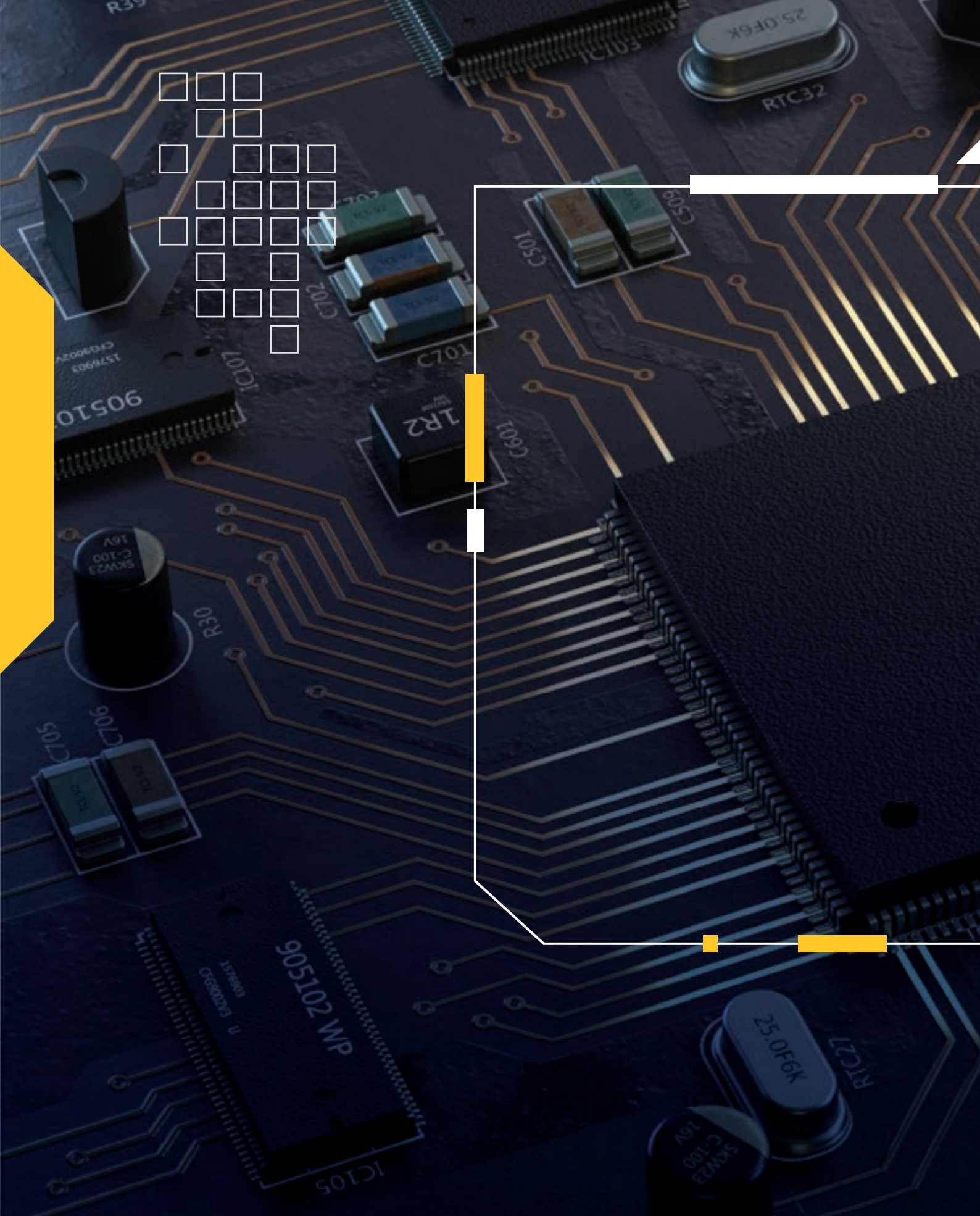






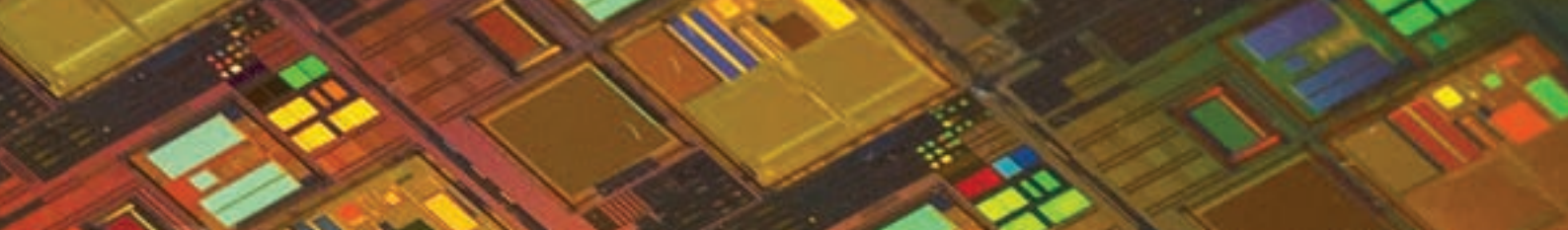
STRENGTHENING HIGH-TECH WORKFORCE DEVELOPMENT

TO INCREASE VIETNAM'S COMPETITIVENESS
IN SEMICONDUCTOR INDUSTRY



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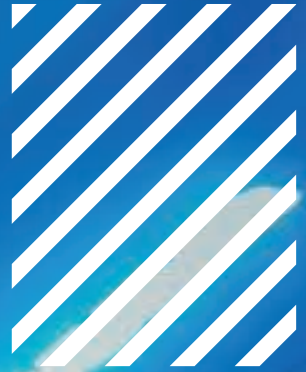
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Executive Summary

Vietnam's Semiconductor Industry: Opportunities and Challenges

Vietnam is positioning itself as a promising player in the global semiconductor industry, thanks to strategic policies, geographical advantages, and a burgeoning talent pool. However, significant gaps in workforce development, industry-academic collaboration, and infrastructure hinder its progress. This summary outlines the opportunities and challenges in the Assembly, Test, and Packaging (ATP) and Integrated Circuit (IC) Design sectors, along with recommendations to address these barriers.

Opportunities in the Semiconductor Industry

Vietnam's potential stems from several factors:

Favorable Government Policies: Incentives, tax breaks, and infrastructure investments attract foreign direct investment (FDI) in high-tech manufacturing.

Strategic Location: Vietnam's proximity to global electronics hubs strengthens its role in international supply chains.

Increasing Demand: Growing use of consumer electronics and automotive technologies drives the need for semiconductor components.

Young Talent Pool: A large number of engineering graduates from technical universities provide a solid foundation for workforce development.

These advantages position Vietnam as a viable player in the semiconductor value chain. However, its ability to capitalize on these opportunities is hampered by critical challenges.

Challenges in Workforce Development

Assembly, Test, and Packaging (ATP) Sector

Training Shortfalls: Vietnam lacks ATP-specific curricula or certifications. Engineers from related disciplines, such as mechanical and electrical engineering, require 6 months to 2 years of on-the-job training, a costly and inefficient process.

Faculty and Facility Deficiencies:

There is a shortage of ATP-specialized instructors, and universities lack the advanced equipment necessary for training. Collaboration between companies and academic institutions to share resources is minimal.

Talent Retention Issues: ATP roles are less attractive due to lower compensation and challenging factory environments, compared to other semiconductor positions like IC design.

Insufficient Skilled Graduates: While some universities offer IC design programs, only about 50 graduates specialize in this field annually. These graduates require additional training to meet industry standards due to outdated curricula and limited practical exposure.

Shortage of Advanced Roles: Critical positions such as System Architects and Chip Architects are significantly underserved. Most Vietnamese design houses work on outsourced projects, with architectural decisions made by overseas partners, limiting local expertise.

Skill Distribution Imbalance: While Digital Design Engineers are in relatively good supply, RF and Analog Design Engineers are scarce due to the specialized knowledge required, which traditional academic programs do not adequately provide.

Infrastructure and Collaboration Gaps: Universities often lack high-cost equipment needed for IC design validation. Weak collaboration between academia and industry further limits opportunities for students to gain hands-on experience.

Strategic Recommendations

1. Establish Specialized Training Programs:

- Develop ATP and IC design curricula aligned with industry requirements.
- Create internship opportunities with industry partners for practical experience.

2. Invest in Shared Resources:

- Establish state-funded training facilities equipped with advanced semiconductor tools.
- Encourage collaboration between universities and businesses to optimize resource utilization.

3. Strengthen Faculty Expertise:

- Attract industry professionals to teaching roles with competitive incentives.
- Enable faculty participation in industry projects to stay updated.

4. Enhance Industry-Academic Collaboration:

- Launch joint research initiatives to align academic training with industry needs.
- Regularly update university curricula to reflect current industry practices.

5. Improve Talent Retention:

- Enhance compensation and benefits for engineers in ATP and IC design.
- Highlight the semiconductor industry's importance in driving innovation and economic growth.

6. Develop Leadership and Business Skills:

- Upskill professionals from related sectors to transition into semiconductor business development.
- Establish mentorship programs for leadership development in the industry.

Conclusion

Vietnam's semiconductor industry has immense potential, driven by strategic advantages and a growing market. However, addressing gaps in workforce development, training infrastructure, and industry collaboration is crucial. By implementing targeted strategies, Vietnam can establish itself as a competitive player in the global semiconductor value chain, fostering economic growth and innovation.

I ■ Introduction





In recent years Vietnam has made significant efforts to develop its technology in general and the semiconductor industry in particular. Vietnam's ability to reach its ambitious socioeconomic development goals will largely depend on its success in transitioning to technology-intensive economic activities. Vietnamese Politburo's 2019 seminal policy statement, Resolution 52-NQ/TW ("On Policies for Actively Participating in the Fourth Industrial Revolution"), underscores the critical role of the technology sector in shaping Vietnam's future. Resolution 52 especially highlights human capital as one of the eight key areas that will impact Vietnam's integration into the digital economy. In fact, human capital is pivotal to this economic transformation.

Vietnam's strategic transition is in line with geoeconomic shifts in the world. During President Joe Biden's visit to Vietnam in September 2023, both the United States and Vietnam highlighted science, technology, and digital innovation as central to their bilateral relationship. The US committed to supporting Vietnam in developing a high-tech workforce. The joint statement from both countries recognized "Vietnam's tremendous potential as a major player in the semiconductor industry." Current global trends in the semiconductor industry reveal substantial opportunities for Vietnam, particularly as semiconductor manufacturers in the United States, Europe, and East Asia seek to diversify their supply chains away from China. To seize these opportunities, the Vietnamese Government has taken several remarkable actions. It has finalized the National Semiconductor Strategy and the National Semiconductor Workforce Plan and established a National Steering Committee on Semiconductor Development led by the Prime Minister. The government has also hosted visits from leading global semiconductor figures, including Nvidia, to enhance partnership in the semiconductor industry. Additionally, it has organized numerous international conferences focused on semiconductor development to foster collaboration and knowledge exchange.

Despite the high priority the Vietnamese government places on high-tech industries and favorable international conditions, Vietnam faces significant challenges in realizing its technological ambitions, particularly in the semiconductor industry. Reports indicate that Intel chose to invest in Eastern Europe rather than expanding its existing facility in Ho Chi Minh City, highlighting Vietnam's ongoing competitiveness issues. In terms of human resources, Vietnam is struggling with both quality and quantity. According to the US-ASEAN Business Council, the country currently has only about 10% of the hardware engineers required to support the semiconductor industry effectively.¹

¹ See "Engineer shortage may harm US plan to turn Vietnam into chips powerhouse," *Reuters*, September 1, 2023.

Available at:

<https://www.reuters.com/technology/engineer-shortage-may-harm-us-plan-turn-vietnam-into-chips-powerhouse-2023-08-31>.

Introduction

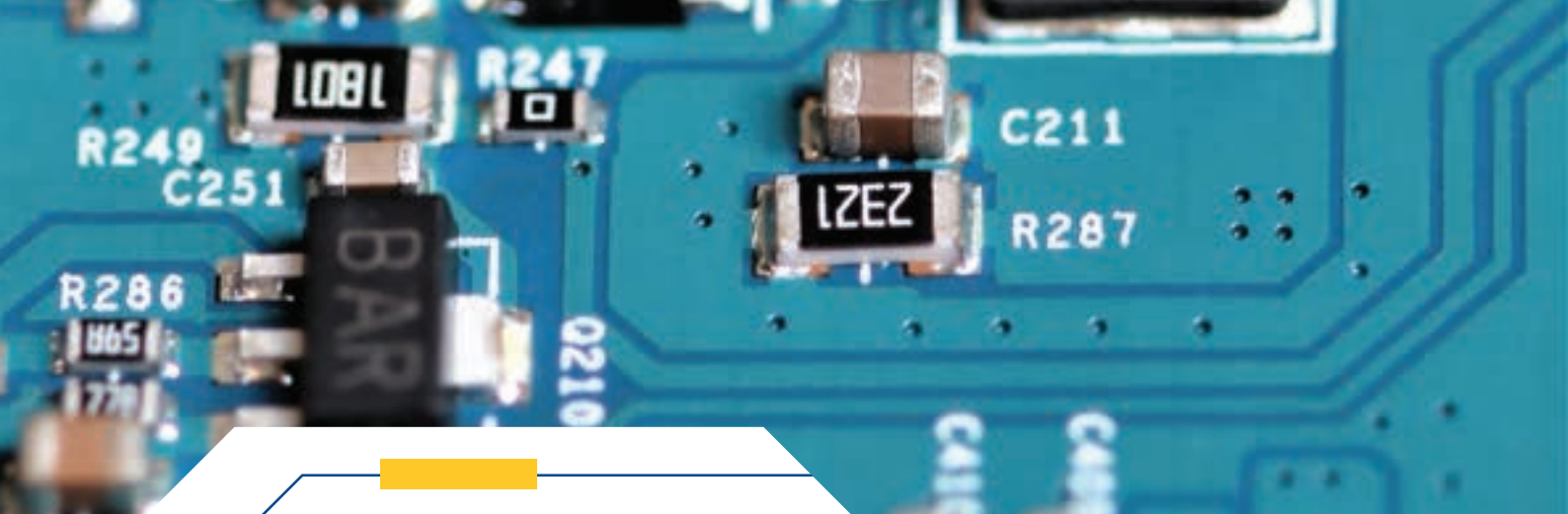
To capitalize on opportunities and address challenges in the semiconductor industry, many universities in Vietnam have recently launched or expanded semiconductor-related programs, such as circuit design, and have strengthened collaborations with local and international firms, academic institutions, and organizations. Despite these efforts, there remains a critical need for a comprehensive study to address key questions essential for developing Vietnam's semiconductor workforce. Specifically, **what are the gaps between the supply and demand for trained personnel for the semiconductor industry in terms of quantity and quality**, both now and in the future? What challenges exist in bridging these gaps, and what solutions can be implemented? This issue involves assessing business needs, evaluating the training capabilities of educational institutions, and formulating effective support policies.

To address these critical questions, Fulbright University Vietnam, in collaboration with the US Embassy in Vietnam, initiated a research project aimed at enhancing the quality of human resources for Vietnam's semiconductor industry. This project builds upon and integrates insights from both national and international semiconductor industry studies. While the primary focus is on Assembly, Testing and Packaging (ATP) as the main downstream value chain, the research also examines and offers implications for the fabrication and design segments of the semiconductor industry.

Particularly, the study seeks to answer the following questions

- Where are Vietnam's main opportunities within the semiconductor industry?
- What are the primary factors limiting the development of Vietnam's high-tech workforce?
- What role can US stakeholders (government, industry, the academy, etc.,) play in strengthening Vietnam's high-tech workforce?
- What is the significant reform to support semiconductor workforce development?





The report is conducted by qualitative research methods with both primary sources (including interviews, discussions, field trips and observations) and secondary data sources (such as previous studies, government reports, organizations' publications, reliable media).² The findings are synthesized and detailed in the following chapters. This report will be shared with stakeholders from the public, private, and education sectors to inform strategic decisions, optimize resource allocation, and support Vietnam's ambition to become a key player in the semiconductor industry.



The report and its findings were finalized at approximately the same time as the Ministry of Information and Communication (MIC) released the National Strategy on Semiconductors (the National Strategy) in September 2024. While the research team made the best effort to consult diverse stakeholders, including policymakers and experts, or working with the MIC, there may be discrepancies in the reports' recommendations against the visions set out in the National Strategy. Potential discrepancies are outlined below.

The development of Vietnam's semiconductor industry by 2050 set out by the National Strategy will be extensive, including chip design, ATP, and chip manufacturing. This research's findings indicate that at least by 2030 Vietnam will not have the economy of scale to support the chip manufacturing sector. Rather, we recommend a higher priority for developing the chip design and ATP sectors.

A target workforce of 50,000 engineers by 2030 for the semiconductor industry was repeatedly mentioned by various levels of leadership at diverse official occasions and on social media. There were, however, inconsistencies in the scope of the industries that this target workforce would serve, which included not only the semiconductor industry but also Electrical and Electronic Engineering and Artificial Intelligence. This research forecasted that Vietnam would need 10,000 engineers for the ATP sector and at most 15,000 engineers for the chip design sector, much of the growth of which will be driven by demand from overseas.

² See Appendix 1. Research Methodology and Data Collection for details.

II Background

A Global Semiconductor Landscape

There are different segments in the global value chain of the semiconductor industry: EDA and Core IP, Design, Equipment, Manufacturing, Materials, Wafer Fabrication, and Assembly, Packaging and Testing (see Figure 1). Each of them accounts for a certain share of the chain. The most valuable segment is Design while EDA and Core IP comprises the lowest value. Notably, the Assembly, Packaging and Testing (APT or also ATP), the most popular section that emerging countries like Vietnam or Malaysia can participate in, makes up only 6% in the global value chain.

Figure 1.

