SEMICONDUCTOR WORKFORCE DEVELOPMENT

A POLICY BLUEPRINT

April 2024

SIA SEMICONDUCTOR INDUSTRY ASSOCIATION

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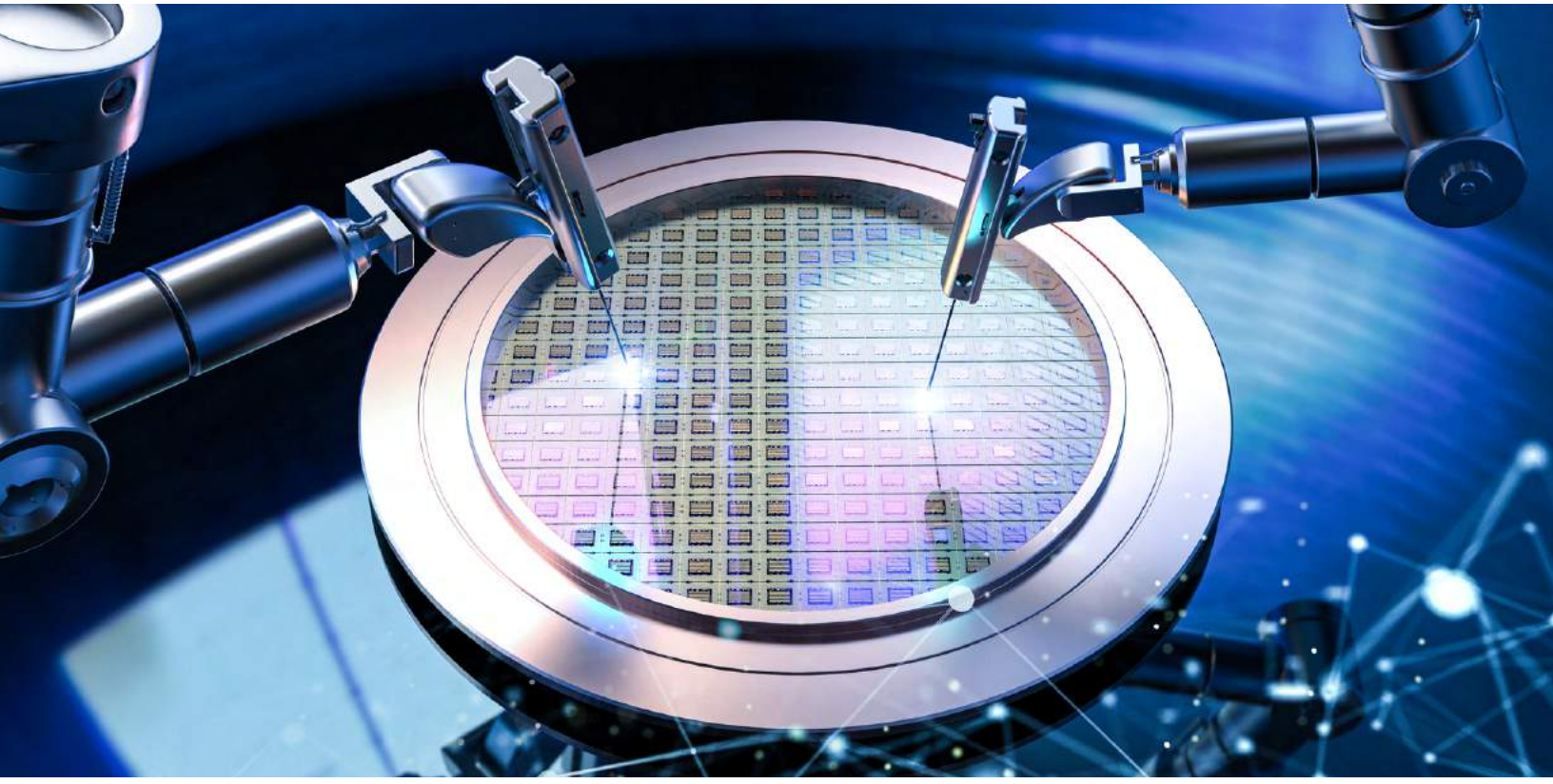
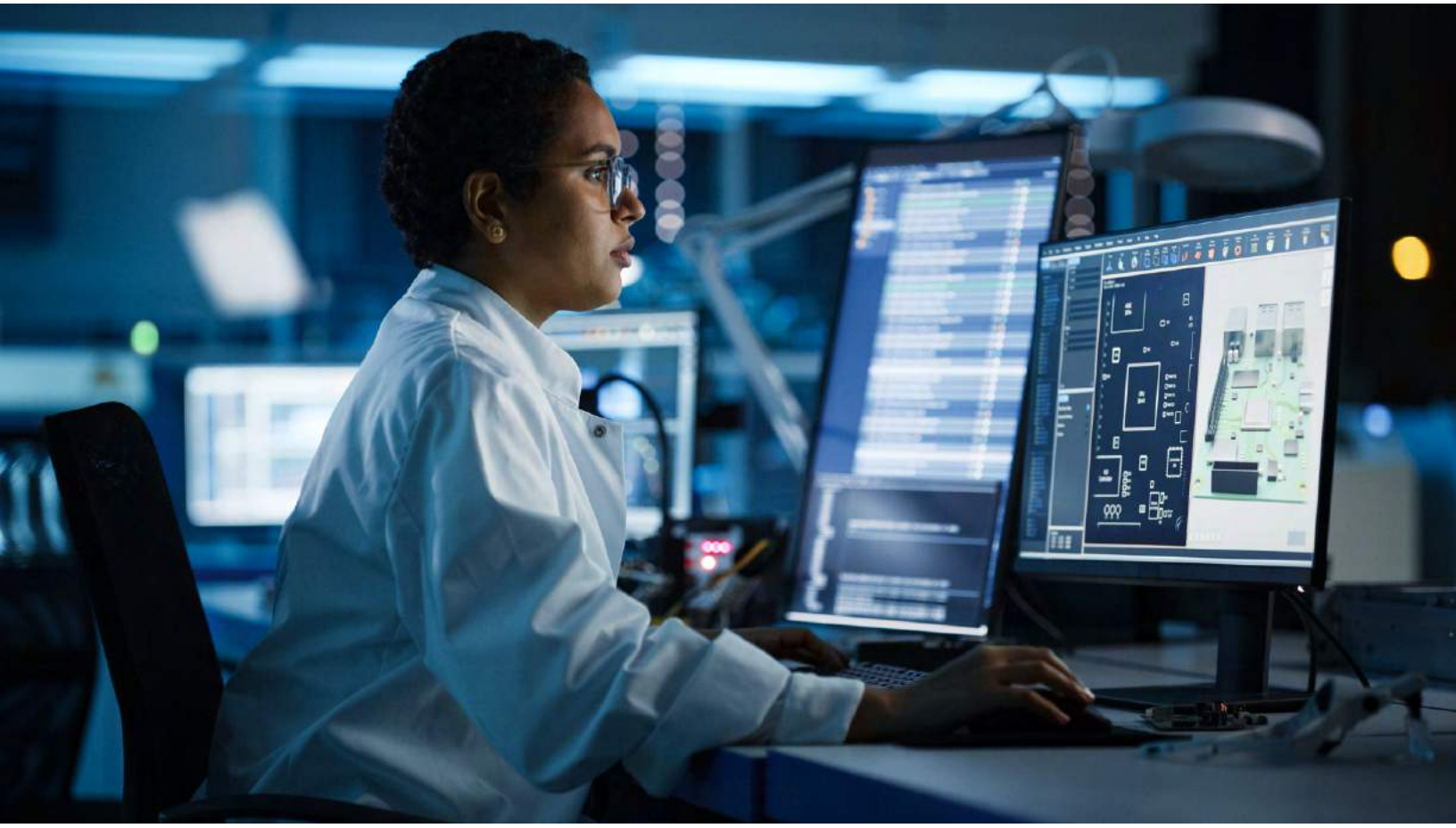


