

THE HUMANOID ISSUE

Bodies, Brains *and* the Real World

The global humanoid race is accelerating. Building a capable machine is only one part of the problem — the winners must combine reliable bodies, adaptable intelligence and commercially viable deployment.

THE HUMANOID ISSUE

Bodies, Brains and the Real World

The state of AI-powered humanoid robots — where the industry has arrived, and how far it still is from the general-purpose autonomous worker of company visions.

BY ALAN SHIMEL

FOUNDER & CEO, TECHSTRONG GROUP

EPIGRAPH

"The humanoid era will not be defined by the first robot that walks naturally. It will be defined by customers repeatedly paying robots to perform useful work without a human quietly standing behind the curtain."

THE PREMISE OF THIS REPORT

ABOUT THIS REPORT

An evidence review of the humanoid robotics industry as it moves from lab demonstration to bounded commercial deployment. It proposes an editorial framework for autonomy and deployment, tests it against the best-documented programs at GXO, BMW, Longcheer, UBTech and others, and asks what a productive humanoid worker actually is.

HOW TO READ THE DATA

Figures are labeled by source. **Independent** figures come from IFR, government agencies and analyst firms.

Customer-reported figures come from the deploying enterprise.

Vendor-reported figures are company claims. All figures as of Aug. 17, 2026.

EDITORIAL NOTE

The essay is the author's own. Statistics are reproduced as published. Company-reported success rates and productivity claims are labeled and should not be read as audited results.

THE REPORT IN FIVE PARTS

- I. A working definition and the three systems that must mature together.
- II. Fifty years of humanoid history and why now is different.
- III. The Techstrong Autonomy Scale and the deployment ladder.
- IV. The global humanoid race — regional strengths and the strategic gap.
- V. Economics, risks, and three plausible futures.

13,318

Estimated global humanoid shipments in 2025 · Omdia

100K+

Totes moved by Agility's Digit at a GXO facility · Agility Robotics

1,250 hrs

Figure 02 operating hours across ~10 months at BMW · BMW Group

30–50%

UBTech Walker S2 productivity vs. human on selected tasks · Financial Times

140+

Chinese humanoid manufacturers in 2025 · MIIT / Xinhua

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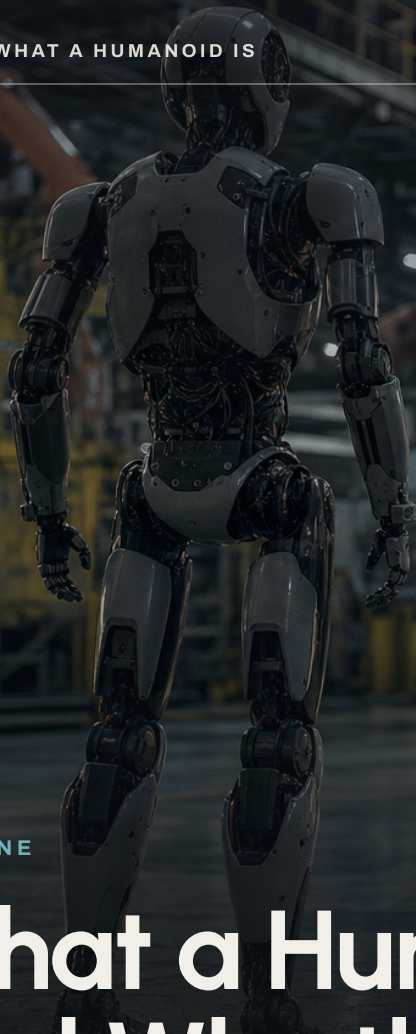
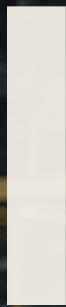
Humanoid robotics has moved out of the laboratory and onto factory and warehouse floors. Chinese manufacturers are producing thousands of machines. American companies are attracting billions to combine advanced bodies with foundation models. Automakers and logistics operators are signing agreements and beginning to collect the physical-world data needed to train the next generation.

The industry is progressing — but it is scaling *bodies* faster than it is proving *autonomous labor*.

This report proposes a three-part equation for a commercially useful humanoid, tests it against the best-documented deployments at GXO, BMW, Longcheer and others, and asks the question the field must finally answer: how independently can these machines actually work?

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PART ONE

What a Humanoid Is, and Why the Category Exists

A humanoid robot is not one product. It is three interlocking systems — **body**, **intelligence and deployment** — that must mature at roughly the same time for the machine to become a useful worker. This section lays out the equation that structures the rest of the report.

IN THIS PART

Executive Summary

The state of the industry in one page, with the five findings that define it.

A Working Definition

What separates a humanoid from an industrial arm — and what it inherits from both.

The Three-Part Equation

Body + Intelligence + Deployment. Weakness in any one halts the other two.

EXECUTIVE SUMMARY

Bodies are scaling faster than autonomous labor is being proved.

Humanoid robotics has moved out of the laboratory and onto the factory and warehouse floor. Chinese manufacturers are producing thousands of machines. American companies are attracting billions of dollars in investment to combine sophisticated hardware with foundation models. Automakers and logistics operators are signing multi-year agreements and beginning to collect the physical-world data required to train the next generation of systems.

This report argues that the industry is progressing, but that it is scaling *bodies* considerably faster than it is proving *autonomous labor*. There is no independent, peer-reviewed benchmark for the productivity or reliability of a humanoid at work. Public evidence is dominated by manufacturer-published totals, customer-reported operating hours and demonstration videos that are not standardized across companies.

Those are meaningful accomplishments. They are not yet economics.

A commercially useful humanoid, this report proposes, is a combination of three systems: a durable, safe, energy-efficient body; adaptable intelligence capable of learning across tasks; and a deployment path — customers, integrators, service organizations and support economics — that turns capability into recurring work.

Tested against that equation, the best-documented programs are impressive but bounded. Agility Robotics' Digit is moving totes at a Georgia facility for GXO under a multi-

year agreement. Figure has logged more than a thousand hours of operating time inside a BMW plant in Spartanburg. AgiBot's A2 has been deployed on Longcheer electronics lines and is being reported through customer-published task counts. UBTech's Walker S2 became the first humanoid to contribute a disclosed line to a listed company's revenue.

Every one of those deployments is narrow. Every one still depends on human supervision for exception handling, mobile-manipulation edge cases and safety oversight. That is not a criticism of the programs — it is the honest current state of the field.

The competitive question is not who ships the most units. It is who first proves, transparently, that a humanoid can perform useful work at a lower cost per productive hour than the alternative, with the reliability, safety and maintenance profile a customer will renew.