Global value chain in semiconductor – by segment

EDA & Core IP

EDA: Design Software (Cadence, Synopsys)
Core IP: Building blocks of chips

Logic (Design, mostly Fabless)

Logic: CPU/GPU/Smartphone chip
Fabless: Chip design company without wafer fabrication

Memory (Design, mostly IDM)

Memory: RAM/SSD, IDM: Chip design company with in-house fabrication

DAO (Design, mostly Fab-lite)

DAO: Discrete, Analog, and Other types of chips
Fab-lite: Company using both in-house and outsource fab

Manufacturing, Equipment

Materials

Wafer Fabrication

Assembly, Packing & Testing

3%

30%

17%

9%

12%

5%

19%

6%

Design accounts for
56%
of total global
value chain

19% Fabrication

6% APT

NVIDIA

AMD

Qualcomm

SAMSUNG

amazon

cadence

TESLA

Apple

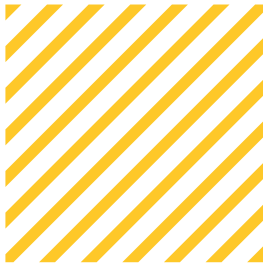
intel

synopsys

LSI

SAMSUNG

intel

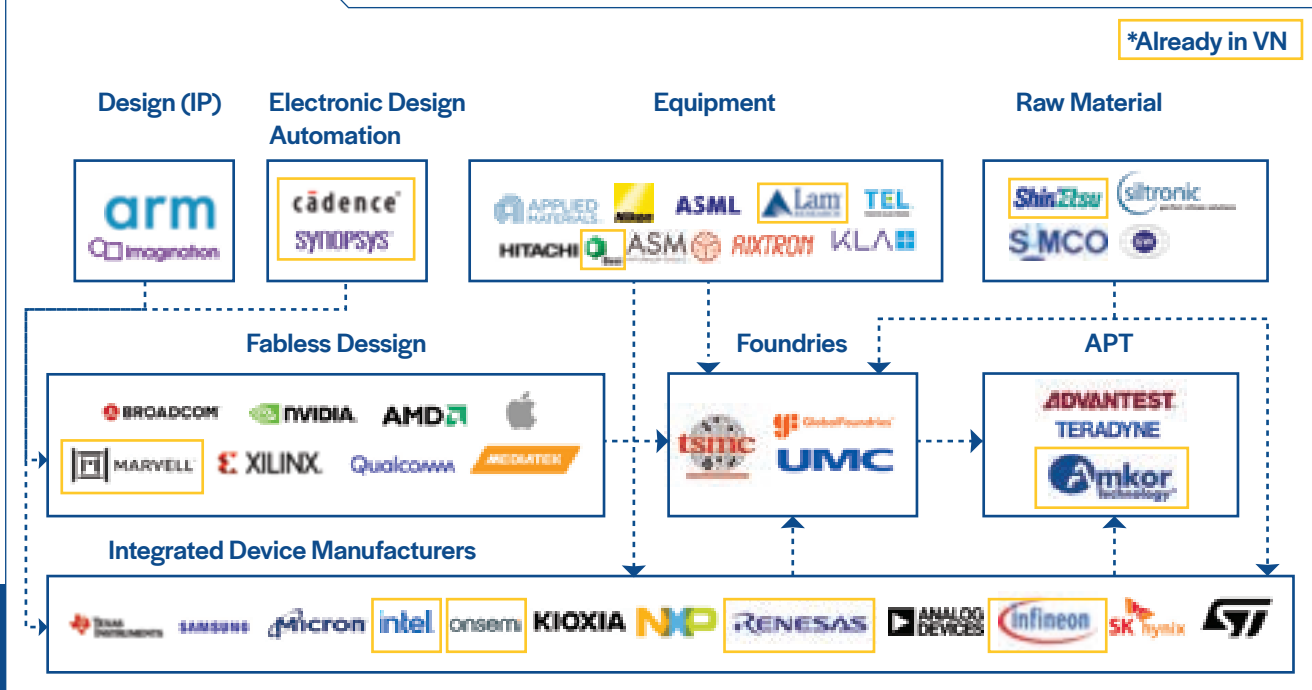


Over the past several decades, the semiconductor industry worldwide has been highly specialized and globalized with each segment dominated by a number of key players or sometimes one or two large firms (see Figure 2).

Figure 2.

Key players in the global semiconductor chain

*Already in VN



Source: Created by Quartr. Note: The exact flows might differ between companies (subsidiaries, hybrid business models, etc.)

The semiconductor industry has experienced a dynamic feedback loop with modern electronics, acting as a result of and a catalyst for advancements in the field. The foundational technology for the industry emerged in the 1940s with the groundbreaking invention of the transistor. Subsequently, the integrated circuit's introduction in the 1950s ushered in an era of rapid miniaturization and mass production, a trend that continued through the

1960s and 1980s. The following decades witnessed a geographical shift in manufacturing leadership towards Asia, with countries like Taiwan and South Korea capitalizing on their efficient production methods. Since the 2000s, globalization has become a defining feature of the industry, with design and manufacturing often separated. This decoupling has led to increasingly complex chips and necessitated significant investments in fabrication facilities (see Table II.1.).

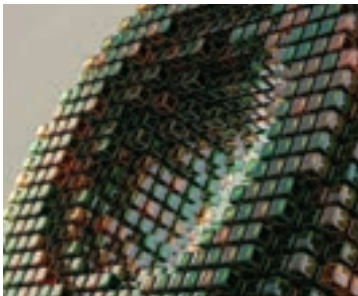
II ■ Background

A Global Semiconductor Landscape

Table II.1. Operation model of semiconductor companies

1950s	1960s	1970s	1980s	1990s	2010s
					Software
				IP Provider	IP Provider
			Fabless	Fabless	Fabless
IDM	IDM	IDM	IDM	IDM	IDM
	Manufacturing Tools	Manufacturing Tools	Manufacturing Tools	Manufacturing Tools	Manufacturing Tools
		EDA Tools	EDA Tools	EDA Tools	EDA Tools
			Foundries	Foundries	Foundries
				Packaging	Packaging

Source: Semiconductor Industry Association (2018)



The "flying geese theory" offers a useful framework for understanding the global trends in semiconductor development. Manufacturing leadership has migrated in response to labor cost differentials. This began with the United States in the 1970s, transitioned to Japan in the 1980s, and eventually relocated to Korea and Taiwan in the 1990s. As these regions grappled with rising labor costs, the United States shifted its focus towards high-value activities such as intellectual property (IP) and equipment supply.

Japan concentrated on advancements in materials science, while Korea and Taiwan solidified their dominance in chip fabrication. The EU focuses on other areas of the semiconductor value chain. European companies are world leaders in producing the machinery used to manufacture semiconductors, with ASML in the Netherlands holding a near-monopoly on advanced lithography machines crucial for creating tiny transistors. Additionally, Europe boasts a robust research base and supplies a significant portion of the chemicals and gases needed for chip production, positioning the region well for future advancements in semiconductor technology.

This globalized and specialized model has significantly transformed operational models within the semiconductor industry. The previous approach, where a single entity managed all production stages, has been replaced by a more segmented and specialized methodology. Distinct companies now specialize in individual production stages, creating entry points for developing nations like China, Malaysia, and Vietnam. These nations can participate in lower-value-added segments like assembly, testing, and packaging (ATP) or by outsourcing IC design.

Beyond their established role in electronics, specialized chips known as AI accelerators are experiencing significant growth alongside the rapid development of generative AI. These chips are custom-designed to handle the complex calculations necessary for AI applications such as facial recognition, natural language processing, and deep learning. This convergence has markedly increased the importance of the semiconductor industry, igniting a high-stakes race among economic powers to secure access to cutting-edge technology. To a certain extent, chips are now considered a matter of national security.



The U.S.-China decoupling significantly impacts the global semiconductor industry, prompting a need for reshoring strategies to reduce reliance on China. With ATP facilities typically situated near downstream electronics businesses, China capitalizes on its position as a global leader in electronic device production, dominating the ATP sector and holding a commanding 38% share of the global ATP market in 2020 (Semiconductor Industry Association, 2021). Moreover, China maintains a near-monopoly on two crucial minerals, gallium and germanium, essential for semiconductor production.

The CHIPS Act, enacted in August 2022, stands as a pivotal piece of U.S. legislation aimed at rejuvenating domestic semiconductor manufacturing and fostering a more resilient, secure, and sustainable global semiconductor value chain. The Act allocates significant funding for research and development of next-generation chip technologies. Additionally, it incentivizes companies to manufacture chips within the U.S. through financial aid. Workforce development programs are also included to cultivate a skilled American chip-making industry. Similarly, The European Chips Act, enacted in September 2023, aims to bolster Europe's position in the semiconductor industry through a €43 billion investment plan known as "Chips for Europe." This initiative seeks to incentivize research, development, and manufacturing of semiconductors within the EU, with the goal of doubling Europe's current market share in the global semiconductor industry to 20% by 2030. By doing so, it aims to reduce reliance on other countries and enhance Europe's technological sovereignty. Additionally, the Chips Act establishes a framework for collaboration among EU member states to monitor supply chains, anticipate shortages, and respond effectively to crises.

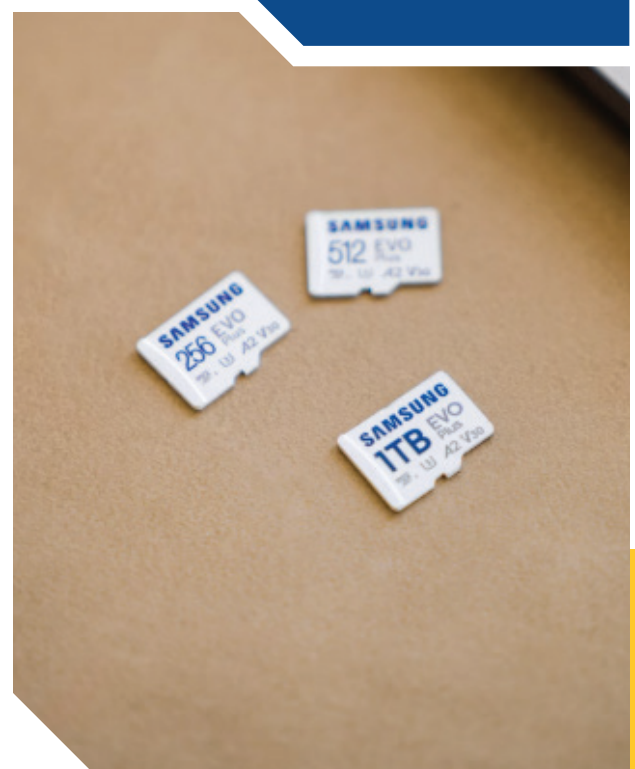
II ■ Background

A Global Semiconductor Landscape



Japan is also making a major push to regain semiconductor industry dominance with a strategy launched in 2021 by the Ministry of Economy, Trade, and Industry, designating semiconductors and digital industries as national priorities. This includes the JPY200 billion Post-5G Fund and the JPY2 trillion Green Innovation Fund. The 2023 revision emphasizes low-power-consumption AI chips and manufacturing infrastructure. In 2022, eight leading Japanese companies established Rapidus, with government funding support, to mass-produce next-generation semiconductors, targeting 2-nanometer chips by 2027, anticipate shortages, and respond effectively to crises.

The K-semiconductor strategy is South Korea's bold move to solidify its position in the semiconductor industry. The strategy includes a \$450 billion investment plan by 2030, aiming to create the world's most comprehensive semiconductor supply chain. This plan features tax breaks to incentivize research, development, and facility building across all industry players, from established giants to nimble startups. The government is establishing a massive semiconductor cluster near Seoul, which will be home to three R&D and education centers, fostering collaboration and innovation. Looking beyond its borders, South Korea is also forging strategic partnerships. Collaboration with the U.S. on R&D and chip manufacturing strengthens both nations' semiconductor industries. Companies like Samsung and SK Hynix are backing this effort with billions invested in U.S. fabrication plants.



Taiwan's strategy focuses on building a skilled workforce and has launched initiatives like the "2025 Top-Down Semiconductor Plan" to cultivate talent through university programs in semiconductors, AI, and engineering. Another key initiative, the "Chip-based Industrial Innovation Program (CBI)," seeks to attract foreign talent and leverage AI in chip design. Additionally, Taiwan fosters international partnerships with the "INTENSE Program," which aims to attract talent to Taiwan for study and employment after graduation, initially targeting students from Vietnam, Indonesia, and the Philippines in 2024. Recent policy changes also include increased tax breaks for R&D spending and additional credits for companies investing in advanced chip-making equipment.



India is embarking on an ambitious journey to become a major player in the global chip making industry. Backed by significant government investment, proposals exceeding \$21 billion are on the table for chip fabrication plants and other crucial facilities. This push extends beyond just manufacturing. India is strategically aiming to develop a complete domestic ecosystem, fostering expertise in chip design, nurturing talent, and establishing assembly/testing facilities. A major chip assembly and testing hub in Southeast Asia, Malaysia is now aiming to become a dominant player in the global chip industry. They are strategically leveraging geopolitical tensions by positioning themselves as a neutral ground for chip production, attracting companies seeking alternatives to China. The government is heavily invested, launching a national strategy to attract over \$100 billion in investments. Malaysia's ambitions are multifaceted. The country is building a massive chip design park to boost domestic expertise and move beyond just manufacturing, climbing the value chain. They are also investing heavily in training a workforce of 60,000 engineers.

Background

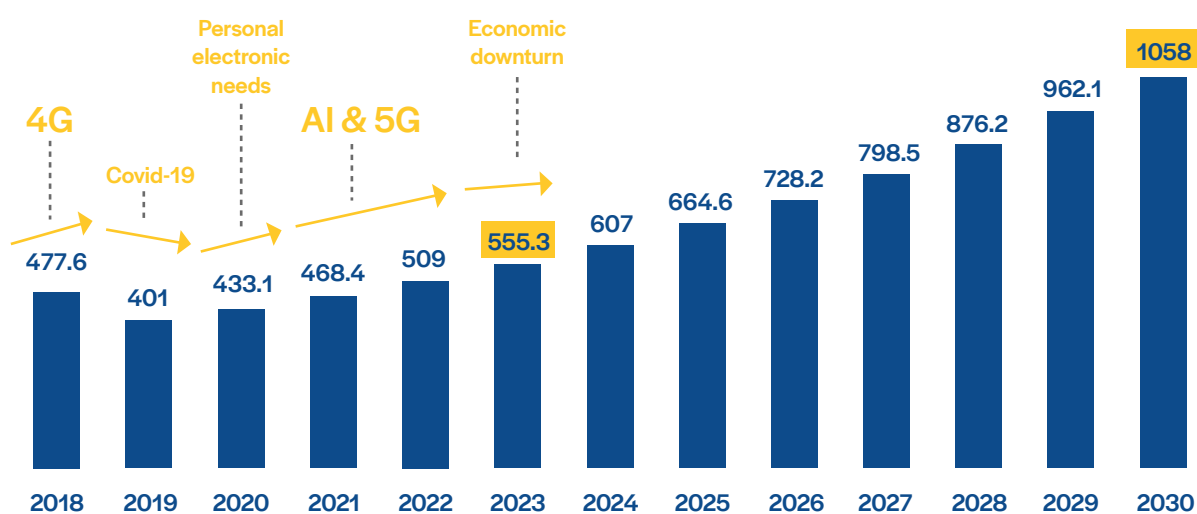
A Global Semiconductor Landscape

The semiconductor industry has demonstrated impressive performance with a compound annual growth rate (CAGR) of over 10% year-over-year. This robust growth trend is expected to persist, with projections indicating continued double-digit expansion over the next decade (see Figure 3).

Figure 3.

Global Semiconductor Market Value

Semiconductor Market Value 2018 - 2030 (Unit: billion USD)

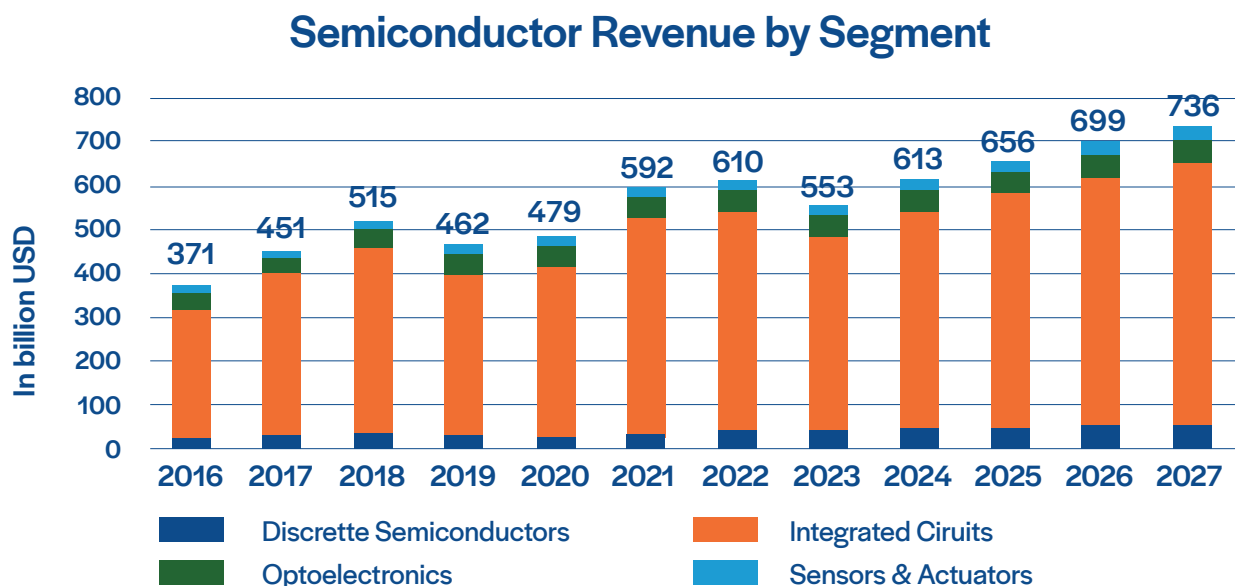


Source: SEMI (2021)

Likewise, according to an estimate by Statista Market Insight (Figure 4), the semiconductor market is expected to be a massive one in 2024, with a projected revenue of US\$613.10 billion. Among different segments of the industry, integrated circuits are the driving force within the market, expected to reach US\$500.70 billion in 2024. This market is also expected to keep growing at a healthy clip, with a compound annual growth rate (CAGR) of 6.30% projected between 2024 and 2027. China is expected to be the top earner in this market, bringing in US\$198.90 billion in 2024.

Figure 4.

Global Semiconductor Revenue by Segment



Source: Statista Market Insights

II ■ Background

B Vietnam semiconductor development

The global chip industry is undergoing a major shift due to the US-China decoupling. Countries are heavily investing in domestic chip production and innovation to reduce reliance on others. Vietnam can capitalize on this global push for domestic chip production by developing a skilled workforce, attracting foreign investment, and building partnerships. By focusing on these areas, Vietnam can solidify its position as a competitive player in the global semiconductor industry.

