel a country's economic growth.

Finally, STEM jobs are attractive -- growing faster (three times faster than non-STEM jobs, according to a Department of Commerce report) and often pay more. Yet, many of our

most innovative companies cannot hire all the technical talent they need and often look overseas for hires. We need to develop and take advantage of all our talent (1) to allow more Americans to share in these attractive job opportunities, and (2) to meet the labor needs and fuel the growth of our innovation economy. The latter is especially important as our country finds itself in an increasingly competitive international landscape and as we look to solve the world's most complex and pressing challenges.

V. What to do?

I believe all of us can play a role in helping develop the full potential of our country's innovative talents. Personally, as a woman in technology, I have felt a heightened calling to address the issues discussed today. My experiences led me in 2005, along with six other women heads of patents and intellectual property from major technology companies, to establish ChIPs (loosely standing for "Chief Intellectual Property" counsel). ChIPs is a non-profit whose goal is to promote the development, mentoring and retention of women in technology and intellectual property. What started as a small gathering of seven women has now grown to over three thousand members worldwide.

Further, as the first woman Under Secretary of Commerce and Director of the USPTO in our country's 200+ year history, I led the launch of the USPTO's "All In STEM Initiative." The purpose of this Initiative is to encourage more girls and women to pursue STEM degrees and careers and to become inventors and innovators for the benefit of our society.

Improving the numbers of women inventors requires a long-term approach and attention and resources at every level. In 1990, the USPTO in collaboration with the non-profit Invent Now started to reach out to girls (and boys) as early as elementary school through such programs as Camp Invention. Each year, more than 100,000 elementary-school-aged kids in all 50 states participate in this week-long, summer camp, where they get hands-on experience on how to design, prototype, build, test and refine a specific device. They also learn about intellectual property rights and contemplate how they might commercialize their creation. The program also gives scholarships to under-represented minorities to participate.

The USPTO also worked with the Girl Scouts and the Intellectual Property Owners Association to create a patch on IP and innovation, an effort I championed during my tenure. To earn the IP patch, the girls had to learn about the fundamentals of patents, trademarks, trade secrets and copyrights, then put their innovative spirits to work to create something. Programs such as this gives girls the skills they need to succeed in the 21st century innovation economy and to become our future inventors and entrepreneurs.

In furtherance of the All in STEM goals, the Agency held workshops for women inventors and entrepreneurs providing information about the basics of intellectual property, how to obtain

such rights and resources offered by the Agency such as the discounts and pro bono services I mentioned earlier. And, to broaden the image of what an inventor looks like, the USPTO created and distributed to school children inventor “baseball” cards, highlighting the stories of some of our country’s greatest inventors, specifically including women inventors.

Outside the USPTO, there is a role for all of us to play in helping develop and grow our full innovative talent. First, measuring and tracking progress on the relevant statistics within our organizations where innovations occur (whether universities, companies, research institutions or governmental agencies) is a good first step. Second, being conscious of the disparate ways we raise our boys and girls – from the toys they play with, to the activities they pursue, to our expectations of them. Third, broadening the image of inventors for all our children, by sharing stories of successful women innovators and, with one’s buying power, encouraging the media to do the same. Fourth, mentoring (something all of us can do) helps. Each of us has the ability to spark an interest in a student, at any age, in science and technology and to help support her or his interest in, and development of, their maximum potential in STEM. Fifth, within each of our organizations, working on ways to reduce unconscious bias and to recruit, retain and provide support networks for women and other under-represented minorities in the STEM fields. This does not entail favoring one group over another, but rather giving someone who might not otherwise have the chance to prove themselves the opportunity to do so. Sixth, if in alignment with an organization’s priorities, including patenting in tenure and promotion decisions, offering clear guidance on how such activities are weighed and providing support and training for such endeavors (e.g., training on patents and the patent process). These are just a few steps that may be taken.

To be clear, I am not advocating for gender parity in the patenting numbers merely for the sake of achieving parity. However, I do believe we need to encourage, develop to its maximum potential and harness all of our nation’s innovative talent, in whatever size, gender, age, color or background it may come, for the benefit of our society and world.

Thank you for the opportunity to provide comments to the Committee. I would be happy to answer any questions.

Mr. JOHNSON of Georgia. Thank you.
Professor Cook, you may begin.

STATEMENT OF LISA D. COOK

Ms. COOK. Chairman Johnson, Ranking Member Roby, and eminent Members the Committee, thank you for the opportunity to testify today about “Lost Einsteins: Lack of Diversity and Patent Invention and the Impact on America’s Economy.”

While we have my cousin, Percy Lavon Julian, to thank for cortisone, which he developed in the 1950s, it was difficult living and being an African American inventor at that time. His home in Oak Park, Illinois, was fire-bombed twice. We as a society have made progress since that time, but invention and innovation could be more inclusive and beneficial to everyone as a result.

Unequal access to invention and innovation can lead to sub-optimal outcomes for individuals and for the economy as a whole. My research with Kongcharoen offers evidence that women and underrepresented minorities are less likely to participate in invention and innovation at each stage of the inventive process: education and training, the practice of invention, and commercialization of invention.

For women and minorities or would-be participants in this category, this can result in an earnings, income, and employment wealth gap. For the economy as a whole, this can result in lower output and living standards. My and others’ research calculates that the size of the economy could be 3 to 4 percent higher if women and underrepresented minorities were included in the innovative process from beginning to end. That is living standards could be higher for all Americans with a more inclusive innovative economy. My research was the first study to systematically examine racial and gender gaps in invention and innovation.

Allow me to say a little about my and related research. In the early stages of education and training in STEM fields, women and underrepresented minorities lag in participation in nearly every STEM field. In 2014, women were awarded 35 percent of bachelor’s degrees in STEM fields, and 16 to 17 percent of those in computer science and physics, and 23 percent of doctoral degrees in engineering. For African Americans, this was 4 percent of all STEM Ph.D. Degrees.

The recent literature on the gender and racial gap related to participation in STEM fields attempts to identify the factors affecting these differences including the impact of social norms and gender stereotypes, peer effects, and professors’ gender on test scores and college majors.

With respect to practicing invention and creating new knowledge or products, women and African Americans not only engage at generally lower levels than their counterparts, but they also earn less and are employed less than their counterparts.

In 2010, the median salary for Whites was \$72,000, and for African Americans it was \$56,000, which was 78 percent of the median salary for Whites. In 2015, the share had only moved slightly to 79 percent. In 2015, the median salary for men was \$87,000 and \$62,000 for women, which was 71 percent of the median male salary.

Among scientists and engineers, in 2015, African American unemployment was 4.7 percent compared to 2.9 percent for whites. The unemployment rate for African American women is nearly double that of all scientists and engineers and more than double that of White women scientists and engineers. Unemployment for underrepresented minority men was just about 4 percent, which is higher than that for White and Asian men and higher than the average for all scientists and engineers.

A few papers in the last decade have focused on the misallocation of talent among inventors and other high-skilled workers. My research found that coed patent teams are more productive than single sex male or single sex female patent teams. Hunt, Garant, Herman, and Munroe investigate the gender gap for commercialized patents and show that the gender gap among S&E degree holders is due primarily to women's underrepresentation in patent-intensive fields and patent-intensive job tasks. They also find that closing this gap would increase U.S. GDP per capita cap by 2.7 percent.

My 2018 research shows that closing that gap—using more recent data, closing that gap would be 0.6 percent to 4.4 percent higher—GDP would be 4.4 percent higher if more women and African Americans received STEM training and worked in related jobs.

Workplace issues for women and minorities go beyond the opportunity to participate in invention and innovation. Recently, tech workers in the U.S. have demonstrated to protest sexual harassment and misconduct, lack of transparency, including forced arbitration for sexual harassment claims, workplace culture, and pay and opportunity inequality. Among the Forbes list of richest people in the world, 5 of the top 10 derive their wealth primarily from the innovative economy. And nine tech firms last year were valued at roughly \$36 billion.

If the aforementioned losses to GDP were being tolerated, firms, technology offices, and patent teams are not being good stewards of America's human capital and inventive capacity. This is a classic coordination problem and market failure. Public policy can help in the research, analysis, and promotion of diverse participation and inventive activities.

I look forward to talking to you more about finding the lost Einsteins as well as the hidden figures, such as Katherine Johnson.

[The statement of Ms. Cook follows:]

Testimony Prepared for the
Committee on the Judiciary, Subcommittee on Courts,
Intellectual Property, and the Internet Hearing
“Lost Einsteins: Lack of Diversity in Patent Inventorship and the
Impact on America’s Innovation Economy”
Dr. Lisa D. Cook
Michigan State University
March 27, 2019

Chairman Johnson, Ranking Member Roby, and eminent Members of the Committee, thank you for the opportunity to testify today about “Lost Einsteins: Lack of Diversity in Patent Inventorship and the Impact on America’s Innovation Economy.”

Unequal access to invention and innovation can lead to suboptimal outcomes for individuals and for the economy as a whole. My research offers evidence that women and underrepresented minorities are less likely to participate in invention and innovation at each stage of the innovative process – training, the practice of invention, and commercialization of invention. For women and African American participants (or would-be participants), this can result in an earnings, income, employment, and wealth gap. For the economy as a whole, this can result in lower output and living standards. My and others’ research calculates that the size of the economy could be roughly 3 to 4 percent higher if women and underrepresented minorities were included in the innovative process from beginning to end. That is, living standards could be higher for all Americans with a more inclusive innovative economy.

My research with Kongchareon in 2010 was the first study to systematically examine racial and gender gaps in invention and innovation. A current and burgeoning literature elucidates racial and gender gaps at each stage of the innovative process (see Appendix A).

The Gender and Racial Gap in STEM Education and Training

In the early stages of education and training in STEM fields, women and underrepresented minorities lag in participation in nearly each STEM field. This is first evident in the awarding of bachelor's degrees. Even though a higher proportion of total degrees were awarded to women in 2014, in STEM fields women were awarded only 35 percent of the degrees. For advanced degrees, women outnumber men in some STEM fields. In 2016, women received 53 percent of the doctoral degrees in biological science and 71 percent of doctoral degrees in psychology. In other STEM fields, they are barely present. In 2016, women received 23 percent of doctoral degrees in engineering and 17 to 18 percent of those in computer science and physics.

The recent literature on the gender and racial gap related to participation in STEM fields attempts to identify the factors affecting these differences. The older literature documents these gaps within various types of inventors. More recent papers attempt to identify both salient factors and outcomes associated with gender and racial differences in STEM participation, including the impact of social norms and gender stereotypes, peer effects, and

professors' gender on test scores and college majors. The ones elucidating participation in inventive activity are the ones reviewed below.

The Gender and Racial Gap during the Practice of Invention

In the process of practicing invention and creating new knowledge or products, women and African Americans not only engaged at generally lower rates than their counterparts, but they also earn less and are employed less than their counterparts. In 2010, the median salary for whites was \$72,000, and for African Americans, it was \$56,000, which was 78 percent of the median salary for whites.¹ In 2015, this share had only moved slightly to 79 percent. While the median salary for men in the innovation economy in 2010 was \$80,000, it was only \$53,000 for women, or 66 percent of the median male salary. In 2015, it was \$87,000 for men and \$62,000 for women, which was 71 percent of the median male salary.² Among scientists and engineers, in 2015 African American unemployment was 4.7 percent compared to 2.9 percent for whites.³ While employment rates are increasing among women and underrepresented minority scientists and engineers, unemployment rates vary significantly by gender and racial and ethnic group. The unemployment rate for African American women is higher than the unemployment rate for all scientists and engineers, nearly double that of all scientists and engineers, and more than double that of white women scientists and engineers. Unemployment for under-

¹ Salary data for 2015 are from NSF (2017).

² NSF (2017). As is true for any salary data, differences will vary across occupations, age groups, race and ethnicity, etc.

³ NSF WMPD 2017 Digest. Data are for 2015.

represented minority men at just above four percent is higher than for white and Asian men and higher than the average for all scientists and engineers.⁴

The literature on gender and racial differences in the inventive process has evolved similar to the literature on STEM participation. The older literature focused on identifying the gaps, while the newer literature has focused on sources or correlates and outcomes.

A few papers in the last decade have focused on the misallocation of talent among inventors and other high-skilled workers. My research with Kongcharoen (2010) found that co-ed patent teams are more productive (at commercialization) than single-sex male or single-sex female patent teams. Hunt, Garant, Herman, and Munroe (2013) investigate the gender gap for commercialized patents. Using the 2003 National Survey of College Graduates, they show the gender gap among S&E degree holders is due primarily to women's underrepresentation in patent-intensive fields and patent-intensive job tasks. They also show that women with a degree in S&E patent little more than women with other degrees, meaning that an increase in the share of women with S&E degrees will not substantially close this gender gap. They find that women's underrepresentation in engineering and in jobs involving development and design explain much of the patent gap. Closing this gap could increase U.S. GDP per capita by 2.7 percent. My 2018 research with Yang executes a similar exercise using more recent data and find that GDP per capita would be 0.6 to 4.4 percent higher if more women and African

⁴ Under-represented minorities include scientists and engineers who are black, Hispanic, and American Indian or Alaska Native. While the disaggregated data are not available, the unemployment rates in the innovation economy for these groups are somewhat similar. Data on gender by race and ethnicity are reported in NSF (2017), but the accompanying data do not allow this calculation to be made.

Americans received STEM training and worked in related jobs. Hsieh, Hurst, Jones, and Klenow (2018) analyze the gender and racial distribution for highly-skilled occupations over the long run, the last 50 years. They show the change in the occupational distribution since 1960 suggests that a substantial pool of innately talented women and African Americans in 1960 were not pursuing their comparative advantage, and this misallocation of talent affects aggregate productivity in the economy. They find one quarter of growth in aggregate output from 1960 to 2010 can be explained by an improved allocation of talent.

Bell, Chetty, Jaravel, Petkova, and John Van Reenen (2016) investigate the characteristics and life trajectories of inventors to develop a comprehensive portrait of U.S. inventors, develop a simple inventor lifecycle model with barriers to human-capital acquisition. They also explore the determinants of becoming an inventor using data on all patents granted between 1996 and 2014 linked to federal income tax returns, combined with data on standard test scores for elementary school children in the New York City public school system between 1989 and 2009. They find an income, race, and gender gap in invention that is primarily due to environment barriers in acquiring human capital – a lack of mentoring and exposure to careers in science and innovation in childhood – and not due to differences in ability. This evidence suggests policies that target low-income, underrepresented-minority, and female children may be more effective in closing the invention gap than top income tax policies. The Institute for Women's Policy Research, Milli, et al. (2016) predict the current slow but steady increase in the share of patents with any women inventor will result in gender parity in the year 2092 and recommend better

tracking of progress, assistance with costs of securing a patent, improved gender diversity in STEM, and improved networking opportunities for women.

