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Semiconductors Practice

How semiconductor companies can fill the expanding talent gap

Companies will need to cast a wider net, improve their employee value proposition, and get more out of their existing workforce.

This article is a collaborative effort by Scott Brugmans, Ondrej Burkacky, Katrin Mayer-Haug, Andrea Pedroni, Giulietta Poltronieri, Taylor Roundtree, and Brooke Weddle, representing views from McKinsey's Semiconductors Practice.

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The semiconductor industry is at the center of a high-stakes race amid a broad recognition that chips will be the engine for the next wave of growth and innovation. From South Korea to Germany to the United States, companies have announced plans for massive new factories. In all, close to $1 trillion in investment is expected from 2023 to 2030.[1] This frenzy of global expansion could reshape the industry and disperse the balance of power around the world.

Manufacturing capacity is just one part of the formula, however. Talent will be a critical part of the equation in this evolving industry. Companies must ensure they can attract and retain a sufficient pool of talent to ensure the new capacity under construction can operate at full steam when it starts production. We have noted previously the challenges semiconductor companies face in talent attraction and retention.[2] Yet too few companies and regions have done enough to address the industry's massive shortfall of qualified workers. The convergence of an insufficient number of graduates, an aging workforce, and an industry with a poor perception among candidates means these new capital projects could be delayed or unable to run at full capacity without urgent, coordinated action.

For semiconductor companies, prioritizing talent as a top strategic objective is no longer an option—it's a necessity. Business leaders can pursue a number of actions to make the most of the existing workforce, harness previously untapped pools of workers, and fill the remaining gaps with contingent labor.

Sizing the talent challenge in semiconductors

Even before the current wave of investment, industry demand for qualified candidates had grown by leaps and bounds. Job postings for semiconductor technical roles in the European Union and United States rose at a CAGR of more than 75 percent from 2018 to 2022.[3] If the semiconductor sector does not become more attractive, the resulting talent gap for engineers will be massive: more than 100,000 each in the United States and Europe and upward of 200,000 in Asia–Pacific (excluding China).[4] Major disparities exist among countries in Asia–Pacific: for instance, India is a potential net exporter of engineering talent, while other countries, such as Japan and South Korea, face severe shortages. And since the number of new graduates hasn't kept pace with job openings, the industry faces increasing demand for talent.

The talent challenge extends across the broader ecosystem of semiconductor value chain players. For example, companies designing and manufacturing the complex, capital-intensive equipment to produce chips face similar challenges in achieving growth and adding required capabilities. In turn, the (often midsize) companies supplying individual parts for these machines also struggle to fill the talent gap—since they are typically located outside talent hubs.

Our analysis identified the primary drivers of increased demand for technical talent at semiconductor companies.

The siting of new construction far from existing talent pools

Building new fabs requires the rapid onboarding of multiple roles, including in manufacturing (process engineers and technicians, area operators, and maintenance services), facilities, quality, and industrial engineering. Skilled construction workers (pipefitters, welders, electricians, and carpenters) are also needed.[5]

To date, each region has benefited from the concentration of talent close to existing semiconductor hubs—think Silicon Valley, Taiwan, and "Silicon Saxony" in Germany. New construction in other areas likely won't be so lucky; companies could face the daunting prospect of developing their own semiconductor ecosystems to serve

[1] McKinsey analysis of data from Gartner and the Semiconductor Industry Association (SIA), 2023.
[2] "How semiconductor makers can turn a talent challenge into a competitive advantage," McKinsey, September 7, 2022.
[3] Based on McKinsey analysis of data from the McKinsey Org Analytics data platform.
[4] McKinsey Global Semiconductor Talent Model.
[5] "Strategies for building US semiconductor fabs: Finding skilled labor," McKinsey, February 7, 2023.

as a magnet for talent. These ecosystems matter because highly skilled workers appreciate having multiple employment opportunities and connecting with similarly minded people. A well-developed ecosystem can also spur cross-pollination among companies, serving to disseminate teamwork practices, tools, and culture.

A shift in required skills

Silicon-based semiconductor chips have gotten progressively more powerful for decades, in line with Moore's Law.[6] More recently, the physical limitations of existing materials have sparked a quest for the next wave of leading-edge chips.