Vietnam's ATP sector, kickstarted by Intel's \$1 billion facility at Saigon Hi-Tech Park in 2010, has recently experienced a surge. This growth trajectory is marked by Onsemi's entry in 2014, Intel's expansion in 2021, the establishment of Hana Micron Vina and Amkor Technology in 2021 and 2023 respectively, the commencement of Victory Giant Technology's construction in 2024, and Samsung's forthcoming production plans.



According to Statista Market Insights, the Vietnamese semiconductor market is poised for significant growth in 2024, with a projected revenue of US\$19.89 billion. Integrated circuits are the backbone of the market, expected to reach US\$16.26 billion in 2024. This market is forecast to see healthy growth with a compound annual growth rate (CAGR) of 9.62% between 2024 and 2027, reaching a market volume of US\$26.20 billion by 2027.



Vietnam also boasts over 30 FDI companies in IC design, including established players like Renesas, Synopsys, and Cadence alongside innovative startups like Ampere, ADTechnology, Inphi, FingerVina, Dolphin Technology. The sector also encompasses numerous smaller firms with around 100 or fewer employees. Notably, Marvell plans to open a large-scale semiconductor design center in Ho Chi Minh city by the end of 2024.

There are a few local IC design companies, VHT (Viettel Group) and FPT are amongst the most noticeable names which currently have small-scale operations with a combined workforce of around 200. Vietnam's Draft Development Strategy for the Semiconductor IC Industry to 2030 with a Vision for 2035, released in December 2023, outlines ambitious goals. By 2030, Vietnam aims to be a leading IC industry hub, generating export revenue of \$20-30 billion USD annually and boosting global competitiveness in terms of quality and value-added products. By 2040, Vietnam is poised to become a crucial player in the global semiconductor ecosystem, encompassing all aspects of the industry, from design and manufacturing to ATP and equipment fabrication.

II ■ Background

B Vietnam semiconductor development



The strategy emphasizes the importance of fostering a skilled workforce. Vietnam boasts a strong talent pool in the semiconductor industry, with 50,000 design engineers, 200,000 electronics engineers, 500,000 technical workers, and 1 million software engineers. To further enhance this workforce, the strategy aims to transition 20,000 to 30,000 personnel from the existing pool of 350,000 IT and telecommunications engineers.

In addition, Vietnam prioritizes several key solutions, including tax incentives to attract investment, fostering a supportive ecosystem for startups, building a robust network of companies and institutions within the semiconductor industry, and establishing a strong framework for coordinating and monitoring the deployment of semiconductor chip technology.



The draft proposal in February 2024 for the Development of Semiconductor Human Resources by 2030, with an orientation towards 2045, aims for Vietnam to have a workforce of engineers deeply involved in the design processes of modern semiconductor chips from front-end to back-end by 2030. They will also be deeply engaged in and mastering parts of the packaging and testing process and working in semiconductor factories. The goal is to train 50,000 engineers participating in various stages of the value chain, including 15,000 design engineers and 35,000 in ATP and other stages. In terms of qualifications, the objective is to train 7,500 with master's degrees, 500 with doctoral degrees, and 5,000 engineers specializing in artificial intelligence.



The proposal identifies a training network for semiconductor industry human resources, comprising 400 institutions, including research institutes, universities, training centers, and enterprises. It plans to establish training, research, and technology transfer centers in three regions: North, Central, and South, with shared infrastructure for training units. The training strategy is based on tripartite cooperation among enterprises, universities, and research institutes, and it encourages international cooperation.



Semiconductor Workforce Demand in Vietnam

A Assessment of Workforce Demand for ATP Sector

This sector analyzes the workforce demand of the semiconductor industry in Vietnam, specifically the segments of ATP and IC design. While the nation's semiconductor strategy envisions fab operations by 2035, no such facilities currently exist.

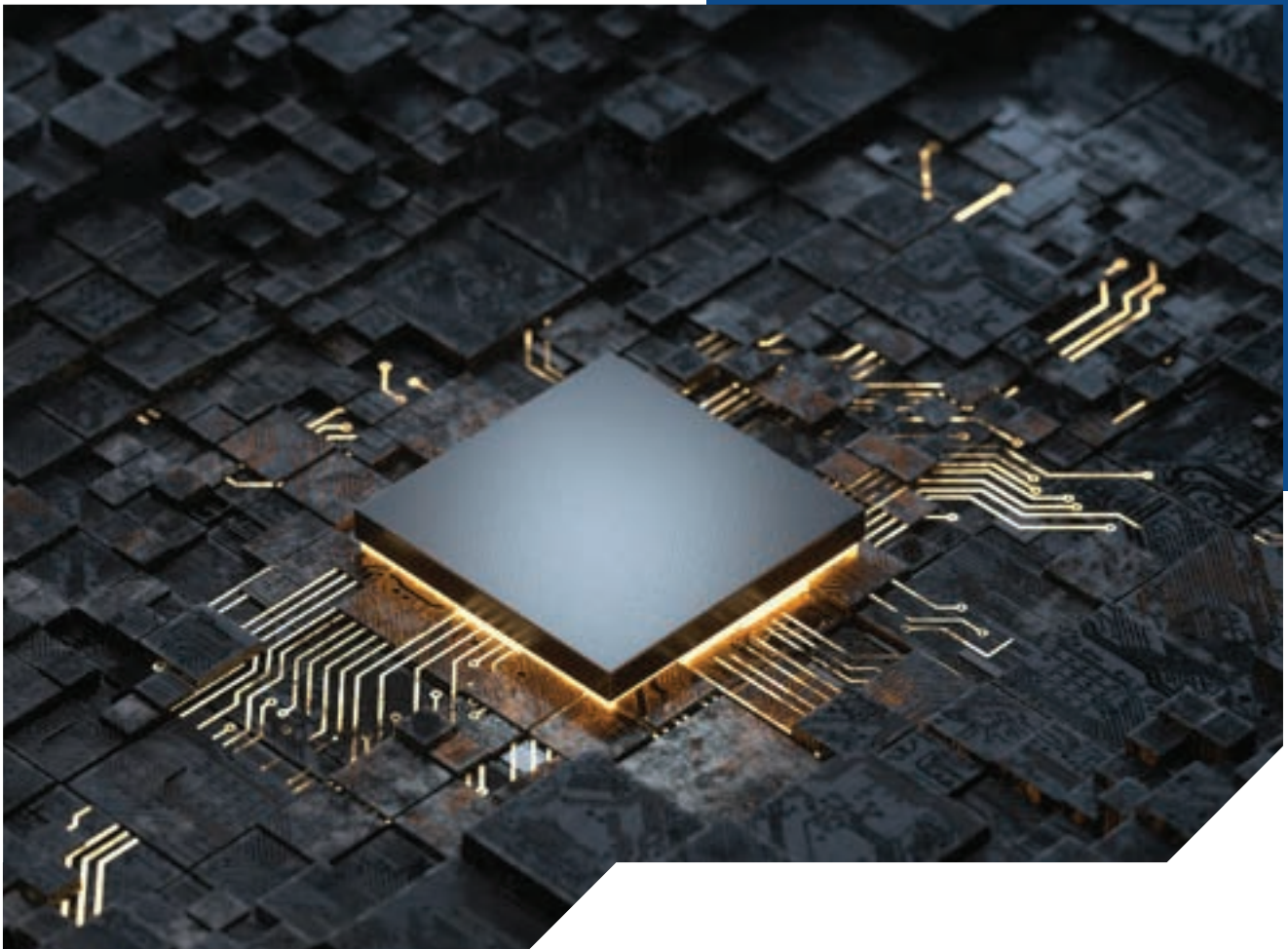
Semiconductor packaging, a critical step in chip production, is also a labor-intensive process. This has led to a geographical concentration, with at least 81% of global Assembly, Test, and Packaging (ATP) activity located in Asia, according to the Boston Consulting Group and the Semiconductor Industry Association. Lower labor and input costs in this region make it an attractive option for manufacturers.

Two core business models dominate the ATP market. Integrated Device Manufacturers (IDMs) handle the entire process in-house, from chip design to final packaging. Alternatively, Outsourced Semiconductor Assembly and Test (OSAT) companies specialize in testing and assembly, offering a cost-effective solution for chip designers who can outsource these steps. Data from Technavio and Mordor Intelligence suggests that OSAT companies captured roughly two-thirds of the market share in 2022, compared to one-third held by IDMs.



Currently, a significant portion of U.S. semiconductor companies rely on offshore facilities for their packaging needs. This can be achieved in two ways. Firstly, many U.S. firms leverage the services of major OSAT companies, primarily located in East Asia. Secondly, U.S.-owned IDM companies with facilities situated overseas can also manage packaging for U.S.-designed chips. For example, despite having a prominent chip design presence in the U.S., Apple reportedly relies on a multi-billion-dollar deal with Taiwanese OSAT company ASE for their ATP needs. Similarly, data suggests other U.S. chipmakers like Intel, Micron, and OnSemi also depend on major East Asian OSAT firms for packaging.

While traditionally, semiconductor innovation focused on miniaturization by increasing the number of components on a single chip ("chip density"), this approach is nearing its physical limits. Companies like Intel, TSMC, and Samsung have competed fiercely to create ever-smaller, more powerful chips, upholding Moore's Law. However, as physics imposes constraints, further miniaturization is expected to yield diminishing returns in terms of efficiency gains.



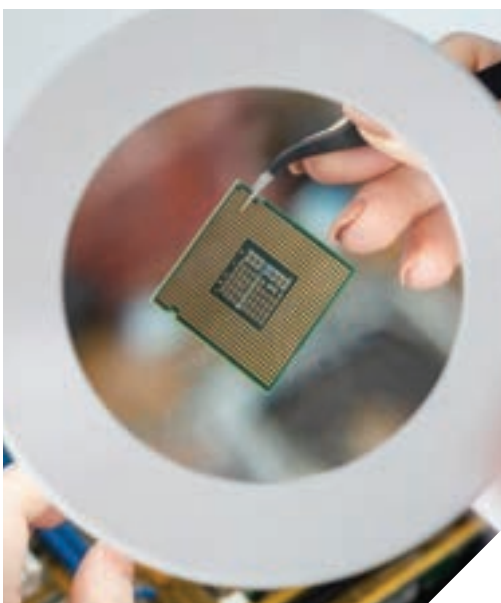
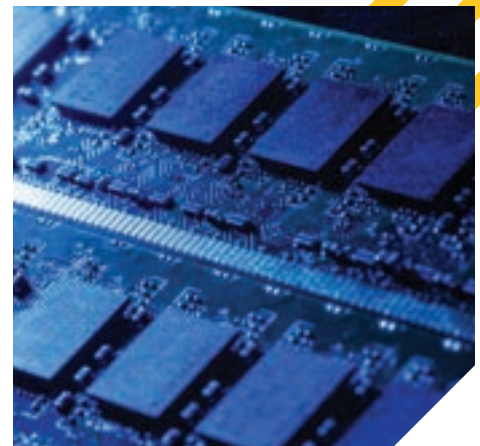
This is where advancements in chip packaging emerge as a crucial avenue for continued innovation. By focusing on innovative packaging techniques, the performance of electronic devices can be significantly enhanced while simultaneously reducing chip power consumption. This shift towards advanced packaging research holds the potential to revitalize the U.S. semiconductor industry and boost its competitiveness in the global market.

Advanced packaging research presents a strategic opportunity to reshape the competitive landscape of the semiconductor industry. Within the Assembly, Test, and Packaging (ATP) market, the packaging segment is poised for significantly faster growth compared to assembly and testing services. According to Cognitive Market Research, the combined Global Semiconductor Assembly and Test Services market reached USD 40.5 billion in 2022 and is projected to grow at a moderate CAGR of 5.5% from 2023 to 2030.

III ■ Semiconductor Workforce Demand in Vietnam

A Assessment of Workforce Demand for ATP Sector

The global semiconductor packaging landscape is undergoing a rapid transformation, driven by a surge in new facilities across Asia. According to the Worldwide Assembly & Test Facility Database, the total number of back-end facilities operated by both IDMs and OSAT companies surpassed 670 in 2024. This signifies a growth rate of nearly 15% annually starting in the fourth quarter of 2021. This expansion is primarily fueled by the establishment of new OSAT facilities in China (over 40), Taiwan (over 20), and Southeast Asia (over 15). This geographic concentration underscores the strategic shift towards Asia as a hub for cost-effective packaging solutions.



Vietnam is well-positioned to benefit from this trend. A prime example is Intel's factory in Ho Chi Minh City (HCMC), which has been operational since 2010 and has consistently expanded its workforce. Our research in 2016 indicated that the factory employed approximately 1,300 people at that time [1]. This ongoing expansion is a testament to Vietnam's attractiveness for ATP investments. Further solidifying this potential is Amkor Technology's recent investment in Bac Ninh province. Amkor's multi-phased project boasts a total investment of 1.6 billion USD, mirroring the scale of Intel's facility. The first phase, valued at 520 million USD, became operational in 2023. Considering the investment size, Amkor's factory is projected to generate substantial job opportunities, similar to the impact of the Intel facility.

This trend is further amplified by the entry of other major players. Hana Micron Vina, another recent investor, began with a smaller initial investment of 12 million USD in their first ATP factory in 2017 in Bac Ninh province. However, they have quickly scaled up new facilities in Bac Giang province, accumulating a total investment of nearly 600 million USD and creating close to 1,000 jobs.

Building on the current momentum in the ATP sector, we anticipate further expansion of existing facilities and an influx of new players between 2025 and 2035. This growth is expected to drive significant labor demand. From a bottom-up perspective, our baseline scenario expects approximately four new facilities, each with a scale similar to that of current Intel facilities, to enter Vietnam during the period 2025-2035. From a top-down perspective, we anticipate an annual increase in the workforce of around 9%. This projection takes into account the slower growth of the assembly and testing sectors, estimated at about 5.5% per annum, and the much higher growth of the packaging sector, estimated at approximately 28% per annum. We anticipate even higher growth rates in our positive and optimistic scenarios, reaching 12% and 15% annually, respectively. These projections are underpinned by the assumption that Vietnam will successfully transition from traditional, low-value-added assembly and testing activities towards the advanced packaging sector, which has a higher growth rate (see Table III.1.).

Our estimates appear more conservative compared to the National Workforce Development Plan for the Semiconductor Industry until 2030 (NWP). While our projections for ATP labor demand align with the NWP's figures (see Appendix III.A), we foresee a 2035 timeframe to reach those targets compared to their 2030 goal.

Table III.1.

Labor demand projection in Vietnam's ATP sector

	2025		2030		2035	
	Engineer	Technician	Engineer	Technician	Engineer	Technician
Baseline scenario (Cagr = 9%)	1.400	4.200	2.200	6.600	3.400	10.200
Positive scenario (Cagr = 12%)	1.400	4.200	2.500	7.500	4.400	13.200
Optimistic scenario (Cagr = 15%)	1.400	4.200	2.800	8.400	5.700	17.100

Source: Authors' estimation. Note: Our survey of current facilities in Vietnam suggests a ratio of 1 engineer to 3 technicians.



Semiconductor Workforce Demand in Vietnam

B Assessment of Workforce Demand for IC Design Sector



According to Cognitive Market Research, the global fabless IC market size reached USD 135.5 billion in 2023 and is projected to grow at a healthy CAGR of 5.9% through 2030. The fabless IC design market is poised for significant growth across key regions like North America, Asia-Pacific, and Europe, fueled by the surging demand for advanced electronics and semiconductors. Asia-Pacific is expected to lead the market, capturing a roughly 50% share, while North America follows closely with a projected 25% share. This growth is driven by the rapid expansion of industries like consumer electronics, automotive, and telecommunications within these regions, which creates a high demand for fabless IC design services and solutions.

Foreign companies hold a major share of the IC market in Vietnam. Our survey indicates the presence of over 30 foreign direct investment (FDI) firms within this sector. While many of these companies are relatively small-scale, there are exceptions. Renesas stands out as the largest, boasting a workforce of nearly 1,000 employees. Additionally, several medium-sized enterprises employ hundreds of individuals, such as Synopsys, Ampere, Marvell, HCLTech, CoAsia, Dolphin Technology, ADTechnology, among others. Utilizing a bottom-up approach, we estimate that these foreign FDI companies collectively employ 3,500-4,000 IC design engineers in 2024.

The Vietnamese IC design sector boasts participation from domestic players alongside foreign giants. Major local telecommunication groups like FPT and Viettel contribute to the market, alongside smaller-scale companies such as VBTech, Wavelet, and VNCHIP.

Based on the National Workforce Development Plan for the Semiconductor Industry by 2030 (NWP) estimating a total of 5,575 IC design engineers (see Appendix III.B), we can infer that local companies are likely to employ between 1,500 and 2,000 engineers in this field.



To forecast the demand for IC design engineers in Vietnam, we have developed three scenarios. The baseline scenario assumes a conservative 6% annual growth rate, mirroring the average growth rate observed in the global IC design industry. Our positive scenario takes a more optimistic approach, projecting a 9% annual growth rate. Finally, the high scenario explores the possibility of rapid growth with a 12% annual increase.

Based on these scenarios, Vietnam's annual demand for IC design engineers is estimated to range from 500 to 1,500 between 2025 and 2035 (Table III.2.). In general, these estimations fall within the range projected by the National Workforce Development Plan for the Semiconductor Industry (NWP). The NWP estimates a total demand of 8,200 to 14,700 IC design engineers by 2030.

Table III.3.2.

Labor demand projection in Vietnam's IC design sector (number of engineers)

	2025	2030	2035	Average annual new employment
Baseline scenario- CAGR 6%	6,300	8,400	11,200	500
Positive scenario- CAGR 9%	6,600	10,200	15,700	900
High scenario-CAGR 12%	7,000	12,300	21,700	1,500

Source: Author's estimation.

IV ■ Supply: Status of training



The wave of semiconductor investment in Vietnam and the industry's demand for human resources have driven educational institutions, from top universities to vocational colleges, to launch training programs related to semiconductors. In 2024, major universities such as Hanoi University of Science and Technology (HUST), University of Information Technology – Vietnam National University Ho Chi Minh (UIT-VNU HCM), and University of Engineering and Technology – (UET – VNU Hanoi) announced the opening of engineering programs specialized in semiconductor. Younger universities like FPT University and Phenikaa University are also making significant investments in this area, not only in training programs but also in facilities and equipment. However, to truly understand the current landscape of semiconductor training in Vietnam, it is essential to look at the regulations and current state of training programs in this field from 2024 backward.