Gender and Racial Gap in Innovation

In the final stage of commercializing invention, or innovation, outcomes are starkly different. Women are only 8 percent of new hires at VC firms.⁵ Female CEOs receive only 2.7 percent of all venture funding, while women of color get virtually none: 0.2 percent. Women and African Americans are often found in legal and marketing departments but are largely missing in technical positions and among executives and boards. In 2014, Fortune ranked several large tech firms based on recently released demographic data. With respect to women executives, One firm was ranked highest with women constituting 43 percent of leadership roles, and two firms were ranked lowest with 19 percent women in these roles. Women constituted just 18.7 percent of boards of S&P 500 firms in 2014, which was up from 16.3 percent in 2011. In 2015, 11 percent of venture capitalists were women, and two percent were African American.⁶

This is the stage where incomes can be high, and wealth generated can be substantial. It is also the stage at which one would observe the most unequal outcomes by gender and race. This is immediately apparent when considering the prominence of tech firms in the most valuable

⁵ Economist (2017).

⁶ Cited in Cook (2018).

public firms and the relative size of these firms. The trillion-dollar valuations of some tech firms put them roughly on par with the GDP of the Netherlands, Mexico, or Australia.

Workplace issues for women and minorities go beyond the opportunity to participate in invention and innovation. Recently, tech workers in the U.S. have demonstrated to protest sexual harassment and misconduct, lack of transparency (including forced arbitration for sexual harassment claims), workplace culture, and pay and opportunity inequality.

Among the Forbes list of richest people in the world, five of the top 10 derive their wealth primarily from the innovation economy. The nine tech firms with initial public offerings (IPOs) last year were valued at roughly \$36 billion, and the most valuable one was valued at approximately \$20 billion.

Entrepreneurs around the globe are amassing wealth in everything from cryptocurrencies to telecoms to bridal dresses. Daniel Ek, the 35 year-old co-founder and CEO of Spotify taught himself to write code in his early teens and started his first business when he was 14. In April 2018, when Spotify went public, he became the tech industry's newest billionaire. On the close of the first day of trading the company was valued at over \$26 billion, with Ek's share worth nearly \$2.5 billion. Tech entrepreneurs continue to dominate the list of the world's billionaires. In the first half of 2018, 11 new tech entrepreneurs became billionaires when companies they founded went public, were acquired, or had new funding.⁷

⁷ Forbes (2018).

This is the stage where gender and racial gaps have been covered the least in the academic literature. My 2010 research with Kongchareon and 2018 research with Yang 2018 include systematic analyses of commercialization of invention by race and gender, but, case studies in the business literature notwithstanding, this is typically not the focus of academic inquiry. Having better data could aid researchers in doing such analysis and aid economic policymakers in improving living standards of all Americans.

Conclusion

In the last two decades, researchers have made substantial progress in studying the participation of women and African Americans at each stage of the innovation process. After the facts of their participation were established, the focus of economists and other scholars has been on sources or correlates and outcomes and increasingly on mechanisms to understand causal factors.

If the aforementioned losses to GDP are being tolerated, firms, technology officers, and patent teams are not being good stewards of America's human capital and inventive capacity. This is a classic coordination problem and market failure. Public policy can help in the research, analysis, and promotion of diverse participation in inventive activities. Legislation, such as H.R. 5768, would be critical to researchers to develop this research further. Having patentees or their agents and attorneys voluntarily and separately report demographic data – gender, race,

ethnicity – upon submission of a patent or other IP application would advance this important line of research further with more precise data. Having the USPTO report on these data annually will shed light on important dimensions of the problem and changes over time. I would propose adding two additional data series for collection: disability status and veteran status. The literature on innovation related to the inclusion of these groups is just developing, and this would be an opportune time to include these inventors in the counts proposed in the legislation, which would be in line with data collected by the Small Business Administration, for example.

Thank you, again, for the opportunity to speak to you today about the timely and important issue of building an inclusive innovative economy that has the potential to raise living standards for all Americans.

References

- Ashcraft, Catherine and Anthony Breitzman. 2007. "Who Invents IT? An Analysis of Women's Participation in Information Technology Patenting". National Center for Women and Information Technology.
- Avilova Tatyana and Claudia Goldin. 2018. "What Can UWE Do for Economics?" NBER Working Paper No. 24189.
- Bayer, Amanda and Cecilia Rouse. 2016. "Diversity in the Economics Profession: A New Attack on an Old Problem". *Journal of Economic Perspectives*, 30(4): 221-42.
- Becker, Charles M. , Cecilia Elena Rouse, and Mingyu Chen. 2014. "Can a Summer Make a Difference? The Impact of the American Economic Association Summer Program on Minority Student Outcomes". NBER Working Paper No. 20407.
- Bell, Alex, Raj Chetty, Xavier Jaravel, Neviana Petkova, and John Van Reenen. 2016. "The Lifecycle of Inventors".
- Bhardwaj, Prachi 2018. "Meet the 11 new tech billionaires that emerged in 2018," *Business Insider*, July 14.
- Bostwick, Valerie K. and Bruce A. Weinberg. 2018. "Nevertheless She Persisted? Gender Peer Effects in Doctoral STEM Programs". NBER Working Paper No. 25028.
- Buser, Thomas, Muriel Niederle, and Hessel Oosterbeek. 2014. "Gender, Competitiveness, and Career Choices". *The Quarterly Journal of Economics*, 129(3):1409–1447.
- Carrell, Scott E., Marianne E. Page, and James E. West. 2010. "Sex and Science: How Professor Gender Perpetuates the Gender Gap". *The Quarterly Journal of Economics*, 125(3):1101-1144.
- Chetty, Raj, Nathaniel Hendren, Frina Lin, Jeremy Majerovitz, and Benjamin Scuderi. 2016. "Gender Gaps in Childhood: Skills, Behavior, and Labor Market Preparedness: Childhood Environment and Gender Gaps in Adulthood". *American Economic Review: Papers & Proceedings 2016*, 106(5):282–288.
- Cook, Lisa D. 2018. "Unequal Opportunity: The Innovation Gap in Pink and Black," in Eric Hintz, Marie Stettler Kleine, and Matthew Wisnioski, eds., *Does America Need More Innovators?* Forthcoming MIT Press.
- _____ and Jan Gerson. 2018. "The Idea Gap in Pink and Black: A Literature Review," mimeo, Michigan State University.

_____ and Chaleampong Kongcharoen. 2010. "The Idea Gap in Pink and Black." NBER Working Paper No. 16331.

_____ and Yanyan Yang. 2018. "The Life Cycle of the Innovation Gap in Pink and Black." Michigan State University.

Ding, Waverly W., Fiona Murray, and Toby E. Stuart. 2006. "Gender Differences in Patenting in the Academic Life Sciences". *Science (313)*: 665-667.

The Economist. 2017. "Girl power: How having a daughter boosts investors' returns," September 30.

Feng, Venus, Jie Ma, and Pei Yi Mak. 2018. "China Gets Four New Billionaires in a Week After Battery IPO," *Bloomberg*, June 14.

Fryer, Jr., Roland G. and Steven D. Levitt. 2010. "An Empirical Analysis of the Gender Gap in Mathematics". *American Economic Journal: Applied Economics*, 2: 210-240.

Hsieh, Chang-Tai, Erik Hurst, Charles I. Jones, and Peter J. Klenow. 2013. "The Allocation of Talent and U.S. Economic Growth". NBER Working Paper No. 18693.

Huddleston Jr., Tom. 2018. "How Spotify's college-dropout founder became a self-made millionaire at 23 — and a billionaire at 35," *CNBC*, April 4.

Hunt, Jean-Philippe Garant, Hannah Herman, and David J. Munroe. 2012. "Why Don't Women Patent?". NBER Working Paper # 17888.

Kahn, Shulamit and Donna Ginther. 2017. "Women and STEM". NBER Working Paper # 23525.

Milli, Jessica, Emma Williams-Baron, Meika Berlan, Jenny Xia, and Barbara Gault. 2016. "Equity in Innovation: Women Inventors and Patents." *Institute for Women's Policy Research*, November 29.

Nollenberger, Natalia, Núria Rodríguez-Planas, and Almudena Sevilla. 2016. "The Math Gender Gap: The Role of Culture." *American Economic Review*, 106 (5): 257-61.

Whittington, Kjersten Bunker. 2009. "Patterns of Male and Female Scientific Dissemination in Public and Private Science" in *Science and Engineering Careers in the United States: An Analysis of Markets and Employment*, edited by Richard B. Freeman and Daniel L. Goroff, 195-228. Chicago: University of Chicago Press.

Zölitz, Ulf, and Jan Feld. 2017 "Understanding Peer Effects – On the Nature, Estimation and Channels of Peer Effects". *Journal of Labor Economics* 35(2).

Appendix: A Review of the Literature⁸

Kahn and Ginther (2017) summarize research on the underrepresentation of women in math-intensive science fields. They examine how culture, gender stereotypes, role models, competition, risk aversion, and other factors contribute to the gender STEM gap. They examine the progression of the STEM gap through school, starting at childhood, solidifying by middle school, and affecting women and men as they progress through school, higher education, and into the labor market.

Nollenberger, Rodríguez-Planas, and Sevilla (2016) focus specifically on the effect of gender-related culture on the math gender gap. They analyze math test scores of second-generation immigrants, finding that immigrant girls whose parents come from more gender-equal countries perform better than those whose parents come from less gender-equal countries. They find the transmission of cultural beliefs on the role of women in society contributes to the math gender gap.

Fryer and Levitt (2010) explore the math gender gap that emerges when children are in elementary school and examine the extent to which it is due to social norms or socialization. Their results document the emergence of a large math gender gap for elementary school children in the U.S. in every stratum of society, but they were not able to document any particular causal pathway. There is a bit of a puzzle in results from international data sets.

⁸ This literature review relies heavily on Cook and Gerson (2018).

They find a negative relationship between gender inequality and female math performance in one international data set, but when they use another data set including Muslim countries, the gender math gap disappears for same-sex schools.

Carrell, Page, and West (2009) focus on the role professors' genders have on men and women's college majors. In math and science classes they find a professor's gender has little impact on male students. In contrast, for female students, the professor's gender has a noticeable effect on their performance, subsequent enrollment in math and science courses, and pursuit of a STEM degree. If high-performing female students' introductory math and science classes are taught by female professors, the gender gap in course grades and STEM majors is eliminated. This gender effect is not present in humanities classes.

Zöhlitz and Feld (2016) examine gender peer effects in a university context and how they influence students' choice of major and labor-market outcomes. Women who are randomly assigned to more women peers become less likely to select male-dominated majors and wind up in jobs where they work fewer hours and their wage grows at a slower rate than their male counterparts. Unlike women, men become more likely to select male-dominated majors after having had more female peers, and their labor-market outcomes are unaffected. Their findings suggest that the increasing female university enrollment in recent decades has inadvertently contributed to the occupational segregation among college graduates that persists in the labor market.

Recent work by Böstwick and Weinberg (2018) focuses on mechanisms associated with attrition by women in STEM doctoral programs. Specifically, they examine gender peer effects on persistence and degree completion in STEM doctoral programs. They demonstrate that women entering cohorts with no female peers are 11.9 percentage points less likely to graduate within six years than their male counterparts. They find that a one-standard-deviation increase in the percentage of female students differentially increases the probability of on-time graduation for women by 4.6 percentage points. They also find that these gender peer effects principally operate through changes in the probability of leaving after the first year of a Ph.D. program and are largest in programs that are typically male-dominated.

Niederle and Oosterbeek (2014) examine data from the Netherlands to investigate whether gender differences in competitiveness explain gender differences in education and labor market outcomes. They find boys are substantially more competitive than girls. This competitiveness is strongly and positively correlated with choosing more prestigious academic tracks that are more intensive in math and science. Their evidence is suggestive that differences in competitiveness explain roughly 20 percent of the gender difference in the choice of academic track.

Chetty et al. (2016) examine the extent to which family characteristics and childhood environment are the cause of gender gaps in employment, earnings, and college attendance for adults. They use the dataset constructed by Chetty et al. (2014) derived from U.S. tax returns data from 1996–2012 to show with graphs and regression analysis the correlation between how

a child grows up and his/her adult outcome. The data support the conclusion that gender gaps in adulthood are rooted in the environment children grow up in, with the effect of being disadvantaged in childhood having more of a negative long-term effect on boys — not the traditional gender gap you research.

In a number of recent papers, economists have turned their attention to the issue of stagnant or declining participation by women and underrepresented minorities in one particular STEM field, economics. Avilova and Goldin (2018) point out that men outnumber women as undergraduate economics majors by three to one nationwide, and even at the best research universities and liberal arts colleges men outnumber women by two to one or more. The authors report results from the Undergraduate Women in Economics Challenge, begun in 2015 as an RCT with 20 treatment schools and at least 30 control schools to evaluate whether better course information, mentoring, encouragement, more relevant instructional content, and other measures could increase women's interest in majoring in economics. Although the RCT is still in the field, results from several within-treatment-school randomized trials suggest that straightforward and inexpensive interventions can make a difference. Becker, Rouse, and Chen (2014) estimate the effectiveness of the AEA's summer program, launched in the 1970's, in increasing racial and ethnic diversity in the economics profession. They find that program participants were over 40 percentage points more likely to apply to and attend a PhD program in economics, 26 percentage points more likely to complete a PhD, and about 15 percentage points more likely to ever work in an economics-related academic job. According to these estimates, the summer program may directly account for 17 to 21 percent of the PhDs awarded

to minorities in economics over the past 20 years. Bayer and Rouse (2016) present data on the relative lack of women and minority groups in the economics profession and review current research on the reasons for the imbalance. They argue that implicit attitudes and institutional practices may contribute to the imbalance at all stages of the pipeline, beginning at the undergraduate level and continuing throughout the academy, with little improvement over time. They review evidence on how diversity affects productivity, concluding that the lack of diversity is likely to constrain the range of issues economists address while limiting their ability to understand familiar issues from new and innovative perspectives. Bayer and Rouse propose measures to augment diversity in the economics profession along with evidence on their effectiveness and identify some promising practices, programs, and areas for future research. Most, if not all, authors on this set of papers addressing issues of participation in the STEM field of economics are or have recently been actively involved in programs designed to increase the number of minorities and women in the economics profession.

Goldin (2014) develops a personnel economics theory of occupational pay differences to explain the gender gap. Using census microdata and survey data to construct women's earnings penalty by occupation, Goldin finds that technology occupations typically are associated with more gender equality, which supports her theoretical model and confirms that changes in the structure of work and more temporal flexibility of jobs reduce the gender gap.