Research into new materials (such as silicon carbide and gallium nitride), advanced packaging, specialized ASIC (application-specific integrated circuit) applications, and the increased importance of embedded software have changed the talent profile for semiconductor companies.[7] Artificial intelligence and machine learning have replaced systems architecture as the most critical skills on the European job market in 2022, and the surge of generative AI could further amplify the importance of these skills (Exhibit 1).[8] Knowledge of applications and new materials has also become more relevant over the past few years.

Thanks to these changes, in 2022 the software engineer role (especially embedded software programming) replaced design engineer as the most critical occupation in the European semiconductor industry.[9]

Persistent attraction and attrition issues

Several patterns in the semiconductor industry have created recurring challenges in drawing top talent.

Demographics and the 'gray to green' transition. The industry is staring down a wave of impending retirements. One-third of semiconductor employees in the United States are aged 55 or older.[10] The European Union fares better, with one-fifth of the workforce in this demographic, but it also has a significant proportion of engineering and manufacturing employees close to retirement age.[11] According to the Association of Electrical and Digital Industry (ZVEI) in Germany and the Federation of German Industries (BDI), about one-third of the country's semiconductor workforce will retire in the next decade.[12] The shortfall of STEM graduates to replace these retirees could leave a yawning labor gap.

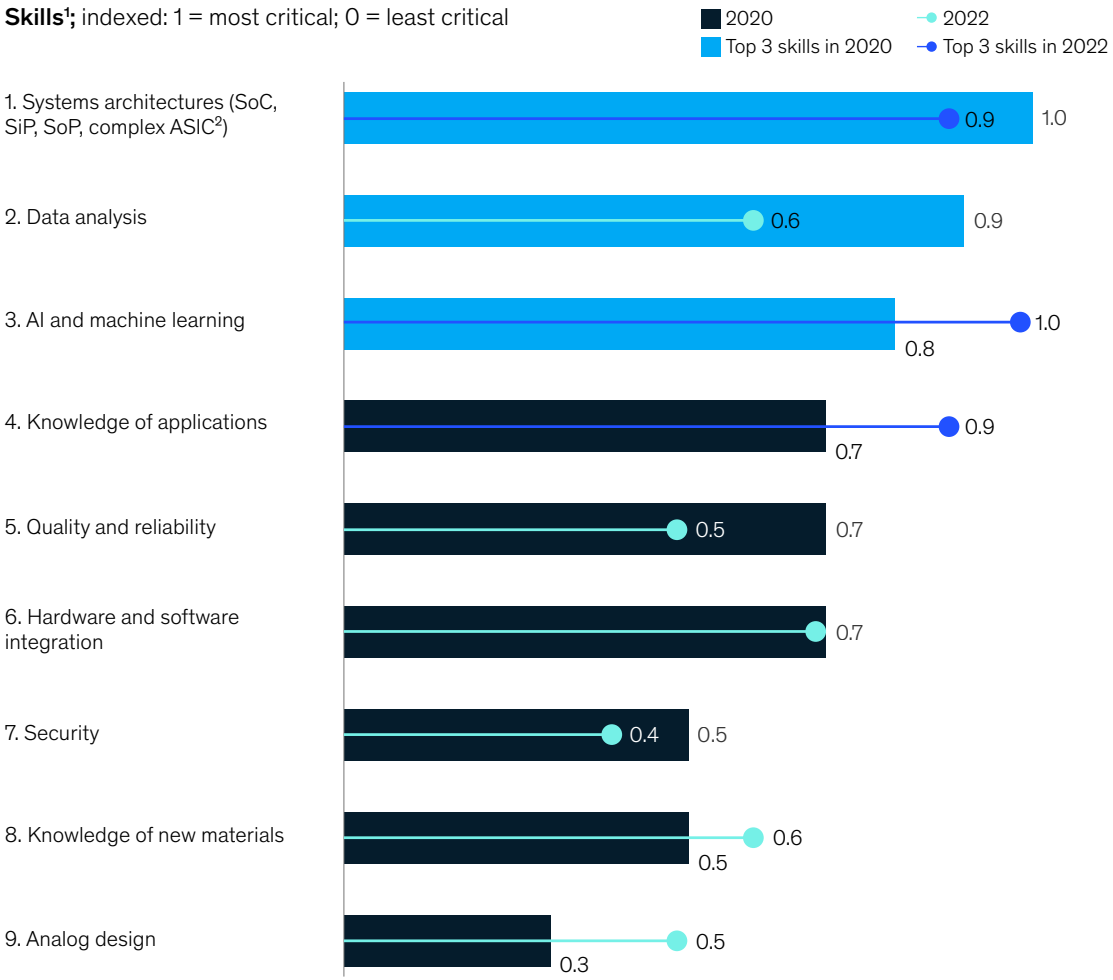
Subpar branding. The semiconductor industry faces a branding and marketing challenge in attracting technology talent. Surveys of both employers and college students indicate a lack of enthusiasm for semiconductor brands. Among senior executives, about 60 percent believe semiconductor companies have weak brand image and recognition compared with other, higher-profile tech companies. Meanwhile, students show more interest in working at consumer-oriented tech companies, which they believe can offer more-exciting jobs, higher compensation, and better development prospects.[13]