A Context: Vietnam currently has no semiconductor training major

Currently, according to the regulations of the Ministry of Education and Training (MOET), Vietnam does not have a training code for semiconductor engineers³. However, universities can establish specializations in semiconductors within related majors. Therefore, the current semiconductor training programs are actually specializations within related majors such as Electronic and Telecommunication Engineering or Electrical and Electronic Engineering. Based on this, our research focuses on analyzing the majors of universities that have semiconductor specializations. We will compare key indicators such as curriculum, related courses, faculty, facilities, and the number of students to provide the semiconductor training landscape in Vietnam.



³ An expert from MOET confirmed this in the workshop organized by our research group in Hanoi

IV ■ Supply: Status of training

B Status of Semiconductor Training at Leading Universities in Vietnam



According to the report from the Ministry of Planning and Investment (MIC), five universities will receive investment to develop quality training programs in semiconductor, including HUST, VNU-Hanoi, VNU-HCM, Da Nang University of Science and Technology, and Posts and Telecommunication Institute of Technology (PTIT). These institutions are the main sources to provide skilled engineers for the semiconductor industry in Vietnam in terms of both scale and quality. This report thus analyzes the training status at those universities to provide a picture of the semiconductor workforce in Vietnam. Table IV.1 (in the Appendix) presents training data of these universities based on key indicators such as curriculum, related courses, faculty, facilities, and the number of students.

4

<https://laodong.vn/giao-duc/5-truong-dai-hoc-lien-minh-phat-trien-nhan-luc-cong-nghiep-ban-dan-1256506.ldo>



1. Hanoi University of Science and Technology (HUST)

HUST is one of the most reputable institutions in Vietnam for semiconductor training. The semiconductor and integrated circuits (ICs) specialization was initially opened within the Electrical and Electronic Engineering major over 10 years ago. In 2023, the university opened a new, more in-depth major in this field called "Microelectronics and Nano Technology". The enrollment is about 190 students/year for the semiconductor specialization across both the "Microelectronics and Nano Technology" and "Electrical and Electronic Engineering" majors. The curriculum is properly designed for semiconductors, from foundational courses like Microelectronic Circuits and Semiconductor Physics and Devices to specialized courses like Semiconductor Manufacturing and Process Control and Analysis and Design of Digital-Analog Integrated Circuits. The total number of credits for the courses related to semiconductor is 51, the highest among semiconductor training programs in Vietnamese universities. The university has about 25 Ph.D.-level faculty members in this field, the largest number among Vietnamese universities according to our survey. In terms of facilities, the university has clean rooms, experimental equipment, measurement devices, server systems, and software licenses for training. In October 2023, the university signed a Memorandum of Cooperation to develop a high-quality workforce in semiconductor and is one of the pillars of the alliance consisting of five leading universities in Vietnam.



2. Vietnam National University, Hanoi (VNU-Hanoi)

VNU-Hanoi, with the University of Engineering and Technology (UET) as the core, has been training in the semiconductor field since 2007 with their establishment of the Smart & Integrated Systems laboratory. Currently, semiconductor and IC design specialization is taught in two majors: Electronic and Telecommunication Engineering and Computer Engineering. However, the actual number of students enrolled in this specialization is relatively low, about 10 to 15 students/year. The curriculum includes basic and specialized courses such as Analog Electronics and Analog Integrated Circuit Design. The total number of credits for related courses is 37. The faculty in this field has about 11 members. The university has relatively complete facilities for training, including a small clean room, server computers, workstations, HAPS emulators for chip testing, FPGA development kits, design software licenses, and related equipment. In 2024, the university aims to further promote semiconductor circuit training, including expanding student numbers, curriculum content, and facilities.



3. Vietnam National University, Ho Chi Minh City (VNU-HCM)

VNU-HCM is a leading institution in semiconductor and IC design training in the southern region. It has three member universities participating in training in this field: HCM University of Technology (HCM-UT), HCM University of Information Technology (HCM-UIT), and University of Science (HCM-US). The University of Information Technology has a specialization in Computer Hardware and IC Design within the Computer Engineering major, with about 70 students per year in this specialization. The specialization has been taught since 2020, with a curriculum involving 44 related credits and many in-depth courses such as Digital System Design with HDL, Digital Circuit Design, and Analog Circuit Design. The faculty includes about 8 members.

HCM-UT has a semiconductor and IC design specialization within the Electronic and Telecommunication Engineering major, with about 80 students/year in this specialization. The total number of credits for related courses is about 45. The faculty includes about 8 to 10 members. The university has facilities that meet training needs, and the program has been taught for many years.

HCM-US has been offering a specialization in Electronics with a focus on IC design since 2008, with an average enrollment of 50 to 60 students per year. The total number of credits for the related courses is approximately 41 credits. By 2024, the school will offer a pilot program in IC design with an enrollment of around 60 students per year, thereby increasing the total number of students to 120 per year. The school is equipped with facilities that meet the training requirements, such as measurement and testing equipment and design software including Cadence and Synopsis. The expert team consists of one associate professor and five PhDs.



4. Da Nang University of Science and Technology

Da Nang University of Science and Technology is the main institution for semiconductor training in the central region. However, until 2024, the university did not have a semiconductor specialization but only the Electronic and Telecommunication Engineering major with some related courses such as VLSI Technology and Circuit Design. The total number of credits for related courses is about 34, the lowest among the five key universities. The faculty is also limited, with about 5 members. The student number enrolled in this field is less than 50 students/year.



5. Posts and Telecommunications Institute of Technology (PTIT)

PTIT is one of the key institutions for semiconductor training with campuses in both the North and the South. Although the Electronic and Telecommunication Engineering program has been around for a long time, the microelectronics/semiconductor specialization was only established in 2023 with an enrollment scale of about 70 students/year for both campuses. The faculty includes about 10 members, some of whom do not have a Ph.D. degree. The training program includes many semiconductor-related courses with a total of about 50 credits. In 2024, the university plans to expand training in this field, including both training scale and facilities.



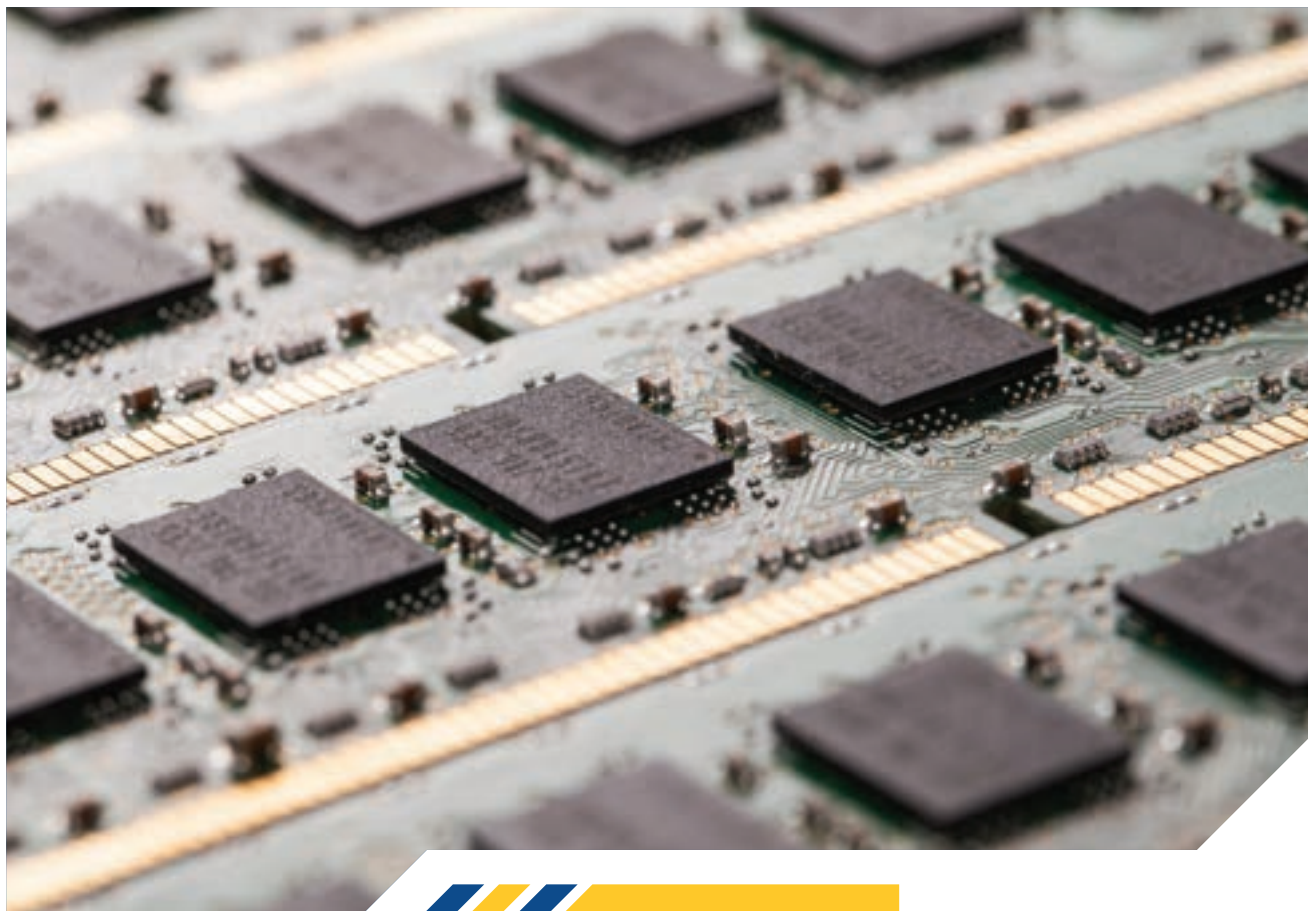
6. Status of Semiconductor Training at Related Universities

Besides the five main universities receiving government investment in semiconductor training, many other technical universities have also started to focus on this field. Specifically, FPT University has established a semiconductor major aiming to enroll and train 1,000 engineers per year starting from 2024. Phenikaa University also established a semiconductor research and

training center in June 2024. Other universities like Can Tho University, Hanoi University of Industry, HCMC University of Technology and Education, Van Lang University, Ton Duc Thang University, etc., also aim to train in this field. However, it is important to understand that the semiconductor industry is a specialized field that requires significant investment in facilities, curriculum, and trainers. Given the limited number of experts in this field in Vietnam, quickly establishing training programs is not easy, not to mention maintaining the training quality.

IV Supply: Status of training

ATP Training in Vietnam



According to discussions in the workshop organized by the research group, Vietnam currently does not have specialized training or related certification programs for ATP. Workforce in the ATP sector in Vietnam are mainly recruited from related fields such as IC design, microelectronics, electrical engineering, electronics, automatic control, nanotechnology, materials science, mechanics, chemistry, etc. With the wave of foreign semiconductor company investments in Vietnam, training institutions, especially vocational schools, have started to pay attention to training human resources for the ATP sector. Their primary approach is to add ATP-related courses to their existing training programs instead of opening an ATP-specific program.

D Vietnam Government's Strategy for Semiconductor Workforce Development

On September 21, 2024, the Vietnamese government announced a program titled "Development of Human Resources for the Semiconductor Industry by 2030, with Orientation Towards 2050". This program outlines strategic approaches to building a skilled workforce for the semiconductor industry, summarized as follows:

- Research and establish mechanisms and policies to attract domestic talent, overseas Vietnamese, and international experts in the semiconductor industry to work in Vietnam:
 - ☐ Competitive salary and bonus mechanisms comparable to regional countries.
 - ☐ Personal income tax incentives.
 - ☐ Long-term work visa support; simplified administrative procedures for international experts.
 - ☐ Support in education, healthcare, social welfare, and housing for the families of high-level workers, lecturers, and senior experts working in the semiconductor industry in Vietnam.
- Research, develop, and implement a talent training program to support the semiconductor industry; establish mechanisms for output-based contracts between agencies, businesses, and universities.
- Research, establish, and refine specific mechanisms for financial support for students, including scholarships, tuition waivers, and reductions for training programs approved by the Ministry of Education and Training and relevant authorities under the Program.
- Research, establish tax and fee incentives to attract domestic and foreign investment in semiconductor industry and human resource training.
- Develop specific mechanisms to facilitate investment in and operation of semiconductor laboratories:
 - ☐ Simplify investment, procurement, and partner selection processes for purchasing equipment for training, incubation, research, and development, especially for national and local shared semiconductor laboratories for training semiconductor industry human resources.
 - ☐ Develop criteria for partner selection and operational mechanisms that ensure ease and promote autonomy and accountability for managing agencies and investors in semiconductor laboratory projects.
 - ☐ Establish a shared-use mechanism for public infrastructure, equipment, and laboratories.

⁵ No. 1017/QĐ-TTg, Hanoi, September 21, 2024, decision on approval for the program "developing human resources for the semiconductor industry to 2030, with a vision to 2050"

Source: <https://vanban.chinhphu.vn/?pageid=27160&docid=211239>

V ■ Analysis of the Supply-Demand Gap

A Classification of Occupations in Semiconductor

This section describes the qualifications for job functions in the semiconductor industry in Vietnam, by first mapping the job functions with the knowledge provided in university majors, then followed by further mapping the more detailed job functions with the skills required in the industry.

The 2 matrices allow us to point out additional areas of knowledge for curriculum upgrade in university curricula, for many different majors. Also, some areas of knowledge can only be obtained in a company environment, which requires close collaboration between industry - education to enhance the quality of the graduated workforce.



To create these matrices, we analyzed organizational charts, job descriptions, and qualifications for various semiconductor industry vacancies. Expert insights, particularly from fabless design and OSAT companies, were incorporated into the analysis. Domestic and foreign universities' curricula and major flowcharts were also analyzed to generate the relevant matrix.

From an education curriculum point of view, there is no semiconductor major. Semiconductor actually is an industry that consists of many different knowledge areas, and similarly, contains many different occupations. The following occupations are based on the current (and projected) semiconductor industry landscape in Vietnam; therefore, some jobs are missing.



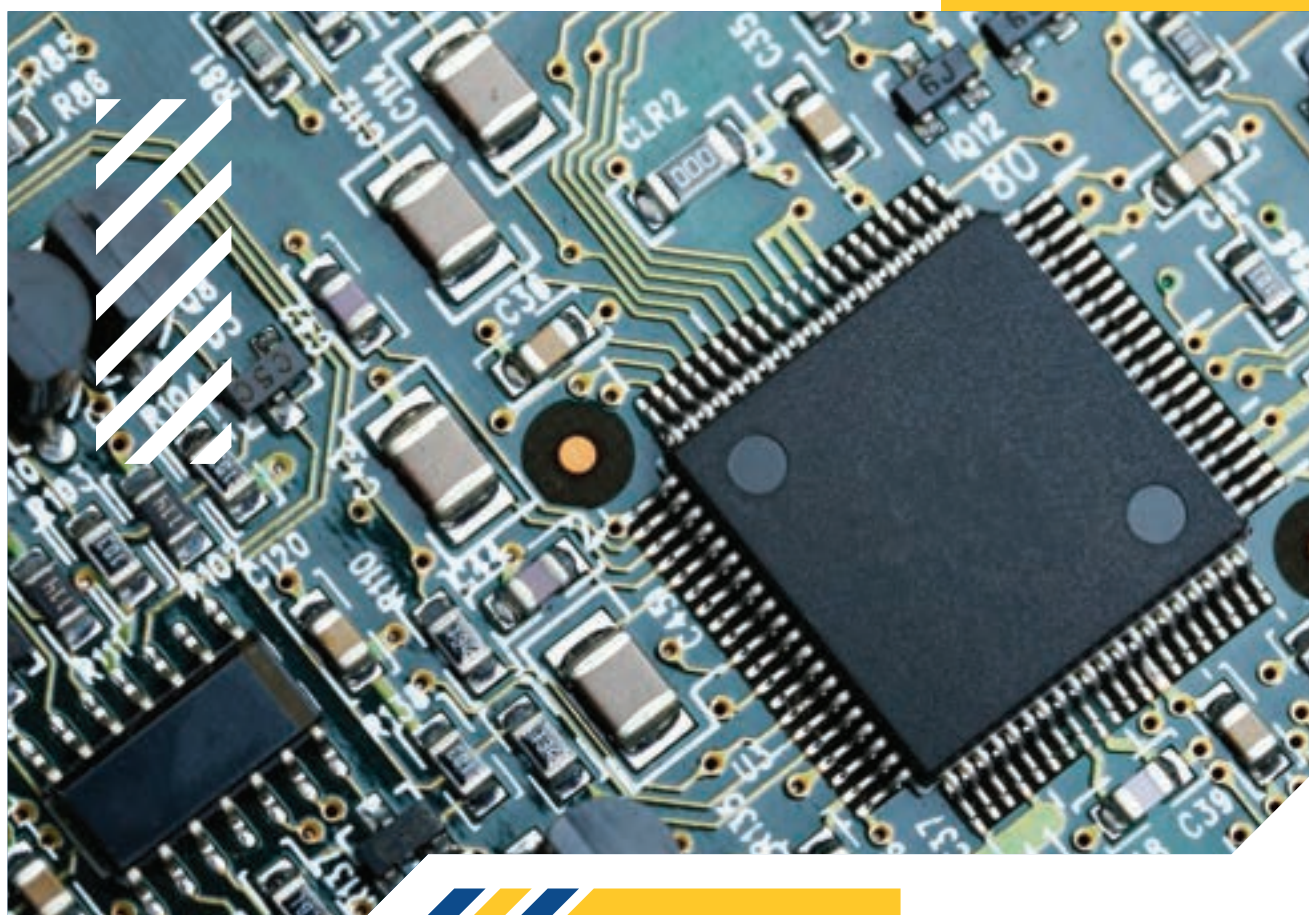
List of occupations in semiconductor industry vs education major are given in Table V.1 below.