Whittington's (2009) research examines how the organization of work environments explains the invention and innovation gender gap in publishing and patenting across sectors and disciplines. Using the 1995 NSF Survey of Doctoral Recipients and inventor-level information

from U.S. patents filed between 1976 and 2002 in the Boston region, Whittington finds the organization of the work setting, e.g., the broadly distributed work of academic science compared to the more horizontally distributed knowledge in biotech firms, the level of hierarchy and the structure of collaboration networks in the work setting, plays a significant role in explaining the gender gap in invention and innovation.

Mr. JOHNSON of Georgia. Thank you.
Dr. Howard, you may begin.

STATEMENT OF AYANNA HOWARD

Ms. HOWARD. Thank you, Chairman Johnson, Ranking Member Roby, and full Committee Chairman Nadler.

My name is Dr. Ayanna Howard, and I am professor and 569 Chair of the School of Interactive Computing at the Georgia Institute of Technology. I also have served as the associate 571 director of research for the Institute for Robotics and Intelligent Machines and Chair the robotics Ph.D. Program.

From 1993 to 2005, I was at NASA's jet propulsion 574 laboratory where I held the titles of senior robotics 575 researcher and deputy manager in the Office of the Chief Scientist. I hold a degree in engineering from Brown University, an M.S. and Ph.D. in electrical engineering from the University of Southern California, and an MBA from the Drucker Graduate School of Management.

My research concentrates on robotics, assistive technologies, and artificial intelligence, which has resulted in over 250 publications. In 2013, I founded Zyrobotics, a Georgia Tech spinoff company which designs AI-powered STEM tools and learning games for children with diverse learning needs. My research has been supported by various industry and government funding agencies ranging from NASA and the National Science Foundation to the Georgia Research Alliance, and Microsoft.

I regularly consult and sit on the advisory boards of a number of organizations concerned with robotics, AI, and workforce development. My work has also been highlighted through a number of awards and articles, including highlights in Vanity Fair, USA Today, and Time Magazine, as well as being recognized as one of the 23 most powerful women engineers in the world by Business Insider and one of the top 50 U.S. women in tech by Forbes.

Despite all these successes, I only hold three patents, which will now be the subject of discussion. I would like to focus on my experience with the patent system. I do consider myself an innovator and an entrepreneur. Invention is core to what I do, and yet I only hold three patents. Even though there has been a gain in female participation in science and engineering, findings have shown that there has been not a corresponding increase in female patent inventors.

My story corroborates with this claim. My first application was filed in 2003 while I was still a graduate student and designed an encryption system using fingerprint biometrics with a small start-up company. Given that neither of us had great financial resources, we put together a patent application that was filed. We eventually dropped pursuit of the application after our patent claims were denied. After all, in the world of logic, a rejection means just that: patent denied.

It wasn't until 10 years later in 2013 that I pursued my next patent. And the only reason that came about was that I needed to submit a provisional patent in order to compete for the NSF I-Corps program, which is basically a boot camp entrepreneurship program for academics and university-derived IP.

I developed at that time a device that enabled children with motor disabilities the ability to interact with tablet devices without

requiring pinching, swiping, or touching. A year later in 2013, when the provisional patent was to expire, after much discussion, Georgia Teach moved forward with filing the patent application. Although it is now 2019, almost 6 years later, it has still not been granted.

So what about the other patents that have been granted? Well, I discovered a little bit of a trick. I hired a great patent lawyer. So, when Zyrobotics, the Georgia Tech spinoff company was founded, it licensed the IP from that first patent. Given that I knew to be competitive, the company had to possess its own IP, we hired an extremely talented patent attorney. Although quite expensive, we secured two patents within a 2-year timeframe. And I finally understood how the process worked, how the back-and-forth dance with the patent examiner evolves, how denial really means “find another way, find another way, find another way,” and how persistence can lead to success.

Unfortunately, the price tag is not very sustainable for a startup company in the education space. I also think it is not that sustainable for an academic institution in which the return on investment is not well defined.

So, given my personal experience in this space, it comes as no surprise to me that women still make up a small percentage of the patent inventors. Reports state that U.S. female-founded startups raise just 2.2 percent of venture capital investment in 2018. Without sufficient capital, how, then, would you prosecute a successful patent application given that the price tag is so high?

I strongly believe, beyond educating entrepreneurs and given the state of affairs that currently we have, a more robust pro bono patent attorney agent program for small businesses would immensely help inventors compete in this patent world. It would also help level the playing field just a bit for women and underrepresented entrepreneurs.

In closing, I appreciate the committee’s attention to this topic. I stand ready to answer your questions and work with you on moving forward to help create a patent system where more researchers like myself can find success navigating the ins and outs of pursuing a patent.

[The statement of Ms. Howard follows:]

**Testimony of Ayanna Howard, Professor and Chair of the School of Interactive Computing
at the Georgia Institute of Technology**

House Judiciary Subcommittee on Courts, Intellectual Property, and the Internet

**“Lost Einsteins: Lack of Diversity in Patent Inventorship and the Impact on America’s
Innovation Economy”**

March 27, 2019

My name is Professor Ayanna Howard and I am an innovator, entrepreneur, leader, and international expert in robotics. Currently, I am the Linda J. and Mark C. Smith Professor and Chair of the School of Interactive Computing at the Georgia Institute of Technology. I have also served as the Associate Director of Research for the Institute for Robotics and Intelligent Machines, Chair of the Robotics Ph.D. program, and the Associate Chair for Faculty Development in the School of Electrical and Computer Engineering at Georgia Tech.

From 1993-2005, I was at NASA's Jet Propulsion Laboratory where I held the titles of Senior Robotics Researcher and Deputy Manager in the Office of the Chief Scientist. I hold a degree in engineering from Brown University, a M.S. and Ph.D. in Electrical Engineering from the University of Southern California, and an M.B.A. from the Drucker Graduate School of Management.

After leaving NASA in 2005, I entered academia and started up my own robotics research lab at Georgia Tech. My research concentrates on advancements in robotics, assistive technologies, and artificial intelligence, which has resulted in over 250 publications. My innovations are focused on designing socially-interactive robots to address the therapeutic and educational needs of children with disabilities. In 2013, I founded Zyrobotics, a Georgia Tech spin-off company, which designs AI-powered STEM tools and learning games for children with diverse learning needs. My research has been supported by various agencies ranging from NASA, the National Science Foundation, Intel, Grammy Foundation, Exxon-Mobil, Microsoft, and the Georgia Research Alliance. Despite all these successes, I only hold three patents, which will be the subject of discussion later.

I regularly consult and sit on the advisory boards of a number of organizations concerned with robotics, AI, and workforce development. My work has also been highlighted through a number of awards and articles, including highlights in *Vanity Fair*, *USA Today*, *Upscale*, *Black Enterprise*, and *TIME Magazine*, as well as being recognized as one of the 23 most powerful women engineers in the world by *Business Insider* and one of the Top 50 U.S. Women in Tech by *Forbes*.

I'd like to now focus on my experience with the patent system. I do consider myself an innovator and an entrepreneur. Invention is core to what I do. I have hardware and software merchandise currently selling on the market. I have productively deployed robot systems in the homes of children with special needs. I have successfully translated research from an academic lab into commercial products. And yet, I only hold three patents. Findings from the U.S. patent office

have shown that, even though there have been gains in female participation in science and engineering occupations and entrepreneurship, there has not been a corresponding increase in female patent inventors. My story corroborates with this claim. My first patent application was filed in 2003, while I was still a graduate student. I was working with a small startup company and designed an encryption system based on fingerprint biometrics to secure the transmission of digital information, which could range from full-length feature films to music recordings to even electronic medical records. Given that neither of us had great financial resources, we put together the application and filed. We eventually dropped pursuit of the application after our patent claims were denied. After all, in the word of logic, a rejection means just that - patent denied!

It wasn't until 10-years later, in 2013, that I pursued my next patent. And the only reason that came about was that I needed to submit a provisional patent in order to compete for an NSF program called I-Corps. NSF I-Corps is basically a program that teaches academics how to rethink how their research impact could go beyond paper publications to having a larger societal and commercial impact. To compete, academics had to have university-derived IP that was produced from an NSF grant. At that time, I'd developed, with my students, a device that enabled children with motor disabilities the ability to interact with tablet devices without requiring pinching, swiping, or touching – which could be difficult for a child with limited upper arm mobility. I quickly had a provisional patent submitted through Georgia Tech (in 2012) so that I could successfully compete for the NSF grant, which we were then awarded.

A year later, in 2013, when the provisional patent was to expire, I'd requested Georgia Tech to move forward with filing the patent application. After much discussion, they finally agreed to file. Although, it's now 2019, and almost six years later, it still hasn't been granted.

So, what about the other patents that have been granted? Well, I discovered a bit of a trick. Hire a great patent lawyer. When Zyrobotics, the Georgia Tech spin-off was founded, it licensed the IP from that first filed patent. Given that I knew, to be competitive, the company had to possess its own IP, we hired an extremely talented patent attorney (that was a Georgia Tech grad and worked with academic startups). Although quite expensive, we secured two patents within a two-year time frame. And, I finally understood how the process worked – how the back-and-forth dance with the patent examiner evolves, how denial really means find another way, and another way, and another; and how persistence can eventually lead to success. Unfortunately, the price-tag is not very sustainable for a startup company in the education space. I also think it's not that sustainable for an academic institution, in which the return on investment is not well-defined.

So, given my personal experience in this space, it comes as no surprise that women still comprise a small minority of patent inventors. Reports state that U.S. female-founded startups raised just 2.2 percent of venture capital investment in 2018. Without sufficient capital, how then would you prosecute a successful patent application given that the price-tag is so high? It's a lose-lose situation given the current state-of-affairs.

Is there anything that I can think of that would have possibly made this journey a bit easier earlier in my career? Or enhanced my positioning in terms of laying claim to my inventions and having broader impact? As a young women engineer, having a patent expert that was able to communicate its importance to scientists and provide a hands-on curriculum for going through

the process of the patent application would have been a start. But, now, I believe, given the current state-of-affairs, a more robust pro bono patent attorney/agent program for small businesses and individual inventors would immensely help inventors compete in this patent world. It would also help level the playing field just a bit more for women and other underrepresented entrepreneurs.

In closing, I appreciate the Committee's attention to this topic. I stand ready to answer your questions and work with you on moving forward to help create a patent system where more researchers like myself can find success navigating the ins and outs of pursuing a patent.

Mr. JOHNSON of Georgia. Thank you, Dr. Howard.
Ms. Armstrong, you may begin.

STATEMENT OF SUSIE ARMSTRONG

Ms. ARMSTRONG. Chairman Johnson, Ranking Member Roby, and Members of the Subcommittee, my name is Susie Armstrong, and I am a Senior Vice President of engineering at Qualcomm. Thank you for inviting me to testify today on this critical topic of diversity and innovation.

As the leading U.S. company engaged in foundational research and development of 5G, Qualcomm believes that diverse innovation is an imperative. We can only solve the world's toughest engineering problems if we bring together teams with different backgrounds and different perspectives.

Our CEO, Steve Mollenkopf, said recently: With 5G, new and previously unsolvable problems will be solved, new generations of innovations and innovators will be born. And we need more great technology minds, and that means getting the next generation, in particular women and underrepresented communities, excited and prepared for the world to come.

Since starting Qualcomm in 1994, I have held various leadership positions at the company but first consider myself an engineer and an inventor. In my experience, invention rarely involves people working alone to develop brilliant ideas. More often, invention is a team effort that requires the creativity, the interaction, the debate, and the multiple perspectives that different collaborators bring to recognize a technical problem or opportunity.

My own invention, called simple packet data, allowed cellular phones to connect to the internet and resulted in the first internet surfing of the 1997 CTIA show on this phone. I created a simple way for a base station to set up a packet data call by bringing to our engineering team my background in a completely separate field, computer communications and ethernet. That invention was impactful. 20 years later, mobile internet has revolutionized the way we communicate, paving the way for 5G and the wireless economy of the future.

But not everybody has equal access to careers in innovation. Multiple studies have shown that women, people of color, and people from lower income families patent at lower rates than those that are White, male, and wealthier.

At Qualcomm, given the complexity of the fundamental 5G technologies we research and develop, we must promote a culture of creativity, risk-taking, and diversity. We simply cannot afford to miss out on those engineers and inventors in underrepresented groups.

We focus our efforts on four key areas to develop inventors both for Qualcomm and for its 5G foundational technologies and also for the industries and applications in use cases that use that ecosystem.

First, as many inventions come from the STEM field, we believe we must encourage STEM education. To spark that interest in such invention careers, we created the Qualcomm Thinkabit Lab, a hands-on program aimed at inspiring the next generation of inventors, where students learn about 5G, the Internet of Things, tech

career, and they create their own Internet of Things invention. The response has been so positive that we have partnered with school districts, universities, and libraries to create Thinkabit Labs in underrepresented communities across the Nation.

Second, we have examined our hiring processes, especially on-campus recruiting. Last year, we added a Historically Black College and University—and two universities with high Hispanic populations to the top schools that we actively recruit at. And we also recruit at the Grace Hopper Conference for Women and Computing. We strive to send recruiting teams that reflect the excitement of wireless and semiconductor fields, reflect the existing diversity in the company and the diversity that we hope to achieve.

Third, we focus on retention and new project opportunities for our diverse employees. We know from research and experience that mixed-gender teams are innovative. So we strive to spread these best practices. We develop employee-led networks to promote professional development. We work on engineering the bias out of our review and project rotation systems. We strive to ensure that diverse employees have access to coaching, mentorship, and career development opportunities and that they, in turn, pass those on.

Finally, we work to create and maintain a strong culture of invention and patenting across the company. We have a strong inventor development program with both online and in-person patenting classes and encourage our patent holders to coach and mentor others. We also recognize our inventors as a way to celebrate them and encourage others. Engineers are proud to have their special badge and business cards with the inventor mark, and their status as patent holders appears in the company directory. Executives send a congratulatory letter to each inventor who obtains a patent, and we hold celebrations for inventors.

In summary, it is a strategic and economic imperative for Qualcomm, for the 5G wireless ecosystem, and for the United States to ensure that inventors from all backgrounds and perspectives participate in solving these challenging engineering problems. Qualcomm is committed to ensuring the diverse people have every opportunity to bring their talents to that imperative.

Thank you for the opportunity to speak with you today, and I look forward to your questions.

[The statement of Ms. Armstrong follows:]

Statement of

SUSIE M. ARMSTRONG
Senior Vice President, Engineering
QUALCOMM, Inc.

Before the
Subcommittee on Courts, Intellectual Property, and the Internet

Committee on the Judiciary
U.S. House of Representatives

Hearing on
Lost Einsteins: Lack of Diversity in Patent Inventorship and the Impact on America's
Innovation Economy

March 27, 2019

Chairman Johnson, Ranking Member Roby, and Members of the Subcommittee:

My name is Susie Armstrong, and I am a Senior Vice President, Engineering at Qualcomm, Incorporated. Thank you for inviting me to testify before the Subcommittee today on this critical topic of diversity in innovation.

