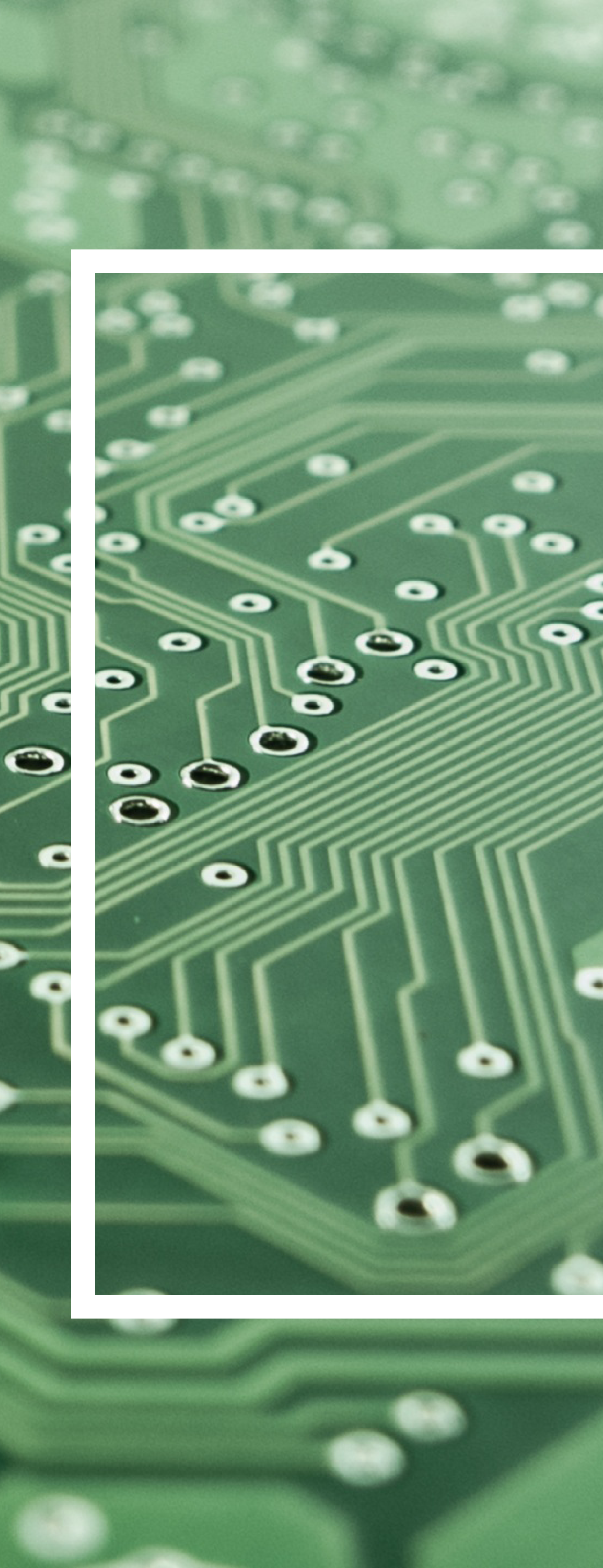

INNOVATING TO INNOVATE?

A NATIONAL REPORT CARD

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INTRODUCTION

The world is perched on the frontier of what some call the "fourth industrial revolution." Life-changing goods, services, and industries will spring from the synergy of advancements in 5G wireless communications, artificial intelligence, robotics, Internet of Things, quantum computing, materials science, biotechnology and nanotechnology.

The economies and enterprises that lead the maturation and integration of these platforms will prosper greatly and set the pace for societal advancement in the years ahead. While the United States has been the global innovation leader for many years, resting on past laurels in the face of intensifying global competition is a strategy for obsolescence.

Other countries understand the importance of innovation and are taking pages from the U.S. playbook to up their game. Sustaining U.S. economic and geostrategic leadership requires that we continuously improve the national innovation system—implementing new and better ways of cultivating and combining world-class human, financial, and collaborative resources essential for innovation.

In 2012, the U.S. Chamber of Commerce Foundation published *American Competitiveness*. It spotlighted the five main requirements for excelling in the tightly-contested global race to innovate.

- Fix America's education and immigration systems to keep the pipeline of technical talent flowing strong
- Strengthen public and private sector research and development
- Bolster cross-sectoral and cross-disciplinary connectivity and collaboration
- Reenergize the nation's manufacturing base
- Modernize America's patent and IP protection systems

Seven years after the publication of *American Competitiveness*, how well is the country performing in each of these categories? Despite modest improvement in some areas, the report card is highly concerning, except, perhaps, to the nation's foreign competitors. Let's breakdown how and why.