Table V.1: Semiconductor education major and role matrix

	Chemical Eng / Chemistry	Material s Sci. / Eng	Environmental Eng	Auto. and Robotics	Industrial Eng	Physi cs	Appli ed Math	Mecha nical Eng	Elec and Comp Eng	Computer / Data Science	IT system and op.	Supply Chain Mgmt.	Semi Business Dev.	Proje ct Mgmt
Program Manager														X
Development Manager									X				X	X
Construction Manager / Project Manager				X	X							X		X
Process and Product Architect		X		X				X	X				X	
Chip System Architect									X	X			X	
Digital Design Engineer									X	X				
Analog / Circuit Design Engineer									X					
RF Design Engineer									X					
Physical / Layout / CAD Design Engineer								X	X	X	X			
Test Engineer	X	X						X	X	X				

Table V.1: Semiconductor education major and role matrix

	Chemical Eng / Chemistry	Material s Sci. / Eng	Environ mental Eng	Auto. and Robotics	Industri al Eng	Physi cs	Appli ed Math	Mecha nical Eng	Elec and Comp Eng	Computer / Data Science	IT system and op.	Supply Chain Mgmt.	Semi Business Dev.	Proje ct Mgmt
Product Engineer	X	X						X	X					
Application Engineer				X					X					
System Engineer				X	X			X			X			
Firmware Engineer				X					X	X				
Field Application Engineer				X					X	X				
Equipment Engineer		X	X	X				X	X					
Process Engineer	X	X	X	X	X	X		X						
Field Service Engineer				X				X	X					
Electrical Engineer									X					
Optoelectronics Engineer								X	X					
Yield and Reliability Engineer				X			X	X	X	X				
Packaging Engineer	X	X			X			X	X					
Process Integrator		X			X			X						
Production Line Manager					X			X	X	X	X			
Operation Engineer					X			X						
Procurement Engineer									X			X		
Supply Chain Manager												X		
Software Engineer										X				
Data Scientist										X				
Fab automation and optimization Engineer				X	X						X			
Environment and Safety Engineer			X											



Even though the majors are similar to the ones usually taught in universities in Vietnam, the syllabi should add/update a certain knowledge related to semiconductor to make the graduates ready for work in the semiconductor industry. Due to the lack of lab equipment as well as industry experience opportunities, graduates still require training in industry facilities after recruitment, though the training period can be shortened with semiconductor knowledge equipped in university.

The following KSA matrix is distilled from Semiconductor Research Corporation's KSA matrix for Advanced Packaging and in consultation with several expert, educator, policymakers of domestic and international contributors.

Table V.2 presents a KSA matrix tailored to the Vietnamese semiconductor landscape, which currently comprises primarily Design and ATP&SME firms, with no immediate prospects for Manufacturing companies.

Job functions were categorized into knowledge-specific groups, such as Chip Design and ATP&SME factory, and common groups including Data Analysis and IT Support, Business Development and General Management, and Procurement. While common groups are applicable across different company types, their headcount and importance may vary based on specific business operations.

Regarding skill necessity, we have classified skills into three levels: Not Required, Desired, and Critical. To maintain a manageable matrix, skill sets, and sub-skills were organized in a generalized manner.

Consequently, some job functions might require only one or two sub-skills at the Critical level but are marked as Critical for the overall skill set. A more detailed sub-skills to job function matrix could be developed with additional time and resources. Find the KSA matrix at Appendix 6: Table V.2: KSA Matrix for Job Positions in Design, ATP and SME in semiconductor in Vietnam.

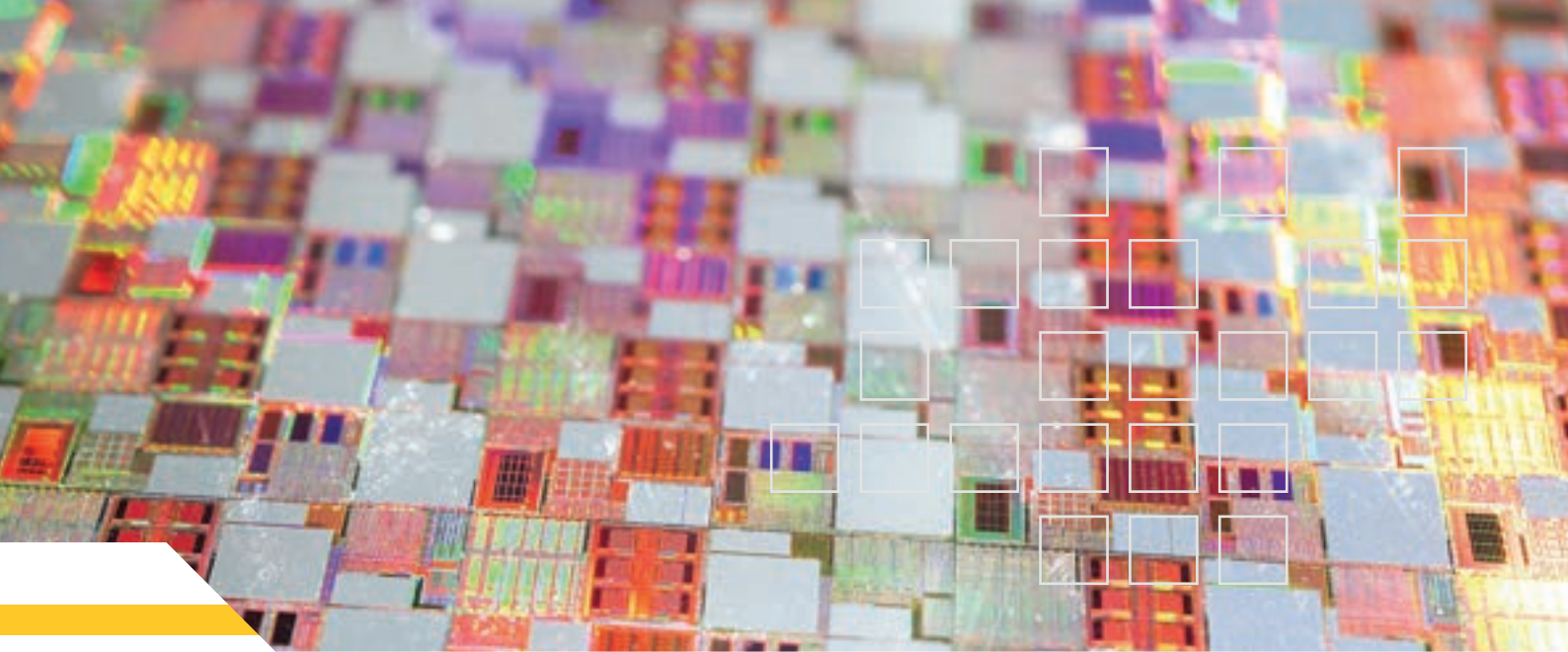
V ■ Analysis of the Supply-Demand Gap

B Gap Analysis in the ATP sector

Lack of Training Programs:

As analyzed in Section IV, Vietnam currently does not have a training program for ATP, including both the specific curriculum and certification by authorized entities. Consequently, the shortage of high-quality human resources in this field is inevitable. Currently, businesses have to recruit personnel trained in related fields. As shown in Table V.1, some job positions in ATP include test engineer, equipment engineer, packaging engineer, production line manager, operator engineer, fab automation and optimization engineer, and environment and safety engineer, etc. can be filled by engineers from related disciplines such as mechanical engineering, electrical and computer engineering, automation and robotics, industrial engineering, data and computer engineering, etc. These are traditional majors with comprehensive training available in Vietnam. However, due to a lack of knowledge in modern semiconductor technologies, engineers from these disciplines cannot immediately meet ATP job requirements and need additional training. Depending on the job position and the company, this additional training can take from 6 months to 2 years. The issue is that this training is currently entirely conducted by the companies for their engineers, without the sharing of resources or expertise between companies and training institutions, or among companies themselves. This results in increased costs and reduced efficiency in training activities.





Lack of Faculty:

Besides the training programs, there is also a severe shortage of experts/instructors in this field in Vietnam. Most of the instructors are trained in IC design and have little practical experience working in factories. This issue, combined with the lack of training programs, affects the quality of training.



Lack of Facilities:

Another challenge in ATP training is the requirement for large equipment and facilities. These requirements often exceed the capabilities of a single training institution. At the state level, there are currently no facilities invested in that can be shared among training institutions.

Unattractive Salary/Benefits:

Additionally, it should be noted that the salary and benefits for engineers working in ATP are not as attractive as those for engineers in other fields such as IC design. Moreover, the challenging work environment in factories makes it even more difficult to attract engineers to choose ATP.



V ■ Analysis of the Supply-Demand Gap

C Gap Analysis in the IC design sector

The IC design sector accounts for over 50% of the value chain. It also enjoys the highest margin in the chain of over 45%, with the lowest initial investment. So obviously, it is the sweet spot that all countries aim for. However, it requires special knowledge as well as certain socio-economic conditions to be successful in.

The integrated circuit (IC) design sector encounters challenges in human resource development similar to those in the automated test pattern (ATP) sector, albeit with varying degrees of severity across different areas. Training programs for IC design engineers have been established for over a decade at major technical universities. Each year, approximately 50 students graduate with specializations in IC design from these leading institutions. Nonetheless, the industry often requires an additional 6 months to 2 years of training before these engineers can be fully assimilated into standard design team workflows. This extended training period is primarily due to the limited number of collaborative research projects between academia and industry, which would otherwise provide students with hands-on experience in the complete IC design and tape-out process. Such collaboration projects are also essential for the continuous updating and transfer of practical design requirements and processes from industry to academic institutions, thereby ensuring that graduating students are trained to meet current industry standards.

The following paragraphs will present a gap analysis of the IC design sector workforce, focusing on the various job positions within the sector that exhibit the highest levels of shortage.



The number of faculty members in the IC design field who possess substantial industry experience is limited, exacerbating the scarcity of industry-academic research collaborations. Additionally, low compensation packages offered by universities further hinder their ability to attract experienced industry professionals to the teaching workforce.

IC design requires significant laboratory resources for performance verification of tape-out ICs. While major universities may possess high-performance computers for design simulation, they often lack the necessary measurement equipment due to its high cost.

Main occupations in the IC design sector include

- Business Leader
- Business Development Specialist
- Project Manager
- System Architect
- Chip Architect
- Digital Design Engineer
- Analog / Circuit Design Engineer
- RF Design Engineer
- Physical Design Engineer
- Verification Engineer
- Test Engineer
- System Engineer
- Application Engineer
- Field Application Engineer
- Firmware Engineer
- Hardware - Firmware integration Engineer
- IT system and operation

The Business and Leadership tracks in IC design, even though they share general knowledge with the same track in other fields, especially the Electronics sector, it also requires specific domain knowledge in IC design that would be difficult for the workforce to acquire without prior working experience. With only around 50 design companies in Vietnam, the shortage is severe, and new startup or FDI companies would face a tough time looking for a local leader candidate.

One source of Business Development personnel that is already available in the market is the Business workforce of electronics component distributors in Vietnam, who are serving a huge Electronics manufacturing sector, sharing the same network of component consumers, and deeply understands the needs of current component consumers in Vietnam. They would need an upskilling course to update the constraints of IC design business and then can be ready to explore the Business Development area. However, given the scarcity of electronic component distributors in Vietnam, the headcount for this workforce is not high.

The level of Architect in IC design is especially important to decide the success of a design project. However, the majority of IC design houses in Vietnam have only tackled up to upper-intermediate level of chip complexity (as shown by 5G Digital Front-End processor project of Viettel, or mid-tier Samsung's Exynos chip in an outsourced project of an FDI company in Vietnam), therefore the headcount that can take Architect level is very limited. Currently, Vietnam's IC design workforce is mainly capable of outsource projects with architecture and block-level requirement breakdown already decided by oversea partners. To grow the Architect level, training in HEI is not enough and suitable.

Being able to deliver a complete design project, any design company should contain all the other occupations in the above list. However, while Digital Design Engineer is closer to Embedded Engineer in traditional curriculum, the RF Design Engineer and Analog/Circuit Design Engineer normally require knowledge closer to Electrical / Electronic Engineering and also demand practical experience with real IC manufactured (tape-out). Consequently, the number of Digital Design Engineers is much higher than the RF and Analog Design Engineers.

Table V.1 described the directly and closely related majors that graduates can be recruited for their respective roles. However, a frequent problem is that the majority of the curricula lack domain knowledge in semiconductors, either in material, manufacturing process, factory setting, IC design constraints in advanced nodes, and real IC measurement after tape-out. The main reason is the slow development of the IC design sector in Vietnam; therefore, the curricula are not updated, and the chances for industry collaboration is low for HEI. For more details, please refer to Table V.2.

VI ■ Bridging the Gap

A LESSONS LEARNED FROM OTHER COUNTRIES AND TERRITORIES

1. Lessons learned from Taiwan



1. Strong Government and Industry Collaboration

The success of Taiwan's semiconductor industry is deeply rooted in a robust partnership between the government, academia, and industry. This collaboration is evident in the establishment of and funding to research institutes like TSRI, the development of university programs aligned with industry needs, and the establishment of supportive policies for talent development.



2. Comprehensive Talent Development Ecosystem

A multifaceted approach to workforce development is crucial. This includes:

Short courses for upskilling and cross-skilling, such as the vocational training and short course programs being offered at ICST (NYCU), are essential for building a solid foundation.

Continuous education and skill enhancement are also critical to keeping pace with rapid technological advancements.

Advanced talent development: Master's programs and research institutes like TSRI provide opportunities for in-depth specialization and innovation.



3. Industry-Driven Curriculum and Training

Ensuring that educational programs align closely with industry needs is vital. The involvement of industry experts in curriculum development, as seen in programs at NYCU and TSRI, guarantees that graduates possess the necessary skills for immediate job relevance.



4. Investment in Infrastructure and Facilities

Access to state-of-the-art equipment and facilities is essential for hands-on learning and research. The establishment of semiconductor production lines, for which the "Semiconductor packaging and testing production line" at Minghsin University of Science and Technology is a typical example, provides students with valuable practical experience.



5. Global Talent Attraction and Retention

To build a world-class semiconductor workforce, it is essential to attract top talent, especially overseas Vietnamese, from around the world. Vietnam should prioritize several key strategies. First, unrestricted repatriation for overseas Vietnamese entrepreneurs is essential to harness the potential of the diaspora. Second, a robust investment ecosystem, including government matching funds and a liquid capital market, is crucial to attract foreign capital. Third, crafting a compelling narrative of Vietnam's industrial renaissance can generate global interest.



6. Focus on Soft Skills

While technical expertise is essential, soft skills like problem-solving, teamwork, and communication are equally important for success in the semiconductor industry. Programs that emphasize these skills, as seen in NYCU's vocational training, can produce well-rounded graduates.

VI ■ Bridging the Gap

A LESSONS LEARNED FROM OTHER COUNTRIES AND TERRITORIES



Lessons learned from the US



1. Overall strategy

As a latecomer in the global semiconductor industry, Vietnam should focus on carving out a niche, such as in Advanced Technology Packaging (ATP) or Integrated Circuit (IC) design, to establish and maintain a strong presence in the global semiconductor map. This strategic approach aligns with the insights shared by Professor Albert Ting from Taiwan, emphasizing the importance of specializing in a specific area to compete effectively in the semiconductor market.



2. Industry-driven training

U.S. universities and community colleges tailor their training programs to meet the specific demands of the semiconductor industry, rather than training students in anticipation of future needs. For example, Arizona State University (ASU) adapted its Ira Fulton School of Engineering programs to train 200 students annually in response to TSMC's requirements. The school offers flexible degree programs, concentrations, and electives that can quickly adjust to industry needs. Similarly, Maricopa Community College has adjusted its training pace in line with the progress of semiconductor fabrication plant construction.



Purdue University's SCALE Hi-AP program was established to address future workforce needs driven by the Department of Defense (DoD). Ivy Tech Community College collaborates closely with Intel and SK Hynix to tailor its training programs, ensuring alignment with industry requirements. Ivy Tech's initiatives, such as the PITCH program for high school students and the CASCADE program with Synopsys for on-the-job training, exemplify its commitment to hands-on, industry-relevant education.

In addition to responding to business demands, U.S. educational institutions maintain strong ties with the semiconductor industry throughout their training programs. This includes designing curricula in collaboration with industry experts, incorporating guest lectures and talks, and providing students with internships and practical experiences directly related to industry needs.

3. Job demands

Job demands in the U.S. semiconductor industry are diverse, reflecting the varying levels of expertise required for different roles. In the Integrated Circuit (IC) design sector, U.S. companies generally prefer Master's and PhD graduates due to their advanced expertise, which is essential for handling complex projects. Undergraduates are typically suited for less complex digital design tasks. Conversely, in Advanced Technology Packaging (ATP), there is a broader range of opportunities. Graduates from community colleges, who have undergone training ranging from 10 days to 2 years, can also find employment. This flexibility allows individuals with varying levels of training to enter the ATP field and meet industry needs.



VI ■ Bridging the Gap

A LESSONS LEARNED FROM OTHER COUNTRIES AND TERRITORIES

Lessons learned from the US

4. Community college training for ATP

Community college training is particularly well-suited for ATP technicians due to its flexibility and accessibility. Unlike university programs, which often have longer durations and less adaptability, community colleges offer training that ranges from 10 days to 2 years, making it easier to meet the specific needs of the ATP sector. These programs feature stackable modules with certificates that can be showcased on LinkedIn profiles or converted into associate degrees for transfer to universities, providing a streamlined path into the semiconductor workforce.



5. Diverse modes of training students for long-term workforce

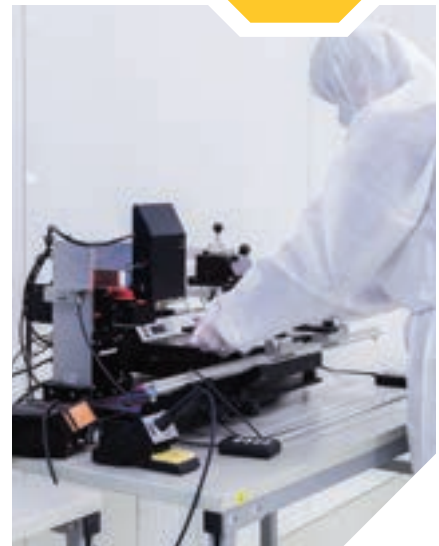
To ensure a sustainable semiconductor workforce, a range of training programs is essential. These may include bootcamps for high school students, two-week programs for first- and second-year college students, and eight-week intensive courses for senior students. Each program should be carefully designed with specific objectives, operational structures, resources, and expected outcomes to effectively prepare students for different educational stages and meet industry needs. This diverse approach ensures that the workforce is well-rounded and capable of addressing various challenges in the semiconductor field.





6. Building labs

Universities can enhance their programs by fostering collaboration with industry, attracting firms to contribute equipment, projects, or research to their labs. This partnership benefits both faculty and students through joint projects, access to cutting-edge equipment, and opportunities to apply their research in real-world contexts. While endowments may help establish labs initially, ongoing operational funding primarily comes from government sources, justified by the economic value of the trained workforce and supplemented by revenue generated from firm services. For smaller-scale training needs, such as those for ATP, colleges like Ivy Tech can develop specialized labs to provide hands-on training and meet industry demands effectively.



