Morgan Stanley

INVESTMENT MANAGEMENT

Counterpoint Global Insights

Embodied AI and the Rise of Humanoid Robots

EDGE | JANUARY 2026

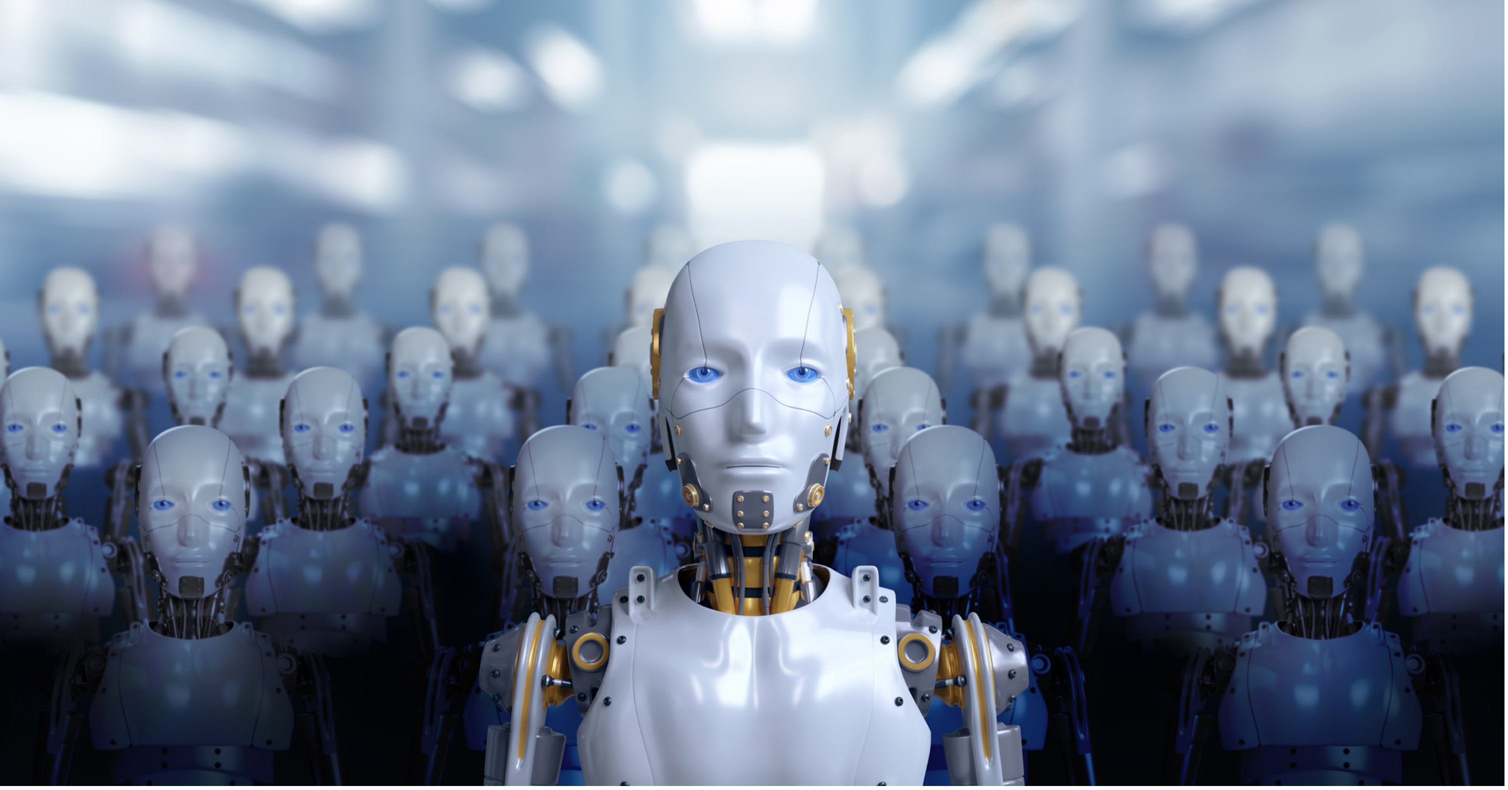
WELCOME TO THE EDGE.
Morgan Stanley Investment Management's Counterpoint Global, shares their proprietary views on big ideas that have the potential to trigger far-reaching consequences—ideas such as blockchain, autonomous vehicles, machine learning and gene editing.