INTRODUCTION



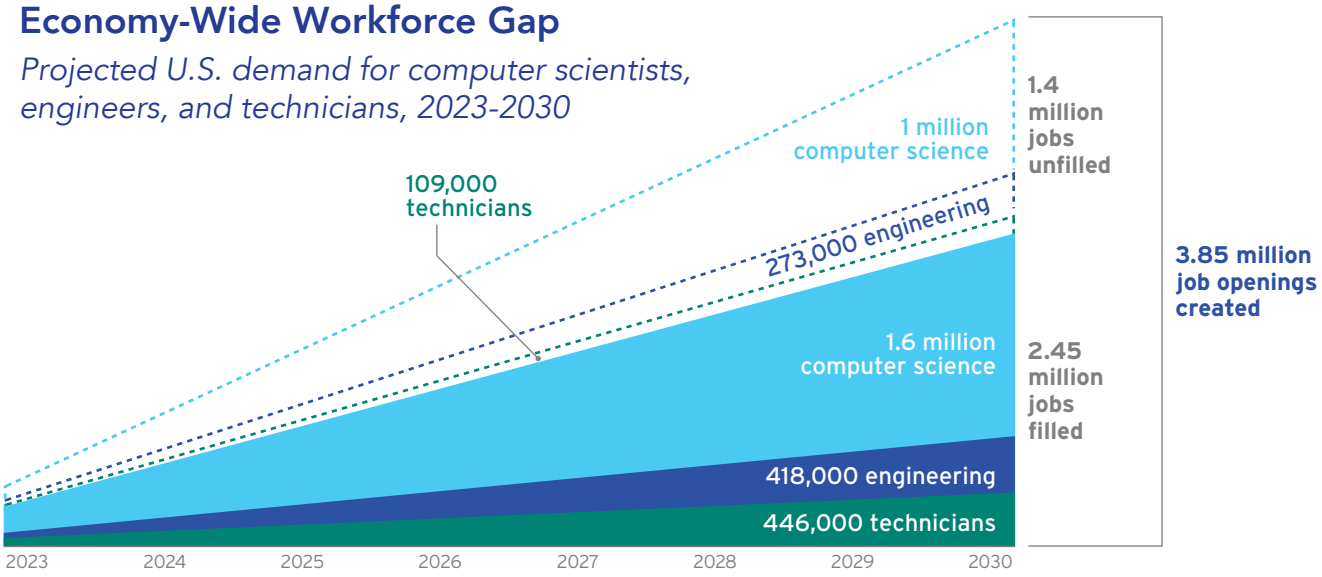
The competitiveness of the U.S. semiconductor industry – and the economic strength, national security, and technology leadership the industry supports – depends on a highly skilled technical workforce. To secure U.S. economic and technology leadership in the future and ensure the goals of the CHIPS and Science Act are met, the U.S. must prioritize the adoption of policies that will create a strong, sustainable, and capable workforce with the necessary skills to allow the U.S. semiconductor industry and other critical and emerging technology industries to compete and lead in the years ahead.

The U.S. Workforce Challenge

A report by SIA and Oxford Economics documented the skills gap facing the semiconductor industry and the U.S. economy as a whole.[1] According to the report, the U.S. faces gaps in skilled workers at all levels for manufacturing and chip design – scientists and engineers with 4-year or advanced degrees (e.g., electrical, chemical, mechanical and process engineers, material scientists, computer scientists), technicians with specialty training but not a 4-year degree (e.g., industrial operations specialists, engineering technicians, equipment operators), and others. As summarized in the following chart, the U.S. economy as a whole is estimated to create 3.85 million additional jobs by 2030 requiring proficiency in technical fields, and an estimated 1.4 million jobs risk going unfilled due to a relative scarcity of skilled technicians, highly educated engineers, and computer scientists.

Economy-Wide Workforce Gap

Projected U.S. demand for computer scientists, engineers, and technicians, 2023-2030



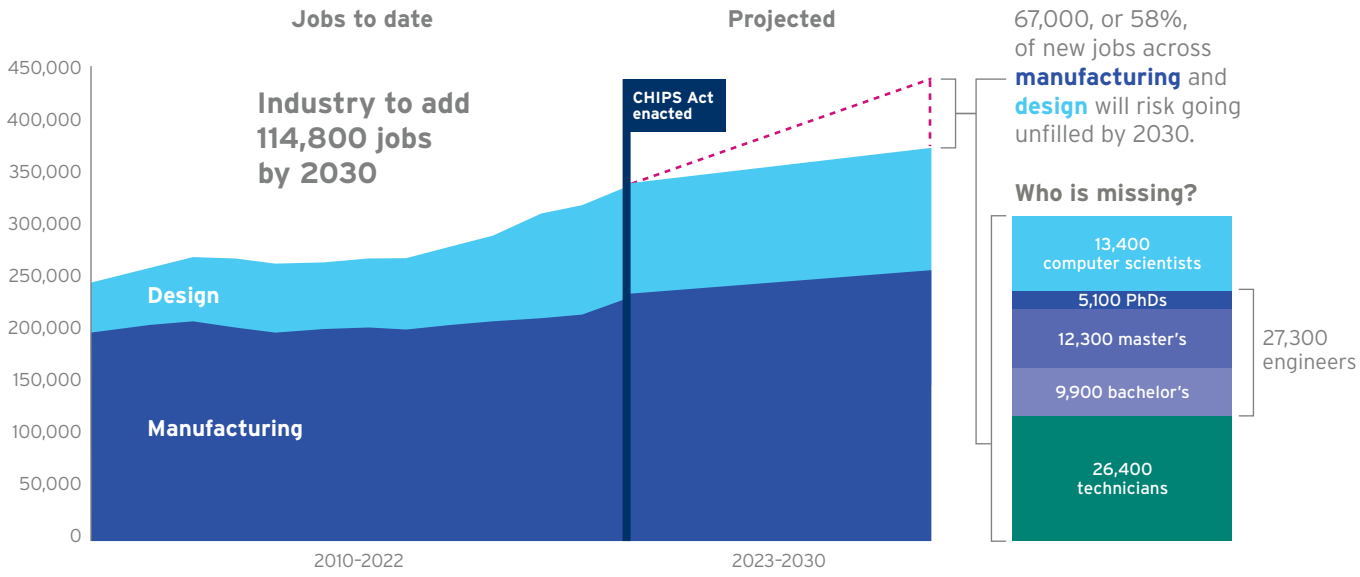
For the U.S. semiconductor industry, the workforce for chip manufacturing and design is estimated to grow by nearly 115,000 jobs by 2030, and roughly 67,000 – or 58% of projected new jobs (and 80% of projected new technical jobs) – risk going unfilled at current completion rates. Of the unfilled jobs, the positions are divided as follows:

- 39% (26,400) will be technicians (most of whom will require some post-secondary training, but not a four-year degree)
- 35% (23,300) will be computer scientists or engineers with a four-year degree
- 26% (17,400) will be engineers at the master's or PhD level

[1] Semiconductor Industry Association / Oxford Economics, "Chipping Away: Assessing and Addressing the Labor Market Gap Facing the U.S. Semiconductor Industry," available at https://www.semiconductors.org/wpcontent/uploads/2023/07/SIA_July2023_ChippingAway_website.pdf.

