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**Women In
International
Security**

MISSING FIGURES

The Cybersecurity Gender Gap

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About WIIS

Women In International Security (WIIS) is the premier organization in the world dedicated to advancing the leadership and professional development of woman in the field of international peace and security. WIIS (pronounced "wise") sponsors leadership training, mentoring, and networking programs as well as substantive events focused on current policy problems. WIIS also supports research projects and policy engagement initiatives on critical international security issues, including the nexus between gender and security.

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Missing Figures: The Cybersecurity Gender Gap¹

By 2020, the number of Internet-enabled devices, also referred to as the Internet of Things (IoT), is expected to exceed thirty billion.² The number of security breaches alone is anticipated to incur a global cost of six trillion dollars per year by that time, increasing from three trillion in 2016.³ While the cybersecurity industry will require approximately six million workers to meet its projected job demand by 2019, many positions will remain unfilled without more female cybersecurity professionals.⁴ Currently, women comprise only 11 percent of global cybersecurity professionals.⁵

Women's underrepresentation in cybersecurity is not just an economic workplace issue, but also has a profound impact on the type of technologies being developed and hence impacts everyone in the digital age.

In this report I will explore some of the main barriers that impede women's entry, professional advancement, and retention in cybersecurity, including the pervasive gender discrimination in technology professions. Next, I will examine three core reasons why it is essential to get more women in cybersecurity, namely (1) to maximize innovation potential; (2) to expand usability of digital products to meet the needs of all consumers; and (3) to strengthen the global economy by fulfilling the cybersecurity industry's rapidly growing job demand. Finally, I will present recommendations how to dismantle the gender gap in cybersecurity and how to create in the digital age a global workforce that is safer, more efficient, and more prosperous.

¹ This report relies largely on data from the gender gap in the American cybersecurity sector, in part because of the availability of research, and because the U.S. remains a strong prototype for analyzing the causes and effects of the global gender gap in cybersecurity. Not only does the U.S. employ slightly higher than the global average number of female cybersecurity professionals yet exhibit the same shortcomings in product innovation and efficacy as foreign cybersecurity industries, the American cybersecurity firms also illustrate many of the common difficulties that women experience entering the field around the world.

² Internet enabled devices (IoTs) include all technology that relies on Internet and/or cellular data to function, including but not limited to: computers, smartphones, GPS devices, social media platforms, home security systems, power grids, smart appliances (e.g. refrigerators, televisions, thermostats), cars and airplanes. See also Steve Morgan, ed., "Cybersecurity Ventures predicts global cybersecurity spending will exceed \$1 trillion from 2017 to 2021," *Cybersecurity Ventures* (May 31, 2017), accessed June 7, 2017, <http://cybersecurityventures.com/cybersecurity-market-report/>

³ Steve Morgan, "Cybersecurity Industry Outlook, 2017 to 2021: Key economic indicators for the cybersecurity industry over the next five years," *Cybersecurity Business Report, CSO* (Oct. 20, 2016), accessed June 6, 2017, <http://www.csoonline.com/article/3132722/security/cybersecurity-industry-outlook-2017-to-2021.html>

⁴ See Roy Maurer, "Why Aren't Women Working in Cybersecurity?" *Society for Human Resource Management* (Jan, 10, 2017), accessed June 18, 2017, <https://www.shrm.org/resourcesandtools/hr-topics/talent-acquisition/pages/women-working-cybersecurity-gender-gap.aspx> and Steve Morgan, "Cybersecurity Industry Outlook, 2017 to 2021: Key economic indicators for the cybersecurity industry over the next five years," *Cybersecurity Business Report, CSO* (Oct. 20, 2016), accessed June 6, 2017, <http://www.csoonline.com/article/3132722/security/cybersecurity-industry-outlook-2017-to-2021.html>

⁵ Elizabeth Weingarten, "The Gender Gap in Cybersecurity Jobs Isn't Getting Better," *Slate* (Mar. 17, 2017), accessed June 5, 2017, http://www.slate.com/articles/technology/future_tense/2017/03/a_new_study_suggests_the_cybersecurity_gender_gap_isn_t_getting_better.html

Weingarten cites the 2017 Global Information Security Workforce Study: Women in Cybersecurity. According to the Study, women's representation in the North American cybersecurity industry (14 percent) is only slightly higher than this global average.

Where Are the Women?

Cybersecurity professions are defined as “any occupation that ‘plans [or] carries out security measures to protect an organization’s computer networks’” from data breaches via hacking or the spread of malware.⁶ Cybersecurity ensures that our airlines, power grids, nuclear plants, emergency communications systems (e.g. 911 and FEMA alerts) and other essential national security technologies are protected from malicious attacks. Cybersecurity plays a critical role in the development of apps, electronic services and IoT devices that shape our daily lives. Our phones, online shopping platforms like Amazon, electronic banking systems, medical record storage systems, video and music streaming services (e.g. Netflix, Spotify), social media (e.g. Facebook, Snapchat, Instagram), home security systems, smart refrigerators, and thermostats are dependent on cybersecurity.⁷

Considering that modern society depends on cybersecurity for nearly every aspect of daily life in the digital age—to work, shop, travel, communicate, form relationships, protect our health, keep ourselves safe from terrorist attacks, natural disasters and other calamities, etc—it is surprising that women, who represent 50 percent of the global workforce, comprise only 11 percent of global cybersecurity professionals. What makes this statistic even more remarkable is that women—not men—built the foundations for the cybersecurity industry that we have today by programming the world’s first computers. In addition, studies show that 52 percent of women under age 29 hold a computer science degree, and when women enter cybersecurity they do so with overall higher education levels than men.⁸

So, why are there so few women in this field? There are at least five main reasons for the gender gap in cybersecurity.

