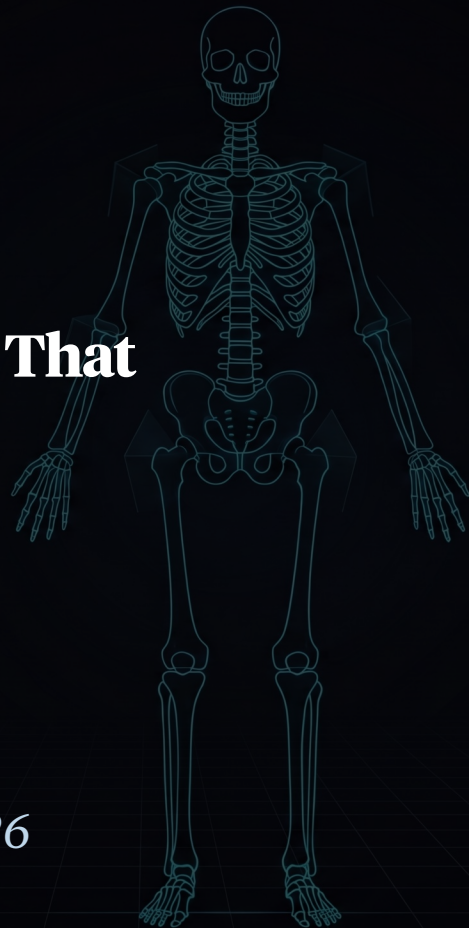


Humanoid Robots: The Data Gap That Capital Cannot Buy

*Underwriting the humanoid-robotics
opportunity · Investment committee · 2026*



Four findings: capital is not the bottleneck · data, dexterity, and supply chain are

Humanoid robots crossed from demo to pilot, but a data-and-dexterity gap · not capital · gates the path to scale.

1**The hype is real and richly funded.**

Four banks project a \$38B–\$7T market; \$2.84B of humanoid-specific VC closed in 2025; Figure AI is valued at \$39B.

2**The binding constraint is data and dexterity, not capital.**

Goldberg (Science Robotics, 2025) pegs the robot-data deficit at 100,000:1, and unstructured manipulation still succeeds only ~30% of the time.

3**China holds the supply-chain high ground.**

94% of rare-earth magnets, 150+ humanoid companies, and a \$35K BOM versus \$100K+ in the West · the EV playbook, run deliberately.

4**Pilots work in narrow structured tasks; ROI is unproven.**

BMW and GXO run supervised and off-hours; Amazon wound down its Digit pilot in 2024. The multi-trillion TAM belongs to 2040-plus.

The hype is real and richly funded

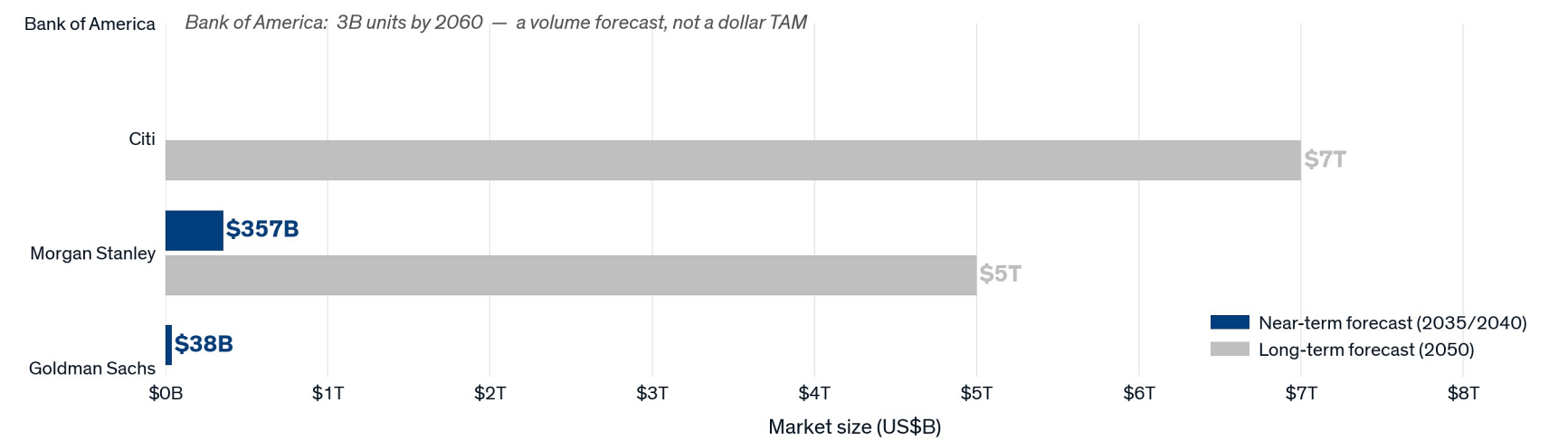
Situation. Humanoid robots have been a laboratory curiosity for decades, with progress slow and commercialization distant.