Counterpoint Global's long-term ownership mindset emphasizes perspective and cross-disciplinary thinking, while our investment process focuses on identifying unique companies with sustainable competitive advantages. Through the EDGE, we share our framework for thinking about change and our process for recognizing patterns that may drastically alter the investment landscape over the long term.

This work complements our team's more traditional, fundamental research to create a framework for long-term investing that is grounded in intellectual curiosity and flexibility, perspective, self-awareness and partnership.

Humanoid robots—robots designed with human-like form, dexterity, and mobility—are emerging as a potentially significant technological development. Historically, robots have excelled in structured industrial settings, performing repetitive and predictable tasks. However, nearly all physical spaces—from tools to workstations to transportation systems—have been shaped around human proportions and behaviors. Tools, workspaces, transportation methods, and daily objects are tailored to human geometry, perception, and motion. A machine that can move and function effectively in environments designed for humans—without requiring structural changes—marks a notable departure from the constraints of past automation.

Recent advances in artificial intelligence, particularly in vision-language models (VLMs), reinforcement learning, and simulation, are expanding the feasible capabilities of robots operating in dynamic environments. As a result, humanoid robotics is transitioning from long-term aspiration to near-term industrial experimentation.



Historical Context and Technological Shift

Early robotics, dating back to the 1960s, largely revolved around fixed industrial machines built to perform repetitive tasks in tightly structured settings. Subsequent decades introduced mobile robots and improved perception systems, enabling broader applications across logistics and warehousing. Despite meaningful progress, these systems remained narrow in capability and were generally confined to environments engineered for their constraints.

The current evolution is distinguished by the integration of AI-driven generalization into physical systems. Humanoid robots seek to replicate key elements of human mobility and manipulation—including bipedal locomotion and fine motor dexterity—to operate across unstructured settings. By pairing adaptable AI with a body plan shaped for human spaces, humanoid systems can operate in everyday environments without the extensive restructuring that earlier robotic platforms often required.

This shift is reinforced by an unexpected factor: social acceptance. Robots with human-like proportions often feel more approachable and easier for people to interact with, which can help reduce friction during workplace adoption. Over time, these social dynamics may ease deployment and increase the viability of humanoids in customer-facing or collaborative roles.

Economic Drivers and the Case for Humanoids

The macroeconomic backdrop strengthens the case for humanoid robotics. Labor markets in developed economies have experienced persistent shortages; in the G7, job vacancies per unemployed person have increased approximately fourfold since 2010. Industries reliant on physically demanding, repetitive, or hazardous tasks—such as manufacturing, logistics, inspection, and facility operations—have faced particular challenges in filling roles.

Humanoid robots present a potential solution for several reasons. First, they operate within existing human infrastructure, reducing or eliminating the cost of reconfiguring work environments. Second, they can theoretically cover multiple shifts without fatigue, potentially lowering unit labor costs over time. Third, they allow companies to offload tasks that pose safety risks to human workers, reducing injuries and associated costs.

AI advancements are also lowering the barrier to broader utility. High-fidelity simulation, a realistic and immersive training method, now allows robots to practice motor behaviors at scale, while reinforcement learning and multimodal models enhance their ability to interpret surroundings and plan multi-step actions. These tools collectively expand the range of tasks robots can perform and enhance their adaptability to real-world variability.

Taken together, these dynamics create a foundation for potential early adoption in industrial and logistics settings, where the combination of labor scarcity, safety considerations, and repetitive workflows align well with the capabilities of emerging humanoid systems.