Qualcomm is a leading U.S. company engaged in ground-breaking research and development of next-generation wireless technologies, and is the undisputed leader in developing foundational 5G technology. Since its founding in 1985, Qualcomm has been at the forefront of wireless R&D, and its technology has driven major cellular wireless standards. The company was the first to recognize and realize the potential of the wireless Internet and mobile broadband, and has helped pioneer other transformative smartphone technologies, including GPS, digital camera and video streaming, and mobile graphics.

Research and development essential to every generation of “G” takes close to a decade, beginning long before the new standard is developed and commercialized. In order to ensure that Qualcomm can continue to fund research in wireless R&D, we patent our inventions, and license them to device makers that incorporate those inventions into their products. Today, Qualcomm holds over 130,000 patents on its technology, and its patent portfolio is the most widely and extensively licensed in the wireless industry, with over 300 licensees.

I joined Qualcomm in 1994 as an engineer working on Globalstar satellite communications. I then worked on the team that developed and commercialized packet data technology—which permits transmission of data over the Internet over cellular links—in the late 1990s. This resulted in the first web-surfing on a cellular phone in 1997.

Since then I have held various positions at Qualcomm, including responsibility for the development and commercialization of all of the software that drives Qualcomm’s chipsets. I served as the head of worldwide Customer Engineering, the group that integrates and commercializes the company’s products in phones and other wireless devices. My responsibilities included engaging extensively with base station makers, carriers, and phone and other device makers in the United States, Asia and Europe to bring those technologies to market.

Although I have held multiple roles within the company, I first and foremost consider myself an engineer and inventor. Sometimes people think that inventors and patent holders are brilliant people working in their garage on their own, coming up with “light bulb” ideas. But more often, invention is a team effort that requires “out of the box” and creative thinking to recognize a technical need or opportunity and solve it. For example, my invention in the late 1990s of “simple packet data”—the technology that allows cellular phones to connect to the Internet—was the result of working in a team, where I was able to come up with a new idea based on my background in computer communications. I was able to bring a unique perspective, and this demonstrates what can happen when someone with a different background is included as part of a diverse team.

At the time, code division multiple access (CDMA) was being promoted for high quality, high capacity voice calls, and my team was working on digital fax. However, my background prior to working at Qualcomm was in the computer communications industry (*i.e.* Ethernet and the internet data protocols TCP/IP). So to me, the digital CDMA voice link looked like just another Ethernet, or dial-up modem link, well suited for carrying Internet packet data wirelessly. So I invented a way to get a base station to set up a packet data call—essentially a wireless phone call for connecting to the Internet—leveraging the work we were already doing for “digital fax.” My invention involved minimal changes to the then-existing base stations and other infrastructure, further simplifying the process of connecting mobile devices to the Internet.

That insight resulted in the first wireless Internet surfing, on a Qualcomm mobile phone, at the February 1997 Cellular Telecommunications Industry (CTIA) show. The download speed was 14.4 kbps, which, by comparison, is over 20,000 times slower than the 300 Mbps download speeds of today’s 4G networks. And 5G networks will be significantly faster delivering up to 20 Gigabits-per second peak data rates and 100+ Megabits-per-second average data rates.

Within one year of our successful mobile web connection, infrastructure manufacturers adopted the technology and had commercialized it in multiple markets. Qualcomm and others in the industry then began focusing on research in “airlinks” that were optimized to carry packet data rather than just voice, and mechanisms for internet connections in a moving phone. Twenty years later, mobile Internet has revolutionized the way we communicate; expanding capabilities from simple web surfing to mobile email, to high-speed browsing, media streaming, and navigation; creating whole new industries, from on-demand services to online content creation, and paving the way for 5G and the wireless economy of the future.

The Diversity Gaps in Patenting

Despite the economic benefits of patents, not all inventors have equal access to the innovation pipeline. Multiple studies have shown that women inventors, inventors of color, and inventors from lower-income families patent their inventions at lower rates than male, white, and wealthier inventors.¹

In 2016, the Institute for Women’s Policy Research (IWPR) found that just 18.8 percent of U.S. patents, as of 2010, listed one or more women as an inventor.² A USPTO study just last month made similar findings, reporting that only 20 percent of U.S. patents list a woman

¹ See generally, Holly Fechner and Matthew S. Shapanka, Closing Diversity Gaps in Innovation: Gender, Race, and Income Disparities in Patenting and Commercialization of Inventions, *Technology & Innovation* 19:727 (2018).

² Institute for Women’s Policy Research, *Equity in Innovation: Women Inventors and Patents* (2016), <https://iwpr.org/wp-content/uploads/wpallimport/files/iwpr-export/publications/C448%20Equity%20in%20Innovation.pdf>.

inventor.³ The USPTO also reported the alarming finding that in 2016, only 12 percent of U.S. inventors who were awarded a patent were women.⁴

Racial and ethnic minority groups also patent at lower rates. According to IWPR, among college graduates, African Americans and Hispanics hold nearly half as many patents as whites—about one percent. African Americans and Hispanics also apply for patents at nearly half the rate of whites as compared with Asian American and Pacific Islanders, who seek patents at nearly double the rate of white men.⁵ African Americans, Hispanics, and white women apply for patents at comparable, and much lower, rates (0.3, 0.3, and 0.5 percent of women college graduates within each racial/ethnic group).⁶ Other studies, including research by Dr. Lisa Cook at Michigan State University, who is testifying before the Subcommittee today, have found that African American inventors are awarded patents at a much lower rate than the general population: from 1970 to 2006, African American inventors received just six patents per million people, compared to over 40 patents per million for women, and 235 patents per million for all U.S. inventors.⁷

Inventors from low-income families also experience a wide gap in inventing: for every 10,000 children born to families with incomes below the U.S. median, just 2.2 will receive a patent in their lifetime, compared with over 22.5 children born to families in the top one percent of income.⁸

Despite the efforts of these scholars, it remains extremely difficult to study gender, race, and income gaps in patenting and commercialization. The USPTO does not currently collect any demographic information on its patent applicants. Legislative or administrative changes that would require the USPTO to collect this data would facilitate efforts by government agencies, academia, and private sector companies to monitor their progress in closing the patent gaps and inform ways for these entities to pursue policies that encourage full participation in innovation and entrepreneurship. Qualcomm looks forward to the forthcoming report required by Study of Underrepresented Classes Chasing Engineering and Science Success (SUCCESS) Act last year,⁹ which will shed further light on the patent gaps among women, inventors of color, low-income inventors, and veteran inventors, and offer recommendations from USPTO, in consultation with

³ Office of the Chief Economist, U.S. Patent & Trademark Office, *Progress and Potential: A Profile of Women Inventors on U.S. Patents* (2019), <https://www.uspto.gov/sites/default/files/documents/Progress-and-Potential.pdf>.

⁴ *Id.*

⁵ Institute for Women's Policy Research, *Equity in Innovation: Women Inventors and Patents* (2016),

⁶ *Id.*

⁷ Lisa D. Cook, The Idea Gap in Pink and Black: A Framework for Research and Policy, Presentation at Inventing America Conference, July 12, 2017 (Washington, D.C.).

⁸ Alex Bell et al, Who Becomes an Inventor in the United States? The Importance of Exposure to Innovation, *The Quarterly Journal of Economics* (2019), 1–67, <https://doi.org/10.1093/qje/qiy028>.

⁹ Pub. L. No. 115-273 (Oct. 31, 2018).

the Small Business Administration, for how to facilitate participation in inventing and commercialization among these underrepresented groups.

Diversity Initiatives at Qualcomm

Inclusion and diversity form core corporate values at Qualcomm and act as major forces that drive our technological innovation, including in 5G. The development and deployment of 5G in particular requires a wide variety of perspectives to solve previously unimagined technological problems. In his keynote at the 2017 Consumer Electronics Show (CES), Qualcomm CEO Steve Mollenkopf said “With 5G, new and previously unsolvable problems will be solved, new generations of innovations and innovators will be born. And we need more great technology minds, and that means getting the next generation, in particular women and under-represented communities, excited and prepared for the world to come.”¹⁰

In other words, diversity and inclusion are not just core values, they are economic and innovation imperatives. If Qualcomm, and its customers, hope to build and commercialize transformational technology that solves new problems in new ways, we need engineers from all walks of life who can dream up new solutions, and we also need people to be inventing new ways to use these technology advances. We promote a corporate ethos that values diversity, and that encourages all of our engineers and employees to participate fully in our innovation, patenting, and commercialization processes.

STEM Pipeline and Talent Recruitment

Qualcomm is proud of our already diverse workforce. Our engineer employees represent 116 different nationalities and speak 74 different languages, and are involved in both internal and external programs to increase that diversity.

But there is more work to do. As countless scholars, including Dr. Lisa Cook at Michigan State University, and Barbara Gault and Jessica Milli at the Institute for Women’s Policy Research, have identified, there is a diversity challenge in the Science, Technology, Engineering, and Mathematics (STEM) pipeline. It is imperative that we continue to encourage STEM education for women and girls, children of color, and low-income children, both in formal and informal programs that expose them to careers in science and engineering.

However, in Qualcomm’s experience, STEM is only one factor in the equation. Over the past 25 years, we have seen the number of women employed in science and engineering occupations rise to nearly 30 percent in 2015 (and higher in some STEM fields) while the women inventor rate—the percentage of inventors awarded a patent in any given year who are women—hovers just above 10 percent.¹¹ Additionally, at Qualcomm, we’re finding that a lower share of women and people of color with STEM degrees are engaging in semiconductor R&D, which typically attracts electrical engineers and computer scientists, those same fields applicable to such visible fields as machine learning, artificial intelligence and financial technology.

¹⁰ <https://www.qualcomm.com/news/onq/2017/01/05/ces-2017-steve-mollenkopf-keynote>.

¹¹ See USPTO, *Progress and Potential* at 5.

In order to attract more qualified applicants to our workforce, we have examined our hiring process, especially on-campus recruiting at colleges and universities. We want to make sure that we send teams of engineers and employees that reflect the existing diversity within our company, and the diversity we hope to achieve.

Employee Training and Networking: Engineering the Bias Out of Corporate Processes

Once we have recruited a diverse workforce, our focus is on preserving a diverse and inclusive environment. As an engineering company, our goal is always to engineer the potential bias out of our process to build diverse and inclusive teams that can most effectively attack some of the biggest engineering problems inherent to bleeding edge wireless R&D. As our former Executive Chairman and CEO Paul Jacobs has said, "Inclusion and diversity are at the very heart of innovation," because "[i]t requires different perspectives to take an idea, perfect it, and turn it into world-changing technology."¹² We strongly believe that diverse, mixed-gender teams are more successful and more innovative, and we strive to create a culture that encourages and rewards teams that embody these values.

Part of this process involves training senior management company-wide about the value of diversity and inclusion, and supporting the development of employee-led networks to promote professional development and collaboration among different employee groups. Qualcomm currently has employee networks for women, Africans and African Americans, Latinos and Latinas, military veterans, millennials, lesbian, gay, bisexual and transgender employees, and differently-abled employees and caregivers for individuals with special needs. We are working to continually and strategically expand these networks and ensure employees worldwide have access to them.

A key component of our training and networking program is ensuring that employees who identify with underrepresented groups have access to leadership, mentorship, and career development opportunities within the company and their functional group.

Qualcomm STEM Initiatives

As a company of inventors, Qualcomm purposefully takes a long term look at invention and diversity. One of our key programs is the Qualcomm Thinkabit Lab. The Thinkabit Lab is a tangible hands-on career engagement program, whose byline is "inspiring the next generation of inventors." Thinkabit Lab was born four years ago after we observed that that students, regardless of age, are not likely to pursue a STEM career without exposure and inspiration. Moreover, students from underrepresented populations struggle to see themselves in science and technology careers that often generate inventors.

The Thinkabit Lab initiative brings a hands-on approach to engage students with cutting edge technologies. For example, in our program, students learn about 5G, the Internet of Things, and careers in technology, and then program a simple circuit board to act as the core of their own

¹² DMBA New Team, Qualcomm Inc. – 2013 50 Out Front for Diversity Leadership, *Diversity MBA Magazine*, July 20, 2013, <https://diversitymbamagazine.com/50-out-front/qualcomm-inc-2013-50-out-front-for-diversity-leadership/>.

IoT invention. The program is not prescriptive, nor is it a competition, but a tool to expose young people to invention and technology.

Over the past three years, we have created Thinkabit Labs in libraries, school districts, and university hubs in underserved parts of the nation to both expand our reach, and to leverage these organizations expertise to promote STEM education. We have created public/private partnerships to create “hub” Labs with Virginia Tech in the National Capitol Region, in downtown Detroit with University of Michigan, with the Chula Vista Public Library in California, and with the Porterville Unified School District in the rural, agricultural central valley of California.

Since the launch of the “Inspired by Qualcomm Thinkabit Lab Toolkit” in May of 2017, we have created over 25 “Inspired by Thinkabit Lab” sites in schools throughout the nation. These districts, universities and libraries have integrated our Thinkabit Lab activities, reaching numbers of students far beyond what we could impact at our cornerstone facility in San Diego. For example, the Innovation Station at the Chula Vista Public Library has served every 6th grader in the Chula Vista Elementary School District for the past two and a half school years.

The teachers, librarians, and administrators implementing these activities have added both their expertise in education and know-how in implementing STEM education programs to further improve and inform our program. Each of the Inspired by Thinkabit Lab sites have implemented the program to be responsive to the educational needs of students in their area and their local workforce, and to showcase the breadth of possibilities in the IoT area for new applications and inventions in such areas. There is a large demand by these Inspired by Thinkabit Lab sites for additional activities, teacher professional development and best practices/lessons learned from the San Diego-based Qualcomm Thinkabit Lab.

Thinkabit Labs have focused on middle school students, though the program can be easily scaled down in age to 5th graders and up into high school. In conjunction with the San Diego Work Force Partnership, we have been discussing ways to use the successful program to engage adults in retraining programs – again, our observation is that some adults do not engage in STEM retraining because they have not been shown that these could be careers for them. As we “age” the program up, we are planning to introduce more specific invention and patent content. We are currently piloting a program at a community college for adults from 18 to 42, and will use this program this summer in Porterville, where we are partnering with ag tech companies to get students to both engage in STEM careers, and to create IoT inventions.

Qualcomm’s Invention and IP Culture

While building the STEM pipeline and attracting diverse talent is a key component of Qualcomm’s innovation culture, so too is encouraging patents for our inventions. These values work in tandem to ensure that every member of team, whatever their background, is participating fully in the innovation process. By working hard to attract a diverse and inclusive workforce, then integrating every engineer fully into our inventing and patenting work, we help to ensure that underrepresented groups fully contribute to Qualcomm innovations.