Complication. AI convergence, state capital, and a surge of well-funded startups shifted the sector into commercial territory in 2023–2025, attracting billions and producing four-bank forecasts ranging from \$38B to \$7T.

Question. What does the funding and valuation landscape actually look like, and what are the committed backers projecting?

Banks disagree on magnitude but agree on direction: a \$38B floor by 2035 rising to \$5–7T by 2050

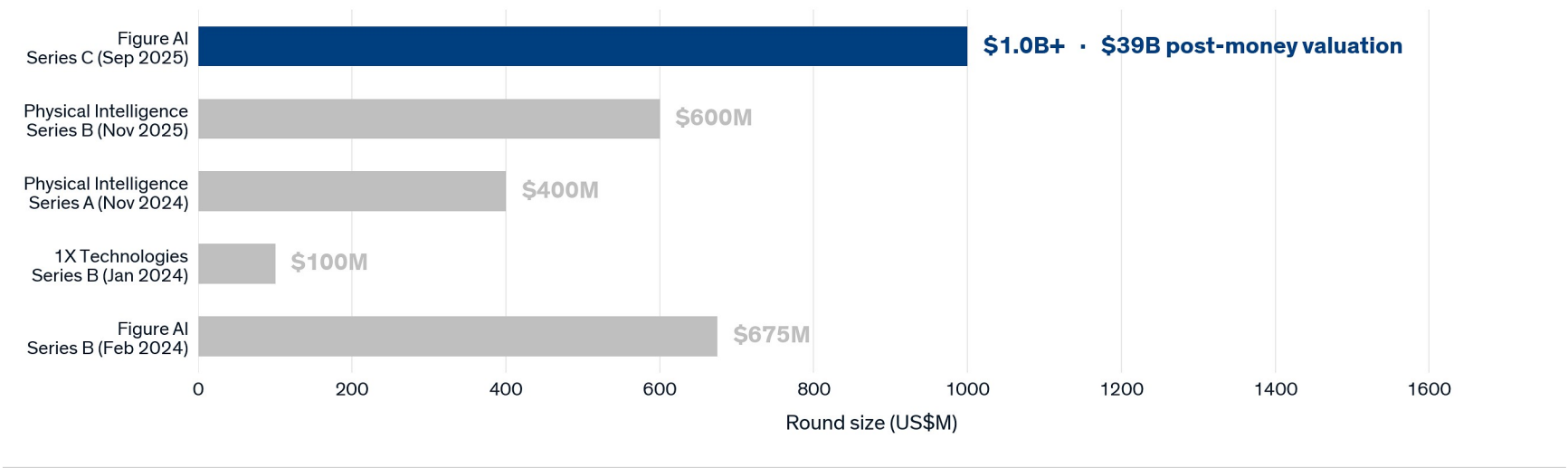
Exhibit 1 Goldman Sachs, Morgan Stanley, Citi, BofA · 2024 to 2026 · published forecasts



Source: Goldman Sachs (Feb 2024); Morgan Stanley (Apr 2025); Citi Global Insights (Nov 2024); Fortune on BofA Global Research (Mar 2026)

Humanoid-specific funding tripled in 2025; Figure AI's \$39B valuation rewrote the investment benchmark

Exhibit 2 Tracxn tracker and company filings · 2024 to 2026 · disclosed rounds and valuations



Source: Tracxn Humanoid Robot Tracker (2025); Figure AI Series C press release (Sep 2025); TechCrunch · Apptronik Series A (Feb 2025); Crunchbase News · Apptronik \$520M extension (Feb 2026)

100,000:1

LLM training data vs. all robot manipulation data ever collected · Goldberg, Science Robotics, 2025

