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SPECIAL COMPETITIVE STUDIES PROJECT

The Robot Deficit

Diagnosing the U.S.-China Competition in Robotics for Advanced Manufacturing

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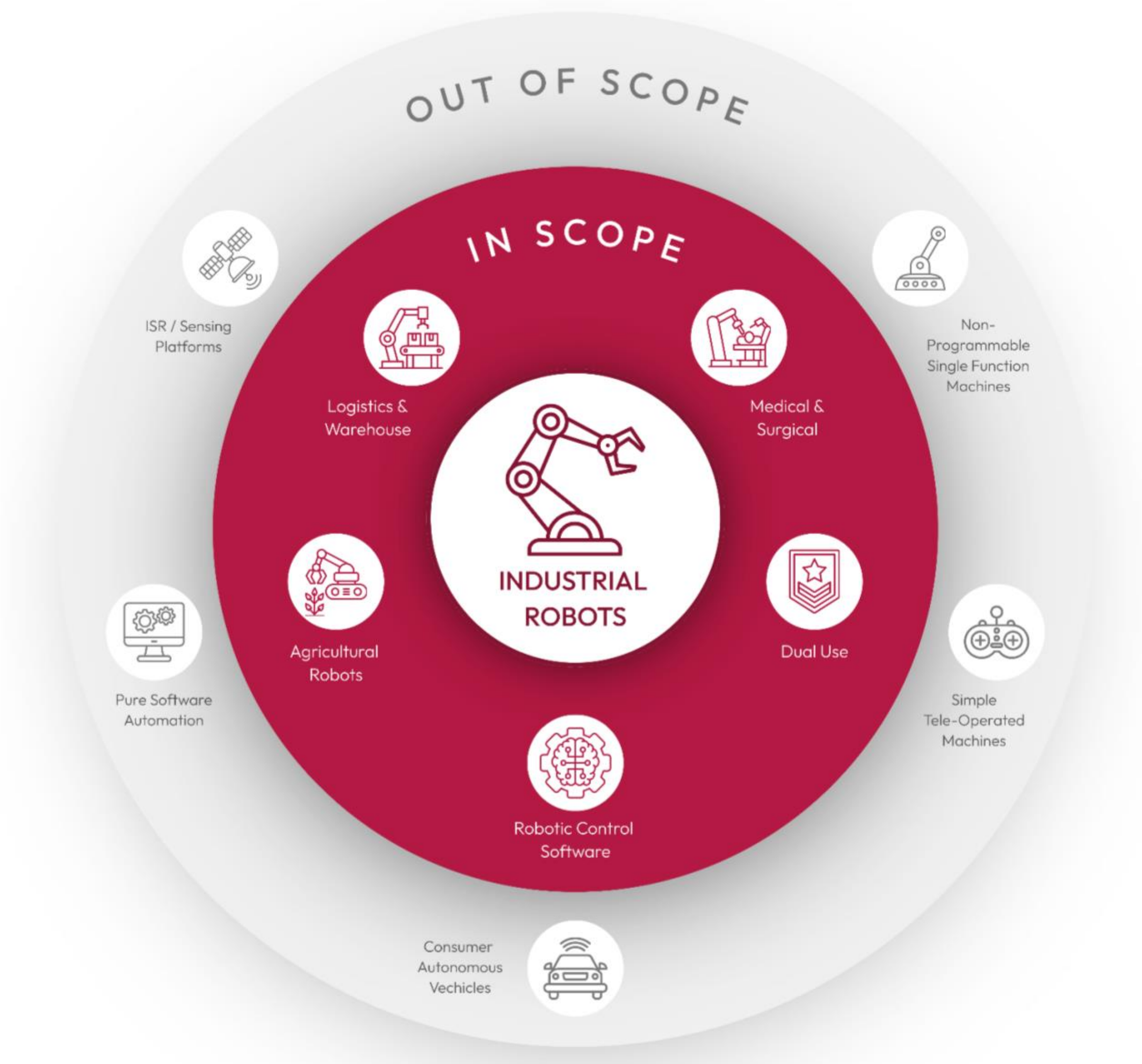
Executive Summary

China is leading the competition in robotics for advanced manufacturing, not only surpassing the United States, but threatening the global leadership of our allies and partners. This assessment diagnoses significant weaknesses for the United States, which currently lacks the industrial capacity and coordinated strategy to match China's rapid expansion. Leadership in this arena will be a key determinant of national security and economic resilience in the 21st century. Domestic manufacturing capacity is a strategic asset, and automation has become the essential mechanism to make rebuilding it feasible in a high-wage economy facing persistent workforce shortages. Consequently, the current "robot deficit" in the United States creates critical supply chain dependencies and national security risks that extend beyond industrial efficiency to the core of national sovereignty.

Analysis using the SCSP Tech Scorecard indicates that China now holds a decisive lead in robotics for advanced manufacturing. While the United States retains a narrow lead in cutting-edge Innovation Leadership, it lags significantly in Industrial Capacity, Market Ecosystem, Talent Pipeline, and National Leverage. While the U.S. ecosystem excels at innovation and integration, it lacks large-scale production capacity, leaving domestic supply chains brittle and dependent on imports from Japan and Europe for the majority of installations. In contrast, China has successfully decoupled hardware from software to become the world's largest producer and consumer of robotics. China has built a self-sufficient industrial base that breaks Western and Japanese monopolies on critical components like precision gears and servo motors. This dominance is reinforced by a "whole-of-country" strategy, including the "Made in China 2025" initiative and state-backed investment funds, which nurtures a production capacity that no other country can match. Conversely, U.S. capital markets favor high-margin software over hardware.

Looking ahead, China's lead is likely to continue to grow absent a concerted U.S. effort to create the strategy, investment, and adoption needed to jumpstart the domestic robotics sector. The current trajectory suggests that China will not only maintain its superiority in manufacturing scale but also challenge for global leadership against established Asian and European giants. The United States faces a critical vulnerability: in the event of a geopolitical conflict or trade disruption, it currently lacks the surge capacity to build the automation tools necessary for societal and defense resilience. Reversing this trend will require a cohesive national framework and sustained investment to rebuild the U.S. robotics supply chain, incentivize hardware production, and cultivate the necessary human capital.

Scope Note



Robot

A programmable, actuated machine designed to autonomously or semi-autonomously perform specific physical tasks within its environment. Its primary function is typically centered on manipulation, such as grasping, moving, assembling, or processing objects, or performing precise, specialized services.

Industrial Robot (ISO 8373:2021)

An automatically controlled, reprogrammable, multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications. The scope is form factor-agnostic and includes robotic arms, wheeled robots, quadrupeds, and humanoids.

Strategic Significance: The Economic and Security Stakes Are High

The competition for robotics leadership is not merely a race for market share, but a struggle to define the physical architecture of the 21st-century. As robotics evolves from static automation to intelligent systems, the ability to design, manufacture, and deploy these tools is now a primary determinant of economic resilience and national power for the United States.

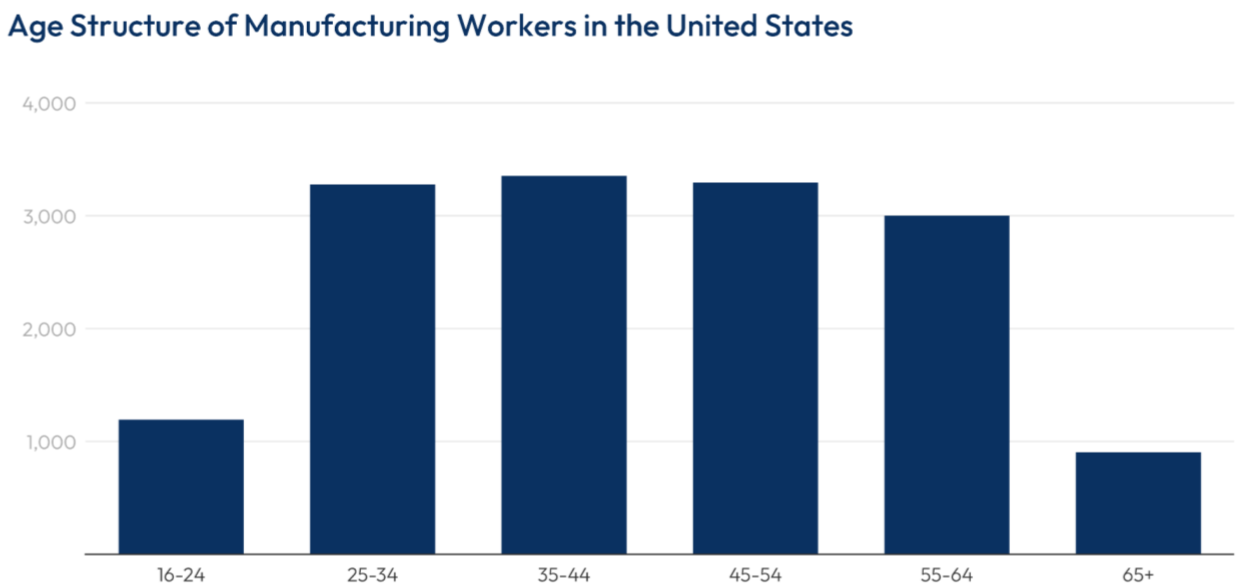
Robotics Adoption Is a Core Driver of Economic Competitiveness and Industrial Capacity

Domestic manufacturing capacity is a strategic asset, and automation is the mechanism that makes rebuilding it feasible in a high-wage economy. Reshoring without automation is unlikely to be durable in the United States, as high labor costs and persistent workforce shortages would quickly recreate the same pressures that drove offshoring in the first place. Robotics enables firms to scale output without proportional increases in headcount and raise throughput while improving consistency and resiliency.[1] When embedded early, automation transforms reshoring from a short-term relocation response into durable industrial capacity with scalable production and resilient supply chains.

Robotics delivers productivity gains in output and utilization, with returns that increase exponentially as adoption scales. International Trade Administration studies have found that a 1% increase in industrial robot density is associated with a roughly 0.8% productivity gain, with substantially larger gains in slower-adopting industries.[2] Unlike one-time process upgrades, robotic systems improve continuously as firms accumulate operational data, refine workflows, and deploy software updates, generating indirect productivity spillovers that reinforce competitiveness over time. Leading-edge products–semiconductors and quantum devices in particular–cannot be manufactured by humans at scale due to precision, repeatability, and contamination constraints. In these domains, the ability to automate is synonymous with the ability to produce.

[1] Kevin Morton, Reshoring in the US: Harnessing Robotics for Manufacturing Renaissance, MSI Viking (2024).
[2] The Role of Automation in Driving Productivity Growth, International Trade Organization (2020).

Persistent labor shortages and demographic pressures have elevated robotics from an efficiency tool to an industrial necessity. Over the next decade, demographic aging and skills gaps are projected to leave roughly 1.9 million of the 3.8 million new manufacturing positions unfilled, imposing a binding constraint on industrial output.[3] Within manufacturing, robotics substitutes most intensive manual labor—particularly in physically demanding, hazardous, and end-of-line roles—while reallocating remaining labor toward higher-value functions in system oversight, maintenance, and real-time optimization rather than eliminating demand outright.[4]



Source: U.S. Bureau of Labor Statistics[5]

Beyond steady-state productivity gains, robotics and automation strengthen supply chain resilience by reducing exposure to disruptions and enabling more adaptive operations. Automation stabilizes production, improves coordination and information flows, and enables firms and supply networks to respond rapidly to shocks such as labor shortages, public health crises, or supplier disruptions. Empirical evidence shows that higher industrial robot penetration significantly reduces firms' exposure to supply chain risk by lowering supplier concentration and

[3] John Coykendall, et al., Taking charge: Manufacturers Support Growth with Active Workforce Strategies, Deloitte (2024).
[4] Sherri Swabb, How Robotics is Helping to Solve Labor Shortages in Manufacturing, Yaskawa (2025).
[5] Labor Force Statistics from the Current Population Survey, U.S. Bureau of Labor Statistics (2024).

improving operational coordination.[6] These firm-level gains scale outward, with regions and interconnected production networks exhibiting greater structural resilience as automation reduces bottlenecks and sustains production continuity.