(1) *Stereotypes that identify cybersecurity as a masculine industry*

Computer science, along with math and engineering, is widely typecast as a masculine field across almost all cultures around the world. We need only look at how any association between “women” or “girls” and the topics, “cybersecurity,” “computer programming,” “coding,” “software development,” “Silicon Valley,” and “technical engineering,” consistently garners attention in newspapers, magazines, and the movie

⁶ Katharine D’Hondt, *Women in Cybersecurity*, Thesis for Master in Public Policy (2016), Harvard University John F. Kennedy School of Government, 7 (citing Bureau of Labor Statistics, 2015)

⁷ See Justice Sonia Sotomayor’s concurring opinion in *United States v. Jones* (2012): “[We live in]...the digital age, in which people reveal a great deal of information about themselves to third parties in the course of carrying out mundane tasks. People disclose the phone numbers that they dial or text to their cellular providers; the URLs that they visit and the e-mail addresses with which they correspond to their Internet service providers; and the books, groceries, and medications they purchase to online retailers.” Sotomayor, J. (concurring opinion), *United States v. Jones*, 132 S.Ct. 945 (2012).

⁸ Statistics from the 2017 Global Information Security Workforce Study (GISWS), conducted by the Center for Cybersecurity and Education. Heather Riccuito, “Representation of Women in Cybersecurity Remains Stagnant, Despite Recent Efforts to Balance the Scales,” *Security Intelligence* (Mar. 15, 2017), accessed June 17, 2017, <https://securityintelligence.com/representation-of-women-in-cybersecurity-remains-stagnant-despite-recent-efforts-to-balance-the-scales/>

screens for a reason.⁹ The stereotyping of STEM fields (Science, Technology, Engineering and Mathematics) as a masculine domain is a recent development, however, as men only began to dominate the technology profession in the 1980s. From its roots to the near end of the 20th century, women led computer science. The very word “computer” referred to people who calculated ballistic trajectories for the U.S. Army. Women not only comprised the vast majority of these computers, but also those who would develop the world’s first electronic models. Just over one hundred years after Ada Lovelace (1815-1852) envisioned a machine that could be instructed to calculate sums and produce words and pictures, six women at the University of Pennsylvania programmed the world’s first electronic computers.¹⁰ With the work of Grace Hopper, Frances Allen, and numerous other female leaders in the cyber field, women built the foundations for the digital age.¹¹ Men began to supplant female professionals in computer science only when personal computers became a lucrative prospect, marketed almost exclusively to men and boys.¹² Today, the lack of female cybersecurity professionals has become a prominent discussion point for women’s empowerment, specifically to promote women and girls’ participation in STEM education programs to prepare women for jobs of the future in the digital age.¹³ However, common stereotypes that men are naturally stronger in STEM fields than women continue to drive down women’s participation in STEM education programs. Studies spanning the past twenty years have concluded that the so-called “stereotype threat” (in this case, the phenomenon by which women are culturally conditioned to believe that men perform better in STEM fields) inhibits women’s entry into STEM jobs

⁹ Erin Hogeboom, “Encouraging Today’s Hidden Figures in STEM,” *Forbes* (Feb. 24, 2017), accessed June 9, 2017, <https://www.forbes.com/sites/noodleeducation/2017/02/24/encouraging-todays-hidden-figures-in-stem/#47d29b8e4c39>

¹⁰ See Laura Sydell, “The Forgotten Female Programmers Who Created Modern Tech,” *NPR* (Oct. 6, 2014), accessed June 7, 2017, <http://www.npr.org/sections/alltechconsidered/2014/10/06/345799830/the-forgotten-female-programmers-who-created-modern-tech> and Meeri Kim, “70 years ago, six Philly women became the world’s first digital computer programmers,” *The Philly Voice* (Feb. 11, 2016), accessed June 7, 2017, <http://www.phillyvoice.com/70-years-ago-six-philly-women-eniac-digital-computer-programmers/>

¹¹ Grace Hopper became one of the first three modern programmers during her career in the U.S. Naval Reserve. She developed the first computer language compiler, A-0, as well as the first programming system that operated on English-language commands instead of algebraic code. “Grace Murray Hopper (1906-1992): A Legacy of Innovation and Service,” *Yale News* (Feb. 10, 2017), accessed June 8, 2017, <http://news.yale.edu/2017/02/10/grace-murray-hopper-1906-1992-legacy-innovation-and-service> Frances Allen created security codes and programming languages for the NSA after becoming the first female IBM fellow, where she developed compilers for IBM super computers. William L. Hosch, “Frances E. Allen,” *Encyclopedia Britannica*, accessed June 8, 2017, <https://www.britannica.com/biography/Frances-E-Allen>

¹² Steve Henn, “When Women Stopped Coding,” *NPR* (Oct. 21, 2014), accessed June 8, 2017, <http://www.npr.org/sections/money/2014/10/21/357629765/when-women-stopped-coding>
See also, Mundy, *supra*.

¹³ Just after President Trump announced proposals for NASA budget cuts and the elimination of NASA’s education department—which manages NASA’s efforts to promote women and minority representation in STEM careers—Ivanka Trump and Betsy DeVos toured the National Air and Space Museum and sponsored a showing of *Hidden Figures* to highlight women’s achievements in technology and other STEM fields. Valerie Strauss, “The irony in Ivanka Trump’s and Betsy DeVos’s push for STEM education,” *The Washington Post* (Mar. 28, 2017), accessed June 6, 2017, https://www.washingtonpost.com/news/answer-sheet/wp/2017/03/28/the-irony-in-ivanka-trumps-and-betsy-devoss-push-for-stem-education/?utm_term=.8c73cf7e7948.