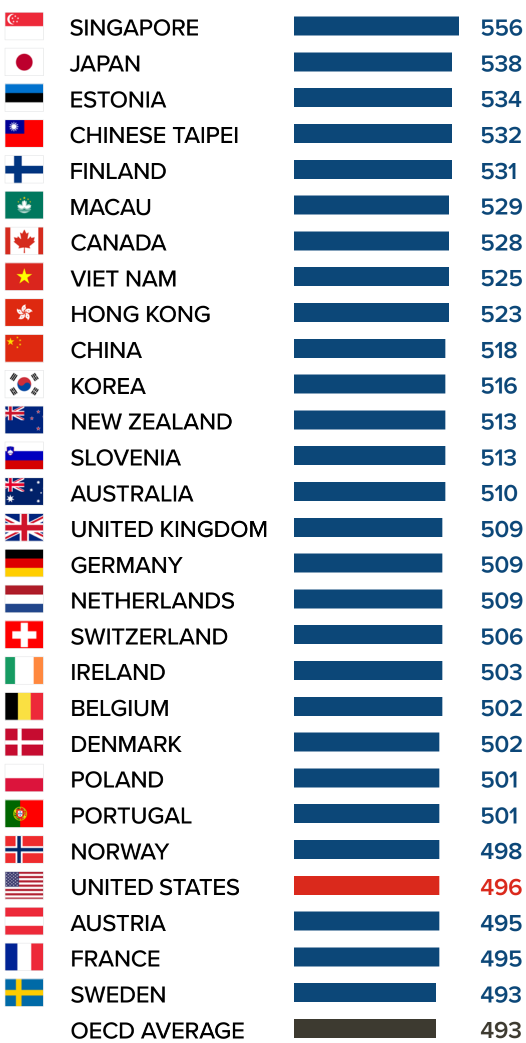
FIXING AMERICA'S EDUCATION AND IMMIGRATION SYSTEMS TO KEEP THE PIPELINE OF TECHNICAL TALENT FLOWING STRONG:

The 2012 report identified concerns with the strength of the U.S. talent pipeline due largely to three factors:

- Exceptionally poor performance by the U.S. student body in science, technology, engineering, and math (STEM)
- An insufficient workforce supply of degreed scientists and engineers[1]
- A suboptimal immigration system for attracting and keeping world-class STEM talent

The most recent ranking of student performance by the Programme for International Student Assessment, placed the United States 25th out of 70 countries in science proficiency and 39th in math proficiency.[2] This places U.S. 15-year-olds toward the back of the pack among students in the 36 member nations of the Organization for Economic Co-operation Development (OECD) -- 30th in science and 19th in math.[3] By comparison, the 2012 evaluation placed U.S. students 20th in science and 27th in mathematics among developed economies.[4]

2015 PISA AVERAGE SCIENCE SCORES



Other key student evaluations, including *Trends in International Mathematics and Science* and *The National Assessment of Educational Progress (NAEP),* tell a similar, still-alarming story of U.S. student underachievement and unpreparedness.[5] The story, as reported by the U.S. Department of Education's National Report Card, includes a widening achievement gap between high-performing and low-performing students, and troubling underperformance by the nation's 4th graders, over half of whom score below grade level in both reading and math.

Developments in the pursuit of STEM bachelor's degrees show a more promising trend. The percentage of U.S. college-bound students seeking technical degrees rose significantly since the 2007 Great Recession.[6] Despite the uptick, the United States continues to trail India, China, and the European Union respectively, in the gross number of STEM undergraduate degrees awarded—understandable given the Asian countries' higher population. However, the data also suggest that a higher percentage of Chinese and Indian students study STEM disciplines compared to that of U.S. students.[7]

The post-recession rise in college-level STEM studies has been accompanied by steady growth in the number of U.S. graduates seeking STEM doctoral degrees.[8] Promising? Yes. Adequate? No. The insufficiency of science and engineering graduates is the primary reason that this year, for the first time, the United States dropped out of the Top 10 in Bloomberg's International Innovation Index.[9] According to Bloomberg, the plunge was caused by "an eight-spot slump in the post-secondary, or tertiary, education-efficiency category, which includes the share of new science and engineering graduates in the labor force."[10] A 2017 report shows that most students in key STEM-related graduate programs based in the U.S. are international students, and "their numbers have been rising much faster than the number of domestic students."[11] Moreover, the United States must do far better at developing workers with education and expertise spanning STEM skills to promote innovation where it is most fertile – at the intersection of disciplines.