The U.S. Lag in Robotics Production Expands National Security Risk Through Dependency, Disruption, and Cyber Attacks

National security risk to the United States increases when robotic systems originate from firms subject to foreign legal compulsion, opaque governance, or limited transparency across software, firmware, and remote-management layers. U.S. lawmakers have raised concerns about Chinese robotics systems operating in sensitive American environments—including law enforcement, research institutions, and defense-adjacent facilities—due to the potential exploitation of embedded connectivity and remote-access features.[7]

These concerns are no longer hypothetical. Security researchers recently identified backdoors in Unitree Robotics' Go1 robot dogs, which are widely used consumer and research platforms manufactured in China, that enabled unauthorized remote access to live camera feeds and device location data.[8] While no direct impacts on U.S. critical infrastructure have been publicly documented, the existence of such vulnerabilities in broadly deployed platforms underscores the latent risks embedded in global robotics supply chains and software dependencies.

As robotics adoption scales across the U.S. economy, the risk extends beyond individual devices. Modern robots are networked, sensor-rich, software-defined systems embedded in essential functions including manufacturing lines, warehouses, ports, laboratories, and correctional facilities. At this level of integration, compromise can trigger physical disruption affecting worker safety, production throughput, and the availability of critical goods. U.S. government assessments of operational technology security have repeatedly warned that digitally

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[6] Yiyun Ge, et al., The Impact of Industrial Robot Adoption on a Firm's Trade Credit, Humanities & Social Sciences Communications (2025).

[7] Trojan Horse Tech: Select Committee Sounds Alarm on CCP Robots Inside U.S. Institutions, The House Select Committee on China (2025).

[8] Sam Sabin, Chinese Robotics Manufacturer Left Backdoor in Product, Axios (2025).

connected physical systems expand the cyber attack surface, exacerbate asset visibility gaps, and introduce opaque remote-access pathways that undermine resilience.[9]

These cyber-physical risks are compounded by structural dependency: the United States increasingly relies on robotics to enhance industrial resilience while remaining structurally dependent on foreign sources for the technologies that enable it. The majority of robotics systems installed in the United States are supplied by foreign-headquartered firms—primarily from Japan and Europe—and many critical subsystems, including precision reduction gears, servo motors, sensors, and controllers, are overwhelmingly produced abroad.[10] Decades of offshoring have left the United States with thin domestic supplier ecosystems unable to translate rising demand for automation into a durable domestic production base. In a disruption scenario—whether from export controls, trade restrictions, sanctions, or geopolitical conflict—access to new robots, spare parts, firmware updates, or integration support could be delayed or constrained.[11] Because robotic systems are deeply embedded in production processes, disruptions at the automation layer can cascade across manufacturing, logistics, and defense-adjacent sectors.

9 High-Risk Series: Urgent Action Needed to Address Critical Cybersecurity Challenges Facing the Nation, U.S. Government Accountability Office (2024).

10 Robot Installed in US Auto Industry Up by Double Digits, International Federation of Robotics (2025).

11 Evan Beard, Frontier Technologies, Industrial Efficiency, & Pro-Innovation Policies, U.S. Congress Joint Economic Committee (2025).

Background: The Robotics Ecosystems in the United States and China are Structurally Different

The U.S. Robotics Ecosystem

The United States excels at robotic innovation and integration, while remaining dependent on foreign manufacturing and limited in demand-side scale. This structure defines both the strengths and vulnerabilities of the U.S. position in global robotics competition.

History: Research Leadership Without Manufacturing Continuity

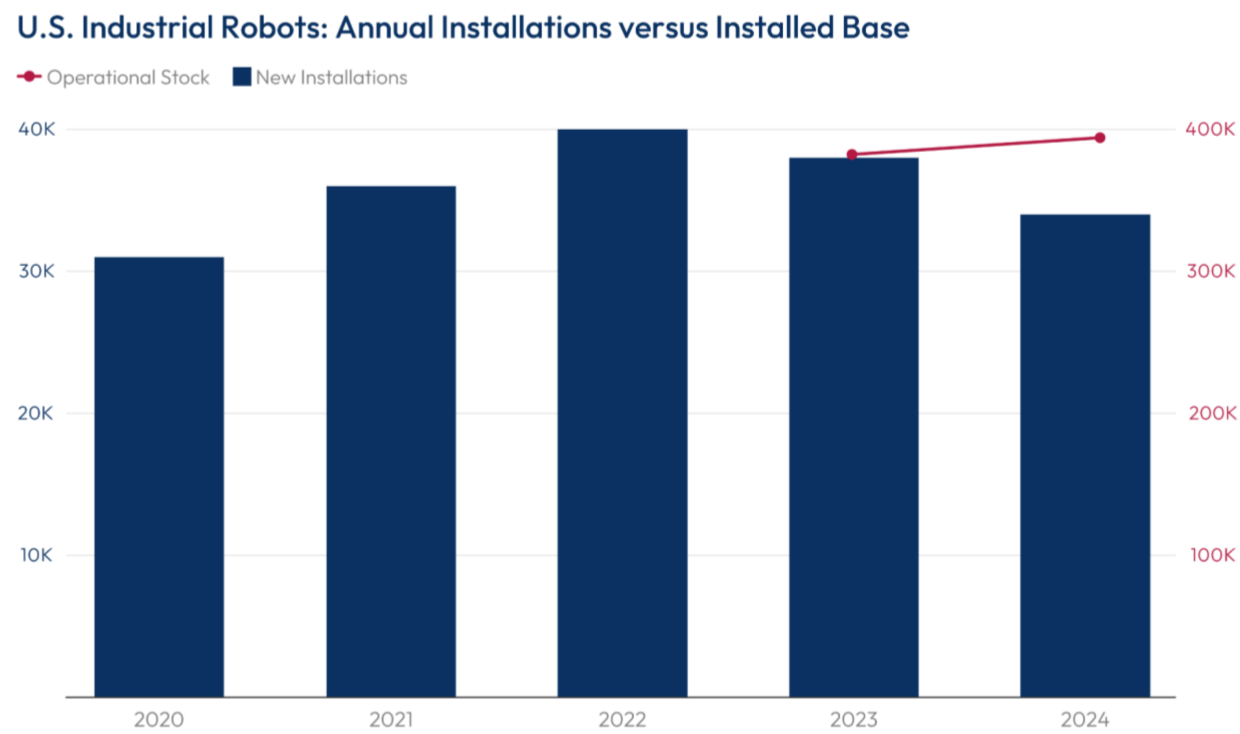
The modern U.S. robotics ecosystem emerged from a combination of federal research investment, university-led innovation, and early industrial automation beginning in the late twentieth century. U.S. government funding through agencies such as the Defense Advanced Research Projects Agency and the National Science Foundation established early leadership in perception, control systems, autonomy, and human–machine interaction.[12] By the 1980s and 1990s, industrial robots were widely adopted in U.S. automotive manufacturing, but large-scale robot production increasingly shifted overseas.[13]

As global manufacturing concentrated in East Asia and parts of Europe, the U.S. robotics ecosystem evolved toward higher-value activities, such as research and software rather than mass production. This transition aligned with U.S. comparative advantages but weakened continuity from research to large-scale manufacturing.

Industry: Strength in High-Value Applications

Use of industrial robotic systems in the United States has grown slowly over time. While the number of new installations of robots has slowed in recent years after a post-pandemic peak in 2022, the total operational stock of these robots in U.S. factories continues to slowly tick up.

[12] The National Science Foundation, NSF's 40-year History Supporting US Robotics Research, Robohub (2014).
[13] Robert Casanova, Industrial Robot Market Trends in the United States, U.S. International Trade Commission (2019).



Source: International Federation of Robotics[14]

Robotics activity in the United States is concentrated in a narrow set of industries. Within manufacturing, automotive remains the dominant user of industrial robots, accounting for roughly 40% of U.S. industrial robot installations in 2024, followed by electronics, metals, and plastics.[15] Installations in the automotive sector grew 11% in 2024, helping to soften the blow of a significant slowdown in other industries. Outside manufacturing, the fastest growth in deployment has occurred in logistics and warehousing, medical and surgical robotics, agriculture, and defense-adjacent applications.[16]

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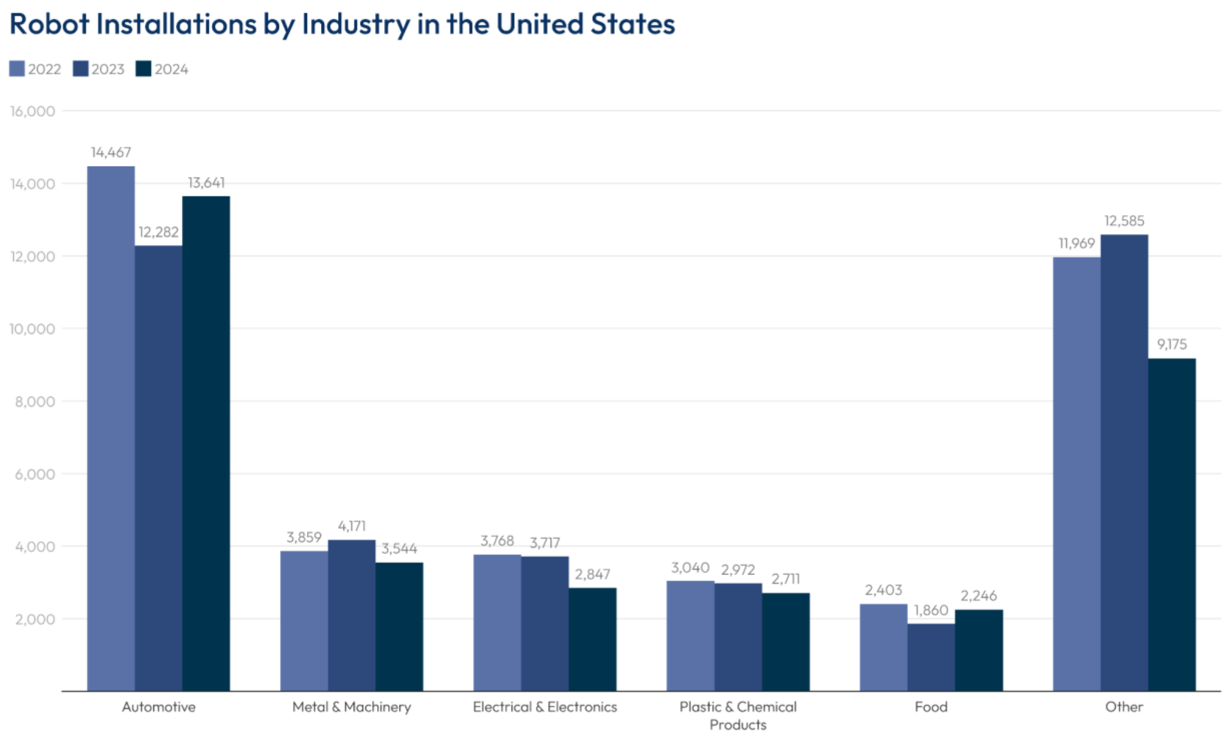
[14] World Robotics Report 2025, International Federation of Robotics (2025); World Robotics Report 2024, International Federation of Robotics (2024).

[15] Robot Installed in US Auto Industry Up by Double Digits, International Federation of Robotics (2025).

[16] U.S. Companies Invest Heavily in Robots - IFR Preliminary Results, International Federation of Robotics (2024).



Source: International Federation of Robotics[17]

These sectors favor intelligent, adaptive systems capable of operating in unstructured or safety-critical environments. U.S. firms have been particularly competitive where performance depends on advanced perception, autonomy, and software integration rather than low-cost, high-volume hardware. In contrast, robot adoption remains comparatively low among small and medium-sized manufacturers, which make up roughly 98% of all U.S. manufacturers, and in sectors such as food processing and construction materials, where integration costs and customization challenges remain high.[18]

The U.S. robotics industry is geographically dispersed, with innovation often concentrated around research institutions and technology hubs rather than manufacturing corridors.

