SEMICONDUCTOR INDUSTRY ASSOCIATION

Comments of Semiconductor Industry Association to Request for Information,

"Charting a Course for Success: America's Strategy for STEM Education"

85 Fed. Reg. 55323 (Sept. 4, 2020)

Submitted October 19, 2020

The Semiconductor Industry Association (SIA) is the voice of the U.S. semiconductor industry, one of America's top export industries and a key driver of America's economic strength, national security, and global competitiveness. Semiconductors – microchips that control all modern electronics – enable the systems and products we use to work, communicate, travel, entertain, harness energy, treat illness, and make new scientific discoveries. The semiconductor industry directly employs nearly a quarter of a million people in the United States, and is the nation's 5th largest export by revenue. In 2019, U.S. semiconductor company sales totaled $209___ billion, and semiconductors make the global trillion dollar electronics industry possible. SIA seeks to strengthen U.S. leadership of semiconductor manufacturing, design, and research by working with Congress, the Administration and other key industry stakeholders to encourage policies and regulations that fuel innovation, propel business and drive international competition. Additional information about SIA is available at www.semiconductors.org.

The U.S. semiconductor industry accounts for roughly a quarter of a million direct jobs in the U.S.. These jobs are split across a range of occupations, with the largest two segments being production occupations – such as factory technicians and line workers (38 percent of the total workforce) and engineering occupations – such as electronics and electrical engineers and chip design engineers (26 percent). In addition, each semiconductor industry job creates nearly 5 additional jobs in the broader economy, on average, meaning the industry creates more than 1 million jobs across the economy.

The U.S. semiconductor industry's innovation edge rests on the efforts of scientists and engineers to develop innovative products that are better than the competition both here and abroad. One of the biggest challenges U.S. semiconductor firms face is recruiting and retaining top science

and engineering talent. SIA companies are actively engaged in workforce and skills development efforts throughout the country, but a comprehensive STEM education strategy is urgently needed to maintain America's talent pipeline and technological edge. Developing the best-and-brightest scientists and engineers domestically, and recruiting talent globally, is critical to ensuring semiconductors remain a top U.S. export and our industry continues to be a key driver of a strong and innovative American economy.

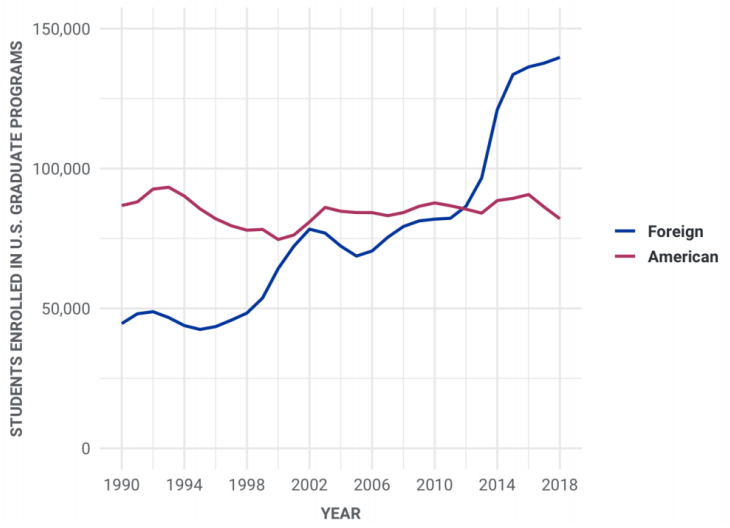
STEM Education Should be a National Priority

To maintain global semiconductor industry leadership and ensure America wins the worldwide race to develop and implement the technologies of the future, the U.S. needs a highly skilled workforce. Leadership in semiconductor research, design, and manufacturing requires access to the best and brightest scientists and engineers from around the world, as well as skilled technicians and other occupations requiring STEM proficiency. In the global race for talent, the U.S. educational system is failing to produce a sufficient number of American workers and students with the necessary STEM expertise to meet the needs of the semiconductor industry and other technology fields[1].

[1] "Winning the Future: A Blueprint for Sustained US Leadership in Semiconductor Technology" April, 2019.