While developing homegrown talent is essential, advanced economies look to attract technical excellence from abroad as a means of importing fresh energy, new perspectives, and critical skills. This strategy heretofore has been a boon for the United States. Nearly one-third of American inventors are foreign born, while immigrants are responsible for a significant share of the nation's most successful, high-employing startups.[12]

The nation's prime conduit for attracting technical experts to its shores is the H1B visa program; *American Competitiveness* chronicled long-standing inadequacies in the program. In 2008, 163,000 applicants vied for 85,000 such visas at a time when technical jobs went wanting.[13] As of April 6, 2018, the congressionally mandated visa cap had dropped to 65,000.[14]

Moreover, waiting times for processing, which average six months, are likely to get longer as the U.S. government's expedited visa processing program has been suspended.[15] Unsurprisingly, the admittance into the United States of professionals with advanced degrees or aliens of exceptional ability decreased from 50,959 in 2012 to 38,858 in 2016.[16]

What hasn't changed over the past six years is that STEM employers still face enormous difficulties in finding the talent they need. In a 2017 report, the New American Economy Research Fund reported "13 STEM jobs were posted online for each unemployed worker that year—or roughly 3 million more jobs than the number of available, trained professionals who could potentially fill them."[17]

In sum, we are not adequately solving what U.S. Chamber of Commerce President Tom Donohue calls the "two-gap" challenge – the skills gap (a shortage of people lacking the critical skills needed to compete for 21st century jobs); and the people gap (that leaves too many businesses without the properly skilled employees they need). The challenge of bridging these gaps sharpens considering that the number of U.S. STEM-related jobs is growing three times faster than non-STEM jobs, with a projected 9 million STEM jobs needing to be filled by 2022.[18]

STRENGTHENING U.S. COMMITMENT TO RESEARCH AND DEVELOPMENT: B-

World-class innovation relies upon strong public and private financial support for basic and applied research and development.

Happily, the U.S. retains the top spot in total R&D spending worldwide.[19] However, China is closing the gap fast.[20] Chinese research and development spending exceeds that of the EU and is projected to surpass total U.S. R&D investment soon.[21] Moreover, the U.S. has slipped from 8th place to 10th place among OECD nations measured by percentage of GDP devoted to research and development.[22]

Surveys show that senior corporate financial executives willingly forego funding R&D to meet short-term corporate profit projections.[23] Additionally, uncertainty over continuity of the R&D tax credit has made the R&D investment climate even worse.

EXPENDITURE ON R&D AS A PERCENTAGE OF GDP

- ISRAEL 4.40%
- FINLAND 3.88%
- KOREA 3.74%
- SWEDEN 3.40%
- JAPAN 3.26%
- DENMARK 3.06%
- SWITZERLAND 2.99%
- USA 2.90%
- GERMANY 2.82%
- AUSTRIA 2.76%

In 2015, Congress took the long-needed steps of making the tax credit permanent and applying it more generously to small businesses and start-ups. Reform, however, stipulates that beginning in 2022 companies using the credit must amortize R&D expenses.[24] Currently, firms may deduct their full, qualified R&D expenses in the same tax year that the cost was incurred. The amortization requirement coupled with the rule's complexity could continue to place a drag on needed R&D commitments.[25] According to the Information Technology & Innovation Foundation (ITIF) "the United States continues to lag other countries on tax treatment of R&D, falling from 10th among OECD nations in 2000 to 25th today."[26]

Another factor clouding the future of U.S. innovation is the global shift in economic power to emerging economies. Corporations are inclined to place R&D facilities where the customer base is growing quickest and trained personnel are readily available. The large population of China and India, combined with their rising consumer demand and surge of a technically-competent workforce, will continue to be an R&D magnet.[27]

Over the past 15 years the number of foreign-run R&D centers in China has increased from 200 to over 1,500.[28] Significantly, Chinese labs are shifting their focus from supporting domestic, low-cost manufacturing to knowledge-driven R&D for global markets.[29]

This is among the trends that have contributed to the growth in Chinese patents. When American Competitiveness was published, China had just eclipsed the United States in the percentage of global patent filings. Two years ago, China's 1.3 million applications accounted for 42% of global applications.[30] The U.S. share accounted for less than half that level.[31] One can argue over comparative patent-quality, but the disparity in volume is a significant competitive indicator.