China is scaling bodies and manufacturing capacity. The United States is scaling investment in intelligence and platform partnerships. Europe, Japan and South Korea are scaling manufacturing discipline and safety practice. The strategic prize is the intersection.

The rest of this report translates that thesis into a working definition, a half-century of context, an autonomy framework, a deployment ladder, the best-documented case studies and the operating metrics the industry should be measured against next.

"The humanoid era will not be defined by the first robot that walks naturally. It will be defined by customers repeatedly paying robots to perform useful work without a human quietly standing behind the curtain."

— THE PREMISE OF THIS REPORT

KEY FINDINGS

Five things the field's own numbers say.

FINDING 01

Bodies are ahead of brains.

Chinese suppliers now ship humanoid platforms in the thousands. Independent Omdia estimates put 2025 global shipments at roughly **13,318 units**, led by AgiBot and Unitree. But independent evaluations of autonomous, multi-task, on-the-job performance remain the exception.

FINDING 02

The best programs are narrow.

Agility at GXO, Figure at BMW, AgiBot at Longcheer and UBTech's Walker S2 are the most-documented deployments. All are structured, bounded and still human-supervised. None are yet general-purpose autonomous workers.

FINDING 03

Customer voice is the new signal.

The most credible numbers of 2025 came from operators — GXO's tote totals, BMW's operating hours, Longcheer's task counts. Vendor demonstrations without customer confirmation should not be read as evidence of deployment.

FINDING 04

The industry has an autonomy gap.

Almost every commercially relevant 2026 humanoid operates at **L1–L2** on the Techstrong Humanoid Autonomy Scale — task-narrow autonomy with human oversight. The move to L3, in which a machine plans across tasks and handles exceptions on its own, is the meaningful technical frontier.

FINDING 05

Economics will decide the winners.

Nobody has yet published an audited, apples-to-apples cost per productive hour for a humanoid worker under supervised conditions. Whoever discloses it first, with credible independent verification, will set the industry's benchmark — and its pricing power.

THE FRAME THIS REPORT USES

Body · Intelligence · Deployment

A humanoid becomes commercially useful only when all three mature together. This report tests the leading programs against that equation and asks which regions and companies are closest to closing it.

A WORKING DEFINITION

What Is an AI-Powered Humanoid Robot?

In this report, an **AI-powered humanoid robot** is a machine that satisfies four practical criteria. It is *bipedal or nearly bipedal*, so it can enter facilities designed for people. It has *a torso, two arms and dexterous end-effectors*, so it can lift, carry and manipulate the objects human workers already handle. It is *controlled by learning-based intelligence* — not a rigid, pre-programmed sequence of joint angles. And it is designed for *real-world tasks*, not laboratory demonstrations.

That last criterion is the one the industry too often skips. A machine that walks impressively in a controlled environment is a demonstration. A machine that repeatedly performs useful, paid work — at acceptable cost, safety and reliability — is a product. The gap between the two is what this report calls the deployment gap.

The humanoid form is not sentimental. It is a hedge against the cost of re-designing environments. Warehouses, factories, hospitals, laboratories, retail floors and homes are built around human proportions — door widths, tote sizes, stair heights, tool handles, shelving depths, seat clearances. A machine that fits those proportions can be dropped into existing workflows with far fewer facility changes than a purpose-built system requires.

Foundation models added the ingredient the field lacked for 50 years. Traditional robots were programmed for specific tasks: to pick a specific object from a specific location using a specific gripper. Move the object two inches, or introduce a new variation, and the program fails. Foundation models — including large language models and, more importantly, vision-language-action models — appear to give humanoids something closer to generalizable, task-flexible behavior.

The transformation is real, but it is not complete. The models still hallucinate. Fine motor control at speed remains difficult. Battery and thermal budgets are tight. Safety cases for close human-robot collaboration are still being written. What is different in 2026 is that a serious industry is now working on all of these problems at once — with customers, capital and manufacturing capacity on the same page for the first time.

Four criteria for "humanoid"

Working definition used throughout this report.

- **Bipedal or near-bipedal** — the machine enters facilities designed for people.
- **Torso, arms, hands** — capable of the manipulation profile of a human worker.
- **Learning-based control** — behavior emerges from training, not from hard-coded joint trajectories.
- **Deployed against real tasks** — the machine has to earn its place in a real environment, not a lab.

THE DEPLOYMENT GAP

Demo vs. product.

A machine that walks impressively in a controlled environment is a demonstration. A machine that repeatedly performs useful, paid work — at acceptable cost, safety and reliability — is a product. Closing that gap is the industry's actual work through 2028.

>> A HUMANOID IS A FORM FACTOR.
>> A WORKER IS A PROOF.
>> THE TWO ARE NOT YET THE SAME.

THE THREE-PART EQUATION

Body + Intelligence + Deployment. All three must mature together.

A commercially useful humanoid is not one breakthrough. It is the intersection of three subsystems that improve on different clocks. Weakness in any one halts the other two.

The **body** is the hardware: bipedal locomotion, dexterous manipulation, sensing, power and thermals, safety, durability and cost. This is the axis where China has moved fastest, driven by a mature EV-grade supply chain for motors, batteries, actuators and precision components.

The **intelligence** is the learning-based control stack: foundation models, vision-language-action systems, world models, imitation and reinforcement learning, on-robot inference and safety-aware planning. This axis is where U.S. companies concentrate.

The **deployment** is the business system: customers, integration partners, service, spare parts, training-data loops and support economics that let a customer renew. This is where evidence is weakest.

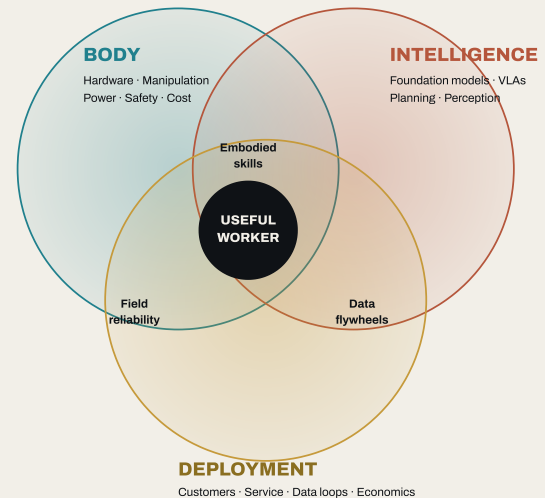


Fig. 01 The three-part humanoid equation. A humanoid becomes a commercially useful worker only at the intersection of body, intelligence and deployment. · Techstrong analysis.