The U.S. is also falling behind its global competitors in most education benchmarks[2]. China is producing many more bachelor's degrees in STEM fields. At the graduate level — which generates the expertise in materials science, physical chemistry, electrical engineering, and other fields of importance to the semiconductor industry — a large percentage of students in relevant fields at U.S. colleges and universities are from foreign countries. In electrical engineering and computer science graduate degree programs at U.S. colleges and universities, the National Science Foundation (NSF) indicates that approximately 80 percent of students are from foreign countries, a rapidly increasing trend[3]. The U.S. needs a comprehensive long-term plan to attract young students — particularly underrepresented women and minorities — to science and engineering and expose them to work in labs, advanced manufacturing, and apprenticeships.

Figure 3. Number of domestic and international students enrolled in semiconductor-related graduate programs at U.S. universities, 1990–2018.



Source: NSF Survey of Graduate Students and Postdoctorates in Science and Engineering. Data includes students in Electrical, Electronics and Communications Engineering and Computer Science.

The number of American students enrolled in semiconductor related graduate programs (around 90,000) has not increased since 1990. In that same period, the number of international students nearly tripled from 50,000 to 140,000 (Source: "The Chipmakers", Center for Security and Emerging Technologies, Georgetown University, 2020)

The Federal Government Should Double Funding for STEM Education

To meet these needs over the long-term, the federal government should increase U.S. investments in STEM education by 50 percent and implement a national STEM education initiative to double the number of American STEM graduates by 2029. Policymakers should support apprenticeships and training programs and work with industry and academia to develop curricula to match the needs of growing technologies that are critical to the future of the

[2] "Second Place America? Increasing Challenges to US Scientific Leadership," Task Force on American Innovation, 2019.
[3] "National Science and Engineering Indicators", National Science Foundation, 2019.

semiconductor industry, such as artificial intelligence, quantum computing, and advanced wireless networks. Furthermore, the 200+ federal STEM programs across agencies need consolidation and measurement, in additional to increases in funding.

The Federal Government Should Promote High Quality STEM Education

Over the long-term and in order to build the next generation of innovators in the semiconductor industry, the federal government must do more to promote high quality STEM education at the K-12 level and up through the higher education system. Studies have shown that students who do not get interested in STEM in or before middle school are much less likely to choose a STEM education path and career[4]. Federal agencies and fees collected through the U.S. high skilled immigration system provide some of the funds for federal K-12 STEM programs; however, the majority of the funding for K-12 education comes from the state and local levels. The largest fraction of federal funding for K-12 education comes in the form of Title I non-discretionary grants from the Department of Education, which should be better targeted toward developing STEM capable students.

Math Proficiency a Limiting Factor for The Domestic Pipeline into STEM fields

According to the most recent National Assessment of Education Progress (NAEP) report, 66 percent of fourth graders are not proficient in science and 60 percent were not proficient in math. Mathematics proficiency is a critical to entrance into all STEM fields, and in particular, the semiconductor fields of electrical engineering, computer science, materials science, and other related scientific fields.

The America COMPETES Reauthorization Act of 2010 included funding for the UTEACH program, now part of the National Math and Science Initiative (NMSI). By allowing math and science majors to earn teaching certificates while earning undergraduate degrees, the UTEACH program increases the pipeline of highly qualified math and science teachers[5]. By providing students with highly qualified math and science teachers, the nation can drastically increase the pipeline of

[4] "State of STEM: Determining High Impact Pathways for the Workforce of the Future", STEM Education Coalition.
[5] National Math and Science Initiative, 2020.

students who are able to achieve math proficiency, subsequent science proficiency, and then enter STEM fields and professions.

STEM Education Initiatives Should Include Apprenticeships

Government and industry should partner to develop industry-led apprenticeship models that are flexible enough to meet the rapid change in advanced manufacturing industries, including semiconductors. Studies have shown that internship or apprenticeship experiences can greatly accelerate new employees' ability to get up to speed and full productivity. Unfortunately, U.S. semiconductor firms find that the existing apprenticeship model is too inflexible for this rapidly changing advanced manufacturing sector. Apprenticeship models must also provide an incentive, potentially in the form of federal funding, for employer participation. Some SIA members are pursuing new, industry-driven apprenticeship models to meet their needs[6].