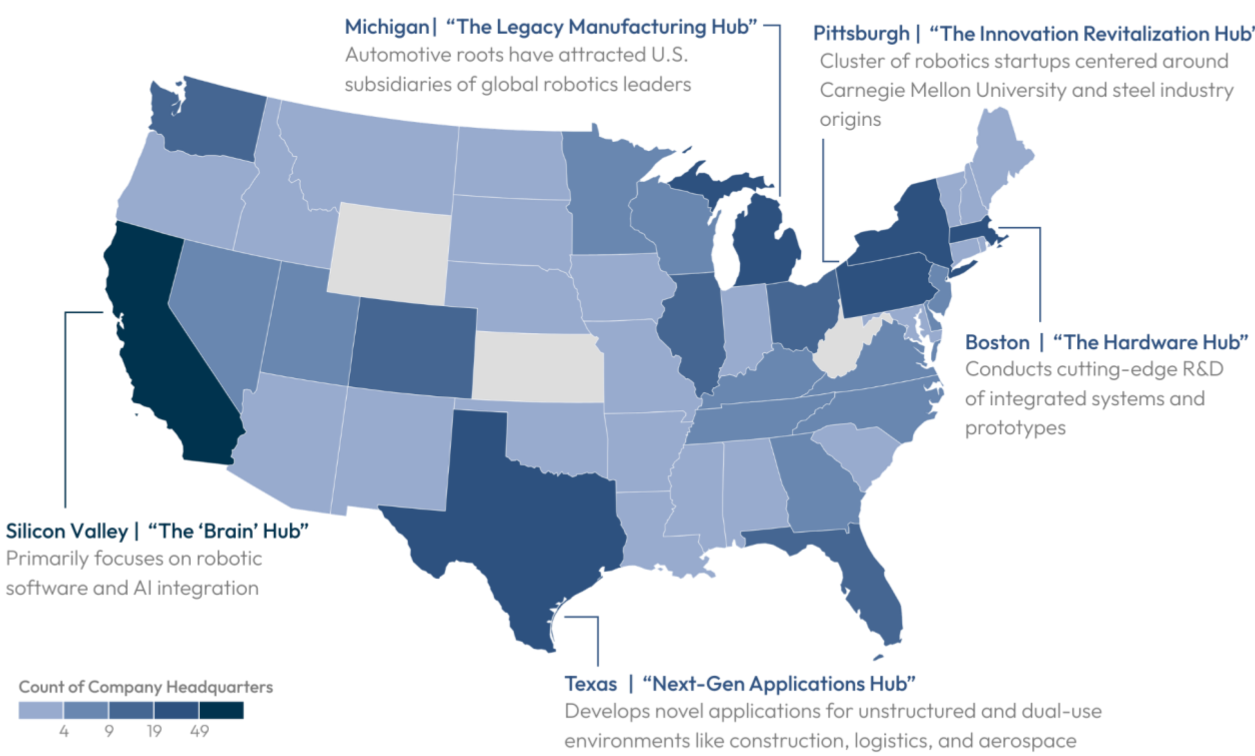
[17] World Robotics Report 2025, International Federation of Robotics (2025).

[18] Facts About Small Business: Manufacturing Statistics 2025, U.S. Small Business Administration Office of Advocacy (2025); Nancey Green Leigh, et al., Disparities in Robot Adoption Among U.S. Manufacturers: A Critical Economic Development Challenge, Routledge (2022).

Global Market Position: Influence Without Manufacturing Scale

Despite its innovation leadership, the United States plays a limited role in global industrial robot production and exports. According to the International Federation of Robotics (IFR), Japan, China, and Germany together account for well over half of global industrial robot production, while U.S.-headquartered firms represent only a single-digit share of global robot manufacturing by volume.[19]

U.S. Distributed Innovation in Robotics for Advanced Manufacturing



Source: SCSP, Pitchbook.[20] Includes venture capital-backed companies in robotics software, hardware, and integrated systems in non-service industrial, logistics, medical, and agricultural sectors.

The "Big Four" manufacturers—FANUC and Yaskawa (Japan), ABB (Switzerland), and KUKA (Germany/China)—continue to dominate the physical "bodies" of industrial automation. The

[19] Global Robot Demand in Factories Doubles Over 10 Years, International Federation of Robotics (2025).
[20] SCSP analysis of Robotics Market Map, PitchBook (accessed 2026).

United States typically ranks outside the top five robot-exporting countries, and the majority of robots installed in U.S. factories are imported.[21]

By contrast, the United States is one of the largest robot installation markets globally, consistently ranking among the top three destinations for new industrial robots.[22] This underscores its role as a consumer, integrator, and application leader, rather than a manufacturing hub. As robotics competitiveness increasingly rewards scale, deployment experience, and cost reduction, this imbalance between innovation leadership and production capacity shapes U.S. economic and national security outcomes.

[21] Daniel Workman, Top Industrial Robots Exporters, Worlds Top Exports (2025).
[22] U.S. Lags China in Factory Robot Deployment by 5 to 1 Ratio, The Gilmer Mirror (2025).

The Chinese Robotics Ecosystem

China has utilized massive government subsidies and vertical supply chain integration to become the world's largest producer and consumer of robotics, now accounting for over 50% of global industrial robot installations and leading the charge in mass-market production.

History: The State-Powered Robotics Sprint

China is a relative newcomer to the robotics industry. In the early 2000s, China's robotics landscape was underdeveloped, primarily driven by state-owned research institutions rather than commercial companies. Chinese robot production was minimal, and the country's total robot sales accounted for only 0.4% of the global market at the turn of the century.[23] In the past two decades, China has become the world's largest market for robotics, accounting for over half of all installations,[24] and one of the top producers of robots, finally capturing the majority of sales within its domestic market in 2024.[25] In the past two decades, both China's adoption and production of robots has skyrocketed, driven by increasing labor costs, government planning, and depleting workforce.[26] This increase in labor costs, combined with rising minimum wages, incentivized Chinese firms to integrate robots into their operations. This adoption proved successful, as companies experienced significant increases in productivity, profit, labor employment, market share, and average wages.[27]

The contemporary state of China's robotics sector is the direct result of long-term government planning, specifically the "Made in China 2025" (MIC2025) initiative.[28] Launched in 2015, this 10-year plan was a directive to mobilize self-sufficient manufacturing and production across multiple high-tech industries, including robotics, AI, and new energy vehicles. The state recognized that rising labor costs and a shrinking working-age population necessitated a radical

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[23] Hong Cheng, et al., The Rise of Robots in China, Journal of Economic Perspectives (2019).

[24] Brian Speagle, Robots and AI Are Already Remaking the Chinese Economy, Wall Street Journal (2025); Hu Weija, China's Emerging 'Robot Dividend' Offers New Insights for Manufacturing, Global Times (2025).

[25] Global Robot Demand in Factories Doubles Over 10 Years, International Federation of Robotics (2025).

[26] Haichao Fan, et al., Labor Costs and the Adoption of Robots in China, Journal of Economic Behavior and Organization (2021).

[27] Richard B. Freeman, et al., The Cause and Consequence of Robot Adoption in China: Minimum Wages and Firms' Responses, Fundamental Research (2024).

[28] Made in China 2025: Evaluating China's Performance, U.S.-China Economic and Security Review Commission (2025).

shift toward automation. The goals of MIC2025 were aggressive and clear: to secure a 70% domestic market share for key sectors like aerospace, communication, and power production by 2025.[29] This strategy has successfully transitioned the Chinese market from a labor-intensive, low-value manufacturing base to high-value, technology-intensive systems in fields such as aerospace, biotech, semiconductors, and robotics.

Industry: Concentrating on Low-Hanging Automation Opportunities

China's robotics industry is primarily concentrated in the electrical and electronics sector, followed by the automotive industry.[30] The increasing use of advanced automation and robotics is allowing key industries, such as batteries and photovoltaics, to lower costs and extend their reach from just high-end producers to many more industrial sectors. Government backing remains crucial, exemplified by Beijing's recent launch of a state-backed venture capital fund, known as the "Big Fund", aimed at securing nearly 1 trillion yuan (approximately $1.4 billion USD) to bolster robotics, AI, and smart manufacturing over the next 20 years.[31]

This national push for robotics is concentrated in key areas that form the core of China's robotics ecosystem. The industry's rapid growth has been driven by concentrated technological innovation in the Yangtze Delta and Pearl River Delta. China has designated major tech hubs around Eastern cities, including Shenzhen, Shanghai, Hangzhou, and Beijing, which specialize in AI, electronics, automation, and industrial robotics.[32]

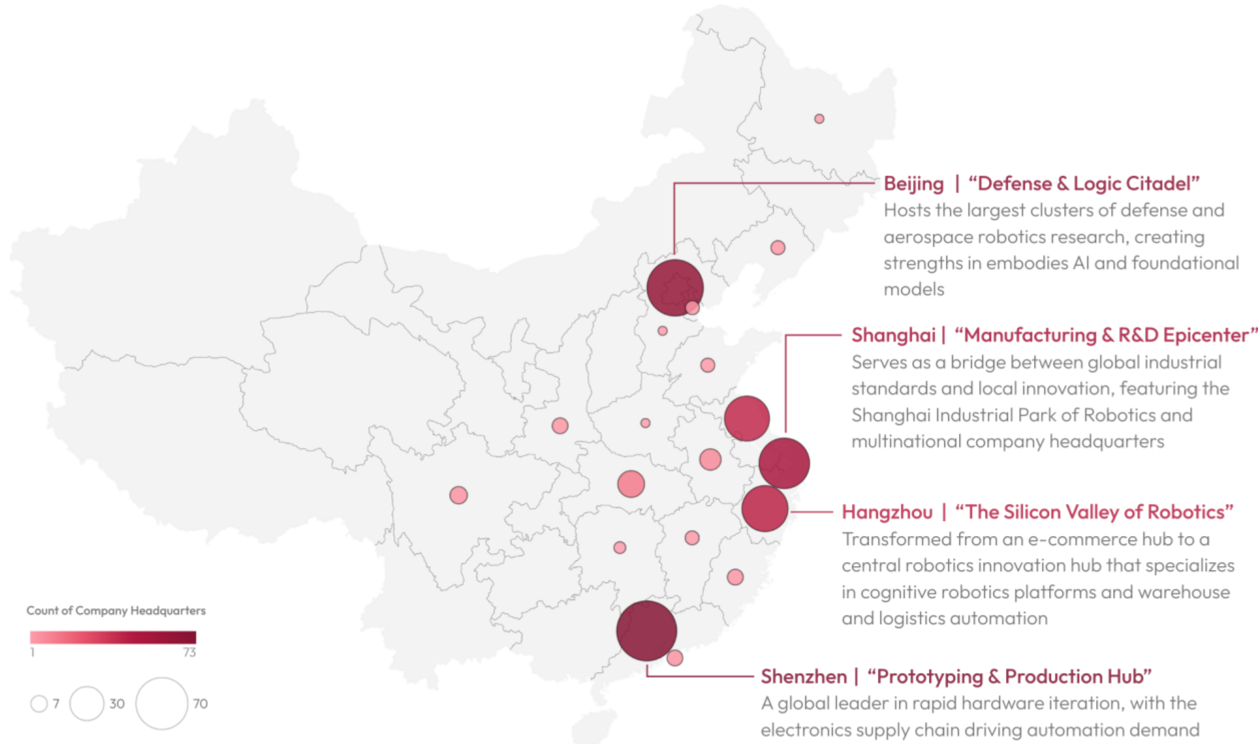
[29] 'Made in China 2025', CWR (2015).

[30] Record 1.7 million Robots Working in China's Factories, International Federation of Robotics (2024).

[31] Greg Bock, Is China Winning the Race for Robotics, AI Insider (2025).

[32] Andres Rodriguez-Pose & Zhouying You, Bridging the Innovation Gap: AI and Robotics as Drivers of China's Urban Innovation, Centre for Economic Policy Research (2024); China Industrial Robotics Market Size, Share & Trends Analysis Report By Application, By End Use, And Segment Forecasts, 2025 - 2033, Research and Markets (2025).