Semiconductor Workforce Gap

Historical semiconductor workforce and projected 2023-2030 gap



This shortfall in workers spans the entire semiconductor supply chain, from engineers that drive the research in design and materials, to the technicians who operate and maintain the equipment on the fab floor. It impacts fabless companies who work exclusively on the function and design of a chip, foundries that focus exclusively on the manufacturing of the chip, integrated device manufacturers (IDM) which do both, as well as supply chain partners who manufacture the sophisticated equipment for chip manufacturing and the specialized chemicals, gases, and materials needed in the process. Solutions to this challenge must address the broad spectrum of skills and knowledge that each role requires, and any of the following recommendations should be evaluated across the needs of the supply chain.

Failing to address this gap in skilled workers poses risks to the ability of the U.S. to compete in the global economy in manufacturing and chip design, our capacity for innovation and technology leadership, and ultimately our national security. Congress and successive Administrations have prioritized the competitive position of the U.S. semiconductor industry, as well as other critical and emerging technology industries of strategic importance (e.g., AI, advanced manufacturing, clean technology, etc.), but their success depends on a comprehensive response that ensures the U.S. workforce is the best educated and trained in the world.

Initiatives under the CHIPS Act

Bridging the skills gap is a top priority for the U.S. semiconductor industry, and companies are addressing this challenge through engagements and partnerships with states and localities, the university community, community colleges, non-profits, labor organizations, veterans groups, and others to develop the skilled workers and expand opportunities for underrepresented communities, to build the semiconductor workforce.[2] In addition, the CHIPS Act creates a solid foundation to build on to address these challenges.

- The CHIPS Act requires companies seeking manufacturing incentives to prioritize workforce development as part of their applications. Companies in the semiconductor industry are expanding partnerships with universities and community colleges to ensure they have the requisite skilled workforce, and these initiatives should be broadened throughout the country.

- The CHIPS Act invests substantial funding in semiconductor-specific research and development programs, including the National Semiconductor Technology Center (NSTC), the National Advanced Packaging Manufacturing Program (NAPMP), Manufacturing USA Institutes, the CHIPS R&D Metrology Program, and the DOD Microelectronics Commons, all of which require a workforce component.[3] These vital programs will advance U.S. innovation in semiconductor technology, while also helping build a skilled workforce to advance American leadership globally.

- The CHIPS Act also included the CHIPS for America Workforce and Education Fund, a $200 million program being implemented by the National Science Foundation.[4]

[2] A partial listing of these efforts is available at White House, "FACT SHEET: Biden-Harris Administration Highlights New Commitments Toward Equitable Workforce Development in Advanced Manufacturing" (Jan. 23, 2024), at https://www.whitehouse.gov/briefing-room/statements-releases/2024/01/23/fact-sheet-biden-harris-administration-highlights-new-commitments-toward-equitable-workforce-development-in-advanced-manufacturing/

[3] The vision document for the NSTC highlighted workforce development as one of the NSTC's three primary objectives. NIST, "A Vision and Strategy for the National Semiconductor Technology Center." https://www.nist.gov/chips/vision-and-strategy-national-semiconductor-technology-center

[4] National Science Foundation, "CHIPS and Science," https://new.nsf.gov/chips

- In addition to the fully funded CHIPS R&D programs, the CHIPS and Science Act authorized substantial increases in funding for R&D programs at various U.S. agencies (NSF, NIST, and the DOE Office of Science), which are critical to workforce development. Thus far, appropriations for these programs are 30% below the levels authorized.

In response to the growing demands for semiconductor talent, community colleges and universities are scaling up their efforts to recruit, educate, and train students for careers in the chip industry. Already, over 50 community colleges have announced new or expanded programming to help American workers access good-paying jobs in the semiconductor industry.[5] Many university engineering departments offer or plan to begin offering semiconductor degrees, certificate programs, or specializations/tracks. These programs, as well as their faculty and facilities, should be supported, expanded, and promoted to students across America.

Other existing programs outside the CHIPS and Science Act are also making an important contribution to meeting this challenge, including initiatives under the Departments of Education and Labor. More must be done, however, to address the talent scarcity facing the semiconductor industry and the U.S. economy as a whole.

[5] The White House, "FACT SHEET: One Year after the CHIPS and Science Act, Biden-Harris Administration Marks Historic Progress in Bringing Semiconductor Supply Chains Home, Supporting Innovation, and Protecting National Security," See: https://www.whitehouse.gov/briefing-room/statements-releases/2023/08/09/fact-sheet-one-year-after-the-chips-and-science-act-biden-harris-administration-marks-historic-progress-in-bringing-semiconductor-supply-chains-home-supporting-innovation-and-protecting-national-s/

SIA Policy Recommendations

To address the workforce needs of the semiconductor industry and other critical industries, Congress and the Administration must work together to advance a comprehensive and ambitious workforce development agenda consisting of a variety of complementary policies. Given the magnitude of the challenge and the range of education and skills needed, no single program or piece of public policy will address the totality of the challenge facing our country. SIA recommends a holistic public policy approach that addresses the challenges of the U.S. semiconductor workforce by implementing effective workforce development solutions.

I. Build the Supply of Engineers and Scientists

1. **Invest in the Innovation Workforce:** Increase and sustain funding for federal research and development (R&D) programs to build America's innovation workforce.
2. **High-skilled Global Talent:** Adopt critical and targeted STEM immigration reforms to ensure America attracts and retains the world's top talent.

II. Improve and Simplify Training of Skilled Technicians

1. **High-quality Workforce Training:** Expand workforce training programs that meet industry's needs, including apprenticeships and career and technical training programs with common and transparent metrics of performance.
2. **Standardization and Portability of Skills:** Ease the transition across educational institutions and workforce development programs.

III. Cross-Cutting Workforce Challenges: Expanding the Pipeline and Addressing Affordability

1. **Expand and Advance the STEM Talent Pipeline:** Prioritize STEM education for individuals entering or already in the pipeline and expand the pool of potential workers, including veterans, women, and underrepresented minorities.
2. **Affordability:** Remove barriers to entry into semiconductor education and workforce training programs through Pell grants, favorable loans, and other financial incentives.

Adoption of these measures presents an opportunity to develop the workforce of the future needed to grow the U.S. semiconductor industry and the economy as a whole.

I. Build the Supply of Engineers and Scientists

Advancements and innovation in chip fabrication and design require highly educated engineers and scientists that push the boundary of what is possible. This talent creates the next generation of manufacturing techniques, chip designs and functionalities, specialty materials, and process equipment that are the lifeblood of innovation in the semiconductor industry and all industries enabled by semiconductor technology. Despite the importance of a strong supply of engineers and scientists, the SIA/Oxford Economics report indicates there is a significant shortage of this top technical talent. Addressing this challenge will require sustained action over years or decades, as the time frame to build this educated workforce requires substantial undergraduate, graduate, and post-graduate education and practical training.

1. Invest in the Innovation Workforce: *Increase and sustain funding for federal R&D programs to build America's innovation workforce.*

Programs at federal research agencies such as National Science Foundation (NSF), the Department of Energy (DOE) Office of Science, the National Institute for Standards and Technology (NIST), and the Department of Defense, including the Defense Advanced Research Projects Agency (DARPA), are critical to advancing basic science and innovation in America while at the same time training the technology leaders of the future. To ensure that America remains the global leader in technology and innovation, there must be increased, sustained funding over time for these agencies to build the innovation workforce.

a. Research and Development (R&D) Programs

In addition to advancing basic and applied research, federally funded R&D programs build the pipeline of scientists and engineers that accelerate American innovation. While the semiconductor R&D programs established by the CHIPS Act received appropriations, many other vital research programs authorized in the "& Science" portion of the bill have not yet received funding, thereby diminishing our nation's ability to sustain the development of scientists and engineers needed for continued U.S. leadership.