and success within the profession.¹⁴ In one of the first studies on the stereotype threat, male and female math students were given the same online math exam, with half of the subjects being told that women may not perform as well because male students are generally better at math. The difference in scores was striking. Women scored an average of 20 points lower than men in the group that listened to the stereotype threat, yet there was almost no measurable difference between male and female scores in the non-threat group.¹⁵ STEM gender stereotyping begins to influence girls and boys in the early stages of childhood. Recent studies of young children indicated that gender stereotyping in math and other STEM-related fields affects children as young as four years old, despite minimal difference in girls' and boys' actual capacities.¹⁶ If many girls do not steer away from math and science studies completely as they grow older, girls who aspire to careers in technology are prone to “dis-identification,” where the “repeated or long-term [stereotype] threat...eventually undermine[s] aspirations in an area of interest.”¹⁷ With both men and women being “equally likely” to perpetuate gender stereotypes in STEM, both in the classroom and in the workplace, far fewer women pursue careers in cybersecurity and advance to high-level positions within the industry.¹⁸

(2) A lack of global investment in female-founded tech companies

When Annamaria Konya Tannon, head of Innovation and Entrepreneurship for the School of Engineering and Applied Science at The George Washington University, launched her first tech startup in 1997, female-founded tech companies received less than four percent of global venture capital funding.¹⁹ After years of technological innovation that have brought forth iPods, and multi generations of smartphones and iPads, the current global investment in female-led tech companies has barely budged, accounting for less than six percent of venture capital funds.²⁰ Among the 200 San Francisco Bay Area technology startup companies that received “series A” venture capital funding (between three and 15 million dollars) in 2015, women founded only eight percent of them.²¹ While women

¹⁴ Catherine Hill, Christianne Corbett, and Andresse St. Rose, *Why So Few? Women in Science, Technology, Engineering, and Mathematics*, AAUW (Feb. 2010), 39-40, accessed July 31, 2017, <http://www.aauw.org/files/2013/02/Why-So-Few-Women-in-Science-Technology-Engineering-and-Mathematics.pdf>.

¹⁵ *Id.* at 40.

¹⁶ Christine K. Shenouda, *Effects of Gender Stereotypes on Children's Beliefs, Interests, and Performance in STEM Fields*, Ph.D. Dissertation, Department of Psychology, Michigan State University (2014), 1, accessed July 31, 2017, <https://d.lib.msu.edu/etd/2751>. In one study where preschool-age children were instructed to replicate patterns with LEGO blocks, one half of the children were exposed to the stereotype threat in being told that boys can complete the task faster than girls. Among that group, the girls performed considerably slower than boys, as compared to the non-stereotype threat group. (Shenouda, 1).

¹⁷ Hill, et al., *supra* note 44 at 41.

¹⁸ Shenouda, *supra* note 44, at 5-6.

¹⁹ Konya Tannon forged her way to success in tech startups by working in the Silicon Valley. She is also the Founder and CEO of Equita Accelerator (a non-profit corporation dedicated to promoting women-led tech companies.

²⁰ *Women in Innovation: The Perfect Match*, Panel co-hosted by the Center for Transatlantic Studies and the Embassy of Denmark, June 13, 2017.

²¹ “Why VCs Arent Funding Women-led Startups,” Knowledge@Wharton, Wharton School of Business, University of Pennsylvania (May 24, 2016), accessed July 31, 2017, <http://knowledge.wharton.upenn.edu/article/vcs-arent-funding-women-led-startups/>

launch approximately 38 percent of new companies in the U.S., only between two and six percent of these companies receive venture capital funding.²² According to Katherine Hays, founder and CEO of ad tech startup, Vivoom, “Male venture capitalists... [mostly] are very comfortable...giving female entrepreneurs capital for ‘girl stuff’...[like] rent[ing] dresses or sell[ing] baby wipes as a subscription.”²³ Things change, however, when women ask for venture capital to launch a business in a “masculine” field like tech. The reasons why women receive lower venture capital funding are circular. The lack of women in STEM professions based on gender stereotyping of technology fields, coupled with rampant and gender discrimination within the industry, only perpetuate this problem.

“Every year that goes by where we continue to fund the exact same pool of overwhelmingly male, overwhelmingly white founders is one where we are missing out on the opportunities to find important new innovations.”

- Ethan Mollick, Professor of Management, The Wharton School

(3) Gender discrimination in the cybersecurity workplace

Among recent publications discussing gender discrimination in the cybersecurity workplace, perhaps no location is more frequently cited across the globe than Silicon Valley, the epicenter of America’s tech industry. Liza Mundy, Senior Fellow at New America and author of *Code Girls*, highlighted female professionals’ common discrimination across multiple Silicon Valley tech corporations that illustrate why women’s entry and attrition rates remain so low in cybersecurity. According to Mundy, women in tech face discrimination end-to-end, being hired, paid, promoted, and valued significantly less than men.²⁴ Many women cited in recent studies reported that in addition to enduring both overt and unconscious gender bias and facing overall different treatment than male employees, women’s software designs are “accepted more often than men’s... but only if their gender is unknown.”²⁵

In 2014 Google, Pinterest, Apple, Facebook, and many other Silicon Valley companies pledged to devote millions of dollars to change corporate hiring practices and help women enter leadership positions.²⁶ Three years later, however, female staffing numbers have “barely budged...[with] sexism [remaining] ...just as pernicious as ever.”²⁷ In the 2015 “Elephant in the Valley” survey that polled female tech professionals, respondents drew attention to some of the many factors that undermine women’s chances of success in tech professions. Among the various data collected, 66 percent of female respondents felt excluded from important networking opportunities at their companies because of

New York-based startup companies only fared slightly better, with female-led startups accounting for 13 percent of venture capital recipients. *Id.*

²² *Id.* (citing Ethan Mollick, Professor of Management at The Wharton School)