China's Robotics Companies Concentrate Around Existing Industry

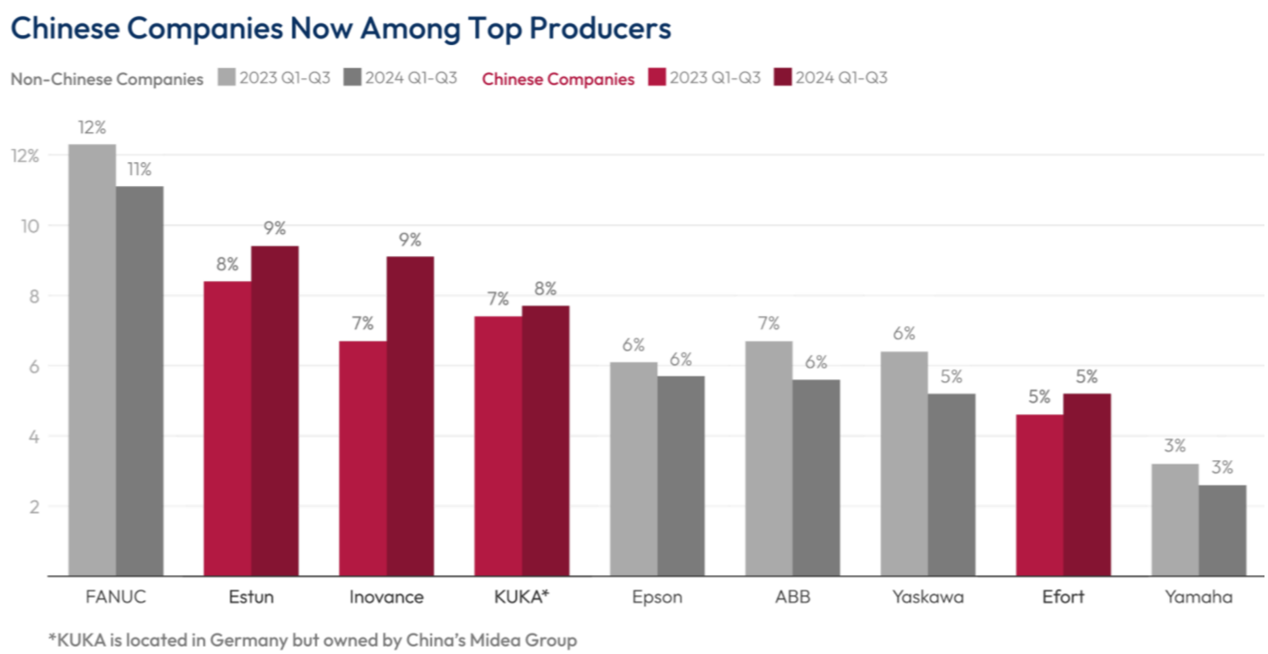


Source: SCSP, Pitchbook.[33] Includes venture capital-backed companies in robotics software, hardware, and integrated systems in non-service industrial, logistics, medical, and agricultural sectors.

These regional clusters are driven by a dynamic mix of national champions and cutting-edge startups. Companies such as Agibot, UBTech Robotics, and Unitree are prominent in the humanoid robotics space and have gained attention at global conferences like CES.[34] In the manufacturing sector, companies like Deep Robotics have established a reputation as direct competitors to U.S. innovation firms like Boston Dynamics.[35] Estun Automation is a key player in the Chinese robotics market, having claimed one of the top spots in global market share and focusing on R&D and innovation both domestically and internationally.[36] Taken together, these

[33] SCSP analysis of Robotics Market Map, PitchBook (accessed 2026).
[34] Sarah Chea, At CES 2026, A Humanoid Robot Showdown between Korea and China, Korea JoongAng Daily (2026).
[35] Coco Feng, Sit Down, Spot: Robot Dog from China's Unitree Tops Boston Dynamics Rival in Payload, South China Morning Post (2025).
[36] Mark Allinson, Top 10 Chinese Industrial Robotic Arm Manufacturers: The rise of Robots in China, Robotics & Automation News (2025).

interconnected firms across various segments demonstrate the breadth and strategic national investment driving the rapid advancement of China's comprehensive robotics ecosystem.



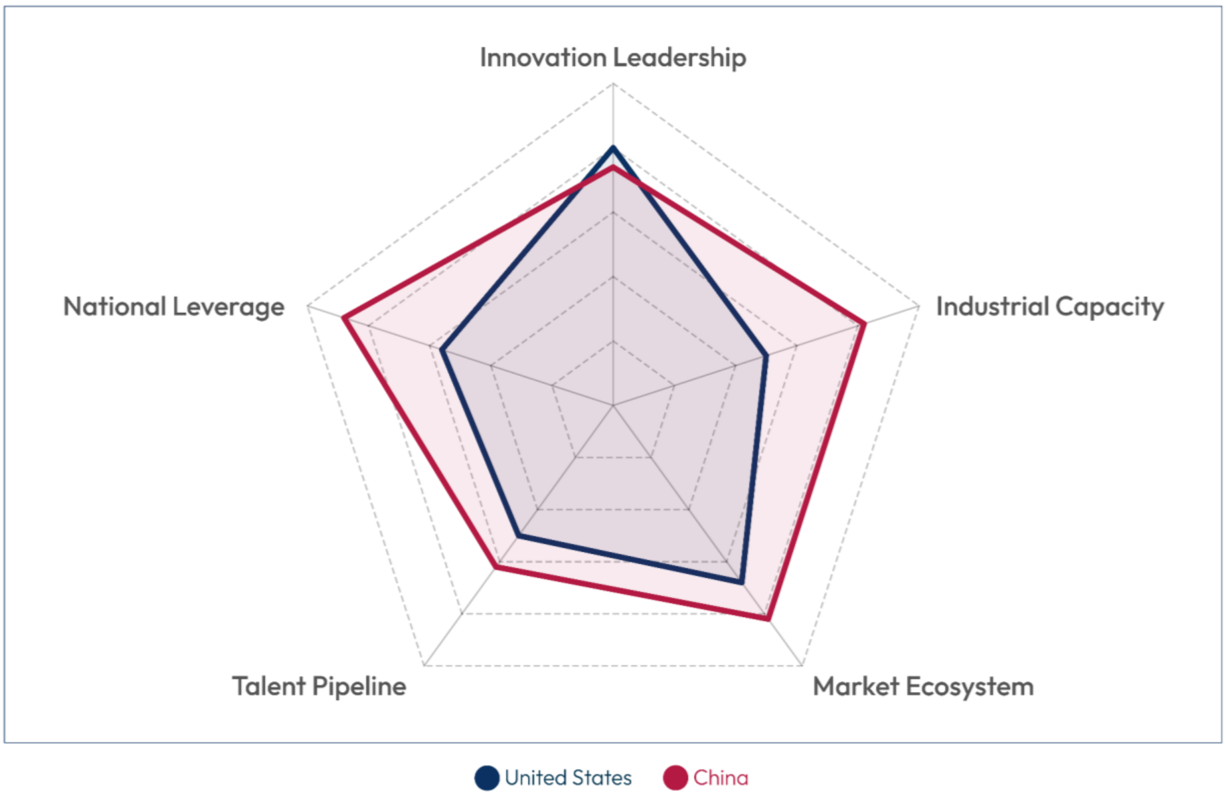
Source: MIR Databank[37]

[37] Chinese Industrial Robot Players Boost Market Share as Industrial Robot Sales in China Climb 5% YoY in Q1-Q3 2024, MIR Databank (2025).

SCSP Tech Scorecard: China Holds the Positional Advantage in Robotics for Advanced Manufacturing

China has the lead over the United States in most aspects of industrial robotics, according to an analysis using the SCSP Tech Scorecard. While the United States maintains an advantage in cutting edge innovation and capabilities driven by its software prowess, it lacks the industry, market, and talent pool to match China's growing dominance. These weaknesses are compounded by the lack of a unified, actionable U.S. strategy to match China's whole-of-country push in this sector.

Tech Scorecard: Robotics for Advanced Manufacturing



Source: SCSP Analysis

SCSP Tech Scorecard

SCSP developed a comparative analysis framework to provide a comprehensive view of the state of the tech competition between the United States and China across a variety of key technologies.[38] The scorecard compares quantitative and qualitative metrics across the five categories SCSP has determined are needed for technology leadership: Innovation Leadership, Industrial Capacity, Market Ecosystem, Talent Pipeline, and National Leverage.

The specific metrics considered are technology-specific and will vary between reports based on the technology readiness level and resource needs of each technology. Data are compiled from open source analysis, subscriptions, and expert surveys.

For more information, please see the appendix.

[38] The Tech Scorecard Methodology, Special Competitive Studies Project (2026).

Innovation Leadership: U.S. Edge in Advanced System Development at Risk

Leader: United States	***Trending Towards: China***

The United States retains a narrow lead in Innovation Leadership based primarily on its strength in the cognitive and software domains of the "brain" that define the future of autonomous systems. However, China has rapidly developed top-tier hardware components, creating a bifurcation where the smartest robots are American, but the most agile robots are increasingly Chinese.

Across the industry, China is making strides to develop world-leading innovation, and its rapid progress suggests that this area is at risk. China is increasingly dominating academic research output—accounting for 285 robotics papers in the top journals compared to 119 for the United States[39]—though Chinese-authored articles receive fewer citations per article than U.S. research, suggesting a lower impact on foundational progress.[40] Much of China's robotics innovation is driven by its university systems, with academic institutes making up 23 of its top 25 patent filers in robotics in 2019, while U.S. innovation often emerges from industry, especially startups.[41] China is also rapidly pushing to increase its influence in international robotic technological standards, with top companies broadly adopting European communications interoperability standards,[42] and gaining a seat at the table for the recent creation of the ISO 21423 draft global standard.[43]

U.S. Software Leads the Way for Next-Gen Autonomy

U.S. strengths in 'smart' robotics are rooted in its critical competitive edge in advanced software, such as computer vision and real-time decision making. These capabilities enable robots to perform well in unstructured environments that are unpredictable and messy, which will help expand the roles and value of next-generation robotics in new areas of manufacturing,

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[39] Control Engineering, Mechatronics, and Robotics December 2024 - November 2025, Nature Index (accessed 2026).
[40] Map of Science, Georgetown University Center for Security and Emerging Technology (accessed 2026).
[41] China's Robotics Patent Landscape, Georgetown University Center for Security and Emerging Technology (2021).
[42] Aaron Prather, Successful Robot Firms Work On Robot Standards, Six Degrees of Robotics (2025).
[43] ISO 21423: Building Global Consensus for Mobile Robot Interoperability, Association for Advancing Automation (2025).

medicine, agriculture, and logistics. Conversely, many Chinese robotics outputs are optimized for a concrete set of specialized tasks, rather than flexible general intelligence. This can be seen in Chinese prototype demonstrations that rely on teleoperation or highly staged environments.[44]

U.S. entities dominate the development of Vision-Language-Action (VLA) models, which are essential for general-purpose robotic reasoning. Major U.S. players like Tesla and Figure AI are developing end-to-end neural networks, where a single AI model processes visual input and outputs motor commands directly.[45] The United States also holds a technical edge in simulation technologies, such as NVIDIA's Isaac Sim, which allow robots to learn complex tasks in virtual environments before physical deployment.[46]

Chinese firms have traditionally pursued a strategy of "fast follower" in software development, allowing them to quickly move up the learning curve and target relatively simple manufacturing use cases where predictability is desired and variability is minimized. However, recent trends point to significant advances for Chinese software in leading-edge embodied AI and middleware efforts.[47]

Chinese Hardware Design Pulling Ahead

China has rapidly closed the gap on innovation in the "body" of robotic hardware. China has developed proprietary harmonic reducer gearboxes and high-performance servo motors that are now strong competitors to Japanese and American designs, breaking the historical quality lock that Western technology held on precision components.[48] The precision and reliability of Chinese robots is now equivalent to many Western competitors, making it sufficient for most

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[44] Jijo Malayil, China's Six-Foot Humanoid Robot Knocks Down Sandbags with Precise Strikes, Interesting Engineering (2026).

[45] End-to-End Reinforcement Learning for Robotics, Medium (2024).