Employees with 'itchy feet.' An increasing number of employees in advanced electronics and semiconductors are at least somewhat likely to leave their current job in the next three to six months—53 percent this year versus 40 percent in 2021.[14] These employees cited an absence of career development and advancement (34 percent) and lack of workplace flexibility (33 percent) as

[6] Moore's Law posits that the speed and capability of computers will double every two years thanks to advances in semiconductor capacity.
[7] Léo Saint-Martin, *METIS skills strategy*, SEMI, November 18, 2021; Olivier Coulon, Jean-Charles de La Roncière, and Léo Saint-Martin, *Yearly monitoring report 2022*, SEMI, 2022; Ondrej Burkacky, Marc de Jong, and Julia Dragon, "Strategies to lead in the semiconductor world," McKinsey, April 15, 2022; "Cracking the complexity code in embedded systems development," McKinsey, March 25, 2022.
[8] *METIS skills strategy*, November 18, 2021.
[9] Ibid.
[10] McKinsey analysis of data from the Bureau of Labor Statistics, 2023.
[11] McKinsey analysis of data from Eurostat, 2023.
[12] Sabine Köhne-Finster, Susanne Seyda, and Dirk Werner, *Shortage of skilled workers in professions in the semiconductor industry*, Cologne Institute for Economic Research, March 7, 2023.
[13] "How semiconductor makers," September 7, 2022.
[14] McKinsey Great Attrition/Great Attraction Survey, March 2023, n = 667.

Exhibit 1

AI and machine-learning skills have recently replaced system architecture knowledge on the European job market.



[1]The skills most sought after by companies and those most difficult to find on the European job market.
[2]System-on-a-chip, system in package, system on package, application-specific integrated circuit.
Source: Léo Saint-Martin, *METIS skills strategy*, SEMI, November 18, 2021; *Yearly monitoring report 2022*, SEMI, 2022; McKinsey analysis

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the top reasons for looking for opportunities with another company (Exhibit 2). This is made worse by the fact that many of those who quit don't just quit a company but leave an industry altogether. Indeed, McKinsey's Great Attrition/Great Attraction Survey found that just 36 percent of respondents in industrials who had quit their jobs from April 2020 to April 2022 took another job in the same industry (compared with 45 percent in technology, media, and telecommunications).[15] Other respondents moved to a different industry or did not return to the workforce due to retirement.