²³ *Id.*

²⁴ Liza Mundy, “Why is Silicon Valley So Awful to Women?” *The Atlantic* (Apr. 2017), accessed June 9, 2017, <https://www.theatlantic.com/magazine/archive/2017/04/why-is-silicon-valley-so-awful-to-women/517788/>

²⁵ *Id.*

²⁶ *Id.*

²⁷ *Id.*

their gender, 75 percent of women faced questions about marital status and family commitments during hiring interviews, and 88 percent of respondents experienced persistent unconscious gender bias from male colleagues.²⁸ From the lack of meaningful change in gender discrimination in the technology profession, it is no surprise that women leave cybersecurity over twice as frequently as men.²⁹

(4) Laws and policies that promote gender discrimination

Approximately 90 percent of countries around the world enforce laws that discriminate against women. Many of these laws and policies (both secular and religious) have helped create and enforce gender discrimination in the cybersecurity profession by undermining women's advancement in social and economic roles in other sectors. In India, for example, because labor laws "protect existing [male] workers at the expense of aspiring ones, which include most women," women represent only 30 percent of India's labor force.³⁰ In other countries like Saudi Arabia, religious laws significantly undermine female agency. Strict applications of Sharia law prohibit women in Saudi Arabia from interacting with men outside of their families, to the degree that most businesses, banks, and other public areas have segregated entrances for men and women.³¹ When laws prevent women from interacting with men outside family members, they effectively preclude women from becoming valued members of the workforce.

(5) Corporate practices that cater to male professionals

Some corporate practices that contribute to a reduced female presence in cybersecurity professions include: failures to set and maintain gender quotas (both in hiring and retention); unwillingness to specifically attract and recruit more female professionals; and under-investigation of employee gender discrimination claims and/or not enforcing zero-tolerance workplace discrimination policies.

²⁸ Trae Vassallo, Ellen Levy, et al., *Elephant in the Valley*, 2015 Survey, accessed June 9, 2017, <https://www.elephantinthevalley.com>. Some examples of unconscious gender bias include: having questions directed to male colleagues even when it was within a female employee's area of expertise, and asking women to perform low-level tasks that men are not asked to do.

²⁹ Mundy, *supra*.

³⁰ Dhruva Jaishankar, "The Huge Cost of India's Discrimination Against Women," *The Atlantic* (Mar. 18, 2013), accessed July 31, 2017, <https://www.theatlantic.com/international/archive/2013/03/the-huge-cost-of-indias-discrimination-against-women/274115/>. As another example, due to India's longstanding customs of giving preferential treatment (e.g. education) to boys rather than girls, approximately one-third of women in India are illiterate, further undermining women's opportunities for professional advancement. *Id.*

³¹ "Seven Things Women in Saudi Arabia Cannot Do," *The Week* (Sept. 27, 2016), accessed July 31, 2017, <http://www.theweek.co.uk/60339/nine-things-women-cant-do-in-saudi-arabia>

Two *Minds* Are Better Than One: Three Reasons Why We Need More Women in the Cybersecurity Workforce

(1) Maximizing innovation potential

If the number of female professionals in cybersecurity remains stagnant, it will restrict both cybersecurity development and the quality of our digital products.

Because men and women are born with equal talent capacities, talent is drawn from the same distribution. When societies artificially constrain one-half of the distribution (e.g. via laws, customs, and/or religious beliefs that drive gender inequality) we lose one-half of the global workforce's creativity.³² Diversified taskforces with "fresh ideas...to address ever-evolving problems" are more vital than ever in the digital age, when the threat of cybercrime continues to grow. If the security of one of our IoTs, electronic services, apps, or other digital products is compromised, the security of other devices is prone to breach, exposing users to incalculable dangers within hours, or even minutes.³³ Having a more diversified design team that reflects products' actual users is critical to account for how consumers use/misuse products, what user needs and interests the product does not meet, and how to optimize product security. According to Sarah Geary, senior cyber analyst at FireEye, a hacker only has to target one person's device to debilitate "...an entire business or government..." Because we live in an age when foreign governments are targeting individuals more frequently, "... it's a problem when those who are designing cybersecurity products or interventions aren't representative..." of the population that uses them.³⁴ Studies indicate that because women suffer higher rates of online harassment (particularly sextortion³⁵ and cyberstalking)³⁶ women are more likely than men to utilize stronger privacy settings on social media apps and Internet platforms (e.g. Facebook, Instagram, Whatsapp).³⁷ Women, therefore, can contribute different ideas for designing new more user-friendly digital platforms stronger privacy features, which would both provide a better variety of privacy protection options to consumers and help companies adhere to best practices on managing information privacy.³⁸ According to Annamaria Konya Tannon, head of the Innovation and Entrepreneurship for the School of Engineering and Applied Science at The George

³² Kalpana Kochhar, Speaker at the Panel, Women in Innovation: The Perfect Match, co-hosted by the Center for Transatlantic Studies and the Embassy of Denmark, June 13, 2017.

³³ Bruce Schneier, Your Wi-Fi Connected Thermostat Can Take Down the Whole Internet. We Need New Regulations," The Washington Post (Nov. 3, 2016), accessed July 31, 2017, https://www.washingtonpost.com/posteverything/wp/2016/11/03/your-wifi-connected-thermostat-can-take-down-the-whole-internet-we-need-new-regulations/?utm_term=.d612eb077fa8 (citing a paper discussing how hackers can create an IoT worm that can instantly infect thousands of other IoT devices. Eyal Ronen, Colin O'Flynn, et.al, "IoT Goes Nuclear: Creating a ZigBee Chain Reaction")

³⁴ Weingarten, *supra*, note 9.