Patenting can be a complex and intimidating process, especially to engineers who have different skills and training, even in a larger company. Our inventor development program includes both online and in-person classes that cover both the basics of patenting and advanced team-building. Given the importance of patents to funding and encouraging invention across the wireless technology ecosystem, we also host invention sessions with engineers from multiple technology areas to encourage cross-functional information sharing.

Because patenting and licensing is a core feature of Qualcomm's business model, we highly value the contributions of our engineers and staff to the invention innovation process. We encourage and celebrate all our inventors, ensuring that they are adequately trained on how to obtain patents, and that they are recognized for their contributions to patented inventions. We also facilitate the submission of inventions to our internal database with a centralized web page that allows inventors and employees to search for Qualcomm innovations and submit new invention ideas to the repository.

It is particularly important to our invention culture to recognize contributions to Qualcomm's innovations. We are leading the world to 5G, and want our engineers to be a part of a team—both within their individual working group and within the broader company—that is focused and united around working together to invent the best technology that changes the world.

To that end, we celebrate all of our inventors. Engineers who contribute to inventions or who are awarded patents are given special "IP cards" to recognize their contributions, and are entitled to a notation in the company directory and on their business cards as patent holders. Monetary awards are also available to incentivize and recognize invention activity. Senior executives also send a congratulatory letter to each inventor who obtains a patent. For the most significant contributions to Qualcomm's patenting, we recognize "Master Inventors," an achievement awarded just 15 times since 2011.

In addition to internal recognitions, we publicize our inventions publicly. Our "Chronicles"¹³ page offers an interactive visual display of over 30 years of Qualcomm patenting, allowing visitors to learn about all of the innovations Qualcomm has contributed to wireless and mobile communications throughout its history.

About Qualcomm, Inc.

Qualcomm was founded in San Diego, California by Dr. Irwin Jacobs and Andrew Viterbi, two University of California at San Diego professors, along with five other leaders in the emerging field of wireless communications. It is the quintessential American success story of a highly innovative startup, whose deep commitment to R&D have positioned mobile as the largest and most transformative communications platform in history. In his 2011 testimony before Congress, Dr. Jacobs explained that Qualcomm "started small . . . but with the determination to innovate in digital wireless communications."¹⁴

¹³ <https://www.qualcomm.com/invention/chroniclesofinvention/index.html>

Efforts to promote commercial adoption of the CDMA standard, however, were not easy. Even after Qualcomm had successfully built and demonstrated a small CDMA system in the 1980s, a Stanford University professor decried the technology, stating that it “defied the laws of physics.” Yet the company persisted, by relentlessly anticipating the future of technology and investing in bringing it to fruition. For example, Dr. Jacobs was among the very first to envision that every person would eventually have their own phone number and communicate wirelessly. One of Qualcomm’s earliest products was a satellite-based vehicle tracking and communications system—an early precursor to GPS technology usage that millions of mobile phone users rely on daily to hail a ride or track their deliveries. Qualcomm recognized early on the ability of the digital cellular link to carry data as well as voice, leading to their development of communications optimized for data, and the first “smart phone.” Qualcomm also invented one of the early mobile “app stores,” a mechanism for safely downloading and running third party software on a phone.

In the three decades since Qualcomm’s founding, the mobile phone first used for simple voice communication has become an extraordinarily powerful mobile computer, thanks to Qualcomm’s innovative CDMA technology—the foundational cellular technology that has enabled every “G” of wireless technology and that continues to underlay the 5G revolution.

Today, the majority of Qualcomm’s employees are engineers whose focus includes long-term R&D on core wireless capabilities. Most of the research work is done at the company’s San Diego headquarters, and in New Jersey, North Carolina, and Texas. Qualcomm’s significant R&D projects require considerable investments of time and resources and may not be commercialized for up to a decade, if ever. Qualcomm’s dedication to R&D results in transformative inventions, including most recently with respect to 5G.

Broad licensing of Qualcomm technology has given rise to a healthy ecosystem consisting of smart devices, networks, and applications. The patenting of innovative technology ensures that this basic technology is publicly disclosed, allowing others to incorporate the technology into their own devices and innovations, and also to improve upon it. Qualcomm participates in and contributes substantially to standards-setting organizations, international bodies of engineers who contribute technology to standards that allow devices and products from different manufacturers and different countries to interact with one another, further encouraging innovation and collaboration.

No other company in the U.S. or Europe has made the same long-term commitment to 5G R&D. Revenue from Qualcomm’s licensing business is invested back into R&D to continue the cycle of innovation. For the past several years, the company has invested over 20 percent of its total annual revenue in R&D, bringing the company’s total R&D expenditures to over \$53 billion.

This level of private sector investment in wireless R&D—which is now being applied to the development of 5G wireless—is unparalleled anywhere in the world. No other U.S. company or government has made a commitment to developing 5G that rivals Qualcomm’s investments. This unique role in the development of 5G means that Qualcomm’s technology has critical importance to U.S. economic and national security interests.

* * *

Qualcomm's leadership in long-term R&D in foundational technologies like CDMA, 3G, 4G, and 5G is only possible because of our talented engineering workforce and a strong patent system that protects the intellectual property of our company. As our competitors overseas strengthen their own intellectual property rights, it is an economic and technological imperative for Qualcomm in particular, and the United States at large, to ensure that inventors from all background and perspectives can participate fully in our innovation ecosystem. Qualcomm is committed to ensuring that women, people of color, low-income individuals, and other inventors from other underrepresented groups can bring their talents to our innovation economy. We look forward to working with this Subcommittee and other members of Congress to support and develop policies that engineer the biases out of innovation, so the United States can continue to lead the world into the future.

Mr. JOHNSON of Georgia. Thank you, Ms. Armstrong.

And, I want to thank all of the panelists for their testimony today.

We will now proceed under the 5-minute rule with questions. I will begin by recognizing myself for 5 minutes.

Professor Cook, thank you for your pioneering work on how many African American inventors there are on patents. In your opinion, is there enough data available to understand the scope of the underrepresentation of racial minorities in patenting?

Ms. COOK. There is not.

Mr. JOHNSON of Georgia. What can be done to improve data collection? And are there any actions that Congress should consider?

Ms. COOK. I think there are a few.

First, I think it is imperative that we collect the data—and suggesting that this be collected separately. These demographic data being collected on gender, race, ethnicity, and so on would be—I think would be very useful.

I would add that adding veteran status and disability status would also be useful because the literature that I have talked about was burgeoning and is burgeoning, Assessment 2010. But there is a lot less on making an inclusive economy in other ways.

So, yes, I think that this is a big first step in identifying African American inventors and other inventors.

Mr. JOHNSON of Georgia. Thank you.

Director Lee, do you have an opinion on that question?

Ms. LEE. I do agree that collecting the data is critically important. From my time in government and also in the private sector, there is nobody that collects data better than the government in terms of accuracy and consistency over the decades. So, if the USPTO could collect demographic information, gender, and so forth, ethnicity, that combined with knowing what technology area the patent is in could give policymakers, agency leaders, private sector leaders, and academics a road map as to areas that are doing well, areas in need of improvement. And we can even compare data to international data points because patents from all over the world flow in through the United States Patent and Trademark Office.

So that sort of insight could be very, very influential and impactful.

Mr. JOHNSON of Georgia. Thank you.

This question I will pose to all four of the witnesses.

What do you think is the biggest obstacle to getting more women and minorities to participate in the patent system, beginning with you, Ms. Lee?

Ms. LEE. There are many. How many of our children—how many of our girls grow up dreaming to be inventors? I ask that question. How could we get more of them to? How can we give them more STEM skills education? How can we recruit and retain? How can we give them the know-how so that once they are professionals in STEM, they know about how to obtain a patent, that it need not be as expensive as one thinks, that there are discounts that are offered to small entities and micro entities. Really getting the information out there that anybody can file for a patent.

As you mentioned, Chairman Johnson, you don't even have to be a free person to get a patent. There is no age restriction. There is no gender restriction. Everybody should be able to get one, and they should know how to participate in the innovation economy.

Mr. JOHNSON of Georgia. Thank you. Professor Cook.

Ms. COOK. I think there are a number of things that could be done. I am on the board of the Lemelson Center for the Study of Invention and Innovation. And it has a spark lab. And I think that it has satellites all over the country. And it does this important work of showing students and schoolchildren how to not only invent but to innovate.

And I think this is the point at which you get in students' heads and children's heads that they can do this. And this is the research that was referenced before by Teddy et al., in terms of exposing children to innovation.

I certainly think knowing an inventor, a famous inventor like Percy Julian, certainly had this primordial—or planted this primordial seed to possibly study this. So I think it is really important to do this as early as possible.

I also think being vigilant with respect to making sure that the EEOC is paying attention to these issues related to workplace harassment and to discrimination. It is not just the pipeline that is the problem. What we are hearing from workers is that it is the climate that exists when they are adults. This unemployment rate, this difference is, I think, primarily due to issues like this.

So your keeping your eye on the ball and making sure that the Federal Government, the agencies tasked with doing so, keep their eyes on the ball with respect to harassment and discrimination will be extremely useful.

Mr. JOHNSON of Georgia. Thank you.

Dr. Howard.

Dr. HOWARD. So, one, it has to be part of the DNA. And the way that you do that is you bring in successful women, patent owners, and inventors from very early on because there are so many things that a woman entrepreneur has to deal with that patents is not in the purview. That is such a "I don't understand that value" a lot of times.

So, by exposing early, you at least start to dig a little bit into the problem.

Mr. JOHNSON of Georgia. Thank you.

Ms. Armstrong.

Ms. ARMSTRONG. And I would say I would echo what has been said along the table about the culture and getting children and minorities and girls into the STEM areas that tend to yield in patents.

I think there is also—and I think a lot of girls and minorities don't see themselves in those careers. And they don't necessarily see themselves as inventors. And they don't know anything about patents. And that actually applies, I think, also to early career women and minorities as well.

Unless you are in a company that stresses patenting and invention, every company stresses creativity and ambition, but I think there is a lack of access to practical tangible tools, perhaps pro bono work for the legal aspects of doing patents. But also, in so

many of these incubators that I see, there is a relatively small number that seem to have actual patenting classes or coursework to help their entrepreneurs write patents.

Mr. JOHNSON of Georgia. Thank you.

We will next hear from the Ranking Member. Well, actually, we will go to Mr. Chabot for questions.

Mr. CHABOT. Thank you very much, Mr. Chairman. I appreciate you going—I want to thank our Ranking Member for allowing me to go. We have got a Small Business Committee that I am the Ranking Member on after this, and so it was very kind of them to let me go.

I want to thank the panel members for their excellent testimony here this morning. I really did appreciate it.

And as you may know, we passed some legislation. Introduced it, but there were a lot of members involved. I want to thank the chair for his involvement and Ms. Velázquez and Mr. Schneider and Mr. Gohmert and a bunch of others for their involvement in it. It is called the SUCCESS Act, which basically stood for Study of Underrepresented Classes Chasing Engineering and Science, SUCCESS Act. We always make these things very long names. But, in essence, it called for a study within the next year on what we can do to increase women, minorities, veterans, and others in obtaining patents. Because as the testimony from the witnesses was, it is very challenging to accomplish that.

And so I guess my first question would be, as we are waiting for—and I will go to you, if I can, Dr. Howard, perhaps, first. And our congratulations, really, on your hard success and being a small business owner yourself and your years of dedication as a NASA scientist and all your other accomplishments, we commend you for that. So I will go to you first, I guess.

As we are waiting for this legislation and study to be—the legislation has passed. It passed the House. It passed the Senate. The President signed it into law. So it is the law. And it extended the patent, the fee structure for 8 years. But it also did what I just mentioned, to encourage women, minorities, and veterans to be able to obtain patents themselves.

As we are waiting for this study, what other things can we be doing in the meantime before the study comes back to accomplish some of those things so that folks aren't waiting for a year to get started? What would you suggest?

Dr. HOWARD. So there is a lot you can do with women and underrepresented entrepreneurs with boots on ground, as they say. So a lot of times we don't even know that this is an issue. I think that there is enough patent owners that would be like: I can come and I can talk to my local community, my local entrepreneurs in my area and work with them, because we have gone through it, and so we know the pain. And we are more than willing, most of us, to come back and help the community. So some of it making those connections.

Mr. CHABOT. Thank you.

In your testimony, you mentioned that one of the things that you would suggest, obviously get a good patent attorney, and they are expensive. You know, I wasn't a patent attorney, but I practiced law for almost two decades out there. Of course, I wasn't expensive.

But in any event, I mean, we charge. Yes, I did pro bono cases periodically. And you mentioned that it would be great if, perhaps, patent attorneys would do things pro bono, if we could find a way to do. And that is great. And some will.

But if you can't get enough of them to do that, then the only other way is paying those high fees or getting somebody else to do it, which means the taxpayer, meaning we have some government program that does it. Those are tough. We have got a \$22 trillion debt. So what can we do—and I will open this up to any of the other panelists as well.

If lawyers aren't going to provide free services, and we don't have the money to do it at the government because we got this \$22 trillion debt hanging over our heads, what can we do either to get lawyers to be more helpful or other things besides that?

Dr. HOWARD. So one thing, and this is just a wild suggestion. So most small businesses do have SBIR grants. Part of that is—there is no way to use it for patents or even partially for patents. And so it might be that that is part of the solution, right? Like, we have this overhead. Like, maybe we can use some of that somehow for patents. And so, yeah, it increases a little bit, but it is already part of the budget, is already part of your DNA. It is a wild suggestion.

Mr. CHABOT. Very good. Not that wild. Pretty good.

Any of the other panelists?

Ms. LEE. As the lawyer on the panel and as a former head of the United States Patent and Trademark Office, there are a lot of resources that are available to inventors. At the agency, I helped launch an initiative to offer pro bono services. Of course, it is never quite enough, right, given the demand. But there are discounted fees.

And I am very proud to say, during my tenure at the U.S. Patent and Trademark Office, I helped launch three of the four regional offices, one in Silicon Valley, one in Denver, one in Detroit, one in Dallas. And you know what? That is getting resources out into the local community so that those individuals there can have workshop training programs, can reach out into the schools, can educate the students on what is intellectual property, who can be an inventor, what does an inventor look like. We distribute baseball, but inventor, collectable trading cards at schools with images of women and minority inventors, right? And we have workshops where people, including women workshops, where they come in, they learn the basics of intellectual property: What is a patent, trademark, copyright, trade secret? How do I figure this out so I could be smarter so that when I engage that lawyer, I can be much more efficient, and I can even write the patent application myself should I so choose?

So there are a lot of resources that are available. There is a lot that can be done. But everybody should have access to the intellectual property system.

Mr. CHABOT. Thank you very much.