REENERGIZING THE NATION'S MANUFACTURING BASE: B+

Stout consumer demand and human capital is not the only R&D magnet;proximity to thriving manufacturing, where innovations can be produced and utilized is also a key factor.

According to the sector's trade association, manufacturers account for two-thirds of U.S. R&D.[32]

Eight years ago, China overtook the United States as the world's largest manufacturer, earning it first rank in that year's Global Manufacturing Competitiveness Index (GMCI) published by Deloitte and the U.S. Council on Competitiveness. The United States trailed China, India and South Korea.[33]

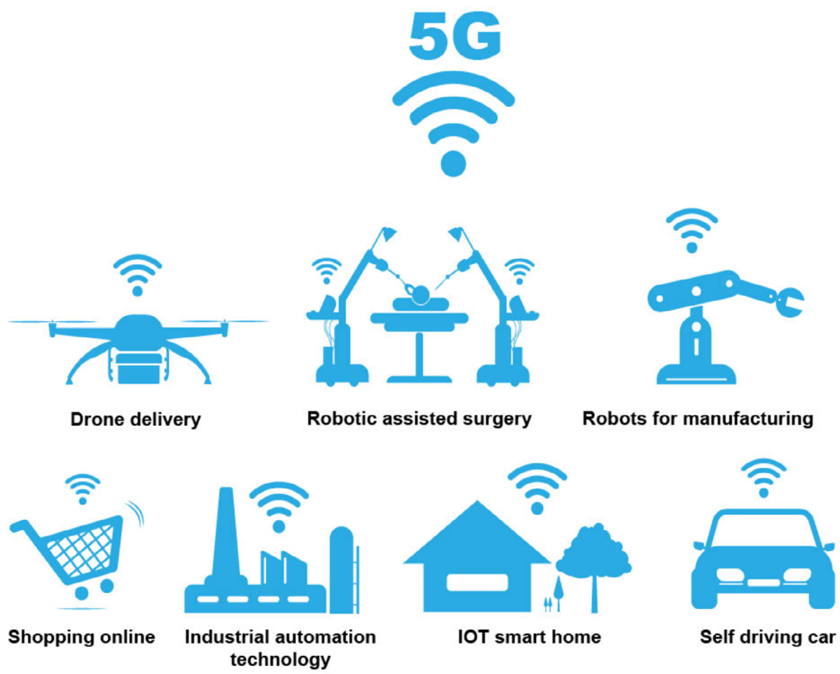
In the intervening years, U.S. manufacturing has hit the comeback trail, earning the number two spot in the 2016 GMCI evaluation and on track to overtake China for the top rank in 2020.[34] The rebound is being accompanied by a significant jump in R&D spending by the domestic manufacturing sector, climbing 10.5% between 2010 and 2015, accounting for inflation.[35] Critics will note that manufacturers' R&D growth as a percentage of spending is rising more rapidly in other countries, but the U.S. manufacturing renaissance is a positive development that will contribute significantly to the nation's long-term fortunes.[36]

BOLSTERING CROSS-DISCIPLINARY COLLABORATION:

Among the United States' most potent advantages is the ability to exploit expertise at the intersection of disparate disciplines and industries. The capacity to bring together diverse minds and expertise to drive innovation is actuated by world-leading research universities and national laboratories, outstanding technology clusters, and cyber-connectivity.

The United States has long led in the development of technology clusters like Silicon Valley, Research Triangle Park, and the Boston Corridor. According to *Business Insider* seven of the top 20 start-up hubs are in the United States.[37] A new approach to evaluating and ranking the world's most productive tech incubators based on patent filings places Japan on top. Three of its clusters --Tokyo-Yokohama, Osaka-Kobe-Kyoto and Nagoya—rate among the global Top 10.[38]

The physical proximity of interdisciplinary academic, research, and commercial institutions is not the only building block of fruitful collaboration. Virtual connectivity, as measured by broadband Internet access and speed, is also key. In 2012, the U.S. ranked 8th in the world in broadband penetration versus today's ranking of 15th in fixed broadband and 7th in mobile broadband penetration respectively.[39] In broadband speed the U.S. placed 12th overall. Today, the U.S.'s 7th position in fixed broadband speed is followed by the 45th spot in the mobile component.[40]



The broadband domain is where perhaps the most influential global race for innovation is taking place, in the form of a future-shaping contest to deploy 5th Generation (5G) broadband networks.