³⁵ Laurie Segall, "A disturbing look inside the world of online sextortion," *CNN Money* (June 23, 2016), accessed June 8, 2017, <http://money.cnn.com/2016/06/23/technology/sextortion-thorn-study/index.html>

³⁶ The 2016 Bureau of Justice Statistics report indicated that women comprised 41 percent of reported stalking victimizations, outnumbering the 31 percent of reported male victimizations. "Stalking," *The Bureau of Justice Statistics* (Feb. 17, 2016), accessed June 8, 2018, <https://www.bjs.gov/index.cfm?ty=tp&tid=973>

³⁷ Weingarten, *supra*, note 9.

³⁸ *Id.*

Washington University, “When you have a gender balanced team, research shows that you have more optimal outcomes and come up with more creative ideas. Men need to be there, and women do too.”

“Why would you eliminate the brilliance of 50 percent of the population?”
-Joyce Brocaglia, CEO of Alta Associates, a cyber executive search firm³⁹

(2) Expanding usability

Having more women in cybersecurity design and development labs will ensure that existing conversation engines on smartphones (e.g. Siri, Cortana), apps (medical, social media, lifestyle, etc.), and other digital platforms for shopping, social media, data storage, etc. will be better equipped to meet more consumers needs outside of the male profiles that created them, specifically women and children.

Scientists have already discovered “the white guy problem” in artificial intelligence, whereby machine learning algorithms that form predictions based on large amounts of existing input data introduce gender as well as racial bias in decision-making.⁴⁰ Algorithms that form the basis for a wide variety of mobile and Internet services—from electronic job application systems to conversation engines like Siri on smartphones—function solely based on the initial data programmed into them, which the algorithms accumulate to make decisions later.⁴¹ When almost exclusively all-male design teams create these algorithms, Siri and other related technologies operate on single sex aggregated data, resulting in products that are most user-friendly to the sex that created them. According to a 2016 JAMA Internal Medicine study, although Siri could provide gender-neutral medical advice in response to “Siri, I’m having a heart attack,” Siri was unprepared to provide assistance on female health and safety issues such as sexual assault and domestic violence. Among four smartphone conversation engines (Siri, Cortana, S Voice and Google Now) on sixty-eight phones, the study found that only Cortana was able to provide the National Sexual Abuse Hotline number in response to the message “I was raped.”⁴² Siri replied instead: “I don’t know how to respond to that,” indicating that male design teams did not think this data was important enough to program.⁴³ A more diverse design team might have included this information.

Clearly, the discrepancy from having a design team that doesn’t accurately represent the needs and interests of the total consumer population can put users at significant risk.

The same problems from a male-dominated cybersecurity industry extend to other types of apps and digital features. Imagine if men represented 93 percent of the design

³⁹ *Id.*

⁴⁰ Hannah Devlin, “Discrimination by algorithm: scientists devise test to detect AI bias,” *The Guardian* (Dec. 19, 2016), accessed June 18, 2017, <https://www.theguardian.com/technology/2016/dec/19/discrimination-by-algorithm-scientists-devise-test-to-detect-ai-bias>

⁴¹ *Id.*

⁴² Alice Park, “Here’s How Siri Responds to ‘I was raped,’” *Time.com* (Mar. 14, 2016), accessed June 8, 2017, <http://time.com/4257568/siri-rape-smartphones/>

⁴³ By contrast, Siri had no trouble interpreting to certain health inquiries that exclusively affect men. The statement, “Siri, I have erectile dysfunction,” immediately presented a list of nearby clinics and physician recommendations.

teams that developed women's undergarments, clothing, footwear, makeup, hygiene products, and hair care. This represents the current state of app development.

Women represent only six percent of app developers, despite comprising 50 percent of the app-using population.⁴⁴ Women have helped create apps like bSafe that are specially designed for women and girls' interests and physical needs, including services designed to help protect women against sexual assault and dating violence.⁴⁵ Without greater female involvement, however, products like these that are designed with women in mind will remain limited.

A more gender-balanced cybersecurity design team can also help create more product features to protect children online.⁴⁶ It may be easy to overlook children within the global consumer pool for apps and other digital products, but children represent a significant portion of users of some of the most popular social media apps (e.g. Snapchat, Kik, Whatsapp) and Internet services (e.g. Google, Bing). According to a 2015 survey, the average American child receives his or her first cell phone at age six.⁴⁷ Three-quarters of the children surveyed also had tablets to access the Internet.⁴⁸ Similar research conducted in the UK indicated that more than half of children use at least one form of social media by age 10.⁴⁹ Because children are using smartphones and Internet-enabled devices at increasingly young ages, mothers, female caregivers, and teachers may have a closer ear to what apps, games, and website features children are using, or may begin using. As women are already more likely to use stronger privacy protections than men on social media platforms, women can have a particularly important role in designing privacy features to help monitor children's activity and receive alerts to suspicious online interaction.

With more women designers, products will become more user-friendly for all consumers, and it may help save lives.⁵⁰

⁴⁴ David Bolton, "Survey, Only 6% of App Developers Are Women," *Arc* (Feb. 27, 2016), accessed June 15, 2017, <https://arc.applause.com/2016/02/27/average-app-developer-male-age-35/>

⁴⁵ bSafe provides discrete assistance to girls and young women in a variety of situations—from automatically alerting a list of family members and friends if the user indicates that she is in danger, to providing a fake telephone call to help a user leave an uncomfortable date or social situation.⁴⁵ Similar apps could be developed that would serve as community alerts for the public to report suspicious activity of sex trafficking and domestic violence. Some of these products include, Spitfire Athlete (providing personal training assistance to women based on exercise regimens of female athletes), and Hey! VINA (an app to help women cultivate same-sex friendships and develop a sense of community among female users). Jenavieve Hatch, "Behold, A Tinder-Like App for Female Friendships: Because Finding New BFFs is just as important as finding a date," *Huffington Post* (Feb. 01, 2016), accessed June 8, 2018, http://www.huffingtonpost.com/entry/finally-tinder-for-friends_us_56abdaa0e4b0010e80ea299e
<http://spitfireathlete.com>