The Architecture of Embodied Intelligence

Humanoid robots rely on the integration of two distinct layers of intelligence:

LOW-LEVEL MOTOR CONTROL (THE "LIZARD BRAIN")

This layer governs balance, gait, reflexes, and real-time coordination, requiring rapid processing at frequencies up to several hundred hertz. Progress in simulation-to-real transfer and reinforcement learning has materially improved lower-body stability and whole-body control, allowing robots to walk, recover from disturbances, and manipulate objects with increasing reliability.

HIGH-LEVEL COGNITIVE REASONING (THE "CEREBRUM")

The cognitive layer focuses on perception, planning, and decision-making. Vision-language models combine visual input with language-based reasoning to interpret scenes, follow instructions, and structure multi-step tasks. However, this layer remains the most significant constraint. Current systems exhibit limited model generalization outside trained contexts and degrade when encountering novel environments. The gap between task-specific competence and broad adaptability remains a central challenge for developers.

To conceptualize maturity, researchers often use a three-level taxonomy:

- **LEVEL 1:** Task-Specific Execution – performing predefined actions with minimal adaptability; dominant state of commercial humanoids today.
- **LEVEL 2:** Task Generalization – adapting skills to new but related scenarios using sensory input and learned priors; current research frontier.
- **LEVEL 3:** Generalized Intelligence – autonomously learning new tasks from demonstration or observation; an aspirational capability requiring significant advances in data, reasoning, and physical control.

Underlying this framework is a common bottleneck: the need for large-scale, high-quality, human-centered data. Current collection methods, such as teleoperation and motion capture, are slow and expensive. Developers increasingly believe that scaled real-world deployment may be necessary to generate the diversity of data required for reliable generalization, paralleling the learning flywheel seen in autonomous vehicles.

Market Potential and Path to Adoption

Viewing the opportunity through the lens of tasks currently performed by people suggests an addressable market of enormous scale, potentially spanning several trillions of dollars. Yet this framing may underestimate the long-term potential. As humanoids become more capable and cost-effective, they could assume tasks that are not economically viable for human labor, enabling new categories of productivity. In this scenario, the number of robots deployed could eventually exceed the number of human workers.

Importantly, meaningful unit volume growth is not expected until the end of the decade. The first meaningful deployments will likely occur in controlled industrial settings, where workflows are stable, infrastructure is uniform, and ROI is easiest to demonstrate. These early deployments may serve not only as proof points but also as critical data-generation engines, accelerating the learning cycles needed for broader application.

Over time, as hardware costs decline, reliability improves, and cognitive models generalize more effectively, humanoids may expand into more complex roles across manufacturing, logistics, retail operations, and potentially consumer applications. However, the pace of expansion will depend heavily on progress in AI generalization and the development of regulatory, safety, and operational frameworks.

Risks and Constraints

Several risks may impede or delay the widespread adoption of humanoid robots:

1. **AI GENERALIZATION LIMITATIONS:** High-level reasoning models struggle with variability and unforeseen scenarios. Without robust generalization, robots may remain confined to narrow applications.
2. **DATA SCARCITY AND QUALITY:** The scale of data required to train reliable embodied systems is far greater than what currently exists. Collecting this data is expensive and operationally challenging.
3. **MECHANICAL AND SYSTEM RELIABILITY:** Bipedal locomotion and dexterous manipulation introduce mechanical fragility. Industrial environments demand durability, uptime, and predictable performance, all of which remain evolving targets.
4. **ECONOMIC VIABILITY:** Early units may be costly, and adoption depends on achieving cost curves that make humanoids competitive with or superior to human labor. The timing of this transition is uncertain.
5. **DEPENDENCE ON FUTURE AI CAPABILITIES:** Fully general-purpose robots may require advances approaching artificial general intelligence (AGI), the timeline for which is indeterminate.