SIA Recommendation: Despite a challenging appropriations environment, Congress should prioritize funding of the "& Science" R&D programs at NSF, NIST, and DOE-Science near levels authorized in the CHIPS and Science Act. Sustained and predictable funding across all R&D accounts at Federal agencies will help to accomplish U.S. technology leadership on a global scale. This includes 6.1, 6.2, and 6.3 accounts at the DOD Office of Research & Engineering and DARPA, as well as NASA, NIH, EPA, and research accounts at the Departments of Agriculture, Transportation, and HHS.

b. STEM Education Programs

In addition to investing in research to support engineers and scientists currently pursuing STEM degrees, we must invest in educating the STEM graduates of the future. Unfortunately, existing programs to address this critical need are under-resourced and are at further risk given significant cuts in funding levels in FY24.

SIA Recommendation: Increase funding for stand-alone STEM education and workforce development programs authorized by the CHIPS & Science Act:[6]

- Undergraduate STEM education ($750M over 5 years - NSF)
- Robert Noyce Teacher Scholarship Program ($436M over 5 years - NSF)
- PreK-12 STEM Education ($300M over 5 years - NSF)
- Increased collaboration with teachers and scientists ($200M over 5 years - DOE)
- Activities to expand STEM opportunities ($115M over 5 years – NSF)
- Rural STEM activities ($100M over 5 years – NSF)
- Scholarships and fellowships ($100M over 5 years – NSF)
- Research and dissemination to increase participation of women and underrepresented minorities in STEM fields ($25M over 5 years – NSF)
- Tribal colleges and universities ($10M over 5 years – NSF)

SIA Recommendation: Increase funding for innovation programs authorized by the CHIPS & Science Act that feature substantial STEM education and workforce development elements:

[6] Brookings, "How federal, state, and local leaders can leverage the CHIPS and Science Act as a landmark workforce opportunity." https://www.brookings.edu/articles/how-federal-state-and-local-leaders-can-leverage-the-chips-and-science-act-as-a-landmark-workforce-opportunity/

- EDA Regional Technology and Innovation Hubs ($10B over 5 years)
- NSF Innovation Engines ($3.25B over 5 years)
- NIST Manufacturing Extension Partnership ($2.3B over 5 years)
- NIST Manufacturing USA Institutes ($829M over 5 years)

c. Coordination of Interagency Efforts

As the need for highly educated workers grows more urgent, it is critical that the federal government make investments in the development of the STEM workforce to increase the number of engineers and scientists, and that these programs are coordinated to maximize results and measure effectiveness.

> **SIA Recommendation:** Establish an interagency process within the EOP/WHO to coordinate STEM workforce development policy and programs in the United States, such as through the establishment of an Office of STEM Workforce Coordination and Policy.

2. High-skilled Global Talent: *Adopt critical and targeted STEM immigration reforms to ensure America attracts and retains the world's top talent.*

Even with significant and effective investments in educating and training top scientists and engineers, such policies will take years to achieve results and will fail to address near-term needs. Given that approximately two-thirds of all graduate students at U.S. universities studying science and engineering are foreign nationals,[7] retaining this scientific talent is essential to maintaining U.S. technology leadership. The U.S. attracts these students due to its top-tier education system, but our immigration policies make it difficult for these students to remain in the U.S. after graduation and contribute to our competitiveness. Instead, our immigration system forces many of these students educated in the U.S. to work and contribute to the innovation in competing countries. As our country takes steps to implement the CHIPS Act and build the domestic pipeline of highly educated U.S. students with STEM degrees, we need a near-term fix that reforms our outdated immigration system to complement the existing U.S. workforce with key foreign scientists and engineers who have the necessary expertise to advance American innovation.

[7] National Science Foundation, National Science Board Science & Engineering Indicators, "Higher Education in Science and Engineering," Nov. 2023. See https://ncses.nsf.gov/pubs/nsb202332

a. Targeted High-Skill Immigration Reform for Emerging and Critical Technologies

As Congress works to address border security and other immigration measures for the country's national security and economic competitiveness, it must also adopt overdue changes to the U.S. employment-based green card system. This action will enhance our nation's economic growth and national security and strengthen critical and emerging technology industries who need access to top global talent. According to estimates by FWD.us, the backlog of immigrant workers and their families seeking a green card is over 1.2 million people.[8]

SIA Recommendation: Congress should advance targeted immigration policies that reduce the employment-based green card backlog and allow domestic industry to employ foreign national workers that will contribute to industries in need of high-skilled talent.

- Enact legislation that eliminates STEM green card backlogs, including critical and emerging technologies, through mechanisms like recapture, and eliminating the per-country green card limits.
- Provide appropriations to U.S. Citizenship and Immigration Services specifically targeted at clearing employment based green card backlogs.

SIA Recommendation: The Administration should prioritize actions and rulemakings that improve efficiency and increase flexibility for companies utilizing employment-based visas in STEM and critical and emerging technologies.

- Reinforce and expand on efforts to increase efficiency, such as the Department of State's H-1B Visa Revalidation Pilot Program. The success of this pilot program should be analyzed, and its expansion should be considered for dependents and others.
- Ensure that the Department of Labor's Schedule A occupation list has updated data and information on critical and emerging industries in need of workers to increase the efficiency of the labor certification process. Additionally, the Department should ensure that any prevailing wage determinations are issued expeditiously, to ensure industry has ample time to accurately forecast and plan.

[8] FWD.us, "Per-Country Cap Reform, Priority Bill Spotlight," Dec. 2023. See: https://www.fwd.us/news/per-country-cap-reform-priority-bill-spotlight/

b. Attract and Retain International Students Graduating from U.S. Universities with Advanced Degrees

The U.S. remains a global leader in higher education and students from around the world consistently seek to come to America to study, especially those seeking advanced degrees. According to a FWD.us report,[9] international students make up 60% of all advanced degree graduates from U.S. universities specializing in a semiconductor relevant engineering or computer science field. Additionally, roughly 80% of all international students with an advanced degree in a semiconductor related field that are graduating this year, want to stay in the U.S. post-graduation. Foreign born workers are critical to America's workforce, especially in areas that require advanced degrees. In 2019, roughly 37% of master's level and 43% of doctorate level science and engineering workers in the United States were foreign born. Foreign students also earned more than half of PhDs in computer and information sciences (59%), engineering (60%), and mathematics and statistics (54%).[10]

SIA Recommendation: Congress should increase pathways for advanced degree students who graduate from U.S. universities to transition their studies into work in a relevant industry in the United States, such as by "green card stapling" for STEM master's and PhDs.

SIA Recommendation: The Administration should expand the existing STEM jobs included on the DHS STEM Designated Degree Program List, which would qualify F-1 students with semiconductor-relevant degrees for a 24-month extension of their Optional Practical Training (OPT) employment authorization.

[9] FWD.us, "The U.S. Semiconductor Industry Needs Skilled Workers for Thousands of Open Jobs. Retaining International Graduates is a Solution," Oct. 2023, https://www.fwd.us/news/semiconductors/

[10] National Science Foundation, "The State of U.S. Science and Engineering 2024," https://ncses.nsf.gov/pubs/nsb20243/preface

II. Improve and Simplify Training of Skilled Technicians

Semiconductor fabrication is a complex, technically advanced manufacturing process requiring a skilled workforce (e.g., industrial operations specialists, engineering technicians, equipment operators, and others) to operate and maintain sophisticated machinery, handle specialized materials, and conduct other operations. These jobs typically require post-secondary training but not necessarily a college degree. SIA estimates that of the projected 67,000 unfilled jobs by 2030, 39% will not require a college degree, and other studies conclude that even higher percentages of semiconductor workers will require some post-secondary training but not a college degree.[11] In addition to policies to build the pipeline of highly educated engineers and scientists, the U.S. also needs to adopt policies to build the quantity and skills of workers able to work as technicians in the semiconductor industry.