7. Trainers' capabilities

Vietnamese trainers should undergo practical, industry-based training from seasoned experts to ensure effective knowledge transfer. While Vietnamese universities excel in teaching theories and foundational knowledge, this alone is insufficient for preparing students for the semiconductor industry. Employees need highly technical and practical skills tailored to specialized facilities, particularly as ATP has become increasingly advanced and technology-driven compared to decades past. Practical training will bridge the gap between theoretical education and the specific technical requirements of the industry, ensuring that graduates are well-prepared for real-world applications.





B RECOMMENDATIONS

1. Recommendations for Training programs (Ministry of Education and Training, universities, technical colleges)

■ In the short term (1-6 months)

- ☐ For regular university programs, additional relevant content will be integrated. Initially, fund personnel to pursue postgraduate training abroad in semiconductor-related fields using government budgets. Concurrently, collaborate with international training institutions to upgrade domestic postgraduate programs, leveraging online courses to bridge training gaps.
- ☐ Develop training certificates with graduates to supplement knowledge. To ensure quality, the certificates should be certified by reputable entities such as American universities or national accreditation centers.

■ Medium term (6-12 months)

- ☐ Ensure that personnel receive practical training through partnerships with industry Vietnam short-term visits to advanced international training facilities with established connections in the program.
- ☐ Organize technical training programs at vocational and technical colleges to equip workers with the skills needed for the semiconductor industry, such as expertise in ATP facilities and semiconductor equipment manufacturing. Collaborate with nationally certified vocational schools (e.g., Taiwan) or those with successful partnerships with production units (e.g., Arizona, Texas, Indiana, Portland) to ensure that the curriculum is current and aligned with industry practices.
- ☐ Implement "train the trainer" programs to update instructors' semiconductor knowledge, enhance their expertise, or provide retraining in relevant specializations.

■ Long term (1-5 years)

- ☐ Organize career orientation programs for high school students focused on semiconductors, introducing job opportunities, and highlighting the value to the economy and national standing, thereby encouraging students to consider a career in the semiconductor industry.
- ☐ Conduct summer boot camps for high school students to provide general knowledge and hands-on experience with projects related to electronics, semiconductors, and testing.
- ☐ Government scholarships should be provided to support talented students in pursuing Master's and PhD degrees in ATP and IC design abroad. Simultaneously, local postgraduate training programs should be strengthened by incorporating advanced curricula from esteemed higher education institutions (HEIs) in countries such as the United States, Taiwan, South Korea, and Japan.

2. Recommendations for Industry - Education collaboration

- Regular communication channels should be established and maintained between industry and education to ensure proactive cooperation that aligns training outcomes with the actual needs of the semiconductor industry.
- That said, it is important to keep in mind that the business processes, technological settings, and requirements are different for different companies. No training program will be able to satisfy the diverse and unique needs of all IC design companies or ATP companies. Companies will (have to) continue to provide on-the-job training to graduate engineers and technicians regardless. Good training programs through close industry - education collaboration, however, will help to reduce the on-the-job training time.
- Besides technical knowledge and competencies, work ethics and business skills (such as effective communications, problem solving, and critical thinking) are critical traits that industry partners value (as evidenced in the Taiwan case study and from exchanges with stakeholders at our workshops).
- Collaboration models between industry and educational institutions can include:
 - ☐ Sponsorship of machinery and equipment
 - ☐ Sponsorship of scholarship programs, internships, and company/factory visits
 - ☐ Businesses sending experts to co-develop curricula and teach relevant content.
 - ☐ Implementing collaborative research programs to tackle practical challenges of semiconductor companies.



B RECOMMENDATIONS

3. Recommendations for policymakers (MPI, MOST, MOET, MOLISA and local governments)

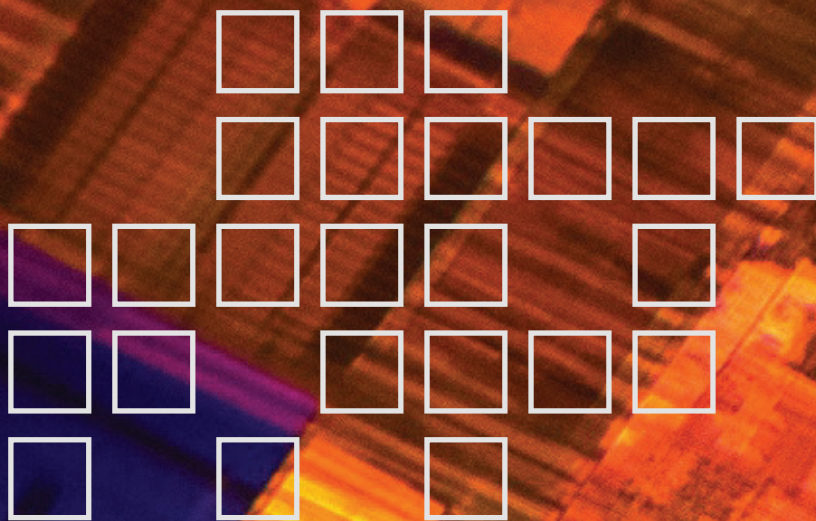
- Utilize research funding to support projects focused on developing new products and expand the scope to include products from foreign direct investment (FDI) in non-traditional sectors.
- Initially, fund personnel to pursue postgraduate training abroad in semiconductor-related fields using government budgets.
- There should be no requirement for a commitment to return to Vietnam; however, recipients must commit to introducing at least two additional scholarships for other students in semiconductor-related programs. If this commitment is not met, the recipient must reimburse twice the cost of their training.
- There should be more participation of the vocational training colleges (3-year degree programs) in the national semiconductor strategy and related programs as they provide the workforce with more practical skills and shorter training than university graduates.
In accordance with more participation of vocational training colleges, there should be more engagement in policy discussions and implementations of the Ministry of Labors, War Invalids and Social Affairs (MOLISA) which oversees over 300 vocational training colleges and centers nationwide.
- There needs a strategy to attract repatriation and contribution of the overseas Vietnamese entrepreneurs and professionals in the semiconductor industry. Besides attractive remuneration packages, such a strategy may want to focus on transformative policies to attract FDI (through more transparent and liquid capital markets) for the semiconductor industry and crafting a compelling narrative of Vietnam's industrial renaissance that can generate global interest.

4. Recommendations for ATP Occupation Shortages (MOET, universities, technical colleges)

- Develop upskilling training courses in ATP for engineers from related fields. These programs should be designed to meet high-quality standards and undergo quality assurance from a reputable organization. Ideally, the certification could come from an authorized entity in Vietnam or a recognized training institution in the United States, ensuring that the courses are both relevant and credible.
- To address the shortage of skilled personnel in key occupations, it is crucial to identify educational institutions with strong capacity to provide targeted training for the market. The institutions best equipped for this task are those with robust programs in high-demand fields, such as engineering, technology, microelectronics, mechanics or automation, both universities and technical colleges or vocational schools. These institutions are well-positioned to offer targeted training and upskilling programs that align with current and future labor market demands, addressing shortages across various sectors.
- To strengthen the semiconductor industry in Vietnam, it is essential to develop a comprehensive strategy that supports specialized training programs aimed at enhancing the role of Vietnamese vocational schools and exploring the potential of continuing education centers.
- While many Vietnamese vocational schools and continuing education centers are making strides in training the workforce for the semiconductor industry, there are several gaps that still need to be addressed to align these institutions more effectively with industry requirements.
- To effectively close the gap between current semiconductor training programs in Vietnamese vocational schools and the industry's evolving needs, several targeted curriculum changes are necessary. These changes should focus on both foundational knowledge and specialized skills to ensure graduates are well-prepared for the demands of the semiconductor industry.
- The government can support semiconductor training in Vietnam by funding modern facilities, fostering industry-academia partnerships, and ensuring curriculum alignment with global standards. Incentives for collaboration, international certifications, and continuous education programs can bridge skills gaps, while policies promoting talent development and retention will help build a competitive workforce in the semiconductor industry.

V ■ Conclusion





Vietnam's ambition to become a semiconductor industry player has drawn significant attention, yet this report reveals several foundational gaps that must be addressed to realize these aspirations. The findings illustrate that while there is a growing demand for semiconductor skills, Vietnam's educational institutions lack a dedicated and holistic semiconductor program. The current infrastructure is insufficient for producing industry-ready engineers, leaving companies to shoulder part of the training costs for new hires. However, the underlying educational framework is sound and promising, as necessary foundational skills can be gleaned from related fields such as Information and Communication Technology (ICT), Electrical and Electronics Engineering, and Mechanical Engineering.

Vietnam's semiconductor workforce development requires a multi-pronged approach to improve infrastructure, curricula, and industry-academia-government collaboration. Universities lack modern facilities that enable hands-on experience in semiconductor technologies, meaning graduates often lack the practical skills required by the industry. Collaborative short-term upskilling and cross-training programs with foreign institutions, especially those from the U.S., offer a valuable opportunity for Vietnam to close this skills gap. Moreover, foreign institutions (in the US and Taiwan) are eager to assist Vietnam in enhancing the skill set of trainers through "train-the-trainer" programs, enabling these trainers to develop and refine semiconductor curricula domestically.

The report's mapping of semiconductor roles to current educational majors serves as a guide for Vietnamese universities to adjust their curricula and integrate more semiconductor-specific content, particularly in disciplines related to ATP (Assembly, Testing, and Packaging) and IC (Integrated Circuit) design to better meet the demands of the industry.

Key Recommendations



Avoid Investment in Chip Fabrication: The high costs associated with establishing chip fabrication facilities make it an impractical investment for Vietnam. The country's resources would be better allocated toward sectors that promise more immediate returns, such as ATP and IC design. Advanced packaging technologies represent a feasible and profitable entry point in the global semiconductor value chain, aligning with Vietnam's strengths in low-cost, adaptable labor.



Attract Foreign Direct Investment (FDI) for ATP: Vietnam should focus on drawing FDI into ATP operations, leveraging its lower labor costs to attract foreign companies. The availability of a high-quality but affordable workforce makes Vietnam an attractive destination for packaging, testing, and assembly processes. Prioritizing FDI with advanced packaging capabilities will allow Vietnam to build a competitive advantage in this sector. Additionally, the ATP sector's labor-intensive nature aligns well with Vietnam's existing workforce, which can be upgraded through targeted training.



Increase Outsourced IC Design Roles: The IC design segment represents a high-value opportunity with significant global demand. To capitalize on this, Vietnam should proactively seek partnerships and outsourced projects from international IC design firms. Engaging Vietnamese firms in IC design outsourcing allows for skill transfer, builds local capacity, and positions Vietnam as a reliable partner in the global semiconductor value chain.



Strengthen Collaboration Between Industry, Educators, and Government: Building a cohesive semiconductor workforce will require closer partnerships between educational institutions, industry players, and the government. This report emphasizes that by integrating real-world projects into academic programs, Vietnamese graduates will better understand the industry's practical requirements and be more prepared to transition directly into the workforce. Programs that bring industry projects to academia will provide students with hands-on experience, making them job-ready upon graduation.



Enhance Semiconductor-Specific Training and Facilities: Establishing specialized training for semiconductor roles, particularly in ATP and IC design, will be essential to reduce the industry's current reliance on costly in-house training. This should involve upskilling engineers from related fields through short, intensive courses designed to meet industry standards. Partnerships with international organizations for curriculum development, as well as accreditation for training programs, will help elevate Vietnam's semiconductor workforce to global standards.



Implement "Train-the-Trainer" Programs: Vietnam's academic institutions face a shortage of faculty members with practical experience in semiconductor technologies. By leveraging international partnerships, Vietnam can upskill its instructors, who can then transfer these skills to future generations of engineers. Notably, several U.S. institutions have expressed willingness to offer training to Vietnamese trainers, a vital step toward creating a sustainable, locally driven semiconductor education ecosystem.



Encourage Policy Reforms to Support the Workforce Strategy: Effective workforce development in the semiconductor industry requires government involvement in fostering a supportive ecosystem. Policies that incentivize partnerships between academia and industry, such as funding for R&D and joint training programs, are critical. Additionally, policies that attract top Vietnamese talent from overseas would further strengthen the domestic workforce, bringing both technical expertise and global perspectives into the Vietnamese semiconductor industry.

Vietnam's potential to become a semiconductor industry leader rests on addressing workforce development needs with strategic, targeted actions. This report reveals that Vietnam is well-positioned to excel in ATP and IC design—segments that align with its current economic strengths. However, without substantial improvements in training infrastructure, industry-academic collaboration, and policy support, Vietnam risks losing out on this valuable opportunity. The recommendations provided herein serve as a roadmap for building a semiconductor workforce that is not only equipped for the industry's current needs but also adaptable to future innovations.

Appendix

Appendix 1.

Research Method and Data Collection

Research Method

This report is conducted by qualitative research methods with both primary sources (interviews, discussions, field trips and observations) and secondary data sources (previous studies, government reports, organizations' publications, reliable media).

Data Collection

Primary data sources include

- 20 interviews (direct and via telephone) from March to May 2024.
- 2 workshops organized by the research team in Hanoi and Ho Chi Minh City in March 2024.
- Comments and discussions with experts at different meetings, seminars, workshops from October 2023 to October 2024.
- 1 field trip to Taiwan and 1 field trip to the US in June 2024.

Experts and organizations that participated in interviews, workshops, comments, discussions, field trips:

- Firms
 - Vietnamese: Viettel, FPT
 - Foreign: Intel, Marvell, Amkor, Hana Micron, Faraday
- Educational institutions
 - Vietnamese
 - ▶ Universities (5 Universities in Appendix 4 and most universities in Appendix 5).
 - ▶ Technical/vocational colleges:
 - ▷ Viet Han Technical College
 - ▷ Cao Thang Technical College
 - Foreign
 - ▶ NYCU
 - ▶ ITSC
 - ▶ TSRI
 - ▶ MUST
 - ▶ UCSD
 - ▶ ASU
 - ▶ Purdue
 - Governments
 - ▶ MIC, MPI, MOST, MOET
 - ▶ HCMC

Appendix 2.

Table III.A: National Workforce Development Plan for the Semiconductor Industry until 2030

	ATP (both engineers & technicians)		IC design	
	2024	2030	2024	2030
Base case	6.000	16.400	5.575	8.200
Middle case	6.000	24.500	5.575	9.500
High case	6.000	35.500	5.575	14.700

Source: MPI

Appendix 3.

Table III.B: IC design companies in Viet Nam

Company	Sector	Location	Origin
FPT	Design	HCM	Vietnam
Viettel	Design	Hanoi	Vietnam
F-Soft	Design, R&D	HCM, Hanoi	Vietnam
ICDREC	Design	HCM	Vietnam
Wavelet	Design	Hanoi	Vietnam
VNCHIP	Design & Packages	HCM	Vietnam
Renesas	Design	HCM	Japan
CM Engineering Vietnam	Design	HCM, Da Nang	Japan
Applistar Corporation	Design	Hanoi	Japan
Faraday	Design	HCM	Taiwan
GUC	Design	HCM	Taiwan
Realtek	Design	HCM	Taiwan
Infineon	Testing, R&D, Design	Hanoi	Germany
Synopsys	EDA Tool & Design	HCM	USA
Ampere	Design	HCM	USA
Marvell	Design	HCM	USA

Appendix 3.

Table III.B: IC design companies in Viet Nam

Company	Sector	Location	Origin
DreamBig	Design	HCM	USA
Signet Design Solutions Co	Design	HCM	USA
Savarti	Design	HCM, Da Nang	USA
Synapse	Design	HCM, Da Nang	USA
Uniquify	Design	HCM	USA
Microchip	Design	HCM	USA
Sitrus	Design	HCM	USA
Inphi	Design	HCM, Da Nang	USA
Dolphin Technology	Design	Hanoi	USA
Cadence	Design	HCM	USA
Top-Vu Technology Inc	Design	Hanoi	USA
AWAH JSC Company	Design, R&D	HCM	South Korea
FingerVina	R&D	Hanoi	South Korea
BOS	Design	HCM	South Korea
Semi Five	Design	HCM	South Korea
ADTechnology	Design	HCM	South Korea
Coasia	Design	Hanoi	South Korea
Hanatec	Design	HCM	South Korea
Coasia	Design	Hanoi	South Korea
Qorvo	Design	Hanoi	USA
Bridgetek	Design	HCM	Singapore

Source: Ngo Tien Thinh, Dissertation, Fulbright University Vietnam, FSPPM graduate student MPP24 (2024)

Appendix 4.

Table IV.1. Current Status of Semiconductor Training at 5 Leading Universities

University	No. of Students	No. of Faculty (PhD Level)	Key persons	Semiconductor-related Course	Course Credit	Training History
Vietnam National University Hanoi (VNU-Hanoi)	10-15	11	Prof. Chu Duc Trinh	Major: Electronics and Communications Engineering Technology Specialization: Microelectronics and Embedded Systems	37	Since 2007
University of Engineering and Technology			Prof. Tran Xuan Tu Assoc.Prof. Bui Thanh Tung Dr. Nguyen Kiem Hung Dr. Bui Duy Hieu	Introduction to Embedded Systems	3	
				Digital Design and Microprocessor	3	
				Electronics Devices	3	
				Analog Electronics	3	
				Digital Electronics	3	
				MEMS Technology	3	
				Analog integrated circuit design	3	
				Digital integrated circuit design	3	
				System on Chip Design	3	
				Fundamentals of microelectronic fabrication and packaging	3	
				Analog Electronics Lab	2	
				Digital Electronics Lab	2	
				Electromagnetics Engineering	3	
Hanoi University of Science and Technology (HUST)	190	25	Assoc.Prof. Nguyen Duc Minh Prof. Chu Manh Hoang Prof. Vu Ngoc Hung	Major: Microelectronic Engineering and Nanotechnology	51	
				Programming design for microelectronics engineering	3	
				Microelectronic Circuits	2	
				Semiconductor Physics and Devices	3	
				Semiconductor Manufacturing Technology	3	
				Analysis and Design of Digital-Analog Integrated Circuits	3	
				Clean Room Technology	2	
				Fundamental of Microelectronic packaging	2	
				Technology for very large-scale integration	2	
				Semiconductor manufacturing and process control	2	
				Semiconductor Optoelectronics	2	
				Electronic Materials	3	
				Integrated Microelectronic Devices	3	
				Digital and Analog Electronics	3	
				Simulation of microelectronic devices	2	
				Introduction of Microelectronic Engineering and Nanotechnology	3	
				Electronic Materials	3	
				Programming design for microelectronics engineering	2	
				Integrated Microelectronic Devices	3	
				EM field for microelectronics	3	
				Nanotechnology for Microelectronics	2	
Vietnam National University Ho Chi Minh City (VNU-HCM)	270	19			41-45	
University of Natural Sciences	120	6	Assoc.Prof. Le Duc Hung Dr. Bui Trong Tu	Major: Electronics and Communications Engineering (Bachelor of Science) Specialisation: Microelectronics	41	Since 2008
				Digital Logic Design	3	
				Electronics Device Physics	3	
				Signal, System and Circuit Analysis	3	
				Electronic Circuit Techniques	3	
				Analog Electronics	3	
				Digital Electronics	2	
				Analog and Digital Electronics Lab	1	
				VLSI Design + Lab	3	
				MEMS , NEMS and Nano Electronics	2	
				Analog integrated circuit design + lab	3	
				Digital integrated circuit design + lab	3	

Appendix 4.