BODY**Hardware**

Locomotion, manipulation, power, thermals, sensing, safety, durability, unit cost. China's fastest-moving axis, riding EV-grade supply chains.

INTELLIGENCE**Learning-based control**

VLAs, imitation and RL, world models, on-robot inference, safety-aware planning. Where U.S. programs concentrate.

DEPLOYMENT**The business system**

Customers, integration, service, spares, training-data loops, support economics. Where honest advantage will show up.

READING THE EQUATION

Three axes, three timelines, one intersection.

Body — closer than most observers assume

Boston Dynamics' fully-electric Atlas already demonstrates human-competitive locomotion and payload envelopes. Agility's Digit is purpose-built for warehouse bulk. AgiBot, Unitree and UBTech benefit from Chinese supply chains built for electric vehicles and consumer electronics — motors, batteries, actuators, sensors and precision manufacturing capacity that no other region can currently match at cost.

Hardware is not solved — cost, power, durability, hand dexterity and manufacturability all still require years of engineering. But the bodies are ahead of the brains.

Intelligence — the harder problem

Foundation models added the missing ingredient. Vision-language-action models — Figure's Helix, Google DeepMind's Gemini Robotics, the RT-2 line of work, Tesla's end-to-end network — combine perception, language understanding and motor control in a single learned system. That is the shift.

But hallucination is a real safety problem in a physical machine. On-robot inference is bandwidth- and power-limited. Data collection has not yet reached the scale that made the current generation of language models. This is the axis on which 2026–2028 will be judged.

Deployment — where evidence is weakest

The industry publishes body specifications and demonstration videos. It rarely publishes cost per productive hour, mean time between failures, mean time to repair, energy per task, integration cost per site, renewal rates or added-task rates. Every one of those is a deployment number, not a hardware number.

The programs that are meaningfully ahead are the ones with real customers reporting real operating data — Agility with GXO, Figure with BMW, AgiBot with Longcheer, UBTech in Chinese factories. Vendors that cannot point to that kind of independent confirmation are not yet at deployment.

RATE-LIMITER

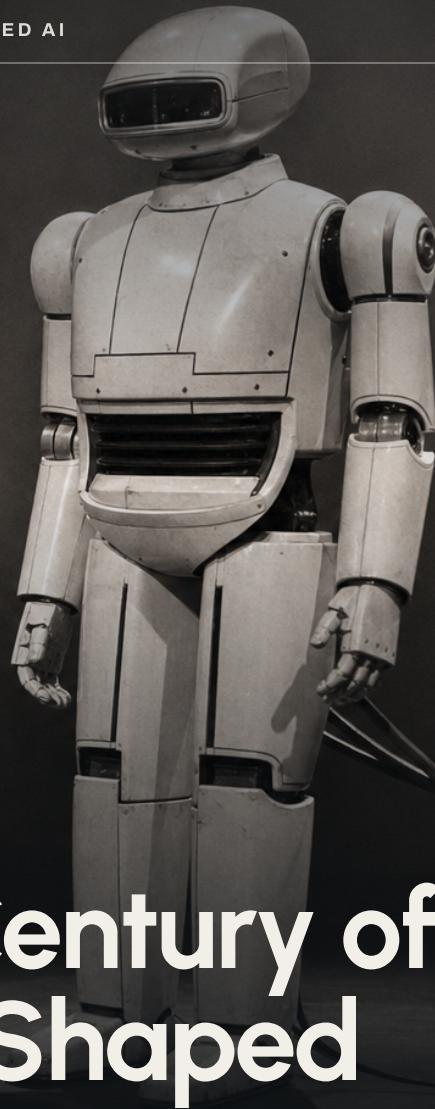
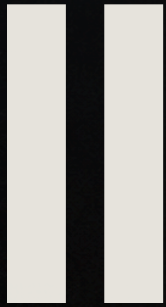
The clock the industry does not control

Every subsystem also runs at a different speed. Bodies improve in 12–18 month hardware cycles. Intelligence improves in months as new models train. Deployment improves in the multi-year rhythm of customer procurement, safety-case sign-off and site retrofit. Whichever subsystem is slowest, that is the rate-limiter on the entire industry.

EDITORIAL POSITION

Don't confuse velocity on one axis with progress on all three.

Shipments and demos measure activity on body and intelligence. Renewals and operating economics measure deployment. The press-release calendar is biased toward the first two.



PART TWO

A Half-Century of Human-Shaped Machines

Humanoids are not a new idea. Waseda's WABOT-1 walked, however slowly, in 1973. What changed in 2020–2026 was not the shape of the machine — it was the addition of learning-based intelligence, capital and manufacturing capacity moving in the same direction at the same time.

CHAPTER POINTS

1973

Waseda University unveils WABOT-1, the first full-scale bipedal humanoid.

1996–2000

Honda's P2 and ASIMO establish reliable dynamic walking.

2013–15

DARPA Robotics Challenge exposes reliability gaps still relevant today.

2024–26

Foundation models plus customer contracts turn demos into deployments.

THE LONG APPROACH

Fifty years of walking, and one decade of learning to work.

The humanoid form has been a research target since the 1970s. Waseda University's WABOT-1, unveiled in 1973, walked haltingly, gripped simple objects and understood a narrow set of Japanese commands. It established the humanoid as a serious engineering discipline. WABOT-2 in 1984 could play the piano and read sheet music. Impressive, but not yet a worker.

Honda's P2 in 1996 was the first fully self-contained bipedal humanoid — its own batteries, its own computers, its own actuators. ASIMO followed in 2000 and became the public face of humanoid robotics for a generation. But ASIMO was a diplomat, not an employee. It was slow, expensive to operate, and its behaviors were carefully scripted for the stage.

The DARPA Robotics Challenge in 2013 and 2015 was, in retrospect, the field's honest moment. Teams built humanoids that struggled with doors, valves, ladders and rubble. The most watched competition finish saw a machine collapse in front of a global audience. That failure exposed, plainly, what physical-world autonomy really requires — perception under uncertainty, force control under

contact, planning under partial information. Nothing about that has become trivial in the years since.

Boston Dynamics kept the field alive through the 2010s with parkour videos of Atlas — hydraulic, expensive, and celebrated as engineering theater rather than as a commercial product.

What changed in 2020–2026 was the arrival of three enabling ingredients at the same time. Foundation models gave humanoids something closer to task-flexible behavior — Google DeepMind's Gemini Robotics and the RT-2 line of research, Figure's Helix, Tesla's end-to-end network, NVIDIA's Isaac and simulation platforms. Chinese manufacturing supply chains, built for EVs and consumer electronics, dropped the unit cost of a competent bipedal platform to a level that supports meaningful shipments. And customer contracts — GXO, BMW, Longcheer, Mercedes-Benz, Amazon — began to give the industry the physical-world data it needs to improve.