My time has expired, Mr. Chairman. Thank you.

Mr. JOHNSON of Georgia. Thank you.

We will now hear from the gentlelady from California, Representative Zoe Lofgren.

Ms. LOFGREN. Thank you very much.

Director Lee, it is good to see you again. This is my second iteration on the PTO report on women inventors. We had the current director out at the San Jose patent office, and we were talking about the role we both played in making sure that office got open. And I will tell you, it is a huge success. So thank you for the efforts that you made, and the community is very supportive.

And one of the things that is so helpful is to have the patent examiners right in San Jose. I mean, the big companies can afford to send people out here to the D.C. area. But for the smaller inventors, the proximity is really a big deal. So it is filling a good mission.

You know, as I am thinking through and thinking back on the discussion we had at the San Jose office, we are falling short in diversity from the beginning with—and it actually gets worse the older people get. We have got girls coding, but the actual number of women entering computer science programs at the university level is declining. And we know we have a problem in industry as well as academia.

So the question is, what can we do about that? And I don't think there is any one answer. But I do think, just focusing on the role of business, because most patents are filed out of the business sector. Comparing even the patent innovation in the academic setting to the business sectors, the business sector does not appear to be doing what it needs to do.

And after the policy discussion we had in San Jose, a lot of the representatives from the companies we were asking, we will need to examine our own procedures because not only is this not good for the country; it is not good for these companies. They are losing out as well.

So I am wondering—you know, I always remember a convention I went to with my then-chief of staff, who was female, at the Santa Clara—city of San Jose convention center. Huge, huge room. It was engineers, electrical engineers, in the valley. And we walked in, and it was like a sea of men. And we looked, and there were like maybe 10 women of the thousands of engineers who were—who kind of glommed together. And I thought, you know, you don't have to have a hostile work environment in the legal sense to not have a welcoming environment.

How do we go about setting metrics to change that? I mean, we can't tell employers how to run their businesses directly. But what could we do as a Congress to kind of help companies move a different direction?

Michelle, you have been at the office. You have been at Google. You have been a patent lawyer. What are your thoughts?

Ms. LEE. Yes. So thank you, Congressman Lofgren. And thank you also for your leadership in establishing the Silicon Valley office. That was a great partnership.

I do think it is critically important that the data be gathered, because companies, even if they gather it, they sometimes don't publish it.

Ms. LOFGREN. Right.

Ms. LEE. And if the government could gather it across the board, across the country, across all ethnicities, across all demographics, and compare that to countries across the world—I understand that

in Romania, the number of researchers in engineering who are women is 44 percent.

Ms. LOFGREN. Right. Canada is also different. I mean, it is not about gender; it is about what we are doing.

Ms. LEE. Correct. So I think it is important to record the data, track the progress, and, therefore, pinpoint and focus by technology area, by industry, because it varies. In the life sciences, the numbers are higher.

Ms. LOFGREN. Right.

Ms. LEE. In computer science, it is much lower. So let's be specific, let's be granular. And Federal agencies, like I say, they collect data over decades, and it is accurate. And that is a very good starting point. So then private sector, policymakers, academics, they can all look at how to improve, where do we need to improve.

Ms. LOFGREN. So one thing that I want to explore is, you know, as we looked at the diversity issue in Silicon Valley, in my district, we said, you know, if you can't measure it, it doesn't exist. I mean, you have to start measuring it, and the big companies did. I mean, Google, in particular, went on a huge effort. I am not saying they succeeded completely, but they have, on diversity and the hiring, published their data and the like.

We could—I think we have jurisdiction, because of our EEOC jurisdiction, to require publication of some of this data. Is that a step that the four of you would recommend?

Ms. COOK. Yes. Excuse me. If I can answer, yes, that would be a huge boon to researchers, but the way they release the data, I can't do anything with them. I can make some good charts, the charts that they make, but I can't do any sort of analysis. Typically, for race and ethnicity, for example, they are bundled into the world workforce.

Ms. LOFGREN. Right.

Ms. COOK. Women are often not divided by technical fields and other fields. And what we know is that they are typically in marketing and in human resources. So I think if you are asking the question about what we can do now, I think one of the things that we are doing in the economics profession is doing a climate survey and coming up with results that are being circulated widely.

And I think it is the climate. I really think it is the climate. It is not the—the supply side. We figured that out. There are a lot of women who would like to be in the tech field, for example, or be an entrepreneur, inventor. This is what I was doing at the—at the White House when I was working on small businesses. But we don't have as much information, and we don't have as much sway. And you all would with the EEOC data, for example, to do something about the climate in particular.

Ms. LOFGREN. All right. Thank you, Mr. Chairman.

Mr. JOHNSON of Georgia. Thank you. We will next hear from the Ranking Member of the Subcommittee, the gentlelady from Alabama, Mrs. Roby. You are recognized for 5 minutes.

Mrs. ROBY. Thank you, Chairman. And again, thank you all for being with us today.

I want to pick up where we left off, Director Lee. We were talking about, with my colleague, the patent pro bono program which provides the free legal services to eligible inventors, the PTO's pro

se assistance program which allows inventors to file their own application and seek the assistance of the patent examiner to identify patentable invention, and the PTO's law school clinic program which allows supervised law students to help inventors file applications. And I guess what I want to hear from you is about, do inventors know that these programs even exist? And if more inventors were aware of these programs, would it likely result in more women and other underrepresented groups filing more patent applications?

And I would go a little bit further to say, it is buried in the website. You have to go through several different clicks before you actually find this information. And so if today's hearing is about making this information more accessible, to me, on the surface, that seems like a really easy fix in terms of the USPTO making this information more readily available. So if you want to weigh in on that, that would be great.

Ms. LEE. Right. Well, thank you for raising the point. So I do not believe that as many people who should know about the programs do know about the programs. So there is a lot more work to be done. And one of the reasons why I was so passionate about the regional offices of the U.S. Patent and Trademark Offices is because we have inventors and potential inventors all over this country. And the distribution geographically of patent holders is not equal.

So those offices, the vision is not just to put examiners in a room and have them process patent applications. When I defined the vision for those regional offices, it was to engage with the community. Having been a user of the USPTO services for the entirety of my career, they offer all these amazing services that, oftentimes, people do not know about.

So through the regional offices and through a lot of hard work at the headquarter office, a core part of the USPTO's work is to get the word out there about the many programs that are available and to tap communities that are underrepresented. So there is more work to be done, but there are great programs, more programs to be developed, but you really have to get the word out there.

Mrs. ROBY. Well, and just to reiterate the point, I mean, if you are—if expense is already an issue and traveling to the regional offices is part of the expenses associated with pursuing this, it makes sense, when we all do everything on this—

Ms. LEE. Right.

Mrs. ROBY [continuing]. All day long, that it could be as easy as visiting the website and having access to that information.

But would it make sense to take the opportunity as well, while the PTO is on campus recruiting science and engineering students, to promote the benefits of patenting by these students and to bring their attention, at the same time, to the existence of many of these assistance programs, so that later in life, even, the students and their businesses can be PTO customers?

Ms. LEE. Absolutely. Any touch point you can have with the local communities, particularly the underrepresented ones, including at career recruiting services, or when they are in elementary school, giving them an inventor baseball card so that one day, they think,

huh, there is the Patent and Trademark Office and if I have an idea, guess what, I can file for a patent through that agency. Any touch point is good.

Mrs. ROBY. That is great. And then just building upon that—because you mentioned it, Dr. Howard, —in your testimony—can you let us know, when did you become aware of the PTO pro bono program, its law school clinic program, and its pro se assistance program?

Dr. HOWARD. Alas, I can say about a week ago. Actually, basically trying to figure out what—reading the report that came out in terms of women and underrepresentation, which is—and I am in this world, and I mentor a lot of young students, women entrepreneurs in Georgia and at Georgia Tech, and, unfortunately, I didn't hear about a lot of these programs.

Mrs. ROBY. So I think you just put the exclamation point on my point, that someone as knowledgeable as you are didn't even know the existence of these programs.

So, Mr. Chairman, I would suggest again that there are some pretty easy fixes here in terms of accessibility.

If anybody else—I have got 10 seconds—wants to weigh in, but I think this is a really important point. These programs exist and can be expanded, and we ought to be looking at ways that we can do that.

Ms. COOK. I would just add that the SBIR and STTR programs are also not very known to inventors and to entrepreneurs, especially underrepresented minorities.

Mrs. ROBY. Thank you, Mr. Chairman. I yield back.

Mr. JOHNSON of Georgia. Thank you.

We will next have Representative Stanton from the great State of Arizona.

Mr. STANTON. All right. Thank you very much, Mr. Chairman. Thank you for highlighting this incredibly important topic and how, if we can help to work on this issue and do better on the issue that these outstanding witnesses have discussed, how it will benefit the American economy.

I am lucky enough to represent the district that includes Arizona State University, is ranked number 17 of all universities worldwide for U.S. patents, so in the top 20. Includes MIT, Stanford, Johns Hopkins, and Harvard. So I am extremely proud to represent an innovative community that cares so deeply about advancing ideas that will undoubtedly have a significant impact not only in Arizona, but across the globe.

However, we are lucky in Arizona and across the country, we are growing in diversity. It is one of our great competitive strengths, but if that is not represented in the growing number of patents, we are not doing our job. It is simply not acceptable that women inventors made up only 12 percent of all inventors on patents granted in 2016.

There is no good reason why leaders in our African American, Hispanic, and other minority communities, why they are so extremely underrepresented in the patent system of our country. There is no good reason why we don't do a better job of collecting information so we can provide better solutions so that the great di-

iversity that we are lucky enough to have in our country can be better represented in our patent system.

So thank you for holding this hearing to talk about these important subject matters and what we in Congress and America can do to help solve this issue.

Ms. Cook, Professor Cook, I wanted to ask you a particular question. I read your testimony in advance. I hope it wasn't covered when I wasn't here, but I was mostly interested in what you indicated about the loss to the American economy. If we don't have greater diversity in our patent representation, it is not just a loss to the individual scientist; it is a loss to all of America. And I wanted to give you a chance to maybe expound upon that point to better explain to people watching here and to Congress how this hurts the American economy.

Mr. COOK. So it is interesting that you would pick up on that. One of the most stark results that I had early on in my research was that single-sex teams were less productive than co-ed teams, and that is what I was being invited to Silicon Valley firms to talk about the most. And I think that makes the economic argument on a micro level. We are leaving—and you know economists hate to do this—we are leaving \$20 bills everywhere. I would say they are Benjamins; they are not even \$20 bills—displaying them everywhere, and we are not picking them up.

This is invention that is going undone. This is higher living standards that are going missed by all Americans. So we should certainly consider that from a policymaking perspective and from the work perspective, the firm's perspective, that it is not making use of this human capital and of America's inventive capacity.

Mr. STANTON. I think that is a great point. America is the world's leading economy, we want to keep it that way. And working with you and others to solve this issue, to make sure that the great diversity that we are blessed to have in America is better represented in our innovation ecosystem, including in patents, that will make the American economy more competitive on a global scale. It is really important.

Thank you for your testimony.

I yield back.

Ms. ARMSTRONG. Representative Stanton, could I add something to that?

Mr. STANTON. Please do.

Ms. ARMSTRONG. I think it is—I love the research data that shows the economic benefit, and I also think it is a very—it is a global issue. And it is a very strategic issue. If you look at the WIPO report, in Korea and China, the numbers for women patenters—patent holders are much higher and growing significantly. And I think we can't afford, strategically as well, to let that trend go unnoticed.

Mr. STANTON. Thank you very much. I guess I still have a minute. So other witnesses, comments on the impact, on the America economy that we are not doing a better job of making sure that women, people of color, are more represented in the innovation ecosystem.

Ms. LEE. Yeah. Just one final point is, not only is it an imperative in an increasingly competitive international landscape, but

some of our most innovative companies cannot hire the technical talent they need, and they are turning overseas to fill the gaps. And they are turning to Congress to alter immigration laws and so forth. So clearly there is an economic imperative as well as a social imperative.

Mr. STANTON. Thank you. I yield back.

Mr. JOHNSON of Georgia. Thank you.

We will now hear from the great Representative from Virginia, Mr. Cline, for 5 minutes.

Mr. CLINE. Thank you, Mr. Chairman.

And thank the witnesses for being here today. This has been very interesting testimony on a very important subject.

As the father of two 7-year-old daughters, I want them to have every opportunity to succeed in whatever field they go into, and I very much encourage the foray into sciences. They are already taking coding classes in school. I didn't even—I couldn't even believe it, in first grade, that they are already teaching coding in the schools, and that is fantastic.

But I am intrigued by the numbers, and I am looking forward to the report, because I think it will provide a little bit more information about, as you were saying, Professor Cook, about the different areas of research. And while women may make up an equal number of scientists in biological and life science fields but not in other areas of science, like engineering, what I am interested in, we have made some progress, and the PTO's recent report indicates that the percent of patents with at least one woman inventor increased from 7 percent in the 1980s to 21 percent by 2016. Would you consider that to be a positive sign, and why has the growth rate slowed since 1998, from 14 percent to 21 percent in 2016, while more and more women are entering scientific fields?

Ms. COOK. So that is a—that is a really good question. And, in fact, that was the starting point of my research in 2010. I saw all of these women going into biological sciences. At the time, I was at Stanford, and I just thought, there is so many opportunities in biotech, why aren't we seeing women among the inventors? So I think that this is definitely a big issue.

I think making sure that there are interesting things for your 7-year-old girls to do, that are just like the things that men would like to do, boys would like to do, I think is a big deal. If we walk down the aisles of a party goods store and you are looking for items for parties, all the pink stuff is princess stuff and all the interesting stuff, like Star Wars and having to do with innovation, is for boys. So I am—I think we really have to start early in terms of the messages we give to students.

And my professors, my colleagues, who talk about having hackathons, say that women typically don't come because they don't find these interesting problems that they are trying to solve. So for all the coding that the women are learning, there are no outlets for them that they find interesting. And I am not going to say the bar is higher for women in terms of interesting projects, but I think at least one can be sensitive to that.

Mr. CLINE. And to the numbers in the recent slowing of the growth rate since 1998, do you think—I mean, do you have any ex-

planation for that? Does it have to do with developments in certain segments of the industry? What would you say to that?

Ms. COOK. I think the patent teams are getting larger, and we know that, patent teams are getting larger. And I think that is just a feature of patent teams getting larger, that women happen to be on them. And I think you just met an equilibrium—the stagnation equilibrium. But what we know from other STEM fields is that there are fewer women going into the fields and going into Ph.D. Programs. So that may be a reflection of what is happening on the front end too.

Mr. CLINE. Would anyone else like to add to that?