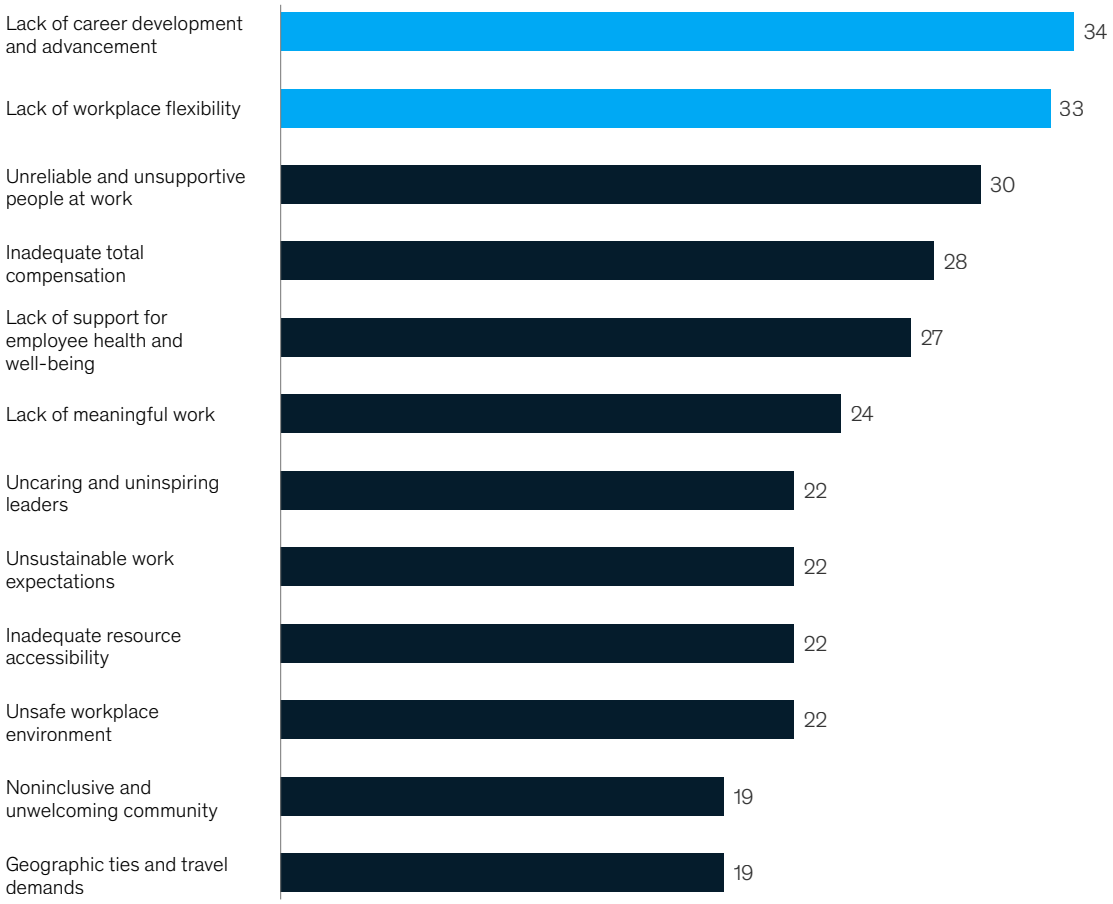
Another challenge for semiconductor companies is that employee satisfaction in the industry still lags behind that of tech and automotive players. The

[15] Aaron De Smet, Bonnie Dowling, Bryan Hancock, and Bill Schaninger, "The Great Attrition is making hiring harder. Are you searching the right talent pools?," *McKinsey Quarterly*, July 13, 2022.

Exhibit 2

In advanced electronics and semiconductors, employees plan to leave jobs in search of career development opportunities and workplace flexibility.

Reasons behind current employees planning to leave, % of respondents[1]



[1]Represents the number of people who selected factors below as top 3 reasons they left their previous jobs.
Source: McKinsey Great Attrition Great Attraction Survey, n = 746

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proximity of a company's business model to software is a contributing factor: for example, workers in foundry, materials, and outsourced semiconductor assembly and test (OSAT) positions report low scores, while those in intellectual property, electronic design automation (EDA), and fabless have the highest employee satisfaction scores.[16]

Key actions to attract and retain semiconductor talent

Despite the uphill battle for tech talent and the widening gaps between supply and demand, semiconductor companies can take several actions to reverse these trends.

[16] "How semiconductor makers," September 7, 2022.

Tackle reasons for current attrition

The past several years have created new expectations among employees for how, where, and when they work. Semiconductor companies that prioritize the fundamentals can ensure their workforce environment meets those expectations.