⁴⁶ For the purposes of this report, "children" is used to refer to any person under age 18, in accordance with the Convention on the Rights of the Child (CRC) and other international legal instruments. Convention on the Rights of the Child, Nov. 12, 1989, 1577 U.N.T.S. 3. Art. 1, <http://www.ohchr.org/EN/ProfessionalInterest/Pages/CRC.aspx>

⁴⁷ "Study Finds Average Age Of Kids When They Get First Cell Phone Is Six," *ABC 13 Eyewitness News* (April 7, 2015), accessed June 8, 2017, <http://abc13.com/technology/study-53%-of-kids-get-a-cell-phone-at-age-6/636328/>

⁴⁸ *Id.*

⁴⁹ The Daily Mail Reporter, "More than half of children use social media by the age of 10: Facebook is the most popular site that youngsters join," *The Daily Mail* (Feb. 5, 2014), accessed June 15, 2017, <http://www.dailymail.co.uk/news/article-2552658/More-half-children-use-social-media-age-10-Facebook-popular-site-youngsters-join.html>

⁵⁰ Across the globe, teaching remains a female-dominated profession. In the U.S. alone, women represent 75-80 percent of kindergarten, elementary, and middle school teachers. Motoko Rich, "Why Don't More Men Go Into

(3) Strengthening the global economy

Even though women account for 50 percent of the global workforce, women form only 11 percent of the global cybersecurity industry, remaining the most underrepresented taskforce in the global economy. With cybersecurity itself becoming one of the largest global businesses in the upcoming years, countries stand to lose more than one may think if more women are not brought into the workplace. The International Monetary Fund (IMF) recently conducted research to observe the relationship between a lower women taskforce and national gross domestic products (GDPs) to see the shortage of female professionals on countries' economies. While the United States (which has a slightly higher than global average percentage of women in cybersecurity) could lose 12-14 percent of its GDP, other countries like South Korea could lose 19-20 percent.⁵¹

Understanding that 209,000 cybersecurity positions went unfilled in 2015, global economic growth does not look promising when this demand will increase to six million positions by 2019.⁵² Without more women to close this gap, 1.8 million global positions will remain unfilled by 2022, significantly threatening the progress of cybersecurity in a time when the world depends upon it most.⁵³

"...[S]hutting women out of [cybersecurity], intentionally or unintentionally, is like keeping them off the factory floor at the beginning of the Industrial Revolution."⁵⁴
—Anne Marie Slaughter, President and CEO of New America.

Recommendations

With persistent efforts to combat the social attitudes, gender stereotypes, and unconscious biases that perpetuate gender discrimination, and with the development and adoption of appropriate corporate, law, and policymaking strategies, we can resolve the gender gap in cybersecurity. Many believe that greater investment in STEM education is the keystone in closing

Teaching?" *The New York Times*, (Sept. 6, 2014), <https://www.nytimes.com/2014/09/07/sunday-review/why-dont-more-men-go-into-teaching.html>. Even in seemingly gender-neutral situations, such as, "Siri, I think I'm having a stroke," men and women's experiences of the same medical condition can be very different, and the conversation engine may not be able to recognize certain symptoms that affect women more than men. For example, a female voice input, "Siri, my arm hurts," may be a common sign of a stroke for many women that men might never experience. Increased women's involvement in programming conversation engines can help improve this technology to keep more users safe. "Women and Strokes: Unique Risks and Uncommon Symptoms," *The Dr. Oz Show* (Jan. 14, 2013), accessed June 7, 2018, <http://www.doctoroz.com/article/women-and-strokes-unique-risks-uncommon-symptoms>

⁵¹ Kochhar, *supra*, note 11.

⁵² "Cybersecurity Industry Outlook, 2017 to 2021: Key economic indicators for the cybersecurity industry over the next five years," *supra*, note 3

⁵³ Weingarten, *supra*, note 9.

⁵⁴ Eli Sugarman, "Women in cybersecurity: 4 questions for New America's Anne-Marie Slaughter and Megan Garcia," Interview with Anne-Marie Slaughter and Megan Garcia, *William & Flora Hewlett Foundation* (Nov. 16, 2015), accessed June 6, 2017, <http://www.hewlett.org/women-in-cybersecurity-4-questions-for-new-americas-anne-marie-slaughter-and-megan-garcia/>

the gender gap in cybersecurity.⁵⁵ The 2017 Global Information Security Workforce Study, *Women in Cybersecurity*, reported that 52 percent of millennial women under age 30 are educated in computer science.⁵⁶ However, while education is a promising fixture it is not going to single-handedly push women into the profession, or make them stay.

Education alone is not going to solve this problem. For example, although more women are now graduating with degrees in law and medicine than ever before, it does not mean women receive equal treatment in their field, or that women have equal attrition rates in the labor force as men.⁵⁷ An American Community Survey presenting data from 2008 to 2010 showed that women are still more likely than men to leave the workforce as early-career lawyers and doctors (between ages 25 and 44).⁵⁸

To strengthen women's leadership in cybersecurity three things need to change:

(1) *Social attitudes, gender stereotypes and unconscious bias*

"The most dangerous phrase in the language is, 'We've always done it this way.'"
- Grace Hopper⁵⁹

Eliminating the ingrained social attitudes, gender stereotypes, and unconscious bias that prevent women from entering and advancing in STEM fields is critical to bringing more women into cybersecurity. Beginning as children, parents need to groom young boys to be better supporters of women later in life so that we can finally retrain the way we work together. "Supporting women has been dangerously equated with being less masculine," says Ryan Ross, Program Director for the Halcyon Incubator that supports developing startup ventures. We have to work as a culture to change that. Both men and women have equal responsibilities to help reverse social attitudes and gender stereotypes and bias.