Ms. LEE. So there was an interesting statistic that in computer science in particular, in the 1980s, like in every other scientific discipline, the numbers were going up, in some areas faster than others, but in computer science, it went down, and people are asking why. And if you look back, there was an article written that, at the time, the personal computer was being introduced, and affluent parents bought their sons personal computers and they learned how to program. So when these kids then go to college and take computer science classes, if you have had experience computer programming, you are going to do pretty well in that computer science class, but if you have never touched a computer, it is going to be a lot harder. So even if you have the intention to enroll in a computer science program, when you have that first class, it is hard.

So what we buy our kids, in terms of toys and activities we engage them in, matter tremendously. And also, if you think about it, the images in the media, about that time, you know, *Revenge of the Nerds*, the images of computer geeks, antisocial, if you are a woman or a girl, who wants to be that? So a lot has to do with image, but a lot too has to do with the toys, the programs, the activities we give to our boys versus girls.

Mr. CLINE. We are buying a lot of Legos in the house right now, but I am also glad in culture—and I see Ms. Lofgren has stepped away, but talking about the climate, I am glad that *Captain Marvel* is a woman. And that movie is coming out now, so I can't wait to take my girls to see that.

With that, Mr. Chairman, I yield back.

Mr. JOHNSON of Georgia. Thank you.

Next up will be the Chair of the Democratic Caucus, New York Representative, Mr. Jeffries, for 5 minutes.

Mr. JEFFRIES. I thank the distinguished Chair of the IP Subcommittee and all of the witnesses for your presence here today.

It seems when you address this diversity challenge that we are confronting in the STEM industry, that there is a recruitment issue that is problematic, that many of you have spoken to, but there is also a retention issue. And if you solve the recruitment issue but don't deal with the retention issue, you know, at the end of the day, you haven't really meaningfully addressed the problem.

And, you know, maybe starting with Professor Cook, but I would be interested in everyone's perspective, what are some of the retention challenges that people of color and women face in the innovation economy?

Ms. COOK. So thank you for your question. I think that one of the things that is becoming more and more evident is that the cli-

mate in many of these patenting firms is not what it should be. And because they are demonstrating—because there are workers from these companies demonstrating, we should listen to them. And if you can do anything, have any sway over, say, the EEOC pursuing these claims, I think that would make a big difference.

There has to be some outside force, because they have not been able to police themselves in this way. We can make the argument—I can go to these firms and talk about the money that is being left on the table because patent teams are single sex rather than co-ed. I can talk about that. I make the profit maximization argument, but I think on the other hand, there has to be enforcement, EEOC enforcement. And there seem to be a lot of things going on that need a watchful eye.

Mr. JEFFRIES. Director Lee, can you comment on sort of the culture at these institutions that may be impacting the ability to retain talented women and/or people of color?

Ms. LEE. Yeah. I mean, it is hard when you don't see people who look like you, and it is hard when they don't look like you in more ways than one. So to the extent—now, that shouldn't stop us from, you know, inspiring those underrepresented minorities to pursue these fields, but greater networks, greater support, greater retention efforts, greater consciousness, measuring the data, focusing on areas that need improvement, it is—it should be within the priorities of a business to want to have these diverse teams. Because as Professor Cook says, diverse teams, if you are thinking about creating something innovative that has never been done before, you get the greatest innovation—and studies have been done on this—with people with different perspectives, who don't look at the problem the same way.

Mr. JEFFRIES. Ms. Armstrong.

Ms. ARMSTRONG. Being from one of these companies who struggles, frankly, to not only recruit, but to maintain a diverse workforce, there is a lot of challenges that have been talked about here as well. And one of them, frankly, is, how do you create this snowball effect. You know, when I was always the only woman in the room, especially when you work overseas, and how do you create an environment where, especially some of the younger people want to work in—people want to work in an environment where they see a diverse team or a set of people that look like them as well.

And so, you know, it is very hard to come up with a set of magic bullets, but there is a number of things that we are working on. Implicit bias does exist. I am sure it exists in all of us. So we are trying to engineer that bias out of our systems, out of our review systems, and out of our project rotation systems, and then certainly recruiting and also trying to show that Qualcomm is a—and semiconductor and wireless technology is a really wonderful place to have a career. But it is a challenge.

Mr. JEFFRIES. Thank you.

And, Professor Howard, if you can just comment briefly in connection with your testimony about sort of the high cost of obtaining a patent and that as a barrier to entry for greater levels of diverse participation. I think you have spoken of sort of the patent fees as well as the cost of representation as challenges that people face, women or people of color.

Dr. HOWARD. Yeah. So the patencies themselves I wouldn't claim is as much of a challenge, but it is basically prosecuting, i.e., going, doing the dance with the patent examiner to finally get the patent issued, that is really the problem. That is the majority of the problem. And if you are a small business, especially women or under-represented, every single dollar you have is primarily so that you can support the business, especially since the angel MVC is not as on par with other groups.

Mr. JEFFRIES. Thank you.

And, Mr. Chairman, hopefully that is one of the things that we can examine in moving forward, in terms of barriers to entry. And I yield back.

Mr. JOHNSON of Georgia. Thank you.

At this time, we will hear now from the Representative from the State of California, the great State of California, Representative Lou Correa, 5 minutes.

Mr. CORREA. Thank you, Mr. Chairman and Ranking Member.

And I want to thank you for putting on this most important hearing. And I want to thank the members of the panel. I have really enjoyed your comments.

I come from California, central Orange County. I represent a district that is essentially very, very blue collar, heavily immigrant, folks that are just trying to make it on a day-to-day basis. That is a doughnut hole. The doughnut, I am surrounded by biotech, high tech, and our challenge is to make that jump. It is very difficult to make that jump from getting our young men and women graduating from high school to work in the biotech sector.

Ms. Lee, I was very pleased to hear that there is all these programs out there, that are very well kept secret, and I hope the Chairman and Ranking Member, all of us can work to get the message out that these programs are there.

As I thought of your comments, I thought back to my days getting my MBA, the concept of actual versus perceived risk. Getting an MBA, a lot of my colleagues, top-class engineers, scientists, getting their MBAs, top schools, all of us dream of hitting it big, the entrepreneurship, you know, the American Dream. Yet a couple of years out, after you stumble a couple of times, you say, you know what, I am going to go after that steady paycheck. I am not going to go and risk my family. I want to start a family. Actual versus perceived risk.

Later on we find out, 15, 20 years later, that you are going to get laid off from that big company, so maybe you should have gone and become an entrepreneur, started your business, so your destiny would have been in your own hands. That is what I am saying, actual versus perceived risk.

And I ask all of you—Ms. Cook, I think you said we got to start out early. But I think we have got to change the mentality of our young folks that are getting their education, which is, we need to develop, not tolerance, but the expectation that in your life, you should be able to take these kinds of risks, do research and development. And maybe the Qualcomms of the world can step up and say, you know what, we are going to, not subsidize, but we are going to invest in R&D and diversity, not because it is the right thing to do, but because it is a smart business thing to do.

You look at a problem from a different perspective, whether it be cultural, societal, language or otherwise, you are going to come up with a great idea that is going to sell. Good business. The challenge is, how do we get our young people to understand that it is safe. It is not really that risky to be an inventor, to go off and engage in being an entrepreneur.

So I am running out of time here, but I would ask all of you to think—I would love to talk to you later on offline about how we roll out some of these programs. I close my eyes, I envision my high schools in my district. I started a program called Young Congressional Leaders. I meet with the kids Saturday mornings to go show them the biotech, the other career opportunities. But we don't talk much about being inventors. You know why? Because I have a lot of friends that tried to be inventors many decades ago and they fell flat and they ran for cover. And we need to teach those young folks, instead of running for cover, push harder and become inventors.

Our country is essentially founded on entrepreneurship. Our country is founded on innovation. And we need to push those folks in the doughnut holes in our society to move on and take command of their lives and our communities.

So I have 45 seconds left. But, again, love to sit down and talk to you. I am going to take names, I am going to take numbers. I want to talk to you about how do we roll out—Ms. Lee, how we teach our kids about these programs. I want to see my schools, my high schools, actually implement some of your programs. The pushback I get is, we don't have any money, Lou, we can't do this. And you are saying that there is money out there. We got a disconnect.

Mr. Chairman, I yield.

Mr. JOHNSON of Georgia. Thank you.

Next, we will hear from Ranking Member Roby once again.

Mrs. ROBY. Well, I just—thank you, Mr. Chairman.

I just have one other statement that I want to make. The infrastructure for the law school clinic and the pro-se assistance programs that we have already discussed, that infrastructure, Mr. Chairman, is already in place. So expanding these programs to other universities would be of no additional expense to either the taxpayer or the patent applicants, and I think that is an important point to make as well. So if we are really serious about access to this information and to these programs, then this can be done already. So that is all I had to say.

Thank you again for being here. Really appreciate your participation. Look forward to continuing to work with each of you to how we can do this better.

So thank you, Mr. Chairman. I yield back.

Mr. JOHNSON of Georgia. Thank you.

This has been a very important first hearing for this Subcommittee. I would like for us to continue on this topic as we proceed through this session of Congress, and on into other sessions of Congress to come. I want to thank our witnesses for being here today.

And without objection, all members will have 5 legislative days to submit additional written questions for the witnesses, or additional materials for the record. And the hearing is now adjourned.

[The information follows:]

[Whereupon, at 11:32 a.m., the subcommittee was adjourned.]

MR. COLLINS STATEMENT FOR THE RECORD

**Statement of Ranking Member
Doug Collins
Hearing on “Lost Einsteins: Lack of Diversity in Patent Inventorship
and the Impact on America’s Innovation”
House Judiciary Committee
Subcommittee on the Courts, IP, and the Internet
Wednesday, March 27, 2019, 10:00 AM**

Thank you, Mr. Chairman. I appreciate the opportunity to discuss these important issues.

The Framers of the U.S. Constitution had the foresight to recognize the importance of the patent system to the success of the United States. Patents mitigate the risk of investment by protecting inventions from copying and outright theft. America’s aggressive investment in research and development, and its creation of so many new innovations, translate into billions of dollars for the U.S. economy and countless high paying jobs. Due in no small part to the patent system, America has become, and for a very long time, has maintained its position as the undisputed leader in innovation. We are home to the world’s greatest inventions and the world’s greatest inventors.

As just one example, a team of researchers at the University of Georgia developed an enzyme therapy to treat a genetic disease that kills infants by the age of 4 months. They discovered a way to alter the genes of chickens, to produce protein-based medicines, in their eggs. Of course, they patented their inventions. In 2015, the biotech startup they formed to bring this life-saving product to market was bought for 8.4 billion dollars. This is just one example of how America's inventive minds are continuing to reach new heights.

But when I read the U.S. Patent & Trademark Office's recent report on patenting by women inventors, I was troubled. Estimates that women inventors make up only 12 percent of all inventors is shocking. How much amazing technology has been invented in this country that never saw the light of day? How many life-saving products were never made? How much information was never disclosed to the world upon which the next brilliant mind can build?

That is why I invited Dr. Howard here today, to tell her story of her amazing success in the lab, but the relatively few patents she has to show for all of her brilliant work. Dr. Howard's credentials are most impressive. Today, she is a professor and Chair of the School of Interactive Computing at the Georgia Institute of Technology. She is also the Chief Technology Officer of Zyrobotics, a company that develops robots that use artificial intelligence to help children with disabilities. Before that, she was a NASA rocket scientist and robotics researcher. I could continue reciting her list of achievements forever.

But even with such outstanding talent, her professional success has not translated into a commensurate number of issued U.S. patents. That is why I am looking forward to hearing from her, and all of the outstanding witnesses here today, on their experiences with the patent system, and to learn more about research on why women represent so few inventors named on

U.S. patents. Most importantly, I want to learn what we can do to promote additional patenting by this untapped American resource.

With that, I yield back the balance of my time.

APPENDIX
MATERIAL SUBMITTED FOR THE HEARING RECORD

Questions Submitted for the Record from Subcommittee Ranking Member Roby
Lost Einsteins: Lack of Diversity in Patent Inventorship and the Impact on America's
Innovation Economy

Question for All Witnesses

1. What recommendations have you for the United States Patent & Trademark Office and the Small Business Administration to help promote the participation of women and minorities in entrepreneurship activities and the patent system?

Questions for Michelle K. Lee, Former Director of the U.S. Patent and Trademark Office

1. The U.S.P.T.O has at least three existing programs for helping inventors cost-effectively apply for patents. They are the Patent pro bono program, the Pro Se Assistance Program, and the Law School Clinic Program. Would expanding access to these programs provide an immediate solution to assist women and minority inventors who have an invention but lack the means to apply for a patent?
2. What suggestions do you have for the U.S.P.T.O. to make their inventor assistance programs more widely known so that more inventors are able to participate in the patent system?

Questions for Dr. Ayanna Howard, Professor and Chair, School of Interactive Computing, Georgia Institute of Technology

1. You testified that small business programs that provide funding to small businesses may prohibit the use of any of those funds to secure patent protection. Should the U.S.P.T.O. work with the Small Business Administration to identify which small business programs should be amended to allow inventors to use funds to secure patents?
2. At what stage in a company's development does the investment in securing a patent make the biggest difference to the growth and overall health of a new business?

Question for Lisa D. Cook, Associate Professor of Economics and International Relations, Michigan State University

1. I find it surprising that in its recent report on women and patenting, the U.S.P.T.O. found that gains in female participation in science and engineering occupations and entrepreneurship are not leading to broad increases in female patent inventors. Is promoting greater participation by girls and minorities in STEM education and by women and minorities in STEM careers at some point going to increase the number of

women and minorities filing patent applications, or is awareness of the patent system by these underrepresented groups the answer?

Question for Susie Armstrong, Senior Vice President, Engineering, Qualcomm, Inc.

1. Can you explain why it is beneficial to companies to ensure that all of their inventors are aware of the value of patents, both to the employees individually and to the overall health of their employer, so that companies consider filing patent applications on all valuable inventions conceived by their employees?

**Questions for the Record Submitted by the Hon. Michelle K. Lee,
former Under Secretary of Commerce for Intellectual Property and Director
of the U.S. Patent and Trademark Office**

**Hearing: “Lost Einsteins: Lack of Diversity in Patent Inventorship and the Impact on
America’s Innovation Economy,” March 27, 2019 at 10 am EST,**

**U.S. House of Representatives Subcommittee on Courts, Intellectual Property and the
Internet Committee**

**Questions Submitted for the Record from Subcommittee Ranking Member Roby
Lost Einsteins: Lack of Diversity in Patent Inventorship and the Impact on America’s
Innovation Economy**

Question for All Witnesses

1. What recommendations have you for the United States Patent & Trademark Office and the Small Business Administration to help promote the participation of women and minorities in entrepreneurship activities and the patent system?

Answer: The U.S. Patent and Trademark Office (USPTO) could help promote the participation of women and minorities in the patent system as well as entrepreneurship activities in a number of ways.