The result is that the same machine form has moved from a scientific problem to a manufactured category. What remains is to prove it is also an economically productive one.

FIGURE 02

A half-century of humanoid milestones

From WABOT-1 to Atlas, ASIMO to Figure — the moments that defined the humanoid's slow move from laboratory to factory floor.

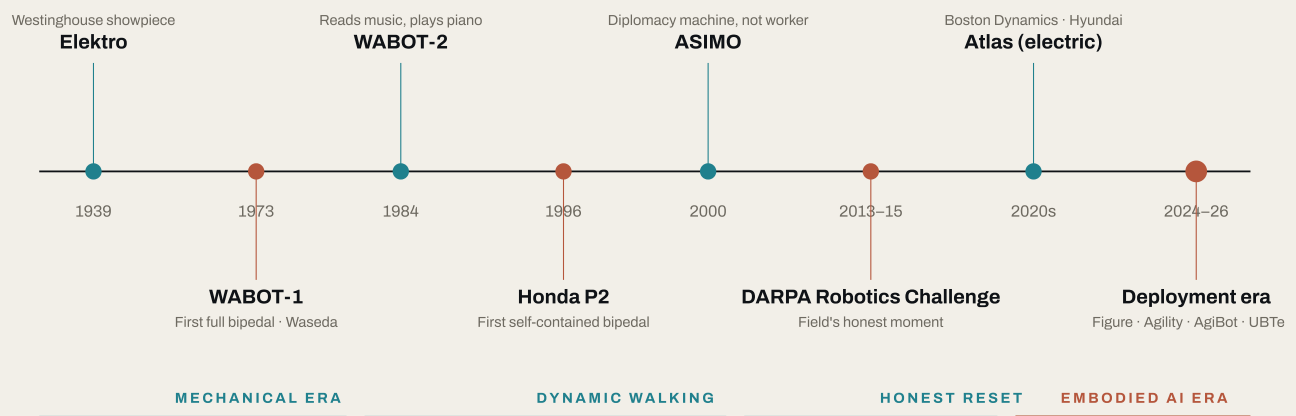


Fig. 02 Milestones in humanoid history, 1939–2026. The field spent 50 years learning to walk. It has spent the last five learning to work. · Techstrong analysis; source dates from Waseda University, Honda, DARPA and company disclosures.

1939–1984

Mechanical Era

Elektro (1939) to WABOT-2 (1984). The humanoid as engineering curiosity — showpieces that established the form and its symbolic weight, not its economics.

1996–2013

Dynamic Walking

Honda P2 to ASIMO to hydraulic Atlas. Reliable bipedal locomotion. But the machines were still hand-programmed; they could walk, wave and climb steps, not learn tasks.

2020–2026

Embodied AI

Foundation models plus manufacturing scale plus customer contracts. The first era in which capable body, learning-based intelligence and paying customers are moving on the same clock.

WHY HUMANOIDS, AND WHY NOW?

Three timelines finally overlapped.

Humanoids in 2026 look different from every previous wave not because the mechanical problem has been solved — it hasn't — but because three separate technological, industrial and commercial timelines have finally overlapped.

The first is **foundation models applied to physical action**. Vision-language-action systems from Google DeepMind, Figure, Physical Intelligence, Tesla, NVIDIA and the Open X-Embodiment collaboration have moved from research to on-robot inference in a way that would have been science fiction in 2019. Progress is fast; hallucination and safety are still real problems; but the direction is set.

The second is **manufacturing capacity**. Chinese suppliers of motors, batteries, actuators, sensors and precision-machined parts — originally scaled for electric vehicles and consumer electronics — are the same components a humanoid needs. That has driven the unit cost of a competent bipedal platform down to a level that supports thousands of units a year, not hundreds.

The third is **customer willingness**. Logistics operators, automakers and electronics manufacturers now have real labor problems and real political pressure to modernize production. That is why GXO, BMW, Mercedes-Benz, Longcheer, Amazon and Hyundai are willing to sign agreements with startups whose products are still being finished.

None of the three, on its own, would be enough. Foundation models on 2019 hardware would be a promise. Cheap bodies without adaptive intelligence would be forklifts with legs. Customer demand without either would be press releases. Together, they are an industry.

THREE OVERLAPPING TIMELINES

Why 2026, not 2016

1. Learning-based control

VLAAs and world models moved from research to on-robot inference.

2. Supply-chain economics

EV-grade motors, batteries and actuators drove humanoid unit cost down.

3. Customer willingness

Labor tightness plus modernization pressure created willing operators.

"Foundation models on 2019 hardware would be a promise. Cheap bodies without adaptive intelligence would be forklifts with legs. Customer demand without either would be press releases."

— THE REPORT'S WHY-NOW THESIS



PART THREE

How Autonomous Is Autonomous, Really?

Every humanoid announcement uses the word "autonomous" freely. This section proposes a scale — six levels, from teleoperated to true generalist — and a ladder that separates a demonstration from a deployment. Both are the language the rest of the report uses.

IN THIS PART

The Techstrong Autonomy Scale

L0 to L5, mapped to what the machine actually decides.

Demonstration to Deployment

A six-stage ladder from lab clip to renewed customer.

The Best-Documented Deployments

Agility · Figure · AgiBot · UBTech · Boston Dynamics.

FIGURE 03 · THE TECHSTRONG HUMANOID AUTONOMY SCALE

From teleoperated puppet to general-purpose worker.

Humanoid autonomy is not binary. The industry conflates six meaningfully different levels of independence, which distorts both press coverage and procurement. This report uses the following framework throughout.

L0	Teleoperated	A human directly controls the robot in real time. The machine is a physical avatar. Common in training-data collection, remote inspection and demonstration videos that a viewer often mistakes for autonomy.
L1	Task-narrow autonomy	The robot performs a specific, narrowly-defined task without moment-to-moment human control. Deviation or exception hands back to a person. This is where GXO's Digit tote work sits.
L2	Multi-task autonomy in one environment	The robot performs several related tasks in a bounded environment (e.g., one BMW cell) with human oversight and exception handling. Most 2026 flagship pilots aim here.
L3	Adaptive autonomy across tasks	The robot handles new task variations within its domain, plans across tasks and manages routine exceptions on its own. This is the meaningful commercial frontier — the level at which humanoids stop being tools and start being workers.
L4	Cross-domain autonomy	The robot moves between different environments — warehouse, factory, hospital — with only high-level goals from a human. No commercially deployed humanoid is at L4 today.
L5	General-purpose humanoid worker	A machine that can be assigned nearly any task a human worker could perform, with minimal instruction and no supervision. This is the aspirational endpoint. It does not yet exist.