Engage State and Local Governments

State and local governments should actively engage with U.S. semiconductor firms to incentivize siting of new facilities and workforce development. One SIA member noted that they have maintained design facilities in certain locales, even as they have shuttered co-located manufacturing operations, because of strong engagement by the state and local government to provide incentives to the company to stay and grow locally. These types of engagements at the state and local level are important avenues for maintaining and growing U.S. semiconductor employment. Firms should also engage workforce development boards and other avenues to build partnerships for workforce development efforts around the country.

Increase Investment in AI Workforce Development Programs

Artificial Intelligence (AI) is bringing disruption across industries and education is no different. AI has the potential to boost rates of profitability by a significant amount (about 14 trillion USD

[6] For example, Citizen Schools, where Western Digital employees lead 10 week in-classroom apprenticeships on a variety of topics including 3D printing, Science, and Mathematics to middle schools students. Other SIA member companies also conduct similar programs.

economic boost by 2035), and AI adoption is just beginning across the industry. The federal government can play a role by funding community college programs that will increase AI workforce readiness and can serve as reskilling centers for workers. Community college systems can be the catalyst for making AI technology skills accessible to as many workers nationwide as possible. Increasing investment in programs such the NSF Advanced Technological Education (ATE) program would help close AI skills gap. With an emphasis on two-year Institutions of Higher Education (IHEs), the focus on educating technicians in a wide array of industry with AI skills will help drive our nation's economy. The program focus on developing partnerships between academic institutions and industry is the right model to build new AI skills sets for future and existing workforce.

Lack of Diversity is Narrowing the Domestic STEM Pipeline

There is a lack of diversity in the U.S. semiconductor workforce and broader STEM pipeline. Representation of women and underrepresented minorities in STEM, and especially in the physical sciences and engineering, has been persistently well below the demographics of the country and enrollment in institutions of higher education overall. Many SIA firms have undertaken targeted diversity initiatives to improve their workforce diversity profile to match or exceed diversity within the pool of available talent. Firms both small and large have shown that through targeted approaches that include focused mentorship, bias training in hiring, and workforce cultural changes, they can improve representation of women and underrepresented minorities within their workforce.

The Federal Government and Universities Should Promote Pathways Into Semiconductor Fields

Industry awareness and brand recognition are low among target populations of graduate students in engineering and computer science. With the rise of “new tech” companies, including Google and Facebook, over the past two decades, many STEM students today have a much lower awareness of the critical role of semiconductors in enabling technology and innovation in sectors across the economy. Many of these students thus end up specializing in areas that are not

relevant to a career in the semiconductor industry[7]. Firms work to varying degrees to address these shortcomings through targeted engagement with college and university campuses on curriculum development and awareness building efforts. The degree of engagement is often a function of both the size of the firm, and thus the resources they have available to bring to bear on workforce development, and the profit margins available in their targeted market sectors. Another contributing factor to this challenge for some firms is recruits' willingness to relocate outside major metropolitan areas where Google, Facebook, and other tech firms are predominantly located.

Hands On Experiences Are Critical to Student Learning and Pathways into STEM

Government and industry should work to bring more hands-on experiences with semiconductors into more classrooms. There is a large body of evidence that shows hands-on and work experiences contribute to better outcomes for workers over the long run and quicker returns on investment for firms that hire those workers. Hands-on experiences, such as "dissecting a cell phone" – as an analogue to biology curricula that include dissections of frogs, for example – should have a role in the curricula. SIA members and other industry stakeholders are actively working on programs that bring such hands-on experiences to students.

For example, FIRST robotics competition, which is heavily supported by sponsorships and partnerships with the semiconductor industry, brings real world experiences for thousands of students around the country. Further, IBM's P-TECH model brings industry and local governments together to develop industry relevant curricula and work experiences for students who will then graduate with a diploma and an Associate's degree. Qualcomm's Thinkabit Labs targets middle schoolers of all cultural and socioeconomic backgrounds that they can be part of the next generation of invention and innovation. These and other examples of educational programs by SIA member companies are crucial in stimulating student interest in STEM.