Reinforce a nontraditional career trajectory for advancement. Many companies take a traditional approach to career paths: when employees distinguish themselves with exemplary work, their reward is becoming a manager and taking on additional responsibilities for their team. It's critical for organizations to recognize that not all high-performing employees aspire to manage people—nor do they all have the people skills needed to excel in these roles.[17] In fact, two-thirds of developers have no ambition to become people managers.[18] To complement traditional people leadership career paths, companies should consider defining an expert path that allows individual contributors to rise through the company ranks. Equally important, companies should seek to be clear about the expectations of managers who lead teams. To ensure that these employees take their people leader tasks as seriously as they do driving content, companies should provide them with the time, training, skills, and tools to do so.

For example, a leading semiconductor company has defined three parallel career paths: management, technical (in which fellow is the highest role), and nontechnical support functions (such as finance, sales and marketing, and HR). This initiative boosted the motivation and overall retention of employees who are interested in career advancement but who want to continue as senior individual contributors. In addition, early talent identification and succession planning play an important role in improving career trajectories and enable companies to develop the future leaders they need to support their growth.

Give power to 'the middle.' Middle managers can find themselves mired in administrative tasks rather than focusing on the work that makes an organization run, such as nurturing talent. On average, just 28 percent of their time is focused on talent and people management.[19] Since they lack the necessary support and resources to manage their teams more effectively, they spend the majority of their time on individual contributor work.

Companies that restructure their organizations to free up middle managers can create "force multipliers," who make their direct reports much better. Actions to support this goal include optimizing team structures and reviewing roles to limit unnecessary layers and processes. Indeed, the top factor contributing to a middle manager's negative experience is organizational bureaucracy, cited by 44 percent of respondents.[20] Companies could also invest in enhancing the people skills of middle managers while improving their overall experience and ensuring they have the right degree of accountability and autonomy. For instance, a McKinsey survey found that providing middle managers with decision-making authority was the top factor in creating a positive environment for them.[21] Ideally, companies regularly review their operating models to ensure that decision-making authority lies in the most optimal position and that interfaces between departments are well defined.

One biotech start-up reviewed its organization and discovered that more than half of its managers had three or fewer direct reports. To optimize its structure, the company increased the number of employees under each manager by transitioning some people managers into expert roles that were better suited to their strengths. These shifts improved the efficiency of more than 200 teams with no reduction in head count.[22]

[17] "Cracking the code on digital talent," McKinsey, April 20, 2023.
[18] Sven Blumberg, Ranja Reda Kouba, Suman Thareja, and Anna Wiesinger, "Tech talent tectonics: Ten new realities for finding, keeping, and developing talent," McKinsey, April 14, 2022.
[19] "Stop wasting your most precious resource: Middle managers," McKinsey, March 10, 2023.
[20] Ibid.
[21] Emily Field, Bryan Hancock, Stephanie Smallets, and Brooke Weddle, "Investing in middle managers pays off—literally," McKinsey, June 26, 2023.
[22] Ibid.

Improve workplace flexibility. Despite the vast changes to workplace schedules and arrangements since the onset of the pandemic, most companies have only begun to scratch the surface for how to adapt to employee expectations. Technology can support a more strategic approach to on-site and remote work, but most organizations are still struggling to strike the right balance in creating true hybrid-work models.[23] Many have mastered basic capabilities, such as advanced workplace technologies that enable synchronous and asynchronous communication seamlessly from anywhere. When it comes to more dynamic practices, companies are missing opportunities to test new work arrangements (such as hybrid) and codify lessons learned, as well as to gauge hybrid versus full-remote experiences. Many still struggle with balancing an employee's desire for remote work with the risk of lower efficiency and a weaker connection to the company and its culture.

However, leaders of hybrid teams will also need to adapt their leadership methods and approaches to successfully lead their hybrid teams compared with fully on-site teams.

Identify and access untapped talent pools

Semiconductor companies could start to address skill gaps by considering several often-overlooked talent pools. For example, women account for only 17 percent of tech roles in the semiconductor industry, compared with 32 percent in social media and 23 percent in industrials.[24] McKinsey's Women in the Workplace research found that women leaders are significantly more likely than men leaders to leave their jobs in pursuit of more flexibility or to work for a company that is more committed to employee well-being and diversity, equity, and inclusion (Exhibit 3).