WHERE THE INDUSTRY ACTUALLY IS

L1 to L2 — with L3 as the next credible target.

Almost every commercially relevant 2026 humanoid deployment operates at **L1–L2**. Public claims of “fully autonomous” humanoids at L3 or above should be treated as aspirational until independently verified by a customer with operating data.

FIGURE 04 · THE DEMONSTRATION-TO-DEPLOYMENT LADDER

Six stages between viral clip and renewed contract.

Every humanoid company sits somewhere on this ladder. Very few say clearly which rung they occupy. This is a diagnostic tool for reading humanoid announcements.



Fig. 04 The demonstration-to-deployment ladder. The width of each bar suggests the accumulating evidence a stage represents. Almost all press-release news lives at Stages 1–3. The industry is only beginning to accumulate honest Stage 4 and Stage 5 evidence. · Techstrong framework.

Stage 6 is the honest signal. A customer that renews a humanoid contract, adds sites or adds tasks is expressing conviction that the machine works. Absent that signal, everything below is an experiment.

Read announcements in these terms. A viral video is S1. A demonstration at a partner site is often S3. "Deployed at customer" is often S4. Actual output contribution is S5. Multi-year renewal with expansion is S6.

COMPANIES KNOWN TO BE ON STAGE 4 – 5

Agility Robotics · GXO — S5 (paid production, disclosed volumes)

Figure · BMW — S4/S5 (supervised autonomy, customer-reported hours)

AgiBot · Longcheer — S4 (customer-reported task counts)

UBTech · Chinese OEMs — S4/S5 (first disclosed line of humanoid revenue)

THE CASE STUDIES

The best-documented humanoid deployments of 2026.

Read against the autonomy scale and the deployment ladder, these are the programs providing the industry's most credible evidence. Numbers are as published by each operator or manufacturer. Independence of each figure is labeled with its source.

CASE STUDY 01 · WAREHOUSING

Agility Robotics · Digit at GXO

Autonomy: L1 · **Ladder:** S5 — paid production work under multi-year agreement.

Agility's Digit is the most operator-documented humanoid deployment on public record. GXO announced a multi-year commercial agreement to operate Digit at a Georgia facility performing tote-handling work — the first known multi-year humanoid-as-a-service arrangement of its kind.

100K+

TOTES MOVED · GXO /
AGILITY

Multi-yr

COMMERCIAL
AGREEMENT · GXO

CASE STUDY 02 · AUTOMOTIVE

Figure · Figure 02 at BMW

Autonomy: L1–L2 · **Ladder:** S4/S5 — supervised autonomy, customer-reported operating hours.

BMW disclosed that a Figure 02 humanoid accumulated more than 1,250 operating hours across approximately 10 months at its Spartanburg plant, working alongside human operators. It is one of the few programs with hours — not headcount — as its headline metric.

1,250 hrs

OPERATING HOURS ·
BMW

~10 mo

DEPLOYMENT WINDOW ·
BMW

CASE STUDY 03 · ELECTRONICS

AgiBot · A2 at Longcheer

Autonomy: L1 · **Ladder:** S4 — customer-reported task-completion data.

Chinese electronics-manufacturing services company Longcheer reported that AgiBot's A2 platform completed more than 64,800 individual tasks across production lines — one of the highest customer-reported task counts of any humanoid in 2025–26.

64,800+

TASKS COMPLETED ·
LONGCHEER

5,168

2025 UNITS SHIPPED ·
OMDIA

CASE STUDY 04 · MANUFACTURING / LISTED CO.

UBTech · Walker S1 & S2

Autonomy: L1 · **Ladder:** S4/S5 — first humanoid revenue line disclosed in a listed-company report.

UBTech's FY2025 annual report disclosed RMB 820.6M of humanoid revenue — ~41.1% of total revenue — the first time a listed manufacturer has isolated humanoids as a reported segment. Financial Times reported Walker S2 reaching 30–50% of human productivity on selected tasks.

RMB 820.6M

FY2025 HUMANOID
REVENUE · UBTECH

30–50%

TASK PRODUCTIVITY VS.
HUMAN · FT

CASE STUDY 05 · REFERENCE PLATFORM

Unitree · H1 & G1

Autonomy: L0–L1 · **Ladder:** S1–S3 — research and reference platform, mostly non-production.

Unitree's H1 and G1 are the most-shipped humanoid platforms of 2025 at estimated 4,200 units, according to Omdia. Their price and openness have made them the reference platform for university robotics programs and startup development — not yet a documented production worker.

4,200

2025 UNITS SHIPPED ·
OMDIA

Research

PRIMARY USE PROFILE

CASE STUDY 06 · CONTRACT MANUFACTURING

Apptronik · Apollo

Autonomy: L1–L2 · **Ladder:** S3–S4 — multiple customer pilots, disclosed partner network.

Apptronik has publicly named GXO, Mercedes-Benz and Jabil as pilot partners for its Apollo platform. It is one of the few U.S. humanoid programs actively working across warehousing, automotive and electronics contract manufacturing in parallel — a broader deployment surface than any single-customer program.

3+

NAMED ENTERPRISE
PARTNERSMulti-
verticalWAREHOUSE · AUTO ·
ELECTRONICS

CASE STUDY 07 · FULLY ELECTRIC ATLAS

Boston Dynamics · Hyundai

Autonomy: L1–L2 · **Ladder:** S3 → committed S5 (2028).

Hyundai Motor Group and Boston Dynamics have committed to production deployment of the fully-electric Atlas at Hyundai's new Georgia plant by 2028 — the humanoid industry's most explicit customer-committed deployment target attached to a specific factory.

2028

GEORGIA PLANT TARGET
· HYUNDAI

Electric

NEW ATLAS PLATFORM

CASE STUDY 08 · VERTICAL INTEGRATION

Tesla · Optimus

Autonomy: Company-claimed L1–L2 · **Ladder:** S1–S3 — internal use, no independently verified paid production.

Tesla positions Optimus as core to its long-term strategy and reports internal deployment at its own facilities. Independent verification of paid production work is limited; most public evidence of dexterous behavior has been demonstration video. The company's ambition is unmatched; its disclosure is not.

Internal

PRIMARY REPORTED
USE

End-to-end

VERTICALLY
INTEGRATED STACK

FIGURE 05

Best-documented humanoid deployments, 2026

A side-by-side reading of the case studies against the autonomy scale, the deployment ladder and each program's headline number. Figures are as published by the operator or manufacturer.