1. High-quality workforce training: *Expand workforce training programs that meet industry's needs, including apprenticeships and career and technical training programs with common and transparent metrics of performance.*

a. Apprenticeships

Registered Apprenticeship programs are perhaps the most effective workforce development program in use in the country.[12] Registered Apprenticeships are an "earn and learn" model of workforce development that provide on-the-job training for

[11] According to one study, over 60% of semiconductor manufacturing roles require no bachelor's degree. Brookings, "With high-tech manufacturing plants promising good jobs in Ohio, workforce developers race to get ready," available at: https://www.brookings.edu/articles/with-high-tech-manufacturing-plants-promising-good-jobs-in-ohio-workforce-developers-race-to-get-ready/. Another study estimated that 53% of all CHIPS jobs would require less than a four-year college degree. University of Massachusetts Political Economy Research Institute, "Employment Impacts of New U.S. Clean Energy, Manufacturing, and Infrastructure Laws" at p. 60, CHIPS-9 (September 2023), available at https://peri.umass.edu/publication/item/1758-employment-impacts-of-new-u-s-clean-energy-manufacturing-and-infrastructure-laws?_gl=1*1juh0mm*_gcl_au*OTQ1NzEwNzM1LjE3MTAxNjc1MDQ.*_ga*OTg4NzA4OTQ5LjE3MDg5NTU5NDU.*_ga_21RLS0L7EB*MTcxMDE2NzUwNC4xLjAuMTcxMDE2NzUxMy4wLjAuMA.

[12] Department of Labor, "Investing in Talent Development: Benefits to employers of registered apprenticeships from the American Apprenticeship Initiative." https://www.apprenticeship.gov/sites/default/files/aai-infographic-employers-11-11-22.pdf. Brookings, "Apprenticeships are an overlooked solution for creating more access to quality jobs." https://www.brookings.edu/articles/apprenticeships-are-an-overlooked-solution-for-creating-more-access-to-quality-jobs/

individuals seeking careers in specific industries, making it a highly valuable approach for the semiconductor industry. Despite steady growth in overall participation rates of employers and apprentices, as well as increased funding over the past decade, utilization of these programs in the U.S. still falls far short of their potential benefit to industry and workers alike.

SIA Recommendation: Simplify, expand, and strengthen Registered Apprenticeships in the semiconductor industry.

- Simplify the registration process for employers to begin or continue their own apprenticeship programs. According to one study, a third of employers say that lack of clarity around registration requirements is a barrier to starting their own program.[13]
    - Given the urgency of meeting workforce needs in the industry, the Department of Labor should commit to a series of pilot projects with employers in the semiconductor sector that grant presumption of approval for apprenticeship sponsorship, allow them to use previously approved models, and conduct in-progress assessments for continuation of eligibility.
    - The Department should also examine the feasibility of a baseline standard of reciprocity for registration and reporting requirements between state apprenticeship programs which states could opt into.[14]
    - In simplifying the process for employers and prospective apprentices, policymakers should provide increased support for apprenticeship intermediaries, such as the National Institute for Innovation and Technology (NIIT) and SEMI Foundation, which provide technical expertise and can facilitate participation with apprenticeship programs.

- Increase funding for Registered Apprenticeship programs to double the number of employers and participants in the semiconductor industry and other strategic industries by 2028, and then again by 2032.
    - To achieve this goal, Congress should double funding specifically for apprenticeships in the semiconductor and adjacent industries, such as through the Growing Apprenticeship in Nanotechnology and

[13] The Aspen Institute, "Recasting American Apprenticeship: A Summary of the Barriers to Apprenticeship Expansion Project Research" (Nov. 2015), available at https://www.aspeninstitute.org/wp-content/uploads/files/content/docs/pubs/Recasting%20Apprenticeship.pdf.
[14] Third Way, "How to Improve the Registered Apprenticeship System," available at https://www.thirdway.org/report/how-to-improve-the-registered-apprenticeship-system.

Semiconductors ("GAINS"), a registered apprenticeship program by the Department of Labor,[15] or the SEMI Career and Apprenticeship Network (SCAN).[16]

- Create targeted marketing to, and incentives for, participants to enter an apprenticeship program in specific industries that align with national economic priorities.

- Create Regional Semiconductor Apprenticeship Schools, modeled after the Apprentice School at Newport News Shipbuilding, that house shared facilities, up-to-date equipment, faculty, and support services, as well as outreach to students and jobseekers in their region.

b. Workforce Innovation and Opportunity Act (WIOA)

WIOA is the nation's primary and core organizing legislation related to workforce development. It represents an important source of training dollars, access to career counseling and job search for millions of job seekers annually. It includes a centralized governance and planning structure that seeks to align education and training efforts between workforce, career technical education (CTE), apprenticeships, and other related programs in states, regions, and localities. SIA strongly supports the reauthorization of WIOA.

SIA Recommendation: Reauthorize WIOA, appropriate additional funds, and implement reforms to improve effectiveness:

- Tie acquired skills, program outcomes, and measures of success with the needs of the industry.
- Require at least half of WIOA's Title I funding to be committed to training.
- Require better transparency of the outcomes and quality of funded programs, including short-term training.
- Increase utilization of pay-for-performance funding mechanisms to ensure quality programs rise to the top and reliable delivery of value to employers and workers alike.
- Increase the actual appropriations under this reauthorization by 5% per year for the next five years to ensure sufficient training resources.

[15] GAINS facilitates partnerships between regional sponsors and training providers to develop, implement and administer competency-based RAPs that target training to meet job requirements and gaps in individual skills. Department of Labor, Industry Intermediary: National Institute for Innovation and Technology (NIIT) https://www.apprenticeship.gov/sites/default/files/NIIT_Intermediary_FY22.pdf

[16] The SEMI Career and Apprenticeship Network (SCAN) is a registered apprenticeship program created specifically for the microelectronics industry. SCAN is a program for entry-level technicians, operators and professionals that teaches both the foundational and specialized skills needed for the well-paid, high-demand jobs in microelectronics. See: https://semiscan.org/

c. Perkins Career and Technical Education (CTE) Act

The Carl D. Perkins Career and Technical Education Act (Perkins CTE Act) is the primary federal law aimed at developing and supporting career and technical education (CTE) programs at the secondary and postsecondary educational levels. The Perkins CTE legislation enjoys strong bi-partisan support, and will be up for reauthorization in the 119th Congress. Given the goal of improving and raising the attainment of applied STEM knowledge, skills, and abilities in our middle, secondary, and post-secondary schools, Congress should enact policies that increase access to and prioritize participation in a CTE experience in middle and high school and are strongly incentivized in community colleges.

SIA Recommendation: Reauthorize the Perkins CTE Act, appropriate additional funds, and implement reforms to improve effectiveness:

- Appropriate at least $12 billion over 5 years for Perkins CTE to dramatically increase the availability of and access to career connected learning and applied industry engagements, with a prioritization of new funding toward semiconductors and other critical and emerging sectors.
- Ensure that all interested high school students can have a meaningful internship and an engaging and informative exposure to a technical career field of interest.
- Fund scholarships for continued post-secondary education and training to students that successfully obtain industry recognized credentials in in-demand industries and occupations.
- Expand dual-enrollment opportunities, the transfer for credits earned, and the utilization of credit-for-prior-learning.
- Increase summer CTE programs for accelerated progress in STEM-related fields.
- Ensure the availability of high-quality education and career counseling for all secondary and post-secondary students.
- Develop effective incentives to attract highly credentialed and qualified teachers to participate in the program.