[46] Gaurav Gupta, Robot Simulation Software: A 2026 Perspective, Black Coffee Robotics (2026).

[47] Yunfeng Lin, et. al., UniCon: A Unified System for Efficient Robot Learning Transfers, Cornell University arXiv (2026); Leaderboard, RoboChallenge (accessed 2026).

[48] Anne Neuberger & Martin Casado, America Cannot Lose the Robotics Race, Andreessen Horowitz (2025).

industrial applications. However, long-term durability in harsh conditions remains an area where Western and Japanese manufacturers still lead.[49]

China has accelerated its innovation development by leveraging foreign capabilities. In recent years, leading Chinese companies have completed high-profile acquisitions or investments, including Midea Group's 2016 acquisition of Germany robot maker KUKA[50] and EFORT's purchase of Italy's CMA and OLCI.[51] Several of the world's top robotics companies have also recently opened production facilities in China, which may provide greater opportunities for knowledge transfer to Chinese manufacturers.[52]

49 Chinese Robot Manufacturers: Industrial Capacity, Cost & Performance, Robot Magazine (2026).
50 Kuka Takeover Approved, Deutsche Welle (2025).
51 Gabriele Carrer, Rome Deploys Special Powers over Beijing's Aims on Italian Robotics, Decode39 (2023).
52 Mike Oitzman, FANUC Increases Investment to Expand China Factory, The Robot Report (2021).

Industrial Capacity: China Becoming Global Powerhouse, United States Lagging

Leader: China	*Trending Towards: China*

China far outpaces the United States in the manufacturing scale, component supply chains, and raw materials for robotics, and is beginning to rival Japan's historic leadership in this area.

China's Robotics Industrial Base Eclipses that of the United States

China leads the United States in the production and adoption of robotics in terms of manufacturing scale, domestic installation share, exports by value, and robot density, underscoring the fundamental divergence in national strategies and market structures. As in other sectors, China's massive domestic market and sustained state support nurture a production capacity that no other country comes close to matching.

China produces more industrial robots annually than the United States, by a wide margin. In the first nine months of 2025 alone, China produced 595,000 industrial robots,[53] exceeding the 2024 total of 556,000 units.[54] As of March 2026, China's congress claimed that industrial robot output had increased 28% in the past year.[55] The surge in production in recent years has enabled Chinese firms to capture the majority of domestic industrial robot installations in 2024, the first time they sold more than foreign manufacturers in China.[56] China's transition from a consumer to creator of industrial robotics is also seen in trade data, with China achieving a positive trade balance in 2024, exporting more industrial robots than it imported.[57]

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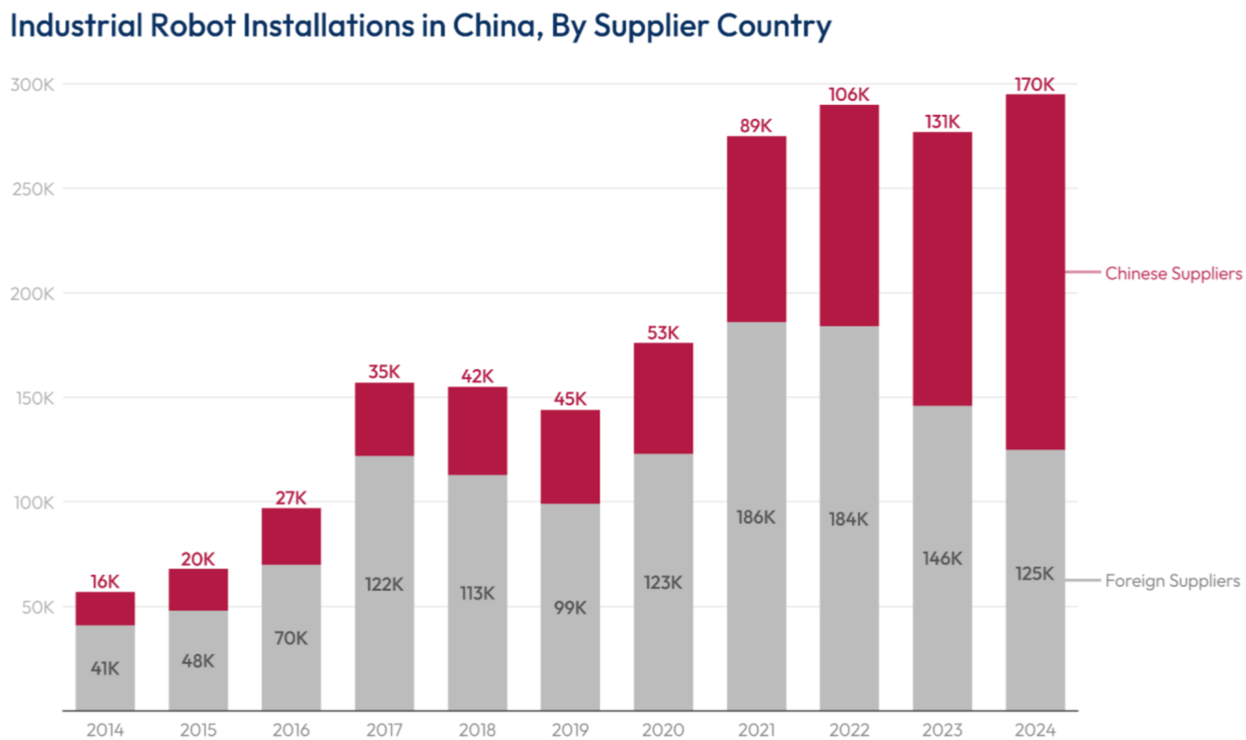
[53] China's Industrial Robot Output Surpasses Full-Year 2024, TechinAsia (2025).

[54] Beijing Gears up for 2025 World Robot Conference with Robotics Innovation, China National Intellectual Property Administration (2025); China Remains World's Largest Industrial Robot Market, The State Council of the People's Republic of China (2024).

[55] National People's Congress, Report on the Work of the Government, NPC Observer (2026).

[56] Global Robot Demand in Factories Doubles Over 10 Years, International Federation of Robotics (2025).

[57] Trade Data, UN Comtrade Database (Accessed 2026).



Source: International Federation of Robotics[58]

The United States' output, in contrast to China's vast manufacturing base, is limited. One indicator of its limited manufacturing scale is trade performance. The United States relies on imports, mostly from European and Japanese companies, to supply the vast majority of industrial robotics installations,[59] and has modest exports of specialized industrial robotics systems. The negative trade balance is indicative of the lack of domestic capacity in the United States and exemplifies the divergence from China's path towards self-sufficiency.[60]

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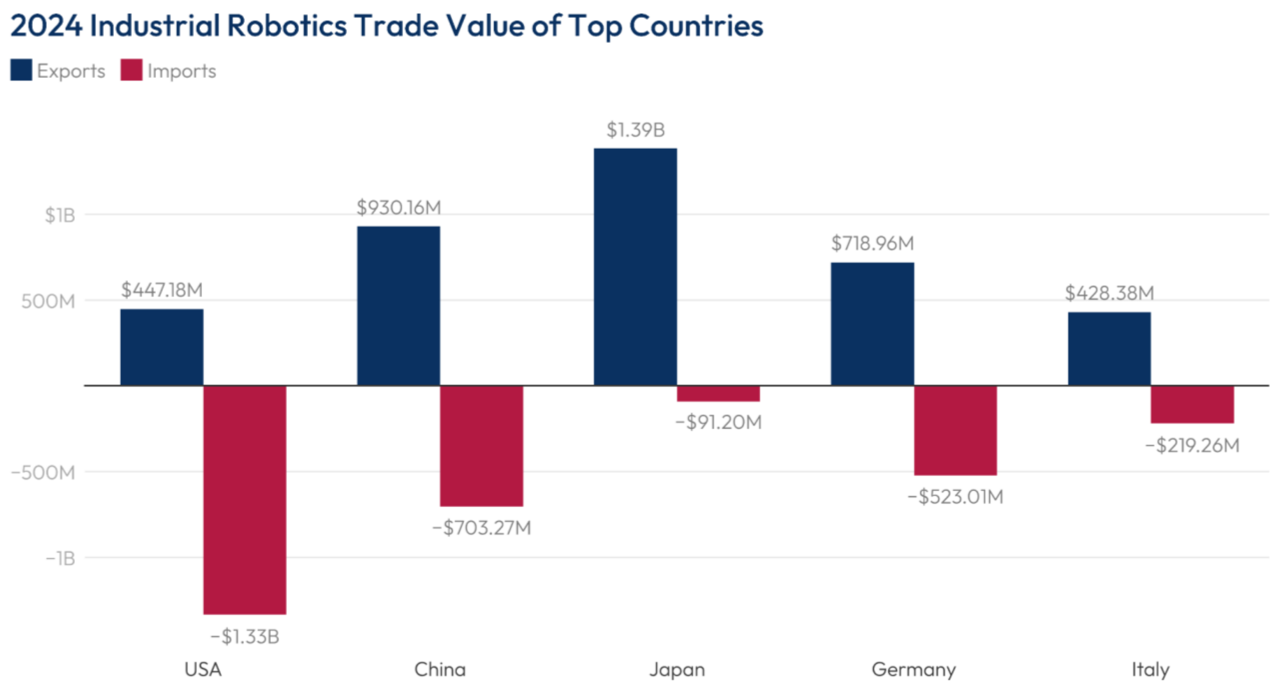
58 World Robotics Report 2025, International Federation of Robotics (2025).

59 Daniel Workman, Top Industrial Robots Exporters, World's Top Exports (2025).

60 Trade Data, UN Comtrade Database (Accessed 2026).



Source: UN Comtrade[61]

Supply Chain Chokepoints Are Single Points of Failure for the U.S. Robotics Industry

U.S. robotics supply chains are brittle. While the lack of major manufacturers for industrial robots in the United States is undesirable, the associated risk is mitigated by the fact that key suppliers are based in Japan (e.g., FANUC and Yaskawa) and Europe (e.g., ABB). Nevertheless, in the event of a conflict or trade embargo, the United States lacks the capacity to build the automation tools needed to ramp up production of defense systems or other platforms necessary for societal resilience.

U.S. assembly alone would be insufficient to overcome supply chain dependencies, as the same concerns exist at the subcomponent level. Precision reduction gears (the 'joints' of a robot), servo motors (the robot's 'muscles'), advanced sensors, and magnets are all potential points of failure that the United States must import, while leading Chinese companies claim they are producing about 80% of their components in-house.[62] A disruption in access to any of these

[61] Trade Data, UN Comtrade Database (accessed 2026).
[62] Wang Zheng & Li Xinping, China's Robot Industry Doubles Revenue in Five Years, People's Daily Online (2025).

would effectively thwart any attempt to create a viable, large-scale industrial robotics industry. For example, U.S. firms are largely dependent on Japanese firms for harmonic reducers and cycloidal gearing, while China controls 90% of the processing capacity for neodymium, the rare earth element needed to make critical permanent magnets for many motors and actuators used in robotics.[63] The impact of Beijing's curbs on rare earth exports in 2025 underscores the urgency with which leaders in government and industry must address this threat to the country's resilience.[64]

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63 How Japanese Speed Reducer Monopolize the Industry, Robotic Paint Group (2020); Analysis of the Market Sales of Japan Harmonic Drive Systems Harmonic Reducers, Hamada (2024); Cycloidal Gearing Market Growth Analysis, Dynamics, Key Players and Innovations, Outlook and Forecast 2025-2032, Intel Market Research (2025); Global Cycloidal Gear Market 2024 by Manufacturers, Regions, Type and Application, Forecast to 2030, Global Info Research (2024); Keith Bradsher, What to Know About China's Halt of Rare Earth Exports, The New York Times (2025).

64 William Matthews, China's Rare Earth Export Restrictions Threaten Washington's Military Primacy, Chatham House (2025).

Market Ecosystem: U.S. Capital Cannot Overcome China's Customer Base

Leader: China	*Trending Towards: China*

While the United States retains the greater ability to fund innovation through deep capital markets, China has successfully built a self-reinforcing economy of robotics. The sheer volume of deployment in China creates efficiencies that the United States, with its smaller, import-reliant market, cannot currently match.