PROGRAM	ENVIRONMENT	AUTONOMY	LADDER STAGE	HEADLINE NUMBER	SOURCE
Agility Digit @ GXO	Warehouse	L1	S5	100K+ totes moved	Agility Robotics · GXO
Figure 02 @ BMW	Automotive	L1–L2	S4–S5	1,250 operating hrs	BMW Group
AgiBot A2 @ Longcheer	Electronics	L1	S4	64,800+ tasks completed	Longcheer / AgiBot
UBTech Walker S1/S2	Manufacturing	L1	S4–S5	RMB 820.6M FY25 revenue	UBTech FY2025 annual report
Unitree H1 · G1	Research	L0–L1	S1–S3	4,200 units shipped (2025)	Omdia
Appttronik Apollo	Multi-vertical	L1–L2	S3–S4	3+ named partners	Appttronik · GXO · MBZ · Jabil
Boston Dynamics · Hyundai	Automotive	L1–L2	S3 → S5 (2028)	Georgia plant · target 2028	Hyundai Motor Group
Tesla Optimus	Internal · Tesla	L1–L2*	S1–S3	Internal deployment claimed	Tesla (self-reported)
1X NEO	Home research	L0–L1	S1–S2	Consumer beta announced	1X (self-reported)

Fig. 05 Best-documented humanoid deployments as of Aug. 17, 2026. Ratings reflect how the operator or manufacturer describes the deployment; asterisks indicate self-reported autonomy claims that lack independent operator confirmation.

READING THE TABLE

Two honest patterns.

1. The programs with the most credible evidence — Agility with GXO, Figure with BMW, UBTech — all publish operator or listed-company data. Numbers with an independent counterparty carry more weight than any vendor demo. 2. Almost every headline metric measures activity, not economics. None of these programs has disclosed audited cost per productive hour. That is the missing data set of 2026.

IV

PART FOUR

The Global Humanoid Race

China is scaling manufacturing capacity. The United States is concentrating capital and foundation-model intelligence. Europe, Japan and South Korea are the industrial-discipline reserve. Whoever holds the intersection first — body plus intelligence plus deployment — sets the terms.

IN THIS PART

Regional advantages at a glance

Body · Intelligence · Deployment across four blocs.

China: scale becomes strategy

Manufacturers, state support and shipments.

United States, Europe, Japan & South Korea

Capital, disciplines, deployment gaps.

FIGURE 07 · REGIONAL ADVANTAGES

Where each region leads on the three-part equation.

Each of the four blocs currently competitive in humanoids has different advantages, and different weaknesses. Read this matrix against Figure 01. No region is leading on all three axes today.

REGION	BODY (HARDWARE & MANUFACTURING)	INTELLIGENCE (LEARNING-BASED CONTROL)	DEPLOYMENT (CUSTOMERS & ECONOMICS)
China AgiBot · Unitree · UBTech · Xpeng · Fourier	Leading — EV-grade supply chain, 140+ manufacturers, unit-cost leadership.	Fast-following. Open-source models, growing academic base, state-directed investment.	Leading — Longcheer, JD, state customers; first disclosed humanoid revenue line (UBTech).
United States Figure · Agility · Apptроник · Boston Dynamics · Tesla · 1X · Physical Intelligence	Competitive — premium platforms, few manufacturing partners.	Leading — VLAs, foundation models, NVIDIA · Google DeepMind training stack.	Building — GXO · BMW · Mercedes-Benz · Jabil · Amazon · Hyundai partnerships.
Europe Neura Robotics · PAL · IIT · Reflex	Competitive — strong industrial engineering base.	Following — strong academic ML, less commercial concentration.	Following — regulated procurement, industrial pilots via automotive OEMs.
Japan & South Korea Honda · Toyota · Kawada · Hyundai · Samsung · Fanuc · Kawasaki	Leading — historic reliability engineering; ASIMO/HRP heritage.	Competitive — strong research base, integration with foundation models improving.	Building — Hyundai · Boston Dynamics Georgia plant target (2028) is the flagship.

Fig. 07 Where each region currently leads across the three-part equation. Reading the matrix: color and "Leading" tags indicate axes where the region is meaningfully ahead of peers; "Competitive" indicates near-parity; "Following" indicates a lag. · Techstrong analysis based on IFR, Omdia, MIIT and corporate disclosures.

THE STRATEGIC GAP

No region is leading on all three axes.

China leads on body and is disclosing early deployment revenue. The United States leads on intelligence and is building a customer roster. Japan and South Korea lead on manufacturing discipline but concentrate their commercial bet on the Boston Dynamics–Hyundai program. Europe is a strong follower without a national platform. The strategic prize is whoever closes all three first.

CHINA · SCALE BECOMES STRATEGY

China ships. The rest still largely demonstrates.

China is the country most aggressively treating humanoids as an industrial category. The 2025 State Council guidance directed provinces and state firms to prioritize humanoid manufacturing and pilot deployment. Provincial governments in Shenzhen, Shanghai and Suzhou are underwriting factories, purchases and demonstration programs.

The industry is not just policy. AgiBot, Unitree, UBTech, Xpeng and Fourier now ship products in the thousands. IFR reported that China accounted for **54%** of all new industrial robot installations in 2024 — the manufacturing muscle memory that humanoids ride on.

The tradeoffs are real. Chinese platforms are, on average, less capable on the intelligence axis than the leading U.S. programs, and much of their public benchmark data comes from vendor demonstrations rather than independent operators. But the combination of unit cost, manufacturing capacity and disclosed deployments — UBTech, Longcheer, JD — is enough to make China the country the rest of the industry has to answer.

The dependency the next 24 months will test: whether Chinese platforms can improve on the intelligence axis fast enough to hold their manufacturing lead as U.S. and European operators demand deployment data, not just delivery numbers.

2025 humanoid shipments

Estimated global units shipped, by manufacturer. Total: ~13,318 units. · Source: Omdia.