These challenges indicate that humanoid development may follow a path similar to autonomous vehicles—significant technical leaps that take longer than anticipated to translate into widespread commercial use.

Conclusion

Humanoid robots sit at the intersection of rapid AI progress, advances in mechanical design, and meaningful changes in global labor dynamics. The technology is still in its early stages, but the rationale for exploration is compelling: robots capable of operating in human-centered environments without costly redesign could fundamentally reshape industrial workflows and labor allocation.

The path forward will likely involve incremental commercial deployment, significant data accumulation, and sustained innovation in both AI and hardware. While uncertainties remain substantial, the long-term implications—economic, operational, and societal—could be profound. For investors and enterprises, humanoid robotics merits careful observation as a potentially transformative frontier of embodied artificial intelligence.

Risk Considerations

There is no assurance that a Portfolio will achieve its investment objective. Portfolios are subject to **market risk**, which is the possibility that the market values of securities owned by the Portfolio will decline and that the value of Portfolio shares may therefore be less than what you paid for them. Market values can change daily due to economic and other events (e.g. natural disasters, health crises, terrorism, conflicts and social unrest) that affect markets, countries, companies or governments. It is difficult to predict the timing, duration, and potential adverse effects (e.g. portfolio liquidity) of events. Accordingly, you can lose money investing in this Portfolio. Please be aware that this Portfolio may be subject to certain additional risks. In general, **equities securities'** values also fluctuate in response to activities specific to a company. Investments in **foreign markets** entail special risks such as currency, political, economic, market and liquidity risks. The risks of investing in **emerging market countries** are greater than risks associated with investments in foreign developed countries. **Privately placed and restricted securities** may be subject to resale restrictions as well as a lack of publicly available information, which will increase their illiquidity and could adversely affect the ability to value and sell them (liquidity risk). **Derivative instruments** may disproportionately increase losses and have a significant impact on performance. They also may be subject to counterparty, liquidity, valuation, correlation and market risks. **Illiquid securities** may be more difficult to sell and value than public traded securities (liquidity risk).

FMIL (Amsterdam Branch), Rembrandt Tower, 11th Floor Amstelplein 1 1096HA, Netherlands. **France**: MSIM FMIL (Paris Branch), 61 rue de Monceau 75008 Paris, France. **Spain**: MSIM FMIL (Madrid Branch), Calle Serrano 55, 28006, Madrid, Spain. **Germany**: MSIM FMIL Frankfurt Branch, Große Gallusstraße 18, 60312 Frankfurt am Main, Germany (Gattung: Zweigniederlassung (FDI) gem. § 53b KWG). **Denmark**: MSIM FMIL (Copenhagen Branch), Gorrissen Federspiel, Axel Towers, Axeltorv2, 1609 Copenhagen V, Denmark.

MIDDLE EAST

Dubai International Financial Centre: This information does not constitute or form part of any offer to issue or sell, or any solicitation of any offer to subscribe for or purchase, any securities or investment products in the UAE (including the Dubai International Financial Centre and the Abu Dhabi Global Market) and accordingly should not be construed as such. Furthermore, this information is being made available on the basis that the recipient acknowledges and understands that the entities and securities to which it may relate have not been approved, licensed by or registered with the UAE Central Bank, the Dubai Financial Services Authority, the UAE Securities and Commodities Authority, the Financial Services Regulatory Authority or any other relevant licensing authority or government agency in the UAE. The content of this report has not been approved by or filed with the UAE Central Bank, the Dubai Financial Services Authority, the UAE Securities and Commodities Authority or the Financial Services Regulatory Authority.

Saudi Arabia

This financial promotion was issued and approved for use in Saudi Arabia by Morgan Stanley Saudi Arabia, Al Rashid Tower, Kings Sand Street, Riyadh, Saudi Arabia, authorized and regulated by the Capital Market Authority license number 06044-37.

U.S.