2. Standardization and Portability of Skills: *Ease the transition across educational institutions and workforce development programs.*

To encourage more individuals to enter the semiconductor field and remain in it, there needs to be a greater level of coordination and awareness of the skills needed for different job positions across training institutions and industry. Therefore, policies must be adopted to improve the standardization of curricula, skills metrics, and accreditation/certification.

a. Standardization of Training Programs and Curricula

The CHIPS Industrial Advisory Committee highlighted the lack of standardization as a key impediment to effective semiconductor workforce development in manufacturing and design: "[M]icroelectronics education and training, while well-intentioned, creative and largely effective locally, exist primarily in a very large number of silos (disciplinary, education level, industry segment and/or geographical) with little standardization, almost no sharing of curriculum, and pockets of proprietary information and training that limit the industry's ability to grow the diverse, multidisciplinary, highly skilled workforce needed."[17] To address this problem, the IAC stated: "All post-secondary educational institutions which receive funding through CHIPS R&D programs should be incentivized to participate in and contribute to an inclusive and highly collaborative national network for microelectronics education that promotes sharing of curricular content and workforce development program models, adoption of best practices, and standard frameworks, for maximum collective benefit."

> **SIA Recommendation:** For the IAC's vision to be fully realized, there needs to be a coordinating body to ensure effective development of common curriculum – at all degree levels – that adheres to industry needs and standards, is cataloged and made readily available, is kept up-to-date, and markets its

[17] IAC R&D Workforce Working Group Update and Recommendations, available at https://www.nist.gov/system/files/documents/2023/02/08/Feb%207%20IAC%20Meeting%20Workforce%20Presentation%20Final.pdf.

availability. As has been previously suggested,[18] this function should be housed within the National Center for the Advancement of Semiconductor Technology (Natcast), the entity that will operate the NSTC. Natcast should collaborate closely with all other federal agencies, industry and educational institutions, subject matter experts, and others as necessary and appropriate. With at least 50 community colleges in 19 states announcing "new or expanded programming to help American workers access good-paying jobs in the semiconductor industry,"[19] Natcast should also consider an easily adoptable curricula and/or training program specifically for community colleges that is adaptable by region.

b. Common and Transparent Measures of Quality and Performance

Across all training and workforce development programs, outcomes and metrics of success should be common, detailed and measurable against industry's workforce needs. This information should be made fully available through the use of open and interoperable data formats to ensure complete transparency and empower students, workers, job-seekers, employers, educators, and policymakers to make informed decisions about quality pathways.

SIA Recommendation: Establish evidence-based strategies supported by data that that will lead to measurable, replicable outcomes, including a strategy to link state systems to enable data sharing on long term outcomes.[20]

c. Transfer of Credits and Recognition of Prior Learning

The United States has one of the world's best education systems, but it is also plagued by inefficiencies and can do a poor job of supporting a large portion of students

[18] White House, "FACT SHEET: Biden-Harris Administration Announces Over $5 Billion from the CHIPS and Science Act for Research, Development, and Workforce," See: https://www.whitehouse.gov/briefing-room/statements-releases/2024/02/09/fact-sheet-biden-harris-administration-announces-over-5-billion-from-the-chips-and-science-act-for-research-development-and-workforce/

[19] White House, "Fact Sheet: One Year after the CHIPS and Science Act, Biden-Harris Administration Marks Historic Progress in Bringing Semiconductor Supply Chains Home, Supporting Innovation, and Protecting National Security." https://www.whitehouse.gov/briefing-room/statements-releases/2023/08/09/fact-sheet-one-year-after-the-chips-and-science-act-biden-harris-administration-marks-historic-progress-in-bringing-semiconductor-supply-chains-home-supporting-innovation-and-protecting-national-s/

[20] GAO report, "Career And Technical Education Perspectives on Program Strategies and Challenges" (March 2022), available at https://www.gao.gov/assets/gao-22-104544.pdf.

seeking smooth pathways from one learning experience to another. According to the Department of Education, "… while nearly 80% of community college students say they intend to transfer and eventually earn bachelor's degrees, actual transfer and degree completion rates are a challenge: only 16% of students who start in community colleges ultimately earn bachelor's degrees within six years, with lower rates for students from low-income backgrounds and students of color."[21] Another study by the GAO "estimated that students who transferred from 2004-2009 lost, on average, an estimated 43% of their credits, and credit loss varied depending on the transfer path."[22] They further found that "transfer students may incur additional costs to repeat credits that do not transfer or count toward their degree." The disconnect between the percentage of students who intend to transfer and the inability to transfer credits creates uncertainty and inconsistency in education and career development and may impact students desire to pursue a career.

SIA recommends the following set of actions to begin to address these challenges, but clearly recognizes that removing the inefficiencies and inequities of our overall education and training system is a multi-year, multi-faceted, and multi-party effort.

> **SIA Recommendations:** As Natcast builds out the repository of common curriculum it should: 1) prioritize the standardization of credits for credit-bearing programs established in line with industry requirements; 2) have credit recommendations determined for the non-credit courses and curriculum; 3) highlight those institutions that agree to accept the credit recommendations in general, and that agree to apply the credit toward the student's major; and 4) ensure that any standardization of credits and credentials is stackable, meaning individuals advancing through the education pipeline are able to build upon and utilize prior learning in a consistent manner despite variables that may impact access, such as location of classes or training.
>
> **SIA Recommendation:** The Department of Commerce, National Science Foundation, Department of Education, and Department of Labor should

[21] Department of Education, "New Measures of Postsecondary Education Transfer Performance: Transfer-out rates for community colleges, transfer student graduation rates at four-year colleges, and the institutional dyads contributing to transfer student success."
https://blog.ed.gov/2023/11/new-measures-of-postsecondary-education-transfer-performance-transfer-out-rates-for-community-colleges-transfer-student-graduation-rates-at-four-year-colleges-and-the-institutional-dyads-contributi/.
[22] GAO, Higher Education: Students Need More Information to Help Reduce Challenges in Transferring College Credits, https://www.gao.gov/assets/gao-17-574.pdf.

establish a national initiative on Learning Transfer. This effort should convene major educational associations and institutions, accreditors, industry, state and federal education and workforce agencies to plan clear steps toward improving the recognition and valuation of prior learning which would benefit the efficiency, equity, and cost effectiveness of all learning. We believe national foundations should join this effort through both leadership and financial support.

SIA Recommendation: Any ongoing effort to standardize previously acquired skills should include a focus on existing military members. As discussed in later sections of this policy blueprint, veterans are a skilled, motivated population, capable of learning and performing at a high level with the right instruction and guidance. Asking these individuals to start from the beginning is a disincentive and missed opportunity for several industries. To fully embrace the skillset that veterans hold when leaving the military, the Administration should contract with an organization to conduct a full analysis of these skills and report on their transferability and the equivalent credential that these individuals should hold.

d. Simplify Career Planning and Labor Searching

The nation's education and workforce development network in the U.S. consists of numerous programs governed by several agencies, each useful to different subsets of students, workers and industry. This decentralized network offers certain benefits, but it can be difficult to navigate for individuals seeking skills, credentials and jobs, and for industry who wish to utilize these programs to fill positions.

Efforts are underway to help make these programs easier to use by both job seekers and employers. Career One Stop[23] allows individuals seeking jobs to input information relevant to their job search, including desired industry, location, skills, and education, and receive several options for workforce development programs, credentials, or training which they can access to pursue open roles. For the semiconductor industry, the NIIT National Talent Hub[24] helps align jobseekers with industry needs.

[23] Additional information on Career One Stop is available at: https://www.careeronestop.org/

[24] The NIIT's National Talent Hub is a state-of-the-art portal that uses advanced data analytics to connect jobseekers and those looking to improve skills in technical, STEM based jobs to employers and training programs that target their specific needs. Different from the typical, more general job matching services that use resumes and job descriptions to create matches, the NIIT's National Talent Hub uses a dynamic database of required job competencies that is continually informed by industry to provide

SIA Recommendation: The Department of Labor should examine a system of information sharing with industry partners, including for the semiconductor industry, so they may have access to qualified workers, as well as up-to-date data and trends which would allow companies to accurately forecast hiring.