First, the USPTO could consider collecting and publishing demographic data on its patent and trademark applicants. Understanding there may be sensitivities surrounding the collection and publication of this information, the Agency should engage in rule making to determine whether, how (including voluntary or mandatory disclosures), and what to collect (e.g. gender, age, ethnicity, veteran status). The Agency might also seek input on how best to share this information including by publishing a report summary and possibly providing application programming interfaces or “APIs” to the data for ease of study and use by external stakeholders.

Second, to the extent it does not do so already, the USPTO should consider systematically recording and monitoring participant numbers for all of its education, outreach and inventor assistance programs including through its Regional Offices and Inventor Assistance Center. As with the first suggestion, measuring and knowing who uses various of its many services will help the Agency provide better support through more effective and targeted programs and better allocation of resources. For example, if the women’s workshops are not well attended, it would be helpful to have a baseline measurement of numbers to aid in setting goals and timeframes for improvement over time.

Third, the USPTO should continue and (resources permitting) expand the many programs offered by the Agency in support of inventors and entrepreneurs including (1) AllInSTEM, (2) Camp Invention, (3) the Girl Scout IP patch, (4) the inventor trading cards, (5) inventor workshops, (6) outreach programs targeting schools, universities and technology incubators, (7)

the Patent Pro Bono and Pro Se Assistance programs, and (8) the Law School Clinic program, all with an eye toward increasing participation by women and other under-represented groups.

Fourth, the USPTO should work more closely with the Small Business Administration (SBA) including co-hosting more events, to reach a broader audience about the services and support offered by both the USPTO and SBA. There is much overlap between the target audiences of the USPTO and SBA. Even if the USPTO and SBA cannot co-host events, the USPTO should consider providing training and access to the USPTO's educational information and content so the SBA team can share with its stakeholders as appropriate. Similarly, the USPTO should consider obtaining educational information and content from SBA to share with appropriate USPTO stakeholders.

Questions for Michelle K. Lee, Former Director of the U.S. Patent and Trademark Office

1. The U.S.P.T.O has at least three existing programs for helping inventors cost-effectively apply for patents. They are the Patent pro bono program, the Pro Se Assistance Program, and the Law School Clinic Program. Would expanding access to these programs provide an immediate solution to assist women and minority inventors who have an invention but lack the means to apply for a patent?

Answer: Yes. The Patent Pro Bono and Pro Se programs in particular could benefit by expanding to achieve broader and deeper coverage.

2. What suggestions do you have for the U.S.P.T.O. to make their inventor assistance programs more widely known so that more inventors are able to participate in the patent system?

Answer: As discussed at the hearing, certainly improving accessibility of information on the USPTO website to make it easier to find relevant information would help. Over the years, the USPTO has made improvements to its website, but further improvements can always be made.

In addition, to the extent not already done, the USPTO should systematically mention these programs at all appropriate stakeholder outreach and engagement events, including through the four Regional Offices in Dallas, Denver, Detroit and Silicon Valley. These Regional Offices afford great reach nationwide and are led by Directors who know the communities and are therefore able to target the relevant groups with greater precision.

Also, given the many resources offered by the USPTO to inventors and entrepreneurs, the Agency could consider creating a “leave-behind” card at events and/or providing a QR code. This QR code could be scanned with a mobile phone and direct the user to content such as a summary of key inventor resources and links to where on the USPTO website to find more information. The “leave-behind” card could also contain such summary and link information. In my experience, many of the USPTO team members do mention these programs, but unless there is something written down that can be easily referenced when needed, it is easy to forget about these resources and/or where to go to learn more.

Questions Submitted for the Record from Subcommittee Ranking Member Roby
Lost Einsteins: Lack of Diversity in Patent Inventorship and the Impact on America's Innovation
Economy

Responses Submitted by Dr. Lisa D. Cook
April 15, 2019

Question for All Witnesses

1. What recommendations have you for the United States Patent & Trademark Office and the Small Business Administration to help promote the participation of women and minorities in entrepreneurship activities and the patent system?

Response

In addition to the USPTO collecting demographic data on patent applicants to measure participation in the patent system, I would suggest the following measures for the SBA:

- Strengthen the SBIR and STTR program such that introductory, networking, recruiting, road-show and other recruiting activities and target women and underrepresented minorities and women, including holding regular events in geographic areas where such populations are present;
- Introduce mentoring efforts in the SBIR and STTR programs with augmented attention to women and underrepresented minorities, including by engaging successful innovators from these groups as formal mentors to all aspiring or current participants in these programs; and
- Enhance the SBIR and STTR program such that reviewers of proposals are from diverse backgrounds, e.g., good representation of women and underrepresented minorities.

I would recommend the following measures for USPTO based on their current programs.

- The USPTO offers education and outreach programs for students, educators, inventors and innovators. Its Patent & Trademark Resource Centers are part of a network of public, state, and academic libraries that support inventors and small businesses with trademark and patent assistance. Staff in its four regional offices collaborate with start-ups, job-growth accelerators, and technology organizations in their regions, assisting with intellectual property services. I would recommend that the USPTO intensify its outreach and recruiting efforts to include places where (potential) inventors, entrepreneurs, and STEM students who are women and underrepresented minorities are concentrated, e.g., HBCUs, women's colleges, large engineering programs, National Society of Black Engineers conferences, etc.
- The USPTO's education programs include its National Summer Teacher Institute, a professional development training program for teachers. The program's goal is to inspire and support STEM learning in the teachers' classrooms. The USPTO could

intensify its outreach and recruiting efforts to include places where teachers in training who are women and underrepresented minorities are concentrated, e.g., HBCUs, women's colleges, and large urban university campuses, to participate in the USPTO's University Outreach Program and bring in a USPTO to speak about important aspects of intellectual property.

Question for Lisa D. Cook, Associate Professor of Economics and International Relations, Michigan State University

1. I find it surprising that in its recent report on women and patenting, the U.S.P.T.O. found that gains in female participation in science and engineering occupations and entrepreneurship are not leading to broad increases in female patent inventors. Is promoting greater participation by girls and minorities in STEM education and by women and minorities in STEM careers at some point going to increase the number of women and minorities filing patent applications, or is awareness of the patent system by these underrepresented groups the answer?

Response

Promoting greater participation is one component of the solution. For example, the literature has shown that women and girls benefit from having role models in STEM fields and in the innovation economy. The only way to get these is to produce more of them. However, increasing participation is not a panacea.

Further efforts are needed to make the innovation economy inclusive. Such issues include mentoring, exposure to invention, blind patent review, and workplace climate.

Mentoring

Mentoring has been broadly suggested as one tool to address the gender and race gap in STEM careers. As aforementioned, Chetty et al. (2018) show that the income, race, and gender gap in invention is primarily due to environment barriers in acquiring human capital – a lack of mentoring and exposure to careers in science and innovation in childhood – and not due to differences in ability. The American Economic Association launched a summer boot camp program in the 1970's to increase racial and ethnic diversity in the economics profession. Mentoring is a key component of this program. Becker et al. (2014) estimated the effectiveness of the AEA's summer program, finding that program participants were over 40 percentage points more likely to apply to and attend a PhD program in economics, 26 percentage points more likely to complete a PhD, and about 15 percentage points more likely to ever work in an economics-related academic job. According to these estimates, the summer program may directly account for 17 to 21 percent of the PhDs awarded to minorities in economics over the past 20 years.

The effectiveness of mentoring is recognized beyond academic papers and university programs, with programs designed to make a difference. US2020, an organization focused on

programming that supports underserved and underrepresented students, has a mission of changing the trajectory of STEM education in America by dramatically scaling the number of STEM professionals engaged in high-quality STEM mentoring with youth. US2020 is building a community of companies, organizations, schools, government agencies, and cities to participate in mentoring, encouraging us to imagine one million science, technology, engineering and math (STEM) professionals mentoring students in kindergarten through graduate school.¹

In the course of interviewing people for my research on racial and gender disparities in patenting and innovation, I asked a number of interviewees about a particular finding in my research. The finding was that AT&T and NASA were two of the entities with which women and African American patentees most frequently had some affiliation, including as interns, post-docs, etc. Among the interviewees who had had an affiliation with these organizations, they typically said that it was mentoring in the practice of invention, including in the process of filing a patent, that had more impact relative to simply the environment or other factors. The SBA could encourage such mentoring through the SBIR and STTR programs, as well as expanding its current initiatives, including its Women's Business Centers, Small Business Development Centers, SCORE, and Veterans' Business Outreach Centers.

Encouraging Invention at an Early Age

Exposing children to invention and innovation is becoming more recognized method of increasing participation. For example, Spark Lab at the Lemelson Center for Invention and Innovation at the Smithsonian Institution is an activity space that allows children to create an invention and to help them think about making the invention useful. Targeting low-income, underrepresented-minority, and female children for such activities is being recommended by the authors and Chetty and coauthors, among others.

Blind Patent Review

A recent paper in *Nature* finds that, all else equal, patent applications with women as lead inventors are rejected more often than those with men as lead inventors. An easy fix would be for the USPTO to engage in the blind review of patent applications by patent examiners.

Workplace Climate

Workplace issues for women and minorities go beyond the opportunity to participate in invention and innovation. Other issues have been brought into stark relief by recent events related to workplace climate, such as recent protests and discussions at Google and Microsoft. Among the issues identified are ones that have been reported about the climate in similar workplaces, such as lack of transparency (including forced arbitration for sexual harassment claims), workplace culture, and pay and opportunity inequality. Most patented invention occurs at firms. Therefore, at public companies shareholders need to hold CEOs more accountable for workplace climate, and, for private companies, boards and CEOs should do the same. Congress

¹ See <https://us2020.org/>.

may also have a role in bolstering the EEOC to investigate such complaints and help to minimize the frequency and intensity of hostile work places for women and underrepresented minorities.

**Questions Submitted for the Record from Subcommittee Ranking Member Roby
Lost Einsteins: Lack of Diversity in Patent Inventorship and the Impact on America's Innovation
Economy**

**Answered by Dr. Ayanna Howard, Professor and Chair, School of Interactive Computing, Georgia
Institute of Technology**

Question for All Witnesses

1. What recommendations have you for the United States Patent & Trademark Office and the Small Business Administration to help promote the participation of women and minorities in entrepreneurship activities and the patent system?

My three recommendations include: 1) provide a more robust communication campaign that communicates the resources already available to assist in the patent application process, 2) expand the resources provided by the regional centers, perhaps as a partnership effort with existing regional or university incubators, in order to maximize engagement of women and minorities in entrepreneurship activities, and 3) provide a more robust pro bono patent attorney/agent program for women and minority-owned small businesses and individual inventors. For example, the requirements for qualifying for the current Patent Pro Bono Program excludes many technically-focused individuals in this target demographic based on income (i.e. given that the percentage of VC and angel funding provided to women and minority entrepreneurs is traditionally low, most technically-focused women and minorities can only start businesses after having amassed some personal financial resources to do so).

**Questions for Dr. Ayanna Howard, Professor and Chair, School of Interactive Computing, Georgia
Institute of Technology**

1. You testified that small business programs that provide funding to small businesses may prohibit the use of any of those funds to secure patent protection. Should the U.S.P.T.O. work with the Small Business Administration to identify which small business programs should be amended to allow inventors to use funds to secure patents?

Yes, the U.S.P.T.O. should work with the SBA to identify which small business programs should be amended to allow inventors to use funds to secure patents. Currently at least two of the SBIR programs (NSF and NIH) state that patent costs are not an allowable expense.

2. At what stage in a company's development does the investment in securing a patent make the biggest difference to the growth and overall health of a new business?

The investment in securing a patent makes the biggest difference in the growth and overall health when the company has, at least, a prototype built out of the invention such that they fully understand the IP associated with the invention and its advantages over the state-of-the-art. At this stage, many companies are able to start seeking investments (and grants) to transition their prototype to a commercially realizable product.

**Response to Questions for the Record from Susie Armstrong
Senior Vice President, Engineering, Qualcomm, Inc.**

Subcommittee on Courts, Intellectual Property and the Internet
Committee on the Judiciary, U.S. House of Representatives

March 27, 2019 Hearing on "Lost Einsteins: Lack of Diversity in Patent Inventorship and the Impact on America's Innovation Economy"

Questions from Representative Martha Roby

1. *What recommendations have you for the United States Patent & Trademark Office and the Small Business Administration to help promote the participation of women and minorities in entrepreneurship activities and the patent system?*

It is critical that the United States Patent & Trademark Office (USPTO) and the Small Business Administration (SBA) continue to promote participation of women, minorities, and other underrepresented groups in the patent system.

The USPTO and SBA must do more to publicize their resources and make sure that the information is easily accessible on their websites. The SBA should work to make sure that women and minorities are familiar with the Small Business Innovation (SBIR) program and Small Business Technology Transfer Program (STTR) program. Both of these programs help women and minorities participate in technological innovation and often many inventors are unfamiliar with these programs.

The USPTO should continue to promote programs like the "All in STEM Initiative" to encourage more girls and women to pursue STEM degrees. The USPTO should also continue to develop programs for elementary school children that will help them learn about intellectual property. These type of programs may help encourage underrepresented groups to participate in the patent system. At Qualcomm, we have worked to develop the Thinkabit Lab initiative, which has helped students learn about technology and invention.

The USPTO and SBA should continue to hold workshops for women and minority inventors so they can learn about intellectual property and patents. The USPTO should also coordinate with their regional offices to make sure that women and minorities know about these programs and engage with members of the local communities. The USPTO should partner with inventors who mentor young women and minority entrepreneurs at universities. Each of these suggestions would help promote the participation of women and minorities in the patent system.

2. *Can you explain why it is beneficial to companies to ensure that all of their inventors are aware of the value of patents, both to the employees individually and to the overall health of their employer, so that companies consider filing patent applications on all valuable inventions conceived by their employees?*

For complex technology companies, success requires the collaboration of diverse teams of employees. No one inventor, no matter how brilliant, can create singular solutions to these tough engineering problems. Qualcomm works to ensure that all employees are trained on the value of patents and licenses to the innovation process, and the importance of intellectual property to both company and their individual success.

At Qualcomm, we are intensely focused on creating a diverse environment and creating opportunities for women and minorities to participate and contribute to our innovations. Patenting an invention is not only a point of pride for the company and the inventors—although Qualcomm celebrates all our inventors as individuals and teams—but is a major component of our performance review process and promotion decisions. Ensuring our employees know that patenting activity will be taken into account in these ways helps to underscore the importance of these activities to the company and the employee's career.

Moreover, patents are a powerful addition to the resume of any engineer. When an engineer applies to work at Qualcomm, we will consider his or her status as an inventor during the hiring process. And while we hope to retain our engineers, a patented inventor who seeks to move on from Qualcomm will find greater success in the job market.