Our research suggests that, to become more appealing to women, companies could focus on providing work options. The most important factors when employees choose an employer are the opportunity to work remotely and to have greater control over both location and schedules, along with healthcare benefits (including mental-health benefits).[25]

Retired people who would like to work but aren't currently doing so—20 percent of respondents in a recent survey of high-income economies—could also help fill the gap.[26] Out-of-work older adults who are interested in securing a job cite barriers such as the lack of attractive opportunities, difficulties in landing a job, and societal barriers (such as mandatory retirement policies and cultural norms).[27] By defining different paths for older adults with previous experience in the sector, companies could create a fast track to help them reenter the workplace in areas in which they have special competencies (such as semiconductor R&D).

Adapting role requirements to focus on an individual's skills rather than their credentials (such as college degrees)[28] could also help companies find and attract a broader pool of candidates who are better suited to fill these positions in the long term.[29] For example, process engineers in fabs are responsible for process stability and recipe optimization and development, a role that requires knowledge of areas such as quality assurance and statistical control, continuous improvement of processes, and the ability to develop new processes, support new product introduction, and lead process-related customer meetings. In some cases, a former operator's shift leader could have these skills and perform the process engineer role despite not having a degree.

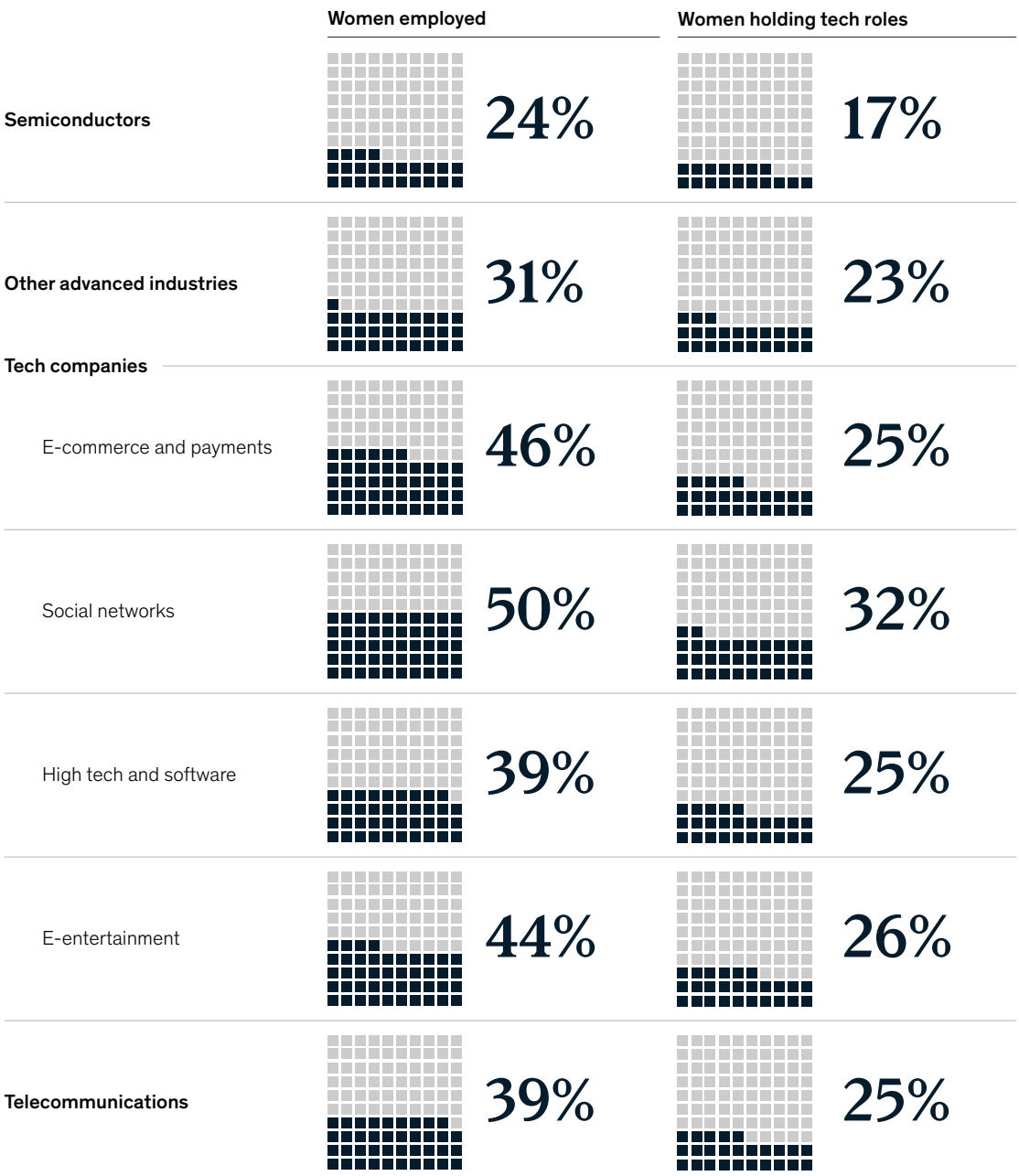
Generative AI could help to accelerate that shift through its capacity to tag abilities in unstructured data—essentially piecing together a candidate's skills based on descriptions of their experience in