SIA Recommendation: Congress should provide funding to states to leverage existing tools and programs, such as the NIIT National Talent Hub, that facilitate connections between job seekers with requisite skills and employers.

e. Invest in the Professionalization and Performance of Education and Career Counselors in High Schools, Colleges, Workforce Development Systems, and Elsewhere

Education and career counselors play a significant role in the decision-making process for millions of students and job-seekers every year, and few recognize the full range of productive and gainful pathways to sustainable careers. We do our students and job-seekers a disservice when their career counselors are unable to provide the best advice to meet their actual needs.

SIA Recommendation: SIA recommends that Congress upgrade standards for career counselors at all levels of the publicly funded education and training system, and invest adequate resources to raise the professional standards for these positions.

insights into the degree of alignment between individuals, careers and course curriculum to put the jobseeker in the driver's seat. Individuals develop life-long learning profiles that are informed by past experiences, courses they take and jobs they hold, enabling them to map out career and education pathways like never before. The system is the only nationally integrated infrastructure of its type designed to broaden the talent pipeline by leveling the playing field for all by improving access for underrepresented populations. Additional information available at https://nationaltalenthub.com/

III. Cross-Cutting Workforce Challenges: Expanding the Pipeline and Addressing Affordability

In addition to adopting policies focused specifically on building the pipeline of engineers and scientists or training skilled technicians, the U.S. must take action to address cross-cutting challenges facing the innovation workforce. Solving these issues for the semiconductor industry requires an approach that encompasses other industries as well, and builds the overall number of students and individuals entering the STEM pipeline.

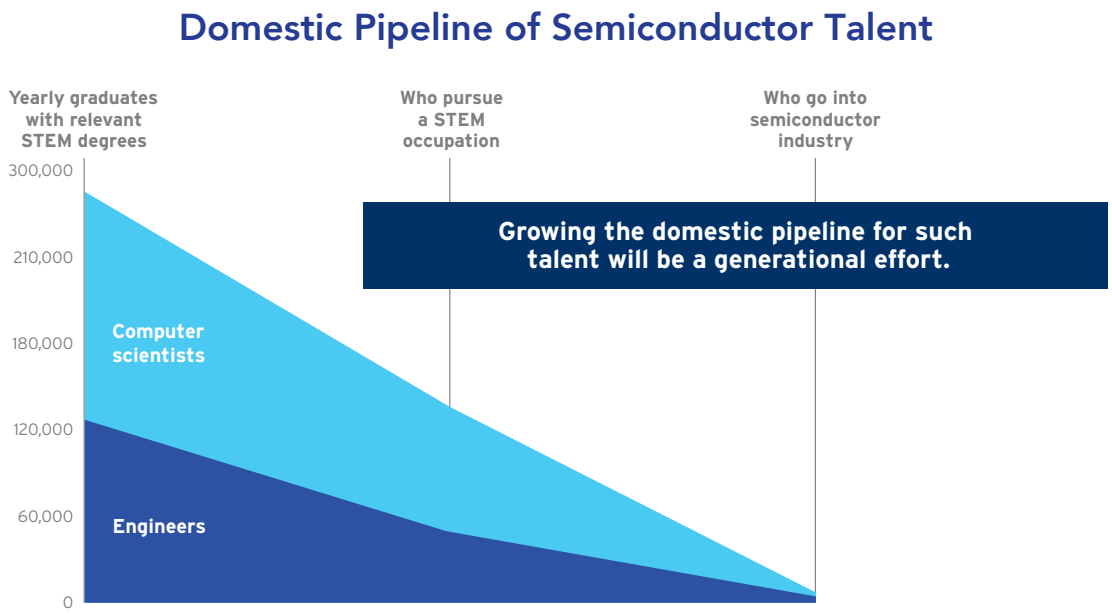
1. Expand and Advance the STEM Talent Pipeline: *Prioritize STEM education for individuals entering or already in the pipeline and expand the pool of potential workers, including veterans, women, and underrepresented minorities.*

The U.S. educational system is not producing sufficient levels of students with capabilities in STEM fields, and there is a lack of awareness of opportunity within the semiconductor industry. To fully address this shortfall, policymakers must consider the entire workforce pipeline, from K-12 to advanced degree students, and those in a postsecondary education, so that we can alleviate the short-term burden by accelerating those already in the pipeline and expanding the number of individuals entering it over the long-term. Addressing these issues is a massive undertaking requiring efforts across states, individual school districts and thousands of stakeholders. Improvements to STEM education must be part of any comprehensive solution. In SIA's "Chipping Away" report, we highlight the industry's demand for technical talent by the end of the decade, and the need to attract more students into STEM degrees, encourage more STEM graduates to join STEM occupations, and promote employment in the semiconductor industry specifically.

a. Semiconductor Industry Awareness

The semiconductor industry suffers from a lack of awareness among students about the long-term jobs available to them in the field causing some to forgo entering a STEM field of study. This lack of awareness also leads most students who graduate with a STEM degree to choose occupations outside the industry. Further, attention should also be paid to creating excitement about the jobs available, but also the rewarding careers individuals can build in the industry. Across the industry, we should help students see themselves benefiting from a commitment to the necessary upfront education and training over time. Leading up to passage of the Chips Act and since, companies spanning the semiconductor supply chain have announced massive capital investments in the United States.[25] With companies heavily invested and domestic facilities beginning production in the coming years, the semiconductor industry provides prospective workers the opportunity to build a long, successful career that can sustain over decades. This expected growth of the industry in America needs to be communicated to students and individuals so they can understand and seize the multi-decade career opportunity before them.

As illustrated in SIA's "Chipping Away" workforce report,[26] only a small percentage of those who study in a STEM field, enter a STEM occupation, and an even smaller percentage enter the semiconductor industry.



[25] Robert Casanova, Semiconductor Industry Association, "The CHIPS Act Has Already Sparked $300 Billion in Private Investments for U.S. Semiconductor Production," available at: https://www.semiconductors.org/the-chips-act-has-already-sparked-200-billion-in-private-investments-for-u-s-semiconductor-production/

[26] Chipping Away, Page 21

SIA Recommendation: To meet semiconductor workforce needs, government, industry, academia, state and local education agencies, and other organizations must work together on an awareness campaign that connects with students of all ages, but primarily high school seniors and community colleges, prior to their decision on subject of study, and once they reach the time to enter the workforce. This awareness campaign should also include opportunities for scholarships and internships, which would encourage them to tailor their education to the semiconductor field and eventually seek work within the industry. The Department of Commerce, in conjunction with Natcast and the NSTC Consortium, should lead this effort in partnership with NSF and the Departments of Education and Labor.

b. Advanced Degree STEM Graduate Moonshot

While America builds the long-term STEM pipeline, we should seek an infusion of advanced degree engineers and computer scientists that can fill the gap. Expansion of the talent pool by engaging students in early education can address those long-term needs but does nothing to provide a near-term supply of engineers that are the lifeblood behind American innovation. Additionally, with a significant number of advanced degree science and engineering workers being foreign-born, and without a near term agreement on high-skill immigration, America needs an intense focus on surging the number of advanced degree STEM graduates produced domestically.

SIA Recommendation: The Administration and Congress should work together to establish a nationwide initiative aimed at increasing the number of advanced degree STEM students that will graduate by the end of the decade. This should include, for example, increased support for NSF's Research Experiences for Undergraduates (REU) program, which funds research opportunities for undergraduate students and can help increase the pipeline of domestic students entering into advanced degree programs.

c. Engage the Veterans Workforce

Each year, more than 200,000 U.S. service members leave the military and enter civilian life. Veterans are an extremely capable and motivated population, which could bring an immediate, detail-oriented skillset to several roles within the semiconductor industry. However, as veterans exit the military, they are met by a complex web of programs intended to assist with the transition from their service into the civilian workforce.