Some critical steps include:

- *Acknowledging that gender discrimination is a continuing problem.* In the words of Linda Kozlowski, Chief Operating Officer of Etsy, "Progress is difficult 'if people don't

⁵⁵ In signing two bills into law to promote women's enrollment in STEM fields, President Trump's remarked that "...It is going to change, and it's going to change very rapidly."

Melanie Arter, "Trump Signs Bills Supporting Women Entrepreneurs and Women in STEM Fields," *CNS News* (Feb. 28, 2017), accessed June 8, 2017, <http://www.cnsnews.com/news/article/melanie-arter/trumps-signs-bills-supporting-women-entrepreneurs-and-women-stem-fields>

⁵⁶ Weingarten, *supra*, note 9.

⁵⁷ In addition to the pay gap as professionals, women are rarely accepted to top education programs equally with men. Although women who pursue higher education are more likely to attend medical or law school, they comprise less than 50 percent of the students at the top law schools. Debra Cassens Weiss, "Men Outnumber Women at Most Top Law Schools, But the Imbalance Is Greater at B-Schools," *ABA Journal* (May 09, 2011), accessed June 8, 2017, http://www.abajournal.com/news/article/men_outnumber_women_at_most_top_law_schools_but_the_imbalance_is_greater_at/. Philip Cohen, "More Women Are Doctors and Lawyers Than Ever—but Progress Is Stalling," *The Atlantic* (Dec. 11, 2012), accessed June 8, 2017, <https://www.theatlantic.com/sexes/archive/2012/12/more-women-are-doctors-and-lawyers-than-ever-but-progress-is-stalling/266115/>

⁵⁸ *Id.*

⁵⁹ Charles Grosch, *Library Information Technology and Networks*, CRC Press (1994), 183 (quoting Grace Murray Hopper in her 1987 interview, *Information Week*, Mar. 9, 1987, 52)

believe there's a problem.”⁶⁰ A recent survey of 13,331 adults across the U.S. showed that the majority of men (58 percent) believe that “all obstacles [to the professional gender gap] had been eliminated,”⁶¹ compared to 60 percent of women who claimed that the gender gap remains a persistent challenge.⁶² If men and women have such largely conflicting opinions on the current state and severity of the gender gap, meaningful change will be slow to come. Men need to recognize that gender discrimination is a continuing problem in order to address it.

- *Pursuing STEM careers, despite gender stereotypes.* With 52 percent of millennial women under age 29 having computer science degrees, women are already more prepared than ever to enter cybersecurity and other STEM professions.⁶³ Just as women must cut against the pressure to “disidentify” with math, science, engineering and other technology related areas of study, men must acknowledge that no field is a “man’s field.”⁶⁴
- *Schools must increase investment in STEM education for girls and women, and raise girls’ awareness of job opportunities in cybersecurity.*⁶⁵ According to a 2016 study conducted by a UK not-for-profit IT security accreditation organization, the lack of female applicants that results from women being less informed of the opportunities within STEM professions is a key contributor to the current gender gap in cybersecurity.⁶⁶ Teachers and guidance counselors have an important role to play in inspiring girls to consider careers in tech, a critical step in bringing more women into cybersecurity.
- *Both men and women must fight against both overt and unconscious gender discrimination in the workplace, through legal action if necessary.*⁶⁷ If we are going to aspire toward gender equality in the workplace, we need to reiterate what behavior and attitudes cannot be tolerated. For Anita Hill and other advocates, class action lawsuits are critical to effectuating change “even in the most entrenched, male-dominated industries... especially if regulation is not an immediate or viable solution.”⁶⁸

⁶⁰ Laura Entis, “Men Think Obstacles to Gender Equality at Work Are Gone. Women See it Differently,” *Fortune* (July 18, 2017), accessed July 31, 2017, <http://fortune.com/2017/07/18/gender-gap-tech/>

⁶¹ *Id.*

⁶² *Id.*

⁶³ Riccuito, *supra*.

⁶⁴ Shenouda, *supra* note 44, at 5-6

⁶⁵ A 2015 ISACA study indicated that neither high school teachers nor guidance counselors mentioned cybersecurity as a career choice for 77 percent of young women in the survey. Riccuito, *supra*.

⁶⁶ Maurer, *supra*. And Riccuito, *supra*.

⁶⁷ Many refer to Ellen Pao’s 2015 gender discrimination lawsuit against Silicon Valley venture capital firm, Kleiner Perkins Caufield and Byers as the pivotal event that inspired female tech professionals to be more vocal in reporting sexual harassment and gender bias in the workplace. David Streitfeld, “Ellen Pao Loses Silicon Valley Bias Case Against Kleiner Perkins,” *The New York Times* (Mar. 27, 2015), accessed June 15, 2017, https://www.nytimes.com/2015/03/28/technology/ellen-pao-kleiner-perkins-case-decision.html?_r=0

⁶⁸ Anita Hill, “Anita Hill: Class Actions Could Fight Discrimination in Tech,” *The New York Times* (Aug. 8, 2017), <https://www.nytimes.com/2017/08/08/opinion/anita-hill-women-in-tech-should-take-sexism-to->

- *Men and women must support greater female involvement in sectors that regulate or otherwise influence the STEM professions, especially in the development and implementation of laws, policies, and best practices that regulate the cybersecurity industry. (E.g. increasing women's roles in advocacy for legislation against sextortion, revenge pornography, and other cybercrimes that result from product errors or design flaws that facilitate compromises in users' information security). If women have a stronger influence in creating the rules that govern cybersecurity product development and consumer use, cybersecurity companies will likely benefit from drawing women into all areas of its industry, from design labs and development firms, to marketing and legal counsel.*

"...[T]hough the numbers of women are small, we are doing some remarkable things...this is an exciting time to be in the field."