[23] Phil Kirschner, Adrian Kwok, and Julia McClatchy, "Is your workplace ready for flexible work? A survey offers clues," McKinsey, June 1, 2023.
[24] Sven Blumberg, Melanie Krawina, Elina Mäkelä, and Henning Soller, "Women in tech: The best bet to solve Europe's talent shortage," McKinsey, January 24, 2023.
[25] "Women in the Workplace 2023," McKinsey, October 5, 2023.
[26] "Age is just a number: How older adults view healthy aging," McKinsey, May 22, 2023.
[27] Ibid.
[28] "Generative AI and the future of work in America," McKinsey Global Institute, July 26, 2023.
[29] "Taking a skills-based approach to building the future workforce," McKinsey, November 15, 2022.

Exhibit 3

Semiconductors lag behind advanced industries, tech companies, and telecommunications in gender balance in Europe.

% of employees, n = >1 million profiles



Source: Analysis of 2022 data from Eightfold AI by McKinsey and Eightfold AI

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previous roles.[30] These capabilities could expand talent pools to include workers in adjacent industrial sectors: for example, workers in clean-room manufacturing (such as chemicals and pharma) and heavy capital equipment (for example, military maintenance and power generation) have skills that are transferable to roles in a fab.

HR vendors are now integrating generative AI into talent acquisition. One global HR technology company uses these tools to generate contextually relevant job descriptions, highlight external and internal candidates who are a good fit, send personal emails, and provide succession planning for high-performing employees. These tools can also identify upskilling and reskilling opportunities and flag employees who could be flight risks.

In general, gen AI can help to elevate the HR function in semiconductor companies. This need is critical, as many companies are seeking to hire unprecedented numbers of new employees quickly, often in locations without existing semiconductor ecosystems.

Enhance storytelling related to semiconductors

The faster pace of technological innovation compels companies to ensure their workforce's skills and capabilities are keeping up. Organizations that make upskilling and continuous learning a part of their culture can gain a recruiting advantage. A focus on career development and well-being can be particularly attractive for a younger workforce. These elements can be promoted in recruitment pitches, storytelling, and online communities to reinforce an organization's commitment to its employees.

Beyond using development opportunities as a recruiting angle, the industry could also collaborate to improve the perception of semiconductors, starting with rebranding (for example, from semiconductors to micro- and nanoelectronics). Moreover, facilitating contacts between universities and semiconductor companies and research centers could increase student exposure to the industry and its career opportunities.