There are several transition programs that have been created over the years, and there is little clarity for service members about which program is best for them, what the differences are, or how they complement each other. Examples of such programs include SkillBridge,[27] TAP, PAYs, Soldier for Life, and Hiring our Heroes. For the semiconductor industry, the NY CREATES Veteran Semiconductor Training & Experience Program (VET S.T.E.P.) offers a 10-week career skills program at the Albany Nanotech Complex. The NIIT VetConnect program also makes the National Talent Hub resource available to transitioning service members and their families at no cost.[28] There are questions of whether there should be fewer, more universal, better funded programs that are military wide as opposed to some that are branch-specific. Employers often struggle with managing the relationships with so many programs and find themselves feeling like there are too many missed opportunities all around.

Exiting members of the military should not simply have the option to join the STEM workforce, but they should be encouraged and be given simple, effective instruction as to how to enter an industry with which they can serve with purpose.

> **SIA Recommendation:** The White House should establish a public-private Advisory Commission on Veterans Workforce Program Coordination, comprising of the Departments of Defense, Veterans Affairs, Labor, and Commerce, Congressional members, veterans' organizations, and industry representatives, to propose a new structure of programs, services, and partnerships to support military transitions and veterans' programs to achieve effective outcomes.

> **SIA Recommendation:** Congress should authorize and appropriate additional funding for veterans transition programs, including SkillBridge, to ensure access to housing or relocation costs are not a barrier to participation for servicemembers and their families. Congress should also enact programs that promote awareness of these programs to potential employers and service member participants.[29]

[27] Additional information is available at: https://skillbridge.osd.mil/
[28] Additional information is available at: https://www.niit.org/vetconnect-veterans-fellowship-program
[29] HR 6900, HR 7097, HR 7098, and others.

d. Encourage Opportunities for Underrepresented Groups in STEM

The issue of awareness of the semiconductor industry significantly impacts individuals who are underrepresented in STEM professions. In 2022, women made up about one third of the STEM workforce. Additionally, only 23% of the STEM workforce was made up by Blacks, Hispanics, and American Indians or Alaska Natives.[30] To increase the overall employee talent pool, policymakers should promote opportunities for underrepresented groups to build on their education and enter STEM industries in need of workers. These opportunities may come in the form of partnerships between industry, academia, government entities, and other organizations.

SIA Recommendation: Continue regional partnerships between community colleges, HBCU's and MSI's with industry so that individuals participating in technical programs at these colleges can follow a pathway to a job.

SIA Recommendation: Build on the activities of initiatives such as the EDGE Consortium to increase the participation of women in engineering careers in industries such as the semiconductor industry.[31]

SIA Recommendation: Increase opportunities for Minority Serving Institutions to participate in R&D by increasing funding for research infrastructure improvements at these institutions.

e. Inspiring Interest in Semiconductor-related Fields among K-12 Students

In order to meet the needs of the domestic semiconductor workforce over the next decade, STEM education in K-12 should be prioritized and encouraged by local education agencies through curricula and teacher training.

SIA Recommendation: Increase appropriations for hands-on learning programs, such as FIRST Robotics.[32]

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[30] National Science Foundation, "The State of U.S. Science and Engineering 2024," https://ncses.nsf.gov/pubs/nsb20243/preface

[31] "The EDGE Consortium recognizes that the goals of the CHIPS and Science Act – to boost US competitiveness, innovation and national security in the global semiconductor landscape – won't be achieved unless historically marginalized groups are included from the start, so we are committed to doubling the number of industry-ready women and people of color for semiconductor-related careers." See: https://www.edgeconsortium.org/.

[32] "FIRST is a global robotics community preparing young people for the future and the world's leading youth-serving nonprofit advancing STEM education." See https://www.firstinspires.org/robotics/frc.

SIA Recommendation: Increase appropriations for the NSF Experiential Learning for Novel Technologies (ExLENT) program.[33]

SIA Recommendation: Expand technology literacy and capability through implementation of the National Technology Education Plan,[34] and ensure students have the tools necessary for STEM learning.

2. Affordability: *Remove barriers to entry into semiconductor education and workforce training programs through Pell grants, favorable loans, and other financial incentives.*

a. Pell Grant Eligibility for Short-Term Workforce and Training Programs

Under current law, Federal Pell Grants are limited to funding college-level education, and are usually awarded only to undergraduate students who display exceptional financial need and have not earned a bachelor's, graduate, or professional degree.[35] Congress is currently considering[36] a reform to extend Pell eligibility to students enrolled in short-term training programs that meet specific parameters. Under this proposal, individuals who may have been unable to enter a short term-training program due to cost would now be able to utilize Pell grants to complete a program that could lead to a job in the semiconductor industry.[37] Given the enormous need in

[33] ExLENT offers experiential learning opportunities in emerging technologies targeting a wide variety of learners, including youth and adults at any stage in their career development, and those who have faced barriers in accessing formal STEM education. See: https://new.nsf.gov/funding/opportunities/experiential-learning-emerging-novel-technologies

[34] Department of Education, "National Education Technology Plan," Jan. 2024. See: https://tech.ed.gov/files/2024/01/NETP24.pdf

[35] To be eligible for a Pell Grant, students must:

- Be an undergraduate student who has not earned a bachelor's degree (with some exceptions for students in post-baccalaureate teaching programs).
- Be enrolled or accepted for enrollment as a regular student in an eligible degree or certificate program.
- Have earned a high school diploma or a GED, or have completed a high school education in an approved home-school setting.
- Be a U.S. citizen or an eligible noncitizen.

[36] House Education & Workforce Committee passed H.R. 6585. Final details are being negotiated.

[37] A study from Harvard Kennedy School emphasizes that "the very workers in need of re-training are those who are least able to invest in upfront tuition costs of reskilling programs and least able to sustain a loss of labor income for the duration of their training." Available at, p. 13: https://www.hks.harvard.edu/sites/default/files/centers/mrcbg/files/125_final.pdf. A study by the Department of Education found that students offered an experimental Pell Grant to pay for a short-term occupational training program were 15% more likely to enroll in additional education that students without the offers. Additionally, "Students offered an experimental Pell Grant to pay for a very short-term occupational training program were 8 percentage points more likely to complete programs considered in high demand in their state." Available at, p. 6: https://files.eric.ed.gov/fulltext/ED609406.pdf

the semiconductor industry – and other similarly-situated sectors – for technicians and other positions that don't require a 4-year degree, the availability of substantial funding for high-quality, job-oriented, short-term training will be essential to filling the pipeline with a trained workforce.

> **SIA Recommendation:** Enact legislation that expands Pell grant eligibility to students enrolled in short-term training programs.

b. Incentivize Enrollment through Favorable Loan Terms

The cost of attendance for education and training programs can often be a deterrent for prospective students who would otherwise be interested in pursuing workforce development opportunities in a given field or skill. Offering students a predictable pathway to afford their degree or certification can increase access and incentivize enrollment.

> **SIA Recommendation:** Policymakers should provide targeted, guaranteed, income-based loan repayment programs that incentivize individuals to study for, enter, and remain in STEM-related positions across in-demand, critical and emerging technology and national security-relevant industries.

CONCLUSION

The U.S. needs to adopt an ambitious, "all-of-the-above" plan of action to meet our industry's U.S. workforce needs and ensure our global competitiveness in the semiconductor industry and other sectors of strategic importance. SIA calls on Congress and the Administration to take action on policies that enhance the skills of U.S. students and the U.S. workforce. Prioritizing the policies set forth in this blueprint are necessary to advance U.S. semiconductor leadership and strengthen the U.S. economy and national security.