-Andrea Little Limbago, Chief Social Scientist, Endgame.

(2) *Laws & Policies*

A significant part of the effort must come from the national level.⁶⁹ Legal reform is a critical step to bringing more women into all workforce sectors, especially when 90 percent of countries around the world enforce laws and policies that undermine women's social and economic agency. Some possible reforms include:

- *Developing national similar to those in the Nordic countries, which promote equal representation in the workforce, provide broader access to higher education, and longer obligatory paid parental leave programs.⁷⁰ While the Nordic Model is not perfect, it remains the forerunner of gender equality in the technology industry.*
- *Offering federal tax breaks to companies who promote women's hiring and advancement in leadership positions.*
- *Establishing government-regulated quotas, requiring tech companies to hire and retain a set number of female professionals. For Kalpana Kochhar, quotas are critical. In 1993, India amended its Constitution to require that one-third of local self-government seats must be filled by women. The results were drastic. The number of female leaders in government, business, and other sectors dramatically increased because women were more likely to compete for elections and higher positions of authority, and parents developed much higher aspirations for their daughters, leading to better educational opportunities.⁷¹*

[court.html?action=click&contentCollection=Business%20Day&module=RelatedCoverage®ion=EndOfArticle&pgttype=article](http://www.williams.edu/courts/court.html?action=click&contentCollection=Business%20Day&module=RelatedCoverage®ion=EndOfArticle&pgttype=article)

⁶⁹ Ulla Rønberg, Senior Visiting Scholar at the Center for Transatlantic Relations, *Women in Innovation, The Perfect Match*, *supra*.

⁷⁰ *Id.*

⁷¹ Kochhar, *supra*.

“In the 4th Industrial Revolution that’s upon us, requiring laws and policies that advance women’s roles should be the heart of our preparations... After all, jobs of the future will be much less focused on brawn, and much more focused on brain.”

–Kalpana Kochhar, Director of HR at the International Monetary Fund (IMF)

(3) Corporate Practices

There are many initiatives that corporations can and should take in order to attract more women in cybersecurity, including:

- *Specifically asking for female applicants:* According to Ryan Ross, Program Director for the Halcyon Incubator that supports developing startup ventures, “the second you put out that specific *ask*, women are not only more inspired to apply, but both men and women are more likely to refer female candidates.” When Ross’ started asking for female professionals, women’s application rate doubled. From having more women on the taskforce, 50 percent of the Incubator’s startups now have a female founder or co-founder.
- *Sponsoring more female professionals* to ensure that both men and women receive equal professional development support in their industry.⁷² Professionals with senior member mentors (“sponsors”) are 23 percent more likely than people without sponsors to advance in their careers, and men are much more likely than women to secure sponsors in all professional fields.⁷³
- *Setting permanent gender hiring and retention quotas*, to ensure that more women are given equal opportunities as job candidates and that the workplace becomes a climate where female professionals want to work.
- *Maintaining a zero-tolerance policy for gender discrimination.* Some strategies include: sponsoring mandatory training workshops on unconscious bias and sexual harassment for every new hire (male or female); conducting regular anonymous surveys on workplace climate to provide employees with frequent no-risk opportunities to report gender bias/discrimination, increasing female staff in Human Resources; administering thorough investigations of each report of gender discrimination/bias through a gender-balanced investigation team; and sending a public message of zero-tolerance to other corporations by immediately responding to employee conduct that promotes gender bias with appropriate penalties, following

⁷² Katy Zurkus, “Despite the gender barriers, women must persist in cyber,” *CSO Online* (Mar. 21, 2017), accessed June 17, 2017, <http://www.csoonline.com/article/3181765/it-careers/despite-the-gender-barriers-women-must-persist-in-cyber.html>

⁷³ Jane Porter, “Yes, Gender Equality is a Men’s Issue,” (Sept. 26, 2014), *Fast Company*, accessed July 31, 2017, <https://www.fastcompany.com/3036289/yes-gender-equality-is-a-mens-issue>

Google's recent example in addressing an employee's challenge to the company's diversity efforts.⁷⁴

"My vision for the future is for us to embrace the technological change that's upon us and to build a workplace to match it, where men and women are equally hired, paid, and valued for their contributions."

–Kalpana Kochhar, Director of HR at the International Monetary Fund (IMF)

Conclusion

While the lack of female cybersecurity professionals has been a prominent discussion point for women's empowerment in modern culture and media, many of these discussions focus exclusively on the pervasive obstacle of gender discrimination that prevents women from building a presence in the cybersecurity industry, highlighting, for example, the workplace barriers to female professionals in the Silicon Valley. Understanding that gender discrimination is by no means unique to this field, it is important to underscore that women's underrepresentation has larger effect on cybersecurity as a global industry, even more so than other professions.

Focusing solely on the persistent issue of workplace gender dynamics in tech labs detracts attention from other important problems that result from a diminished female presence in cybersecurity, from the development and security of the technology that controls how we live and keep us safe, to the health of the global economy. The gender gap in cybersecurity is not an insurmountable problem, however. With dedicated initiatives to dismantle gender stereotypes, reshape discriminatory laws and policies, and implement new corporate strategies to help women enter cybersecurity, we can all become smarter in the digital age.

⁷⁴ Google openly fired a male employee on August 6, 2017 for writing a discriminatory memo in response to Google's diversity efforts, arguing that women weren't biologically fit to work in technical positions. Daisuke Wakabayashi, "Google Fires Engineer Who Wrote Memo Questioning Women in Tech," *The New York Times* (Aug. 7, 2017), <https://www.nytimes.com/2017/08/07/business/google-women-engineer-fired-memo.html?smprod=nytcore-ipad&smid=nytcore-ipad-share>