Table IV.1. Current Status of Semiconductor Training at 5 Leading Universities

University	No. of Students	No. of Faculty (PhD Level)	Key persons	Semiconductor-related Course	Course Credit	Training History
				System on Chip Design and Design Verification + lab	3	
				Scripts for Automation VLSI Designs + lab	3	
				Intelligent Integrated Systems	3	
				Internship	3	
				Major: Electronic Engineering (Master of Science)	24	Since 2007
				Specialisation: IC Design and Microelectronics		
				Advanced IC Design	4	
				Advanced Analog and Mixed Signal IC Design	4	
				SoC Design	4	
				MEMS Design	4	
				Device Modeling and Integrated Circuit Simulation	4	
				DSP Hardware Design	4	
University of Technology (UT)	80	5	Dr. Tran Hoang Linh Dr. Huynh Phu Minh Cuong Dr. Nguyen Ly Thien Truong	Major: Electronics and Telecommunications Engineering Specialization: Microelectronics	45	
				Semiconductor Physics	4	
				Digital Designs	3	
				Electronic Circuits	3	
				Microprocessor	3	
				Electronic Workshop 1 & 2	2	
				Embedded System Design	3	
				IC Design	3	
				Embedded System Programming	3	
				Digital Signal Processing on FPGA	3	
				Computer Architecture	3	
				Digital IC Design	3	
				Analog and Mixed Signal IC Design	3	
				Electronics Circuits for Communications	3	
				Microwave Engineering	3	
				Antennas and Radio Wave Propagation	3	
The University of Danang (UD)	50	5	Dr. Huynh Viet Thang Dr. Vo Tuan Minh Dr. Nguyen Van Cuong	Do not have Semiconductor-related Specialization	34	
				Electronic Circuits	3	
				Electronic Circuit Theory 1 & 2	5	
				Digital Engineering	3	
				Antenna and Wave Propagation	3	
				PBL 2: Electronic Circuit Design	3	
				Microprocessor	3	
				Computer Architecture	2	
				Hardware description language and FPGA	3	
				Embedded Systems	3	
				VLSI Technology	3	
				IC Design	3	
Posts and Telecommunication Institute of Technology (PTIT HN & HCM)	70	10	Dr. Nguyen Ngoc Minh Dr. Nguyen Trung Hieu Dr. Truong Cao Dung	Major: Electronics and Telecommunications Engineering Specialization: Microelectronics	50	Since 2023
				Electronic Devices	3	
				Digital Electronics	3	
				Electronic Measurement	2	
				Analog electronics	3	
				Electronic circuit theory	3	
				Computer Architecture	3	
				Power electronics	3	
				Digital system design	3	
				Electronic circuit project	2	
				Embedded systems	3	
				Embedded systems project	2	
				VLSI design	2	
				Digital system project	2	
				Digital IC Design	3	
				Advanced electronic design	2	
				Topics on Semiconductor Technology	2	
				Analog IC Design	3	
				RF IC Design	2	
				Mixed-signal IC Design	2	
				Fundamentals on micro stripline and ID packaging	2	

Appendix 5.

18 public universities being invested to develop semiconductor laboratories

As part of the program "Development of Human Resources for the Semiconductor Industry by 2030, with Orientation Towards 2050," approved by the government on September 21, funding will be allocated for equipment and licensed software to establish, upgrade, and modernize semiconductor laboratories at 18 public universities in the table below. The list of universities may be adjusted based on their actual conditions and proposal submissions.

No	University
1	Vietnam National University, Hanoi (University of Natural Sciences)
2	Vietnam National University, Ho Chi Minh City (University of Information Technology)
3	University of Danang
4	Hanoi University of Science and Technology
5	Thai Nguyen University
6	Hue University
7	Military Technical Academy
8	Posts and Telecommunications Institute of Technology
9	University of Transport and Communications
10	University of Science and Technology of Hanoi
11	Hanoi University of Industry
12	Vinh University
13	Can Tho University
14	Ho Chi Minh City University of Industry
15	Ho Chi Minh City University of Technology and Education
16	Vietnamese-German University
17	Electric Power University
18	Academy of Cryptography Techniques

Appendix 6.

Table V.2. KSA Matrix for Job Positions in Design, ATP and SME in semiconductor in Vietnam

SKILLS ➡		SKILLS																					
		Device Operations & Characteristics		Logic Circuit	Analog Circuit	Mixed Signal Circuit	Physical Design	RF Circuits	SoC, ASIC, FPGA, SIP, SSD	HDL/HVL, Circuit Simulators	Programming Lang & Applied Math	Co-simulation & System Emulator	Board Design & Layout	Signal Integrity and High speed design	Performance validation	Electrical, Optical, Thermal and Mechanical	Electronic Parasitic Extraction and Simulation	FEM & CFD	Data Analysis	Statistics	Design of Experiment	Neural Networks/Deep learning	Programming Languages
		Device Concepts & Circuit Design		System Design, Verification, Simulation Tools					Validation and Application		Modeling and Simulation		Experimentation		AI/ML Concepts								
Chip Design	Product Architect	Critical		Critical					Desired		Critical		Desired		Not Required								
	Roadmap Development Manager (Design)	Desired		Desired					Not Required		Desired		Desired		Not Required								
	Digital Design Engineer	Critical		Critical					Not Required		Desired		Critical		Desired								
	Analog/RF Circuit Design Engineer	Critical		Critical					Desired		Desired		Critical		Not Required								
	Test Engineers	Critical		Desired					Critical		Desired		Desired		Desired								
	Product Engineer	Critical		Critical					Desired		Desired		Desired		Not Required								
	Application Engineers	Desired		Desired					Critical		Desired		Desired		Not Required								
	Layout/CAD Engineer	Desired		Desired					Not Required		Not Required		Not Required		Not Required								
	Systems Engineer (Design)	Desired		Critical					Desired		Desired		Desired		Not Required								
Field Application Engineer	Not Required		Desired					Critical		Not Required		Not Required		Not Required									
Sup port	Firmware Engineer	Desired		Not Required					Desired		Not Required		Desired		Desired								
	Software Engineer/Developer	Not Required		Not Required					Not Required		Not Required		Desired		Desired								
Biz & GM	Program Managers	Not Required		Not Required					Not Required		Not Required		Desired		Not Required								
	Data Scientist	Not Required		Not Required					Not Required		Desired		Desired		Critical								
	Business Development	Not Required		Not Required					Not Required		Not Required		Critical		Not Required								
	HR & WF Dev	Not Required		Not Required					Not Required		Not Required		Not Required		Not Required								
	Finance	Not Required		Not Required					Not Required		Not Required		Not Required		Not Required								
Pr oc u	Regulatory & Compliance Manager	Not Required		Not Required					Not Required		Not Required		Desired		Not Required								
	Environmental Affairs	Not Required		Not Required					Not Required		Not Required		Desired		Not Required								
	Procurement Eng	Not Required		Not Required					Not Required		Not Required		Not Required		Not Required								
	Supply Chain Manager	Not Required		Not Required					Not Required		Not Required		Not Required		Not Required								
	Process Architect	Desired		Desired					Not Required		Desired		Desired		Not Required								
ATP & SME Factories	Process Integrators (Team Lead)	Desired		Not Required					Not Required		Not Required		Desired		Not Required								
	Quality, Yield and Reliability Engineers	Not Required		Not Required					Desired		Not Required		Critical		Not Required								
	Operations/Productivity Engineers	Not Required		Not Required					Not Required		Not Required		Desired		Not Required								
	Equipment Engineer	Not Required		Not Required					Not Required		Not Required		Desired		Not Required								
	Facilities	Not Required		Not Required					Not Required		Not Required		Not Required		Not Required								
	Field Service Engineers	Not Required		Not Required					Not Required		Not Required		Not Required		Not Required								
	Process Control	Not Required		Not Required					Not Required		Not Required		Desired		Not Required								
	Process/Mask Engineer	Not Required		Not Required					Not Required		Not Required		Desired		Not Required								
	Optoelectronics Eng	Not Required		Not Required					Not Required		Desired		Critical		Not Required								
	Metrology/Inspection	Not Required		Not Required					Not Required		Not Required		Desired		Not Required								
	Packaging Engineer	Desired		Desired					Not Required		Desired		Desired		Not Required								
	Environmental & Safety Engineer	Not Required		Not Required					Not Required		Not Required		Desired		Not Required								
	Fab Technician	Not Required		Not Required					Not Required		Not Required		Not Required		Not Required								
	Lab Technician	Not Required		Not Required					Not Required		Not Required		Not Required		Not Required								

KSA-Matrix-MAPT-1.xlsx. (part 1)

Appendix 6.

Table V.2. KSA Matrix for Job Positions in Design, ATP and SME in semiconductor in Vietnam

SKILLS ➡		FMEA	Quality & Reliability	Physical & ELectrical Failure Ananlysis	Prog languages (Python, Java, C++, C#, Ruby)	Data structures, Algorithms, Object Oriented Programming	Operating System, Embedded OS	Software Development Life Cycle	Financial Modeling & Simulation	Business strategy development	Company policy and goals development	Regulatory Policies	Talent development and retention	Semiconductor	Physics	Environmental Science	Chemistry	Electronic Materials	Litho	Wet Etch	Dry Etch	CMP	Implant	PVD/CVD
		Failure Analysis		Software Development				Business Dev. and Analytics		Team & Organizational		Semiconductor Processes & Fundamentals												
		Not Required	Desired	Desired				Desired		Not Required		Desired												
Chip Design	Product Architect	Not Required	Desired				Desired		Not Required		Not Required		Desired											
	Roadmap Development Manager (Design)	Not Required	Not Required				Not Required		Not Required		Not Required		Not Required											
	Digital Design Engineer	Desired	Desired				Not Required		Not Required		Not Required		Desired											
	Analog/RF Circuit Design Engineer	Desired	Not Required				Not Required		Not Required		Not Required		Desired											
	Test Engineers	Desired	Desired				Not Required		Not Required		Not Required		Not Required											
	Product Engineer	Desired	Desired				Not Required		Not Required		Not Required		Desired											
	Application Engineers	Desired	Desired				Not Required		Not Required		Not Required		Not Required											
	Layout/CAD Engineer	Not Required	Not Required				Not Required		Not Required		Not Required		Desired											
	Systems Engineer (Design)	Not Required	Desired				Not Required		Not Required		Not Required		Not Required											
	Field Application Engineer	Not Required	Desired				Not Required		Not Required		Not Required		Not Required											
Support	Firmware Engineer	Not Required	Critical				Not Required		Not Required		Not Required		Not Required											
	Software Engineer/Developer	Not Required	Critical				Not Required		Not Required		Not Required		Not Required											
	Program Managers	Not Required	Not Required				Desired		Critical		Desired		Desired											
Biz & GM	Data Scientist	Not Required	Critical				Not Required		Not Required		Not Required		Not Required											
	Business Development	Not Required	Not Required				Critical		Desired		Desired		Not Required											
	HR & WF Dev	Not Required	Not Required				Desired		Critical		Not Required		Not Required											
	Finance	Not Required	Not Required				Desired		Not Required		Not Required		Not Required											
	Regulatory & Compliance Manager	Not Required	Not Required				Not Required		Not Required		Not Required		Desired											
Procurement	Environmental Affairs	Not Required	Not Required				Not Required		Not Required		Not Required		Desired											
	Procurement Eng	Not Required	Not Required				Not Required		Not Required		Not Required		Desired											
	Supply Chain Manager	Not Required	Not Required				Desired		Desired		Desired		Desired											
ATP & SME Factories	Process Architect	Not Required	Not Required				Not Required		Not Required		Not Required		Critical											
	Process Integrators (Team Lead)	Desired	Not Required				Not Required		Not Required		Not Required		Critical											
	Quality, Yield and Reliability Engineers	Critical	Not Required				Not Required		Not Required		Not Required		Desired											
	Operations/Productivity Engineers	Not Required	Not Required				Not Required		Not Required		Not Required		Not Required											
	Equipment Engineer	Desired	Not Required				Not Required		Not Required		Not Required		Desired											
	Facilities	Not Required	Not Required				Not Required		Not Required		Not Required		Desired											
	Field Service Engineers	Not Required	Not Required				Not Required		Not Required		Not Required		Desired											
	Process Control	Not Required	Not Required				Not Required		Not Required		Not Required		Desired											
	Process/Mask Engineer	Desired	Not Required				Not Required		Not Required		Not Required		Critical											
	Optoelectronics Eng	Not Required	Not Required				Not Required		Not Required		Not Required		Not Required											
	Metrology/Inspection	Not Required	Not Required				Not Required		Not Required		Not Required		Desired											
	Packaging Engineer	Desired	Not Required				Not Required		Not Required		Not Required		Desired											
	Environmental & Safety Engineer	Not Required	Not Required				Not Required		Not Required		Not Required		Desired											
	Fab Technician	Desired	Not Required				Not Required		Not Required		Not Required		Desired											
	Lab Technician	Not Required	Not Required				Not Required		Not Required		Not Required		Desired											

KSA-Matrix-MAPT-1.xlsx. (part 2)

Appendix 6.

Table V.2. KSA Matrix for Job Positions in Design, ATP and SME in semiconductor in Vietnam

SKILLS →		Operations planning	Demand Planning	Inventory Management	Design for availability	Optical Microscopy	SEM	AFM	Ebeam, Brightfield/Darkfield tools	Equipment Design & Maintenance	Vacuum installation and maintenance	Read & Understand Electrical drawings	Sort, Assembly & Test Power Delivery, Signal Integrity & Heat Transfer	Metrology	Mechanics of Materials	Factory Planning	Production Line automation	Factory Optimization	Mechanics and Materials
		Supply Chain Concepts				Metrology & Inspection				Semiconductor Equipment			Advanced Packaging			Automation and Robotics			
		Desired	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
Chip Design	Product Architect	Desired	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Roadmap Development Manager (Design)	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Digital Design Engineer	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Analog/RF Circuit Design Engineer	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Test Engineers	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Product Engineer	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Application Engineers	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Layout/CAD Engineer	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Systems Engineer (Design)	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Field Application Engineer	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
Support	Firmware Engineer	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Software Engineer/Developer	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Program Managers	Desired	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
Biz & GM	Data Scientist	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Business Development	Desired	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	HR & WF Dev	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Finance	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Regulatory & Compliance Manager	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
Procurement	Environmental Affairs	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Procurement Eng	Critical	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
ATP & SME Factories	Supply Chain Manager	Critical	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Desired	Not Required	Not Required	Not Required
	Process Architect	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Critical	Not Required	Not Required	Not Required	Not Required	Not Required	Critical	Not Required	Not Required	Not Required
	Process Integrators (Team Lead)	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Desired	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Quality, Yield and Reliability Engineers	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Operations/Productivity Engineers	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Desired	Not Required	Not Required	Not Required	Not Required	Not Required	Critical	Not Required	Not Required	Not Required
	Equipment Engineer	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Not Required	Not Required	Not Required	Critical	Not Required	Not Required	Not Required
	Facilities	Not Required	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Critical	Not Required	Not Required	Not Required	Not Required	Not Required	Critical	Not Required	Not Required	Not Required
	Field Service Engineers	Not Required	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Critical	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Process Control	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Desired	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Process/Mask Engineer	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Optoelectronics Eng	Not Required	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Metrology/Inspection	Desired	Critical	Critical	Critical	Critical	Critical	Critical	Critical	Critical	Critical	Critical	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Packaging Engineer	Not Required	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Not Required	Not Required	Not Required	Critical	Critical	Critical	Critical	Not Required	Not Required	Not Required
	Environmental & Safety Engineer	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	Fab Technician	Not Required	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Desired	Not Required	Not Required	Not Required	Desired	Not Required	Not Required	Not Required
	Lab Technician	Not Required	Critical	Critical	Critical	Critical	Critical	Critical	Critical	Desired	Desired	Desired	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required

KSA-Matrix-MAPT-1.xlsx. (part 3)

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Case study 1: Taiwan's Educational and Research Ecosystem

Based on the Taiwan field trip by FUV team for the semiconductor industry (June 11-14, 2024).
Objectives. What are the training programs and policies by universities and research labs to equip students with the skills and knowledge the semiconductor industry needs?

Introduction

The semiconductor industry is a cornerstone of global technological development, powering innovations in everything from smartphones to autonomous vehicles. However, the rapid growth of this industry has created a critical shortage of skilled talent, particularly engineers with specialized expertise in semiconductor manufacturing, design, and testing. To meet this growing demand, universities and research institutes play a pivotal role in providing the necessary training programs that equip students with the skills and knowledge required by the semiconductor industry.

This case study explores the training programs and policies implemented by Taiwanese universities and research institutes, focusing on the Taiwan Semiconductor Research Institute (TSRI), National Yang-Ming Chiao Tung University (NYCU), and Minghsin University of Science and Technology (MUST). These institutions, supported by government policies and strong industry collaboration, have developed comprehensive training initiatives designed to meet the semiconductor industry's exacting needs.

Training Programs and Policies at Key Taiwanese Institutions

Taiwan Semiconductor Research Institute (TSRI)

TSRI, a government-funded research institution, provides a range of cutting-edge training programs aimed at equipping both local and international researchers with the skills necessary for semiconductor innovation. Its key programs include:

- **Hands-on Research and Training:** TSRI offers access to advanced research facilities, including clean room labs and specialized equipment. The institute charges users only 10% of the full price to democratize access to these resources, ensuring that talented individuals, regardless of financial means, can engage in high-level research and development.
- **Curriculum Development by Industry Experts:** TSRI's curriculum is regularly reviewed by a committee of industry leaders and academic experts, ensuring that the training content is always aligned with the latest technological developments and market needs.
- **Comprehensive Training Options:** TSRI provides a diverse range of training programs, from week-long intensive courses to extended programs that culminate in certification and equipment proficiency. These programs are designed to build skills in specific areas of semiconductor technology, including wafer fabrication, testing, and packaging.
- **International Collaboration:** In partnership with the International Technology Supply Chain (ITSC), TSRI is launching international programs tailored to the needs of global semiconductor industries. These programs will combine online learning with in-person, hands-on experiences and culminate in joint certifications with National Yang-Ming Chiao Tung University (NYCU).