While 3G and 4G networks were evolutionary, bringing economic game changers like the GPS, 5G is revolutionary—offering Internet speeds over 10 times faster than today's and one-tenth the latency. Its capacities will enable the life-changing innovations that will dominate the future in artificial intelligence, robotics, autonomous vehicles, and smart cities. The first nation to develop 5G will have an enormous advantage in top measures of global competitiveness, including the capacity to innovate manufacturing, corporate attraction, foreign direct investment, and cybersecurity. It's a race that Deloitte says China is currently winning; but the story is still being written, as the United States is making a major push to get there first.[41]

MODERNIZING AMERICA'S PATENT AND IP PROTECTION SYSTEMS: C–

Abraham Lincoln, an inventor as well as president, counseled the importance of adding "the fuel of interest to the fire of genius." The reference was to the national patent and IP protection system that incentivize innovators to create economic value.

As noted in *American Competitiveness*, lengthy processing and persistent backlogs have long-plagued the country's patent system. While some progress has been made in reducing the logjam and speeding action times, the improvement is modest at best.

As of mid-2018, the U.S. Patent and Trademark Office (USPTO) reported 540,677 unexamined patent applications, modestly better than the 608,000 pending applications reported in 2012.[42] The waiting time on First Office Action Pendency (the average number of months from the patent application filing date to the date a "First Office Action" by the USPTO) has dropped from 21.9 months to 15.6 months.[43] Similarly, Traditional Total Pendency (the time that a patent application is originally filed to when the USPTO issues or abandons the patent), which stood at 32.4 months in 2012 has shrunk to 24.2 months.[44] However, a 2015 Inspector General Report sharply criticized the USPTO for lack of quality assurance in patent processing.[45]

Perhaps the greatest threat to U.S. innovation is found in the post-patent arena, where Intellectual Property (IP) piracy and theft take an enormous toll. A study by the Commission on the Theft of American Intellectual Property published after *American Competitiveness* chronicled the monumental cost to the United States of IP theft and piracy in terms of lost revenue, jobs, GDP, and innovation.[46] A recent estimate of IP theft's climbing cost to the United States range from $225 billion to $600 billion per year.[47]

Much of the problem owes to lax enforcement abroad; however, the inability to recognize and enforce patent protection domestically is why the U.S. Chamber of Commerce Global IP index dropped the U.S. patent system out of the top 10 worldwide.[48]

A 2017 follow-on report by the Office of the U.S. Trade Representative on serial IP violators, reasserted that "China is home to widespread infringing activity, including trade secret theft, rampant online piracy and counterfeiting, and high levels of physical pirated and counterfeit exports to markets around the globe. It further chronicled China's unrelenting effort to impose "indigenous innovation" policies that unfairly disadvantage U.S. rights holders.[49] The report also identified "new and growing concerns" regarding India's IP protection practices and standards, and serious enforcement shortfalls by other key trading partners.[50]

IP piracy and counterfeiting remain a clear and growing threat to U.S. innovation and the integrity of the global trading system, exacerbated by lengthening supply chains, cyber-insecurity, and insufficient standards and practices of oversight and enforcement.

CONCLUSION

The U.S. innovation system faces many challenges and threats, both internal and external. While significant, these challenges are surmountable provided the nation modernizes its innovation system. More succinctly: the United States must innovate to innovate. By doing so, the United States can secure its position at the vanguard of the fourth industrial revolution, assuring U.S. global economic and geostrategic leadership well into the 21st century. Failure will mean slowly yielding primacy to other countries that are working overtime to replace the United States as the global leader and rules setter.

Here are ten of the most important steps the U.S. can take to assure the life-improving, economy-growing innovation pipeline remains strong and productive. Achieving these steps will go a long way in helping the nation to lead what promises to be the most creative and exciting epoch of invention in human history:[51]

10 STEPS THE US CAN TAKE FOR A STRONG AND PRODUCTIVE INNOVATION PIPELINE

1. MODERNIZE STRATEGY

Provide for the regular development and updating of a comprehensive and national innovation strategy (along the lines of the National Security Strategy and Quadrennial Defense Review) and regularly report to the public on implementation status and results

2. RUN A CAMPAIGN

Undertake a STEM revitalization campaign to significantly improve the subject-matter proficiency and readiness of America's student body through better curricula and advanced teaching methods

3. EXPAND RESEARCH

Expand public and private research programs and centers of excellence in STEM pedagogy and the study of innovation

4. PROMOTE STEM

Launch a major national campaign to inspire young Americans to choose STEM degrees and professions

5. COMMIT TO R&D

Significantly expand public and private research and development through conducive public policy, industry norms, and corporate leadership