It is also critical to connect the often highly specialized job of each individual worker to the significant impact the company and semiconductors have on the world. Research has found that when employees find their work to be meaningful, their performance improves by 33 percent, they are 75 percent more committed to their organization, and they are 49 percent less likely to leave.[31]

Reimagine workforce productivity

Companies could invest in building the relevant skills internally by moving past traditional, generic programs to focus on tailored learning journeys. This approach to reskilling and upskilling could be summed up as "experiences and apprenticeships, not courses," crafted specifically for the necessary roles and job families (which organizations could identify as part of a workforce planning effort).[32]

Decreasing onboarding times and accelerating time to competence are critical levers to increase productivity, so these journeys need to start the moment a new employee walks through the door. Onboarding speed can be boosted through tech-enabled levers to enhance knowledge management and new-skill development. For example, large language models could enable organizations to "assetize" existing knowledge from today's workforce quickly and easily.

In addition, companies could harness generative AI to reduce skills requirements, accelerate skills development, or both. AI and the newest frontiers of generative AI have the potential to double the productivity of software developers, enabling them to complete coding tasks up to twice as fast.[33] More concretely, generative AI can expedite manual, repetitive work (such as autofilling standard functions and documenting code functionality), jump-start the first draft of new code, and accelerate updates to existing ones. In addition, increasing simplicity and user-friendliness of

[30] Bryan Hancock, Bill Schaninger, and Lareina Yee, "Generative AI and the future of HR," McKinsey, June 5, 2023.
[31] *People & Organization Blog*, "Making work meaningful from the C-suite to the frontline," blog entry by Timothy Bromley, Taylor Lauricella, and Bill Schaninger, McKinsey, June 28, 2021.
[32] *Operations Blog*, "Ops 4.0—The Human Factor: The need for speed in building skills," blog entry by Markus Hammer, McKinsey, July 13, 2022.
[33] "Unleashing developer productivity with generative AI," McKinsey, June 27, 2023.

platforms (such as low-code and no-code)[34] could reduce the need for additional software developers, since people without significant experience could still be effective at writing basic code.

As the industry further matures, cost will become more important, and increasing productivity is a key driver.

Draw on outsourced labor to manage shortages

Labor shortages are likely to persist—particularly in roles that may not be needed on a long-term basis. Examples include construction, equipment installation, and specialized maintenance. For such roles, companies can rely on outsourced labor services to address critical gaps. This approach is not as simple as filling individual roles, however. Both semiconductor companies and labor providers should be prepared to work together closely. Strategic cooperation and management can ensure the proper planning and allocation of outsourced resources, prevent double booking, and maintain schedules and productivity as planned.

Other industries provide a road map for talent outsourcing in the face of workforce challenges. For example, the healthcare industry adapted to dramatic pandemic-related labor shortages by accelerating the use of travel contract labor (for example, travel nurses). This shift was enabled by an existing, mature outsourcing model characterized by multiple staffing agencies with preexisting hospital relationships and rapidly scalable travel nurse sourcing and placement services. Hospitals applied this approach to solve other forecasted demand swings, such as an increase in patients during local holidays in snowbird destinations.

The IT industry also offers valuable lessons. Its demand for outsourcing has grown due to aging software infrastructure, an embrace of remote work, and increasing technology specialization (for example, AI-driven data analysis and integration projects). The transition from relying on internal core staff for all business functions to outsourcing noncore industry functions (such as low-skilled technicians, linen services, and security) has enabled organizations to concentrate their resources on filling critical positions.

The semiconductor industry is not alone in facing a talent shortfall, but its rapid expansion in the coming years creates a greater sense of urgency. The most successful organizations will not only expand their candidate pools by being more strategic and resourceful but also implement efforts to get more from their existing workforces.

The growth of the semiconductor market and new fab builds will boost demand for talent, requiring increasingly sophisticated approaches such as hiring at scale and in a short time frame—frequently in locations without existing semiconductor ecosystems. Indeed, the industry and governments appear to recognize the need to close the gaps that have been created in rapid succession following the passage of legislation in multiple countries to support semiconductor production. Numerous programs are under way to increase the supply of skilled construction craft laborers, semiconductor engineers, and technicians. Further evaluation will be needed to understand whether existing programs are on pace to fully close the emerging talent gap.

These recent trends reinforce that it is critical for organizations to take their people strategies as seriously as their business strategies. There's no time to waste.

[34] Harald Bauer, David Ebenstein, Giulietta Poltronieri, and Jan Paul Stein, "Is industrial automation headed for a tipping point?," McKinsey, June 16, 2023.

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