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These policies and programs ensure that TSRI not only contributes to Taiwan's domestic semiconductor workforce but also attracts global talent, positioning itself as a critical player in the worldwide semiconductor ecosystem.



National Yang-Ming Chiao Tung University (NYCU)

NYCU is another key institution in Taiwan's semiconductor talent pipeline. The university works closely with leading semiconductor companies such as TSMC and MediaTek to design training programs that meet the industry's most pressing needs. Key aspects of NYCU's training programs include:

- **Industry-Driven Curriculum:** NYCU's specialized certificate programs are developed in collaboration with semiconductor giants like TSMC and MediaTek. These programs ensure that students gain relevant skills aligned with current industry demands. The curriculum focuses on both technical knowledge and practical applications, ensuring graduates are job-ready.
- **Vocational Training for Semiconductor Careers:** The International College of Semiconductor Technology (ICST) at NYCU offers a 300-hour vocational training program, which is certified by the university and its industry partners. This program focuses on technical proficiency but also emphasizes the development of soft skills such as work ethic, teamwork, and motivation—qualities that are highly valued by semiconductor employers.
- **Cross-Border Educational Opportunities:** NYCU is also committed to providing opportunities for international students, offering scholarships and cross-border training partnerships. The university has set up an international talent pipeline, particularly for students from Southeast Asia, including Vietnam, to help them gain critical skills and integrate into Taiwan's semiconductor ecosystem.
- **Continuous Curriculum Updates:** The university's curriculum is continuously updated in consultation with industry partners to keep pace with new developments in semiconductor technology, from advanced chip design to manufacturing and testing. These updates ensure that graduates possess the skills that are most in demand in the global semiconductor market.



Minghsin University of Science and Technology (MUST)

Minghsin University has developed a comprehensive set of programs and policies focused on semiconductor training, particularly in semiconductor packaging and testing. Some of its standout initiatives include:

- **Industry-Aligned Programs:** MUST has established the first “Semiconductor Packaging and Testing Production Line” in Taiwan and offers specialized training in this area. Its curriculum is closely aligned with industry needs, ensuring students develop practical, job-ready skills in semiconductor packaging and testing technologies.
- **Hands-On Training and Internship Opportunities:** Students at MUST gain valuable hands-on experience through internships with industry partners. These internships allow students to apply their theoretical knowledge in real-world settings, enhancing their skills and employability upon graduation.
- **Comprehensive Graduate Programs:** MUST offers two master’s degree programs for international students, designed to integrate both academic study and practical work experience. These programs offer flexible pathways: one includes two years of study followed by two years of work experience, while the other offers one year of study followed by three years of work experience. This hands-on, industry-oriented approach ensures that graduates are well-prepared to meet the demands of the semiconductor industry.
- **Government Scholarships and Financial Support:** To attract international students, particularly from Vietnam, MUST offers government-sponsored scholarships that cover tuition fees. Industry partners also provide living stipends, which help alleviate the financial burden on students and encourage greater participation in the semiconductor training programs.
- **Language Proficiency:** Recognizing the importance of Chinese in the semiconductor industry, MUST emphasizes the development of language skills to enable students to integrate more effectively into the Taiwanese semiconductor workforce. Graduates of the university’s programs are expected to be proficient in Chinese, as it is often the primary language used in research and industry settings.

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Government Policies Supporting Semiconductor Talent Development

Taiwan's government plays a crucial role in supporting semiconductor training programs and policies. Several government initiatives have helped create a robust ecosystem for semiconductor workforce development:

- **Government Funding and Investment:** The Taiwanese government allocates significant resources to semiconductor education and research, including annual grants to leading universities such as NYCU, NTHU, NTU, and NCKU. This funding supports both academic research and workforce development programs, underscoring the government's commitment to building a sustainable talent pipeline for the semiconductor industry.
- **Scholarships and International Collaboration:** Taiwan offers scholarships for international students, particularly those from countries like Vietnam, to pursue master's degrees in semiconductor fields at its top universities. This initiative helps attract global talent, particularly from regions with growing semiconductor markets, such as Southeast Asia.
- **Industry Partnerships:** The Taiwanese government has fostered strong partnerships between universities and semiconductor giants such as TSMC, MediaTek, and others. These partnerships ensure that training programs are not only up-to-date with industry needs but also that students have direct access to industry expertise and internship opportunities, further strengthening the pipeline of talent.
- **Workforce Development Initiatives:** Taiwan's workforce development policies emphasize a comprehensive approach, focusing on technical expertise, practical experience, and soft skills. These policies ensure that graduates are not only technically proficient but also possess the interpersonal and problem-solving skills needed to thrive in the semiconductor industry.

Conclusion

Taiwan's universities and research institutes, supported by government policies, have developed comprehensive training programs to equip students with the skills and knowledge required by the semiconductor industry. These programs are characterized by industry-driven curricula, hands-on training opportunities, and strong partnerships between academia, government, and the semiconductor sector. By aligning educational offerings with industry needs and providing substantial financial support, Taiwan has created a robust ecosystem that produces highly skilled semiconductor professionals.

For countries like Vietnam, Taiwan's model offers valuable lessons in building a sustainable semiconductor workforce. By adopting similar strategies, such as investing in education, fostering industry-academic partnerships, and offering targeted scholarships, Vietnam can build its own semiconductor talent pool and position itself as a competitive player in the global semiconductor market.

Case study 2: Addressing the U.S. Semiconductor Workforce Shortage Through University and Research Lab Training Programs

Based on the US field trip by FUV team for semiconductor industry (June 24-28, 2024)

Introduction

The U.S. semiconductor industry is a cornerstone of global technological innovation, driving advancements in consumer electronics, artificial intelligence, telecommunications, and national security. However, as demand for increasingly sophisticated semiconductor technologies grows, the industry is grappling with a critical shortage of skilled workers. To address this challenge, leading universities, community colleges, and research institutions across the U.S. have developed specialized training initiatives aimed at closing the workforce gap and preparing students for careers in semiconductor manufacturing, design, and research.

This case study highlights several key initiatives in the U.S. semiconductor education ecosystem, including those at UC San Diego, Arizona State University (ASU), Purdue University, and community colleges like Maricopa and Ivy Tech. These programs offer diverse pathways to equip students with the necessary technical expertise. By examining these initiatives, this study also offers insights and recommendations for Vietnam, a country that is rapidly expanding its technology and semiconductor sectors, as it faces similar workforce challenges.



UC San Diego (UCSD) – Advanced Labs and Industry-Relevant Training

UC San Diego's Jacobs School of Engineering is at the forefront of training the next generation of semiconductor engineers. The Power Management Integrated Circuit (PMIC) Lab at UCSD provides hands-on training in cutting-edge technologies, including power design, microcontroller integration, and high-current applications. The lab's focus on vertical integration and reducing chip packaging for space optimization is aligned with the latest trends in semiconductor innovation.

Key strengths of UCSD's program include:

- **State-of-the-art research labs:** These labs provide students with access to advanced tools and equipment to work on real-world semiconductor problems.
 - **Industry collaboration:** UCSD partners with major semiconductor companies, allowing students to work on projects that directly address industry needs.
 - **Graduate-focused education:** UCSD's programs cater particularly to master's and Ph.D. students, emphasizing research and high-level technical expertise.
- Recommendation for Vietnam:** Vietnam can benefit from establishing similar advanced training labs within its leading technical universities, emphasizing partnerships with global semiconductor players. Given the rapid growth of the Vietnamese tech sector, facilitating research and development (R&D) capabilities in key areas like power management and chip packaging could attract international companies looking to expand into Southeast Asia.

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Arizona State University (ASU) – A Hub for Semiconductor Education and Workforce Development

ASU's Ira Fulton School of Engineering offers a comprehensive array of semiconductor-focused programs. With partnerships with global industry leaders like TSMC, ASU provides hands-on training in semiconductor fabrication, equipping students with practical experience that directly translates to industry needs. Approximately 200 students each year gain experience in semiconductor manufacturing, ensuring a steady flow of qualified candidates into the workforce.

ASU's flexibility is another strength:

- **Customizable programs:** ASU offers degrees with semiconductor-focused concentrations, allowing students to tailor their education to specific industry demands.
- **Industry-driven curriculum:** Collaborations with companies like TSMC allow ASU to adapt its curriculum to the evolving needs of the semiconductor industry.
- **Global workforce development:** ASU's International Technology and Skills Initiative (ITSI) is expanding workforce training globally, targeting universities and vocational schools in regions like Southeast Asia and Latin America.

Recommendation for Vietnam: Vietnam could create similar collaborations between its top universities and global semiconductor companies to develop localized workforce training programs. Expanding these initiatives to include regional partnerships would help foster a robust semiconductor ecosystem in Southeast Asia and provide cross-border workforce mobility. Additionally, Vietnam could tap into programs like ITSI to enhance its semiconductor education infrastructure.



Maricopa Community College – Bridging the Semiconductor Skills Gap

Maricopa Community College in Arizona offers a model for bridging the skills gap in semiconductor manufacturing. By collaborating with major semiconductor companies like Intel and TSMC, Maricopa has developed a semiconductor training curriculum tailored to meet industry needs. The program includes stackable certificates that allow students to build their qualifications incrementally and gain hands-on experience with advanced tools like robotic arms and programmable logic controllers (PLCs).

The program's strengths include:

- **Hands-on training:** Students gain practical, real-world experience with the same tools and technologies used in semiconductor manufacturing.
- **Industry partnerships:** Intel's involvement ensures that the program stays aligned with current industry standards and provides financial support to keep the curriculum updated.
- **Accessibility:** The hybrid learning model, which combines online and in-person instruction, makes the program accessible to a wider audience.

Recommendation for Vietnam: Maricopa's hybrid learning model, which integrates digital badges and stackable credentials, could be a model for Vietnam's vocational training programs. By offering flexible, modular courses that allow students to gain certifications in stages, Vietnam could rapidly develop a more agile, skilled workforce capable of supporting its growing semiconductor manufacturing sector.

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Purdue University – Leading Innovation in Semiconductor Research and Education

Purdue University's School of Electrical and Computer Engineering (ECE) and the Birck Center for Nanotechnology are key players in semiconductor education and research. Purdue offers a range of programs focused on the entire semiconductor lifecycle, from design to manufacturing. Initiatives like the STARS and SURF programs provide students with hands-on experience and mentorship from industry leaders, preparing them for careers in semiconductor research and development.

Purdue's strengths include:

- **Comprehensive curriculum:** Purdue offers programs that cover digital logic design, microprocessor design, semiconductor packaging, and high-performance computing applications.
 - **Industry partnerships:** Collaborations with companies like Intel, ASML, and SK Hynix ensure that students are exposed to real-world industry practices and cutting-edge technologies.
 - **K-12 outreach:** The SCALE K-12 Microelectronics Program encourages younger students to explore semiconductor technologies, ensuring a pipeline of future talent.
- Recommendation for Vietnam:** Vietnam's universities could adopt Purdue's model of comprehensive, multi-level education in semiconductor technologies. In addition to offering undergraduate and graduate programs, Vietnam could develop outreach programs for high school students to build awareness and interest in semiconductor careers. Collaboration with international companies would further enhance the effectiveness of these initiatives.



Ivy Tech Community College – Training the Semiconductor Workforce

Ivy Tech Community College in Indiana provides specialized training for semiconductor manufacturing through hands-on learning in clean room environments and advanced manufacturing processes. By partnering with Purdue University and semiconductor companies like Intel and SK Hynix, Ivy Tech ensures that its curriculum remains aligned with industry needs.

Key elements of Ivy Tech's approach include:

- **Technical certifications and degrees:** The college offers both short-term technical certifications and longer associate degrees, providing flexible pathways for students to enter the workforce.
- **Clean room training:** Ivy Tech's clean room labs provide essential hands-on training for students, preparing them for roles in semiconductor fabrication and manufacturing.

Recommendation for Vietnam: Vietnam could expand its focus on clean room training and certification programs, which are critical for semiconductor manufacturing. Developing regional training centers that offer hands-on experience in clean room environments would help Vietnam build a skilled workforce capable of supporting semiconductor fabrication plants.

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Key Takeaways and Recommendations for Vietnam

Industry-Academic Collaboration Drives Success: Partnerships between universities, research institutions, and semiconductor companies ensure that training programs are industry-relevant. Vietnam should foster similar collaborations to align its educational initiatives with real-world industry needs.

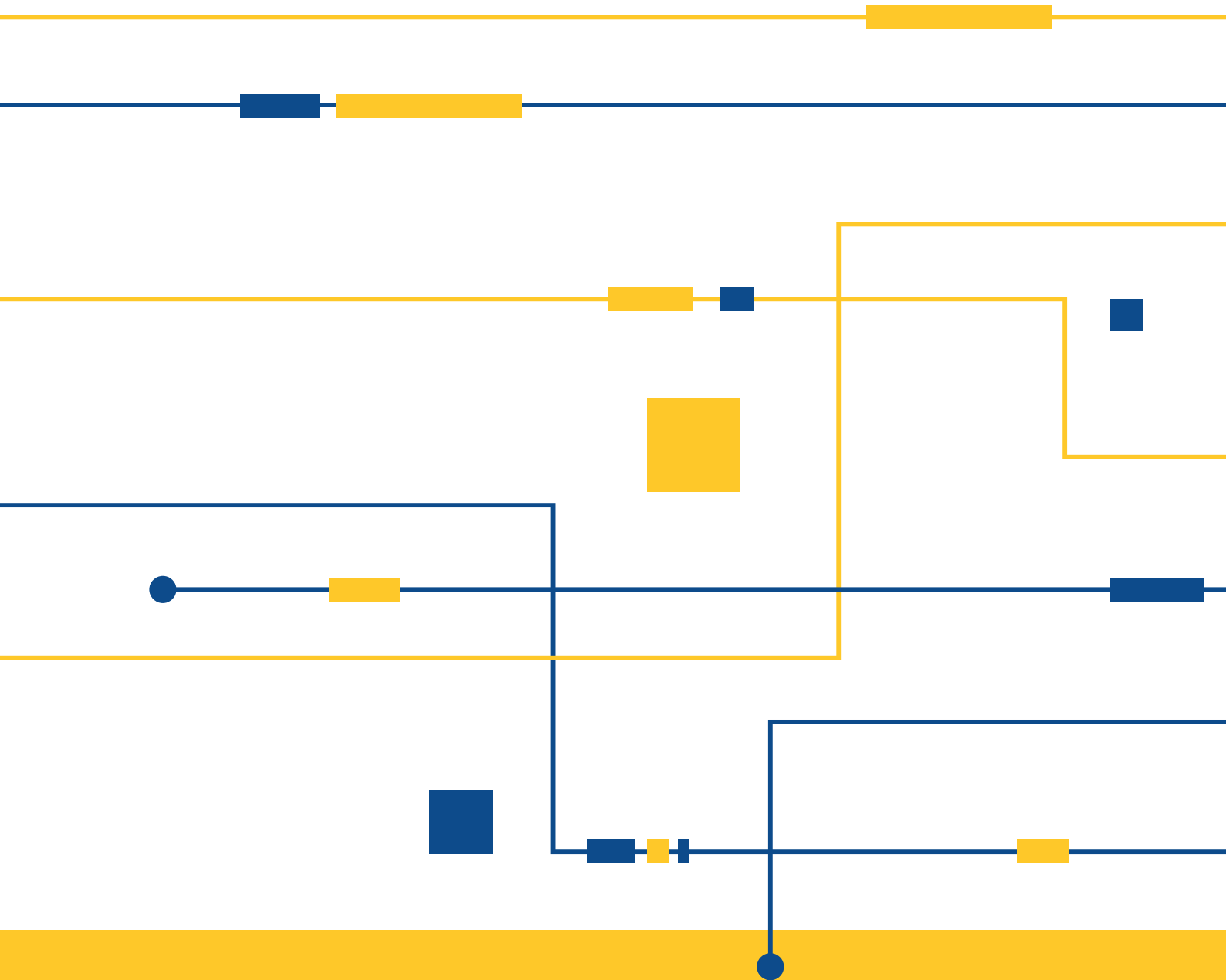
Hands-on, High-Tech Training Labs: U.S. institutions like UCSD and Purdue invest heavily in cutting-edge research labs. Vietnam should invest in building advanced semiconductor labs at universities and vocational training centers to ensure students gain practical experience with state-of-the-art tools.

Flexible, Accessible Education: Programs at ASU and Maricopa Community College offer flexible learning models, including stackable certifications and hybrid training. Vietnam can adopt similar models to provide more access to semiconductor education, particularly for students in remote or underserved regions.

Global Workforce Development: Initiatives like ITSI at ASU and SCALE K-12 at Purdue emphasize global workforce development. Vietnam could participate in international training initiatives and create exchange programs to build a global network of semiconductor professionals.

Targeted Programs for Specialized Roles: Programs like Purdue's Hi-AP and Ivy Tech's clean room training are designed for specialized roles in defense and high-performance computing. Vietnam should develop targeted programs that meet the specific needs of its semiconductor industry, particularly as the country builds new fabrication plants and expands its tech ecosystem.

By taking inspiration from these U.S. initiatives, Vietnam can build a robust semiconductor education and workforce development system, positioning itself as a key player in the global semiconductor supply chain.



Conclusion

The U.S. semiconductor industry is tackling its workforce shortage through a comprehensive array of educational initiatives, driven by leading universities and community colleges. By fostering strategic industry partnerships, offering hands-on training, and delivering cutting-edge curricula, these institutions are producing graduates with the technical skills and practical experience necessary to fuel the future of semiconductor manufacturing and innovation. As global demand for semiconductor talent continues to grow, these programs will play a pivotal role in ensuring that the U.S. remains at the forefront of this critical sector. For countries like Vietnam, the U.S. model provides valuable insights on how to cultivate a skilled workforce capable of supporting a rapidly expanding semiconductor industry.

[1] FUV's Report: Intel Products Vietnam: 10-Year Investment Impact Study Report 2006-2016