6. SUSTAIN RENAISSANCE

Sustain America's manufacturing renaissance by creating a world-class business environment in which they can thrive

7. ENHANCE CYBERSECURITY

Lead the world in cybersecurity to foster the growth of highly-networked 4th Industrial Revolution technologies and to capitalize on the benefits of 5G innovation

8. IMPROVE SPEED

Improve the speed, efficiency, and quality of the U.S. patent processing system

9. ACHIEVE NEW ACCORDS

Achieve the new international accords to promote the enforcement of intellectual property worldwide

10. FOSTER COLLABORATION

Nurture innovation hubs, promote cyber-connectivity, and foster the growth of partnerships spanning disciplines, institutions, and borders to expand the frontiers of human knowledge and creativity

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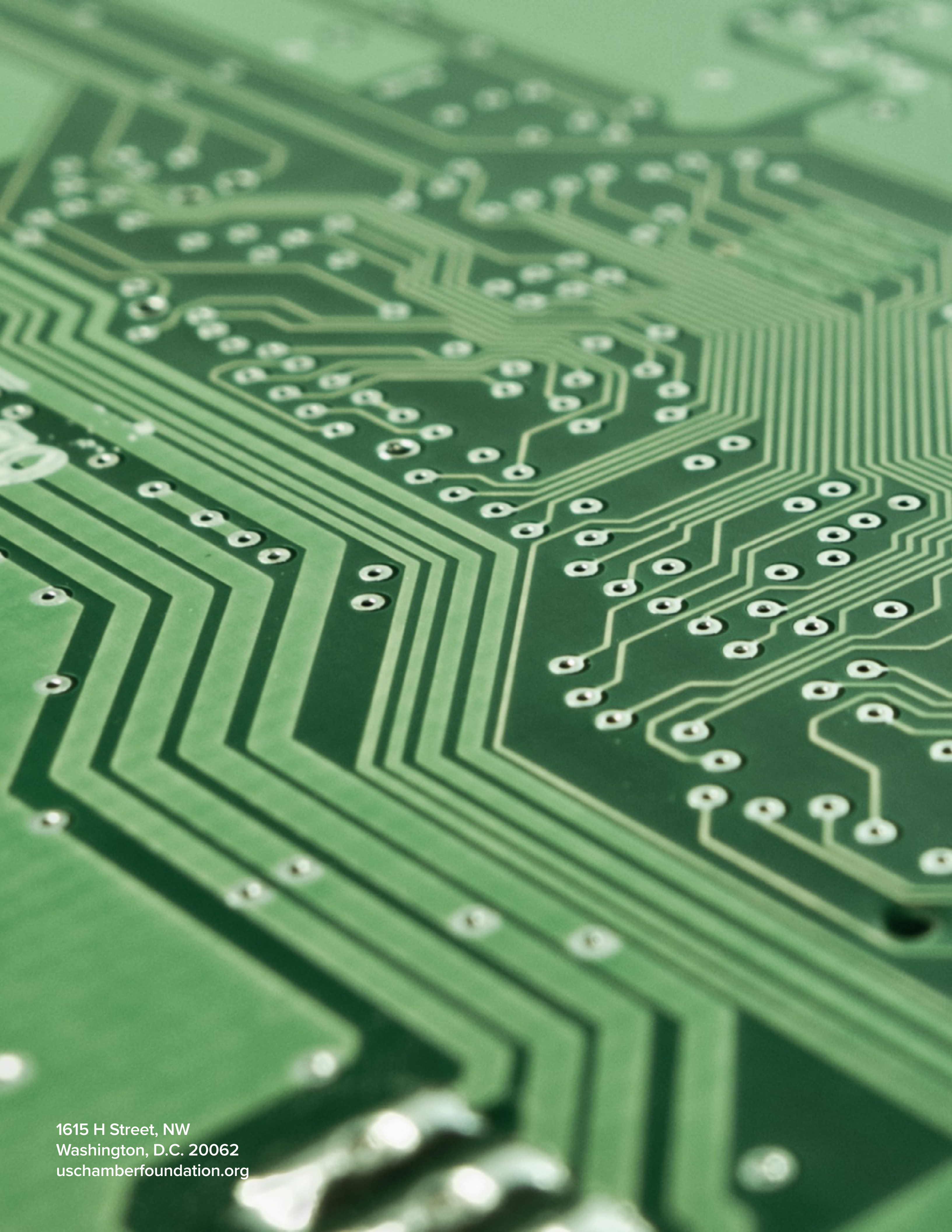

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