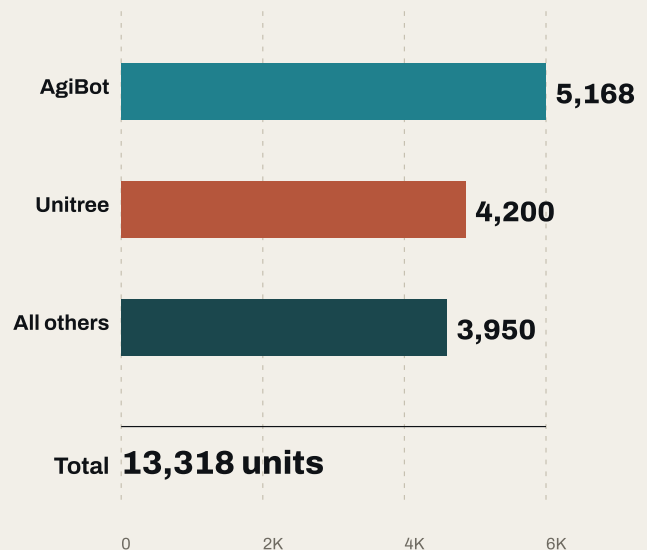


Fig. 06 2025 humanoid shipments by manufacturer. AgiBot and Unitree together account for roughly 70% of estimated global shipments. · Source: Omdia.

THE CHINESE FOOTPRINT

140+ humanoid manufacturers registered in China in 2025 (MIIT / Xinhua).
54% of global new industrial-robot installs in 2024 (IFR). Provincial subsidies and state-buyer pilots in Shenzhen, Shanghai and Suzhou now underwrite meaningful volumes.

UNITED STATES · BETTING ON THE BRAIN

The U.S. bet: pair the best bodies with the best models.

The United States has the deepest concentration of learning-based control research and the majority of the venture capital flowing into humanoids. Figure, Appttronik, Agility, Boston Dynamics, Tesla, 1X and Physical Intelligence together represent the industry's densest cluster of frontier work — and its most-hyped one.

The intelligence axis is where American programs are most credibly ahead. Figure's Helix, Google DeepMind's Gemini Robotics, Physical Intelligence's foundation models and Boston Dynamics' Hyundai-backed control stack are visible in ways Chinese competitors have not yet matched publicly.

The body axis is a mixed picture. Boston Dynamics' fully-electric Atlas and Agility's Digit are world-class. Figure, Appttronik and 1X are engineering their own dexterous platforms. But none of them, at 2026 prices, can approach Chinese unit costs. Which puts pressure on the U.S. industry to prove that superior intelligence — higher productivity per hour, faster ramp per site — more than compensates for higher bill of materials.

The customer axis is finally building — GXO, BMW, Mercedes-Benz, Amazon, Jabil, Hyundai. The next 24 months will show whether the U.S. can convert intelligence advantages into operator-reported production data at Chinese-competitive economics.

UBTech humanoid revenue

FY2024 → FY2025, RMB millions. · Source: UBTech FY2025 annual report.

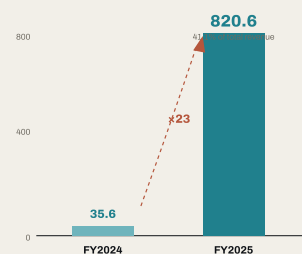


Fig. 08 UBTech humanoid revenue, FY2024 → FY2025. The first year humanoid revenue is disclosed as a segment in a listed company's annual report. · Source: UBTech FY2025 annual report.

WHY UBTECH MATTERS

UBTech's FY2025 disclosure is not proof of profitability — it reported a net loss of RMB 789.8M. But it is the first time a listed manufacturer isolated humanoids as a segment. That normalizes analyst coverage, and it puts pressure on every peer to do the same.

THE THIRD BLOC

Europe waits. Japan and South Korea concentrate their bet.

Europe's humanoid programs are technically competent and commercially quiet. Neura Robotics, PAL Robotics, Italy's IIT and academic-industry collaborations across Germany, France and the Netherlands maintain strong hardware and control research. But none of these programs has yet published a customer-reported deployment on the scale of the U.S. or Chinese leaders. Europe's route to competitiveness runs through its automotive OEMs and industrial integrators — Siemens, KUKA, Bosch and their peers — more than through pure-play humanoid startups.

Japan is the historical humanoid superpower and the current sleeping giant. Honda's P2 and ASIMO defined dynamic walking. Kawada's HRP series and Toyota's Human Support Robot informed a generation of academic research. But Japan's leading commercial companies have concentrated on service and industrial robots rather than a public humanoid platform play. The country's manufacturing discipline — six-sigma reliability, safety-case documentation, mean-time-between-failure engineering — is the reserve the humanoid industry will eventually need to draw on.

South Korea has, in Hyundai Motor Group, the most explicit customer-committed humanoid deployment on the global map. Hyundai owns Boston Dynamics and has committed to production deployment of the fully-electric Atlas at its Georgia plant by 2028. That single program is the West's most credible answer to Chinese manufacturing scale — a global automaker signing up for humanoid labor with a named site and a named target year.

Samsung's ambitions in humanoid platforms and Hanwha's investments in dexterous manipulation round out a South Korean bet that is bigger than the country's population suggests.

Read the third bloc this way. Europe is following on all three axes without a national champion. Japan is a manufacturing-discipline reserve that has not yet chosen a humanoid platform to promote nationally. South Korea has concentrated its bet through Hyundai, and that bet is the industry's cleanest 2028 test.

None of these markets is China-sized on units or U.S.-sized on capital. All three are structurally important because they are where the industry will eventually have to prove reliability and safety at automaker discipline — not warehouse tolerance.

"Whoever is first to publish an audited cost per productive hour for a humanoid worker sets the industry's pricing power. Right now nobody has — and that is the honest gap in the 2026 story."

— BODIES, BRAINS AND THE REAL WORLD

V

PART FIVE

The Economics of a Humanoid Worker

Nobody in the industry has yet published an audited, apples-to-apples cost per productive hour for a humanoid worker. Whoever discloses it first, with credible independent verification, sets the industry's benchmark — and its pricing power.

IN THIS PART

Cost per productive hour

The number the industry does not yet publish.

What could slow the humanoid revolution

Safety, data, energy, capital, geopolitics.

What happens next

Three plausible futures and a conclusion.

THE NUMBER THAT MATTERS

Cost per productive hour is the humanoid industry's missing benchmark.

Every humanoid announcement in 2025 and 2026 has measured activity. Totes moved. Hours logged. Tasks completed. Units shipped. Revenue disclosed. These are meaningful numbers — but they are not economics.

The single number the humanoid industry has not yet published is *cost per productive hour* under supervised, real-world conditions. It is the number that finally decides whether a humanoid is cheaper than the alternative — a person, a fixed automation cell or a task-specific mobile robot. Amortized capital, energy, service, spares, integration and supervision all roll up into it. Whoever discloses it first, with credible independent verification, sets the industry's pricing power.

Twelve operating metrics would give the industry the language it needs. They are listed opposite. They are also the metrics enterprise buyers will demand of any vendor pitching a multi-year deployment. If a vendor cannot produce them — or credibly estimate them from a real customer — that vendor is at Stage 3 of the deployment ladder, not Stage 5.