Funding Skews Towards U.S. Companies

Investment in industrial robotics is surging as AI advancements and reshoring initiatives create new opportunities. Robotics and advanced manufacturing companies captured 16% of AI deals in 2025, more than any other tech sector.[65] From 2018 to 2024, U.S. robotics investment averaged over $7 billion annually, more than double Chinese robotics investment during that time period.[66] However, in 2025, China's push for embodied AI and the creation of the state-led "Big Fund"[67] have fueled a surge in spending, with spending in the first half of 2025 reaching $3.2 billion, exceeding total 2024 spend.

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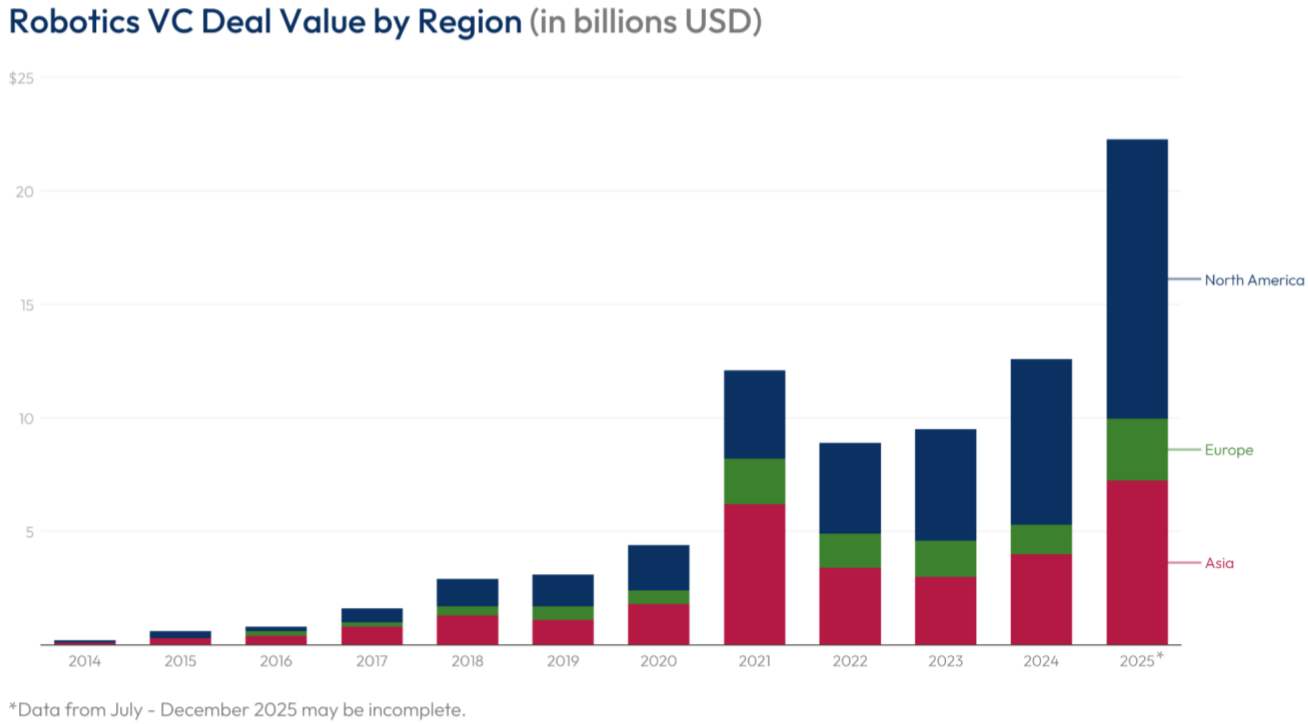
[65] State of AI 2025 Report, CB Insights (2025).

[66] US, China Dominate Global Robotics VC Landscape with Around 75% Share of Investments Raised during 2018-2024, Reveals GlobalData, Global Data (2025).

[67] China to Invest 1 Trillion Yuan in Robotics and High-Tech Industries, International Federation of Robotics (2025).



Source: Pitchbook[68]

U.S. capital markets have reinforced the focus on advanced software capabilities at the expense of industrial robotics hardware because investors are attracted to the high margins, better scalability, and lower risk exposure.[69] Up to 97% of hardware-focused startups in the United States have failed in recent years,[70] and sustained investment in legacy industrial sectors that seek to automate is comparatively less attractive. Despite efforts to bridge the hardware 'valley of death' and incentivize private investment in physical scale-up, such as the Department of War's Office of Strategic Capital financing for manufacturing equipment in critical technology sectors,[71] U.S. patient capital in this area is insufficient to compete with China's state-backed financial scale. China has significantly more companies that produce hardware and components for robotics and has a slight edge on total integrated robotics companies.

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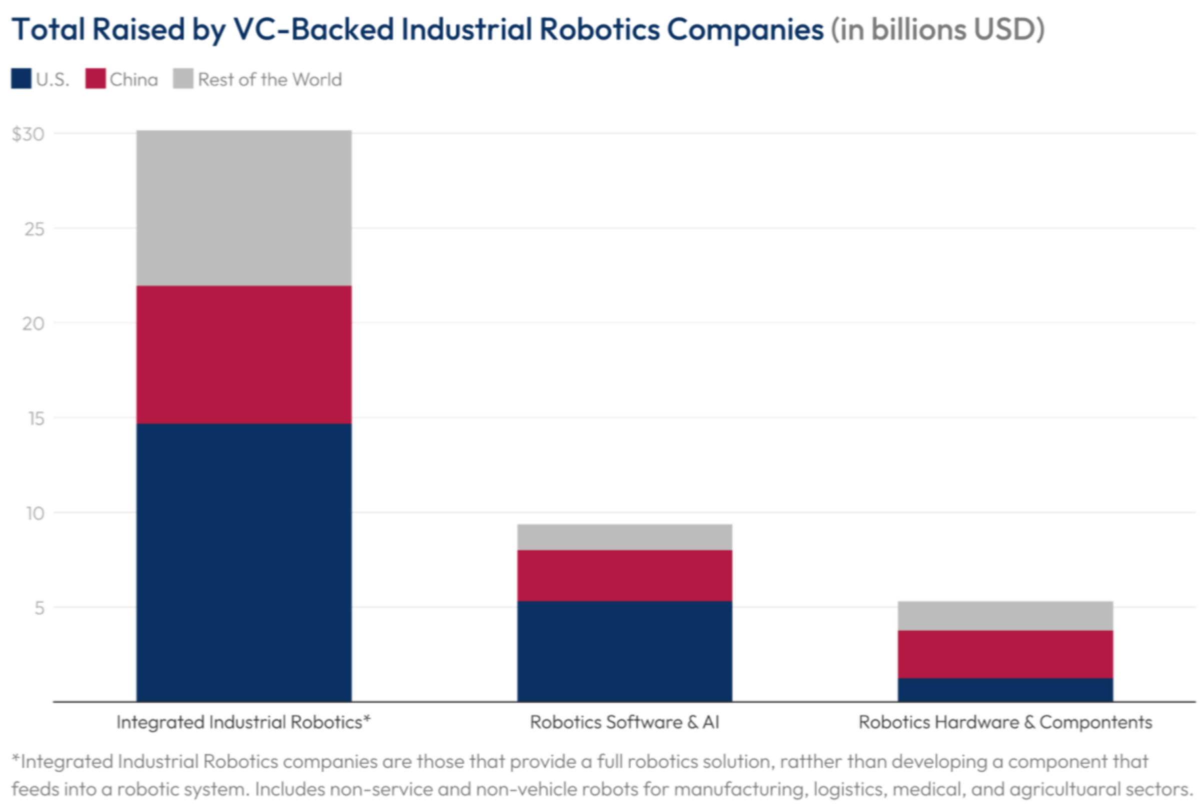
[68] SCSP analysis of Robotics Market Map, PitchBook (accessed 2026).

[69] Tech Edge: A Living Playbook for America's Technology Long Game, Center for Strategic & International Studies (2026).

[70] Gilberto Garcia-Vazquez & Muirae Kenney, Why Do Hardware Startups Fail?, RoboticsTomorrow (2024).

[71] Scott Freling, et. al., DoD's Office of Strategic Capital Reports Significant Interest in Domestic Manufacturing Loan Program, Inside Government Contracts (2025).

The United States has a huge advantage in software and AI companies for robotics, with the funding for these companies far outpacing their Chinese counterparts.[72]



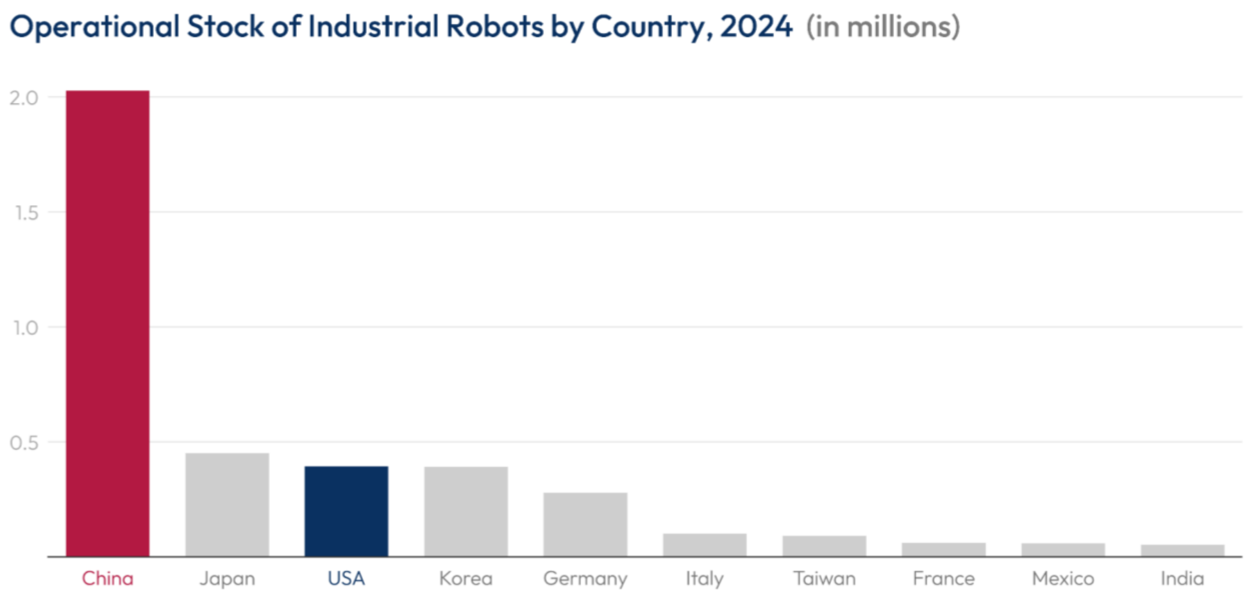
Source: Pitchbook[73]

Low Costs, Broad Customer Base Propel China's Market Share

China's robotics market is bolstered by its cost efficiencies and domestic customer base that reinforce market share and domestic adoption even if the financial performance of companies lags. In 2024, the last year for which complete data is available, 54% of all of the industrial robot installations occurred in China, while the U.S. market accounted for just 6% of global installations.[74] This high level of adoption is self-reinforcing, creating efficiencies of scale that reduce the cost of robotic systems, which in turn incentivizes greater adoption. According to

[72] SCSP analysis of Robotics Market Map, PitchBook (accessed 2026).
[73] SCSP analysis of Robotics Market Map, PitchBook (accessed 2026).
[74] Global Robot Demand in Factories Doubles Over 10 Years, International Federation of Robotics (2025).

Morgan Stanley, the cost of raw materials for a typical humanoid robot built with a non-Chinese supply chain is approximately $130,000. In contrast, a unit built using the Chinese supply chain has a raw cost of roughly $46,000.[75] China's operational stock of deployed industrial robots was over 2 million units as of 2024, more than five times the number of units in the United States at that time.[76] Fewer deployments can mean fewer opportunities to generate, capture, and iterate on operational datasets—raising the cost and time required to reach comparable performance.