NOT FDIC INSURED | OFFER NO BANK GUARANTEE | MAY LOSE VALUE | NOT INSURED BY ANY FEDERAL GOVERNMENT AGENCY | NOT A DEPOSIT

LATIN AMERICA (BRAZIL, CHILE, COLOMBIA, MEXICO, PERU, AND URUGUAY)

This material is for use with an institutional investor or a qualified investor only. All information contained herein is confidential and is for the exclusive use and review of the intended addressee, and may not be passed on to any third party. This material is provided for informational purposes only and does not constitute a public offering, solicitation or recommendation to buy or sell for any product, service, security and/or strategy. A decision to invest should only be made after reading the strategy documentation and conducting in-depth and independent due diligence.

ASIA PACIFIC

Hong Kong: This document has been issued by Morgan Stanley Asia Limited, CE No. AAD291, for use in Hong Kong and shall only be made available to "professional investors" as defined under the Securities and Futures Ordinance of Hong Kong (Cap 571). The contents of this document have not been reviewed nor approved by any regulatory authority including the Securities and Futures Commission in Hong Kong. Accordingly, save where an exemption is available under the relevant law, this document shall not be issued, circulated, distributed, directed at, or made available to, the public in Hong Kong.

Singapore: This material is disseminated by Morgan Stanley Investment Management Company, Registration No. 199002743C. This material may not be circulated or distributed, whether directly or indirectly, to persons in Singapore other than to (i) an accredited investor , (ii) an institutional investor as defined in Section 4A of the Securities and Futures Act, Chapter 289 of Singapore ("SFA"); or (iii) otherwise pursuant to, and in accordance with the conditions of, any other applicable provision of the SFA. This publication has not been reviewed by the Monetary Authority of Singapore.

Australia: This material is provided by Morgan Stanley Investment Management (Australia) Pty Ltd ABN 22122040037, AFSL No. 314182 and its affiliates and does not constitute an offer of interests. Morgan Stanley Investment Management (Australia) Pty Limited arranges for MSIM affiliates to provide financial services to Australian wholesale clients. This material will not be lodged with the Australian Securities and Investments Commission.

JAPAN

For professional investors, this material is circulated or distributed for informational purposes only. For those who are not professional investors, this material is provided in relation to Morgan Stanley Investment Management (Japan) Co., Ltd. ("MSIMJ")'s business with respect to discretionary investment management agreements ("IMA") and investment advisory agreements ("IAA"). This is not for the purpose of a recommendation or solicitation of transactions or offers any particular financial instruments. Under an IMA, with respect to management of assets of a client, the client prescribes basic management policies in advance and commissions MSIMJ to make all investment decisions based on an analysis of the value, etc. of the securities, and MSIMJ accepts such commission. The client shall delegate to MSIMJ the authorities necessary for making investment. MSIMJ exercises the delegated authorities based on investment decisions of MSIMJ, and the client shall not make individual instructions. All investment profits and losses belong to the clients; principal is not guaranteed. Please consider the investment objectives and nature of risks before investing. As an investment advisory fee for an IAA or an IMA, the amount of assets subject to the contract multiplied by a certain rate (the upper limit is 2.20% per annum (including tax)) shall be incurred in proportion to the contract period. For some strategies, a contingency fee may be incurred in addition to the fee mentioned above. Indirect charges also may be incurred, such as brokerage commissions for incorporated securities. Since these charges and expenses are different depending on a contract and other factors, MSIMJ cannot present the rates, upper limits, etc. in advance. All clients should read the Documents Provided Prior to the Conclusion of a Contract carefully before executing an agreement. This material is disseminated in Japan by MSIMJ, Registered No. 410 (Director of Kanto Local Finance Bureau (Financial Instruments Firms)), Membership: the Japan Securities Dealers Association, The Investment Trusts Association, Japan, the Japan Investment Advisers Association and the Type II Financial Instruments Firms Association.

Explore our site at **www.morganstanley.com/im**