[7] "Current and Future Domestic Workforce Needs to Support a Domestic US Semiconductor Industry", SIA Response to NIST RFI, 2018.

R&D Investments by the Federal Government are Key to STEM Talent Development

Federal government investments in basic and applied semiconductor research have historically been important in domestic workforce development. Consortia efforts like SEMATECH jointly funded by government and industry in the 1980s and 1990s, provided instrumental research and engineering experience that led to a new generation of leaders in semiconductor engineers and scientists.

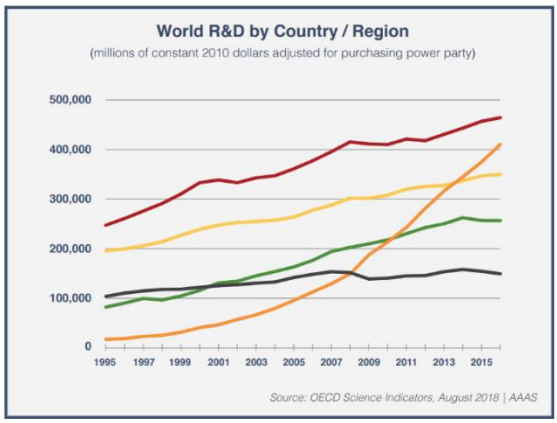
To make breakthroughs in the key technologies expected to drive future economic growth and to maintain American leadership in the face of global competition, the U.S. needs to invest ambitiously in semiconductor research- and triple its federal investment over the next five years. The U.S. semiconductor industry invests nearly 20 percent of revenue in research and development, among the highest of any industry sector, amounting to approximately $40 billion in 2019.

Unfortunately, government investment in research has been declining or been flat for many years. In contrast, key competitors are dramatically increasing their research spending, including targeted investments in semiconductor research. The U.S. risks losing its innovation edge and the global competition for technology leadership if under-investment persists[8].

GRAPH 1.2
World R&D by Country/Region
(millions of constant 2010 dollars adjusted for purchasing power party)

- USA
- China
- EU-28*
- Japan
- Rest of World

** For this report, the term 'EU-28' refers to the 28 member states of the European Union as of early 2019: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom*



Bipartisan legislation pending in Congress calls for significant increases in federal investment in semiconductor research (American Foundries Act, CHIPS for America Act). These investments are needed to maintain U.S. technology leadership and to build the pipeline of talent for the industry

[8] "Second Place America? Increasing Challenges to US Scientific Leadership," Task Force on American Innovation, 2019.

in the future. We call on Congress and the administration to enact and fund these initiatives to ensure the U.S. maintains its leadership for decades to come.

Reform High-Skilled Immigration to Enable Access to Global Talent

As the U.S. takes action to improve STEM education to build the next generation of scientists, engineers, and other skilled workers, it must also reform the broken system of high-skilled immigration. As set forth in these comments, measures to improve our STEM education system will require long-term action with a sustained commitment to funding over decades. Over the near term and while we implement STEM education improvements over the long-term, the semiconductor industry in the U.S. needs the ability to recruit and retain talent from around the world, including STEM graduates from U.S. colleges and universities. Otherwise, the U.S. risks losing the race for talent and the competition for global technology leadership.

SIA urges the Congress and the Administration to work together to reform the high-skilled immigration system by eliminating counterproductive caps on green cards so qualified STEM graduates from U.S. colleges and universities, as well as STEM graduates from around the world, can work, innovate, and contribute to U.S. leadership in the semiconductor industry and boost our economy. Foreign nationals in STEM fields, particularly those with advanced degrees, should be automatically eligible to work in the U.S. and contribute to our economy. Finally, restrictions on the entrance of students, researchers, and experts, and others, that were implemented in 2020 need to be lifted in order to ensure a high-quality pipeline of students, experts, and scientists into the research ecosystem.