Source: International Federation of Robotics[77]

China's low-cost alternatives to Western robotic systems have rapidly gained traction both domestically and globally, with their market share skyrocketing in the past five years. Though Japan remains the top exporter as of 2024,[78] China's cost-competitive systems are especially attractive in emerging robotics markets across the global south, such as India where robotic installations are expected to grow over 16% annually over the next five years and high startup costs are a key barrier.[79]

[75] Humanoid Robot Cost Structure Undergoes Major Shift, Tiger Brokers (2025).
[76] Global Robot Demand in Factories Doubles Over 10 Years, International Federation of Robotics (2025).
[77] Global Robot Density in Factories Doubled in Seven Years, International Federation of Robotics (2024).
[78] Trade Data, UN Comtrade Database (accessed 2026).
[79] India Industrial Robotics Market, Next Move Strategy Consulting (2025).

At the same time, the smaller manufacturing base in the United States leaves a larger potential addressable market that is projected to grow more rapidly than Asian and European markets, and increasing demand for collaborative and intelligent robotic software is likely to further boost the U.S. industry.[80] By 2027, industrial robotics revenue growth in the Americas is expected to outpace Asia, according to Interact Analysis.[81] If firms are incentivized to adopt robotics and automation as part of a push to expand American manufacturing, this higher adoption rate would reinforce these opportunities and make domestic supply chains more enticing.

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80 George Chowdhury, Global Robotics Market Outlook, ABI Research (2025).

81 Samantha Mou, Global industrial robot shipments declined in 2024, recovery expected in 2025, Interact Analysis (2025).

Talent Pipeline: China's Strength in Numbers Outcompetes U.S. Quality

Leader: China	***Trending Towards: China***

China is successfully scaling a massive "industrial army" through domestic academic expansion and a "reverse brain drain" of mid-to-senior level experts, yet it struggles to foster the open, meritocratic environment needed to retain the world's top 1% of researchers. In contrast, the United States maintains a lead in groundbreaking innovation but faces a critical structural labor gap and "geopolitical push" factors that are driving technical talent back to Chinese institutions. This creates a strategic crossroads where China's challenge is quality of high-level research, while the U.S. challenge is the sheer scale and alignment of its technical workforce.

Education

China is strengthening its talent pipeline through both domestic education and the repatriation of international experts. Leading institutions like Tsinghua University, Shanghai Jiao Tong University (SJTU), and Zhejiang University have significantly expanded their academic offerings, introducing specialized majors and programs to increase student engagement with AI and robotics.[82] Over the last decade, China has launched more than 7,500 new engineering majors, with nearly 100 dedicated to robotics, and holds over 190,000 robot-related patents.[83]

The United States has some of the most advanced and groundbreaking academic programs in the robotics and robotic software sectors, however it struggles with job placement and scale. As of 2024, the United States has been grappling with a structural labor gap that is projected to leave 2.4 million jobs unfilled by 2028.[84] This shortage of skilled workers is not limited to labor-intensive roles. Companies using or seeking to adopt robotic systems also urgently seek candidates who possess practical, hands-on technical skills like sensor calibration and software proficiency in Python or Robotic Operating System, alongside the soft skills necessary for

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82 Lee Chong Ming, China's Top Universities Plan to Roll Out 'Embodied Intelligence' Majors to Fuel Beijing's Robotics Push, Business Insider (2025).
83 Ryan Fedasiuk, Beijing's "Robot Army" Isn't Science Fiction. It's Already Here., American Enterprise Institute (2025).
84 Preparing the Manufacturing Workforce, ARM Institute (2025).

effective human-robot collaboration.[85] Ultimately, the most successful individuals in this field will be those who can navigate real-time troubleshooting and adapt to AI-integrated workflows with a blend of technical expertise and sound professional judgment. While the United States faces a skills misalignment, youth programs like FIRST Robotics, after school programs, competitions, and industry-led youth programming are teaching robotics programming and mechatronics to bridge the gap at an early age.

Talent Recruitment

In China, the trend among foreign-trained experts has shifted, resulting in a measurable "reverse brain drain." The Organisation for Economic Co-operation and Development (OECD) reports that since 2021, China has surpassed the United States in the net inflow of scientific researchers.[86] This influx is increasingly driven by a "geopolitical push" rather than solely financial incentives. Specifically, the Department of Justice's 2018 "China Initiative" created an atmosphere of suspicion that discouraged Chinese-American scientists from remaining in the United States, leading to a 75% increase in departures from U.S. institutions by 2023.[87] Many experts returned to China seeking career stability as much as funding. China's robotics labor market is also bringing in talent from regional countries with Beijing's recently introduced K-visa program, comparable to the U.S. H-1B visa, to attract skilled workers.[88] These strategies have been very effective in building a massive "industrial army" to staff companies like DJI, Unitree, and Ubtech with world-class engineers capable of rapid iteration.

The success of these programs, despite a high volume of returning engineers and talent, is complex. China effectively recruits from the "top 15%" of talent, who are considered highly productive mid-to-senior level engineers. However, it struggles to attract the "top 1%" of researchers, who often prefer the open, experimental environment of U.S. universities,[89]

[85] Lisa Masciantonio, Analyzing Current Trends in the Robotics Job Market, ARM Institute (2025).
[86] Reverse Brain Drain? Exploring Trends among Chinese Scientists in the U.S., Stanford Center on China's Economy and Institutions (SCCEI) China Briefs (2024).
[87] Chen Jing, How US Suspicion is Pushing Chinese Researchers into Beijing's Arms, Think China (2025).
[88] Chan Ho-Him, China Rolls Out its Version of the H-1B Visa to Attract Foreign Tech Workers, Associated Press (2025).
[89] Reverse Brain Drain? Exploring Trends among Chinese Scientists in the U.S., Stanford Center on China's Economy and Institutions (SCCEI) China Briefs (2024).

struggling with reintegration,[90] or perceive better job prospects outside of China. Returning Chinese talent frequently encounter an academic culture that prioritizes "guanxi" (relationships) over merit, and state funding often includes stringent requirements for immediate commercial viability, which impedes basic science research.[91] Nevertheless, contributing to the tendency of foreign talent to remain in the United States, a vast majority of the world's top talent in robotics and AI originates from China, and most of these experts work for American companies and universities.[92] As the new K-visa sparks interest from more skilled workers in India and Southeast Asia, local engineers and workers have started to feel threatened. This concern is likely a knee-jerk reaction to the sudden opportunity for foreign talent to consider China, but when given a choice, many job seekers still tend to prefer opportunities outside of China.

Upskilling

Despite China's increase in engineering programs and degrees, the resulting availability of skilled talent remains inadequate. The Made in China 2025 initiative focuses on upskilling existing highly skilled workers with specific technical abilities, rather than recruiting new talent.[93] To address this deficiency, there are intermittent efforts to find more talent in robotics and advanced manufacturing. For instance, in Shanghai, facilities like the ABB Robotics Training Center offer programs to better equip workers and those interested in the field with the skills needed to understand, operate, and improve robotic technology.[94] Similarly, Zhinanche Robot Technology in Nanjing runs short-term workshops to educate people interested in industrial automation, allowing students to practice as automation engineers upon completion.[95] While not as widespread as government-backed university degrees, these programs have proven essential in mitigating the existing mismatch between job market demands and the labor supply.

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[90] Ying Zhang, et al., Can Scientists Remain Internationally Visible after the Return to their Home Country? A Study of Chinese Scientists, Industry and Innovation (2025).

[91] Dan Liu, et al., Academic Career Development of Chinese Returnees With Overseas Ph.D. Degrees: A Bioecological Development Perspective, Frontiers in Psychology (2022).

[92] Cade Metz & Eli Tan, In the A.I. Race, Chinese Talent Still Drive American Research, New York Times (2025).

[93] Ricky Li & Ian Shine, The Future of Jobs in China: The Rise of Robotics and Demographic Decline are Opening up Skills Gaps, World Economic Forum (2025).

[94] ABB Robotic Training Center, ABB (2025).

[95] Jennifer Pak, Inside a Training Center That's Trying to Bridge China's Robotic Skills Gap, Marketplace (2025).

The United States lacks a coordinated approach to upskilling, largely due to a persistent misalignment between industry needs and external training programs.[96]

[96] Emmet Cole, Upskilling and Automation: Two Proven Solutions to the Labor Shortage, Association for Advancing Automation (2024).

National Leverage: China is Successfully Implementing a Coordinated Strategy

Leader: China	*Trending Towards: China*

	United States	China
POLITICAL MANDATE	Genesis Mission Executive Order, Robotics Roadmaps, Reidustrialization Goals	Five-Year Plans ("Made in China 2025"), National Industrial Targets
FUNDING MECHANISMS	Government-backed Programs, NSF, DOE, DoW, Tax Incentives	"Big Fund," National and Provincial Investment Guidance Funds
INDUSTRY COORDINATION	A3, ARM Institute, NIST	Pilot Zones, State-backed firms

The United States has the potential to develop a competitive strategy, but it currently lacks the unified national approach that China is successfully implementing to close its own gaps.[97] By developing a comprehensive strategy, the United States could leverage its software advantage to address its hardware limitations.

China's market dominance is reinforced by aggressive government support, notably through the 15th Five-Year Plan and "Big Fund," which accelerates the mass production of robots and ensures control over global component supply chains.[98] State-sponsored efforts through government subsidies at the local and provincial level have driven the robotics sector in China.[99] Furthermore, no other country has a national robotics strategy as comprehensive as China's. At both the national and local government levels, billions of dollars have been allocated to build

[97] Didi Tang & Matt O'Brien, US Robotics Companies Push for National Strategy, Including a Central Office, to Compete with China, Associated Press News (2025).
[98] Mark Minevich, How the U.S. Can Beat China in the Battle of the Robots, TIME (2025).
[99] Camille Bouellnois, et al., Far From Normal: An Augmented Assessment of China's State Support, Rhodium Group (2025); Jacob Gunter, et al., Beyond Overcapacity: Chinese-style Modernization and the Clash of Economic Models, MERICS (2025).

venture capital funds for robotics, AI, and other critical technologies.[100] China's major robotics players have close ties with the government. Efort is about one-third owned by provincial government guidance funds, and government entities and investment funds hold a more than 25% stake in Unitree, according to data from WireScreen.[101] Estun Automation is a defense contractor, with the People's Liberation Army (PLA) providing a customer base to support its robot manufacturing.[102]

In addition to a central political strategy and ambitious investment in robotics and related manufacturing companies, China presents an integrated whole-of-country system to intertwine industry with government and academia. Major robotics manufacturers like Siasun Robotics and Estun Automation depend on support from academia as they rise through the ranks and become more competitive among global robotics manufacturing leaders.[103] China's localized and growth-oriented safety regulation environment also bolsters its industry's ability to rapidly experiment, iterate, and deploy robotic systems.[104] While this creates substantial risks that U.S. and European regulations seek to mitigate, and could constrain certain exports, China is prepared to accept the risks to gain the experience and data needed to achieve its established strategic goals.

The United States, on the other hand, lacks a comprehensive national strategy for robotics. For decades, the robotics field in the United States has been fragmented, and collaboration between industry and the federal government is inadequate. Experts have proposed solutions requiring the two sectors to address the challenges facing U.S. robotics. U.S. trade associations have recommended measures such as tax incentives for robotics, federally funded programs, and a dedicated government office to prioritize robotics and advanced manufacturing.[105]

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[100] Robert D. Atkinson, et al., A Time to Act: Policies to Strengthen the US Robotics Industry, Information Technology and Information Foundation (2025).

[101] WireScreen database (accessed 2025).

[102] WireScreen database (accessed 2025).

[103] Who's Who China's Robotics Industry, The Wire China (2025); Martin Casado & Anne Neuberger, America Cannot Lose the Robotics Race, Andreessen Horowitz (2025).

[104] Tao Mingyang, China's MIIT Sets Up Standardization Committee for Humanoid Robots to Reinforce Sector's Global Competitiveness, Global Times (2025); The Rise of China's Robotics Industry: Modernize or Perish!, Asian Robotics Review (2025).