Cost is not the whole story. A humanoid that costs slightly more per productive hour than a human worker but eliminates injury risk, scales overnight and improves month-over-month with data is still valuable. But that value has to be measured. Right now, it is not.

The twelve operating metrics

Figure 09 · The disclosure set the industry should adopt.

1. Productive hours / day	2. Tasks / hour
3. Success rate	4. Interventions / shift
5. MTBF between failures	6. MTTR to repair
7. Energy / task	8. Maintenance / mo.
9. Integration cost / site	10. Renewal rate
11. Added tasks / yr	12. Cost / productive hr

Fig. 09 The twelve operating metrics the humanoid industry should disclose to move from activity reporting to true economics. · Techstrong analysis.

A MODEST EDITORIAL PROPOSAL

Publish the twelve numbers, or stop calling it a deployment.

This report is agnostic about which humanoid company wins. It is not agnostic about the language the industry uses to describe itself. A machine that has not been measured against these twelve metrics has been demonstrated. It has not been deployed.

DOWNSIDE CASES

What could slow the humanoid revolution?

Nothing in this report should be read as inevitability. The humanoid industry has real, unresolved risks — any of which could stretch the timeline to a real general-purpose worker by years.

RISK 01**Safety incidents at scale.**

A humanoid causing a serious workplace injury — even a single one — would reshape the regulatory conversation overnight. Safety cases for close human-robot collaboration are still being written. This is the industry's largest single-event risk.

RISK 02**Physical-world data does not scale.**

Language models scaled on the internet. Humanoid intelligence needs physical-world demonstrations, teleoperation logs and simulation. Collecting that data at the volume required is slower, more expensive and more geographically constrained. If the data flywheel does not turn, capability plateaus.

RISK 03**Energy, thermals and hand dexterity.**

Battery capacity, motor efficiency, thermal management and fine-motor dexterity remain hard engineering. Two-hour operating windows and finger-level manipulation gaps constrain the tasks a humanoid can credibly own. Progress will be incremental, not exponential.

RISK 04**Capital cycles turn.**

Humanoid economics assume a period of patient capital. A funding downturn could shrink the number of programs able to sustain multi-year customer pilots. The industry will consolidate. The question is whether it does so before or after the deployment data is credible.

RISK 05**Geopolitics and export controls.**

China leads on manufacturing. The United States leads on foundation-model intelligence. Any decoupling scenario — export controls, tariffs, sanctioned components — slows both sides. The industry that emerges may be more regional and less integrated than today's supply chain.

RISK 06**Public backlash on displacement.**

If humanoids move onto factory floors visibly faster than displaced workers are retrained, the political conversation will move faster than the technology. Zoning, procurement rules and labor-law responses could constrain deployment in ways today's rollouts don't yet contemplate.

THREE FUTURES

What happens next in humanoids.

Three futures are all plausible given today's evidence. The industry will move between them faster than any linear forecast implies — and any of the three would rank as a major economic shift.

FUTURE A

Specialized Humanoid Success

Humanoids succeed in narrow verticals — warehousing, automotive tier-1, electronics contract manufacturing — without ever becoming general-purpose. Cost per productive hour crosses over in three or four industries. This is the base-case outcome; it is still an industry-defining one.

3–5

VERTICALS
WITH
CROSSOVER
ECONOMICS

L1–L2

STEADY
AUTONOMY
PLATEAU

FUTURE B

The Data Flywheel Turns

One or more programs collect enough physical-world training data to move to genuine adaptive autonomy — L3 — before 2030. This is the future that produces a Google-scale outcome: a runaway leader whose data advantages compound into general-purpose capability.

L3

ADAPTIVE
ACROSS
TASKS

Winner-tilted

MARKET
STRUCTURE

FUTURE C

The Correction

A safety incident, a capital downturn or a data-collection plateau lengthens the timeline. The industry consolidates. Bodies keep shipping in China. Intelligence work continues in U.S. labs. Real general-purpose deployment slips into the 2030s. Progress, but slower.

2030s

GENERAL-
PURPOSE
DEPLOYMENT

Consolidation

INDUSTRY STRUCTURE

FIGURE 10 · HOW TO READ THE THREE FUTURES

Only Future B is winner-take-most. Futures A and C are large, multi-vendor markets where geographic manufacturing, integration discipline and customer relationships matter as much as raw model capability. The next 24 months of disclosed operating data will decide which future is being lived.

CONCLUSION

Putting the three pieces together.

The humanoid industry has arrived in a serious commercial phase. It has not yet arrived at economics.

The bodies are shipping. The intelligence is improving. The customers are willing. What the field lacks is a shared, disclosed set of operating metrics — a way to prove, transparently, that a machine can perform useful work at a lower cost per productive hour than the alternative.

The programs that will define the next three years are the ones already working on the intersection. Agility with GXO. Figure with BMW. AgiBot with Longcheer. UBTech's disclosed revenue line. Boston Dynamics with Hyundai, on a named site and a named year.

The countries that will define the next decade are the ones that pair manufacturing scale with foundation-model intelligence, and both with an honest deployment story. No single region holds all three today.

The humanoid era will not be defined by the first robot that walks naturally. It will be defined by customers repeatedly paying robots to perform useful work without a human quietly standing behind the curtain. That is the equation. It is not yet solved. The next 24 months will show which programs, and which countries, are closest to closing it.

NOTES & SOURCES

How to read the data, and where it came from.

Methodology. This report is an editorial synthesis of publicly available industry data. Figures are reproduced as published by their sources.

Labels. *Customer-reported* = deploying enterprise (GXO, BMW, Longcheer, Hyundai). *Vendor-reported* = manufacturer (Agility, Figure, AgiBot, UBTech, Unitree, Tesla, 1X, Appttronik, Boston Dynamics). *Independent* = analyst, association or government body (Omdia, IFR, MIIT, NIST, DARPA, State Council).

Definitions. "Deployment" means Stage 4+ of the demonstration-to-deployment ladder — supervised autonomy at a real customer, not a demonstration.

Autonomy ratings. Case-study and Figure 05 ratings are Techstrong's assessment based on public evidence as of Aug. 17, 2026, using the six-level Techstrong Autonomy Scale.

Currencies. Renminbi values are as reported by UBTech; comparisons are in the currency of the underlying disclosure.

Editorial. Company-reported success rates, order values and productivity claims are labeled and should not be read as audited results.

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ABOUT TECHSTRONG

Techstrong Group publishes across DevOps, cloud native, AI, security and semiconductors, delivering analysis, video and events to enterprise practitioners and decision-makers.

COLOPHON

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