[105] Greg Bock, Is China Winning the Race for Robotics, AI Insider (2025).

However, despite years of efforts to create strategy and roadmaps, the lack of breakthrough federal legislation supporting the industry and regulatory burdens continue to create bottlenecks to progress. The initial steps for the United States to gain a strategic advantage are slowed down by a process involving numerous, inefficient, and largely un-automated regulatory approvals.[106] The recently announced Genesis Mission represents a positive step for robotics with the aim to double the productivity and capabilities of American engineering and science.[107] This timely call-to-action offers a moment for U.S. scientific discovery to bolster the federal government's approach to robotics technologies.[108]

One key factor differentiating the U.S. and Chinese approaches is the difference in public perception and political accountability. In the United States, public skepticism creates significant political friction, as policymakers struggle to balance the need for global competitiveness against intense concerns over job displacement and labor rights. Conversely, China views automation as an existential necessity to address its shrinking workforce and aging population, resulting in high public trust and a unified, state-led strategy that prioritizes rapid deployment.[109] Ultimately, while the United States is slowed by internal debates over the societal impact of robots, China's primary barriers are external, centered on international tech sanctions and semiconductor shortages.[110]

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[106] Martin Casado and Anne Neuberger, America Cannot Lose the Robotics Race, Andreessen Horowitz (2025).
[107] John Josephakis, NVIDIA, US Government to Boost AI Infrastructure and R&D Investments Through Landmark Genesis Mission, NVIDIA (2025).
[108] Navin Girishankar & Chris Borges, The Genesis Mission: Can the United States' Bet on AI Revitalize U.S. Science?, Center for Strategic and International Studies (2025).
[109] John Power, Trust in AI Far Higher in China Than in the West, Poll Shows, Aljareeza (2025).
[110] Kyle Chan, et al., China's Evolving Industrial Policy for AI, RAND (2025).

Outlook: China’s Dominance Likely to Grow Absent Concerted U.S. Effort

China’s strengths and trajectory across all of the facets of robotics leadership suggest that not only will it maintain its superiority over the United States in this arena, it is likely to challenge for global leadership against the Asian and European robotics giants within just a few years. The United States, on the other hand, will not be able to overcome its weaknesses overnight. It will take a cohesive national framework and years of sustained investment to rebuild the U.S. robotics supply chain, incentivize adoption, and cultivate the required human capital. Until then, the United States has minimal surge capacity in automation-intensive manufacturing and is exposed to significant economic and security vulnerabilities.

Wildcards and Areas to Watch

Will China Decouple from the U.S. Robotic “Brain”?

China’s emphasis on open-source models and progress toward creating competitive domestic alternatives to the U.S.-created open source Robot Operating System could drastically accelerate China’s robotics capabilities and displace U.S. and Western leadership in specialized, high-tech segments. New open-source vision-language-action models, for example those released by DeepSeek and Alibaba Qwen, lower the barrier to entry for Chinese domestic robotics hardware firms by eliminating licensing fees and reducing the need to hire expensive technical talent. Chinese firms and state-backed open-source foundations are also advancing novel domestic robotics middleware, such as M-Robots OS, a robot operating system built on OpenHarmony by Open Atom Open Source Foundation and Shenzhen Kaihong.

If these operating systems become the common ‘language’ for robots in China, a separate Chinese software stack becomes not just viable, but potentially dominant given China’s majority global market share.

Will Humanoid Robots Prove Vital to Next-Gen Industrial Capacities?

Humanoid robots have captured the public imagination in recent years, and several companies are betting on industrial humanoids as the next leap in advanced manufacturing automation. Proponents of humanoids in this sector argue that the ability of these intelligent robots to backfill spaces designed for humans in existing factories without capital intensive retrofitting make them attractive to a broad swath of companies.[111] Many questions remain as to if humanoids will be able to achieve the performance standards that would allow them to fulfill this promise, or if they will ultimately be seen as a flashy distraction.[112]

If humanoids do prove to be the future of industrial robotics, China has established a formidable lead. In the past five years, Chinese companies have commercially launched 6 humanoid robot models while just two are available from the United States.[113] China continues to lead in unveiling new prototypes, previewing 34 models in 2024, outpacing the 8 announced in the United States.[114] Mass production of humanoids in China has dramatically lowered costs compared to the low-value prototype models available from U.S. companies.[115] Chinese humanoid models like the Unitree G1 and H1 have demonstrated walking speeds and stability recovery that rival or exceed top-tier U.S. hardware.[116] China has filed 7,705 humanoid patents over the last five years—five times the U.S. total of 1,561.[117]

There is still opportunity for the United States to strengthen its position in this field. The goal for humanoids to operate flexibly in unstructured environments fits with typical U.S. strengths. The recent announcement that Hyundai factories in the United States plan to deploy Boston Dynamics' Atlas humanoid starting in 2028 signals a shift from prototyping to testing that will create more opportunities for iteration and progress in U.S. systems.[118]

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111 Top 5 Robotics Trends for 2026, International Federation of Robotics (2026).

112 Sean McLain, Even the Companies Making Humanoid Robots Think They're Overhyped, Wall Street Journal (2025).

113 List of Humanoid Robots (accessed 2026).

114 Adam Jones, et al., The Humanoid 100: Mapping the Humanoid Robot Value Chain, Morgan Stanley (2025).

115 Dean Fankhauser, Unitree G1 vs. Boston Dynamics Atlas: Your Guide, Robozaps (2025).

116 Andrew Paul, Oh Good, The Humanoid Robots are Running Even Faster Now, Popular Science (2024).

117 China Races Ahead of US in Humanoid Robot Patents over 5 years, Tech in Asia (2025).

118 Heekyong Yang & Abhirup Roy, Hyundai Motor Group Plans to Deploy Humanoid Robots at US Factory from 2028, Reuters (2025).

Will China Escalate Retaliatory Measures to Undermine U.S. Efforts at Reindustrialization?

Given its virtual monopoly on a range of inputs for robotics components, such as rare earth minerals processing and low-end hardware subcomponents, China has significant geoeconomic leverage. Should Beijing choose to weaponize this leverage it could starve nascent American robotics startups of essential hardware, forcing them to rely on inferior substitutes or face prohibitive delays that stall innovation cycles. Throughout 2025, China has made evident its willingness to use the leverage of its supply chain chokeholds to push back against U.S. policies with various rounds of rare earth and magnet restrictions,[119] raising the risk that the U.S. robotics sector could be a casualty of future geopolitical tension.

Will Materials and Intelligence Breakthroughs Negate Specialized Hardware?

Current technological research has the potential to loosen the chokepoints of the robotic hardware stack that pose challenges for the United States. On the materials science side, a breakthrough in magnet-free motors such as switched reluctance motors or magnets made from common materials like iron nitride magnets could bypass the China-centric rare earth supply chain entirely.[120] A step-change in artificial intelligence for robotic control could have a similar effect if advanced software is able to help achieve some robotic tasks on basic, less precise hardware that could be sourced from non-specialized factories.

[119] Gracelin Baskaran, China's New Rare Earth and Magnet Restrictions Threaten U.S. Defense Supply Chains, Center for Strategic and International Studies (2025).

[120] Motors without Rare Magnets: What are the Options?, Power Transmission Engineering (2019).

Appendix: Tech Scorecard Scorecard Matrix

The Tech Scorecard relied on expert scoring of quantitative and qualitative data across many technology-specific metrics relevant to each category of positional advantage in robotics for advanced manufacturing. Final scores were determined by a weighted average of the below metric scores. The 1-to-5 ranking corresponds to the following rubric:

1 - Negligible / Nascent: The country has minimal presence or capability in this metric. The data point is insignificant on a global scale.

2 **- Emerging / Minor:** The country is active but below the global average or industry standard. They are followers or niche players. Performance is functional but clearly inferior to top-tier competitors.

3 - Competitive / Mainstream: The country operates at the global industry standard. The metric represents a healthy, functioning ecosystem that meets current market needs but does not differentiate itself as superior.

4 - Advanced / Leading: The country is among the top tier globally. The metric shows performance, scale, or quality that exceeds the average and rivals the best.

5 - State-of-the-Art / Dominant: The country sets the global benchmark. This metric represents the absolute peak of what is currently possible.

	Metric	Source(s)	Weight	U.S. Score	China Score
Innovation Leadership	**Share of research papers in top journals**	The Nature Index	Low	3	4
	Research impact (citations per article)	Center for Security and Emerging Technologies, Map of Science	Low	4	3
	Recognition of top innovation	Robot Report Innovation Awards 2025	Low	5	2
	Number of patents	Center for Security and Emerging Technologies	Low	3	5
	Repeatability and precision capabilities	SCSP Expert Survey	Medium	4	4
	Speed of movement	SCSP Expert Survey	Medium	3	4
	Average task completion time	SCSP Expert Survey	Medium	4	5
	Reliability and Mean Time Between Failure (MTBF)	SCSP Expert Survey	Medium	4	3
	Leadership in Vision-Language-Action (VLA) Models	Industry Studies - Andreessen Horowitz, 36Kr	High	5	3
	AI and machine learning integration	SCSP Expert Survey	High	4	4
	Sensor and perception systems	SCSP Expert Survey	High	5	4
	Simulation-to-Real success rate	SCSP Expert Survey	High	4	3
	Real-world training data availability	SCSP Expert Survey	High	3	4

Industrial Capacity	**Annual number of robots manufactured domestically**	China National Intellectual Property Administration; UN COMTRADE	High	2	4
	Share of domestic demand filled with domestically produced robots	International Federal of Robotics, World Robotics Report	High	2	4
	Domestic production of reducers	Industry Studies - HD Harmonic; SCSP Expert Survey	Medium	1	3
	Domestic production of Servo motors	Industry Studies - Mordor Intelligence; SCSP Expert Survey	Medium	3	4
	Domestic production of controllers	Industry Studies - MIR Databank; SCSP Expert Survey	Medium	3	4
	Domestic production of advanced sensors	Industry Studies - FDD Action, China Market Insider; SCSP Expert Survey	Medium	4	4
	Access to critical minerals for magnets	New York Times	Medium	1	5
	Precision machining capabilities	SCSP Expert Survey	Low	4	5
	Metallurgy capabilities	SCSP Expert Survey	Low	4	4
Market Ecosystem	**Domestic industrial robot installation market size**	International Federal of Robotics, World Robotics Report	Medium	3	5
	Market growth projection	ABI Research	Low	4	3

	Share of global industrial robotics exports	UN COMTRADE	High	3	4
	Number of companies	Pitchbook	Low	4	4
	Private investment	Pitchbook; GlobalData	High	5	3
	Cost competitiveness of industrial robot components	Morgan Stanley	Medium	2	5
	Robot density (per 10,000 manufacturing workers)	International Federal of Robotics, World Robotics Report	Medium	3	4
	Total operational stock of industrial robots	International Federal of Robotics, World Robotics Report	Low	3	5
Talent Pipeline	**STEM PhD graduates**	Center for Security and Emerging Technologies	Medium	2	3
	Students in robotics higher education programs	National Information Society Agency	Low	3	4
	Technician / operator training programs	SCSP Expert Survey	High	2	4
	Availability of opportunities in robotics	Bureau of Labor Statistics; SCSP Expert Survey	High	2	2
	Job placement of foreign trained experts	National Science Foundation	Low	4	2
	Youth robotic awareness programs	SCSP Expert Survey	Low	4	4
National Leverage	**Strength of government strategy (goals, timeline, funding)**	SCSP Expert Survey	High	2	5

	Government funding for robotics research	International Federal of Robotics, World Robotics Report; Public Spend Forum	Medium	5	3
	Quality of subsidies for robot production	SCSP Expert Survey	Medium	2	4
	Quality of subsidies for robot adoption	SCSP Expert Survey	Medium	2	5
	Strength of subnational strategies	SCSP Expert Survey	Medium	3	5
	Public sentiment towards robotic automation (ie, political feasibility)	SCSP Expert Survey	Medium	2	4
	Sway in international robotics associations	SCSP Expert Survey	Low	4	3
	Cohesion of domestic industry associations	SCSP Expert Survey	Medium	3	5