The binding constraint is data and dexterity, not capital

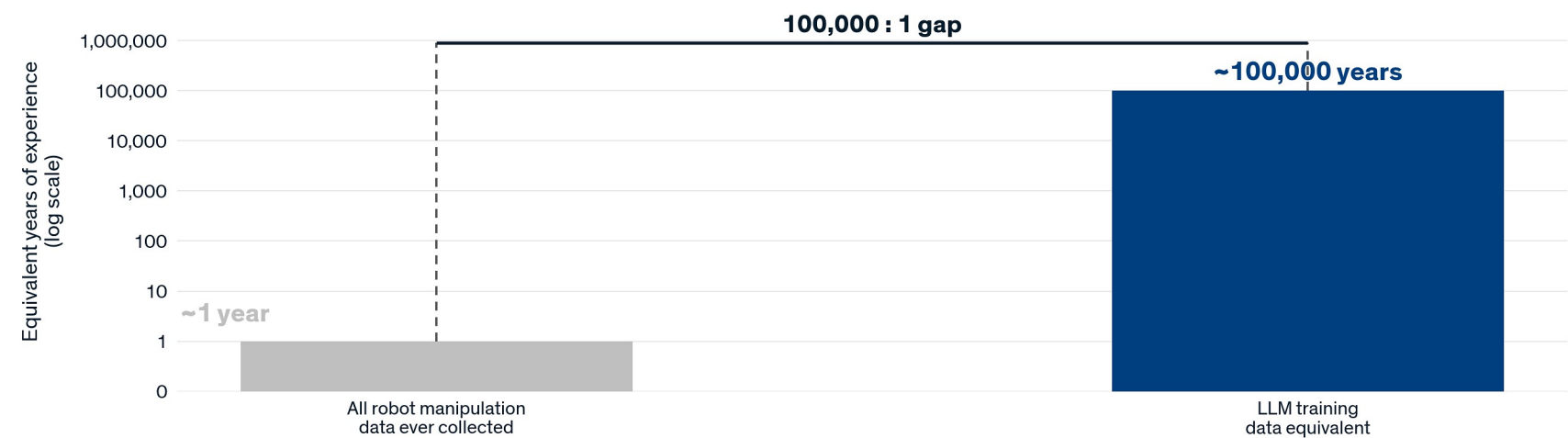
Situation. AI delivered LLMs trained on a near-infinite internet corpus, and investors expected the same pattern to carry over to robots.

Complication. Robots need sensorimotor training data that almost no one has ever recorded, leaving a structural 100,000:1 gap between LLM and robot training data that capital cannot close directly.

Question. Why is the data gap so hard to close, and what are the most credible paths?

LLMs predict words; robots must predict motor commands • and almost no motor-command data has ever been recorded

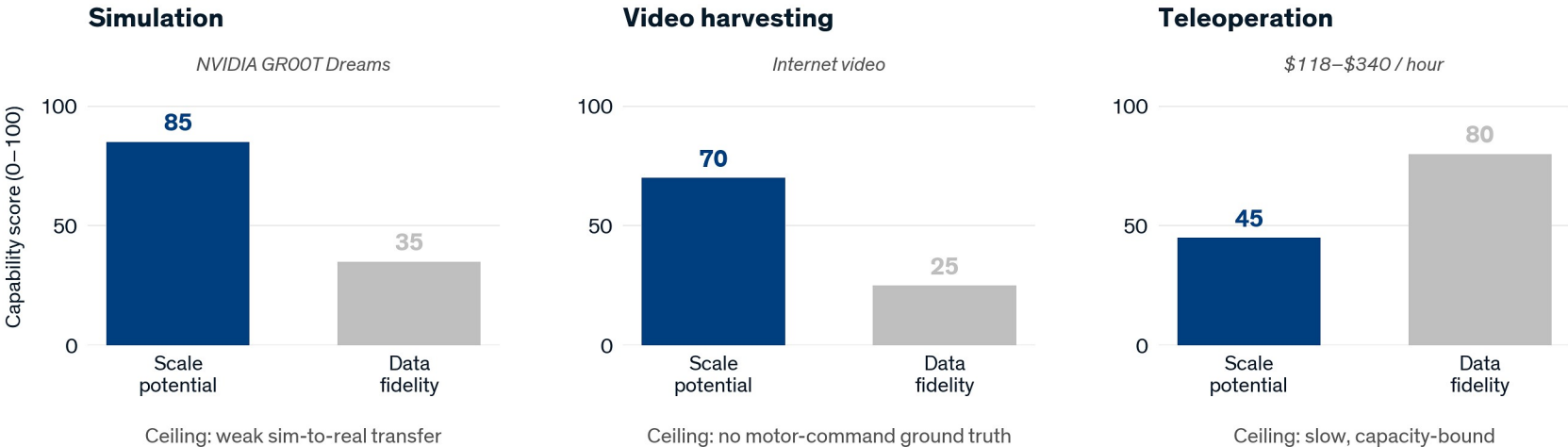
Exhibit 3 Goldberg, Science Robotics 2025 • LLM versus robot corpora • equivalent-years estimate



Source: Goldberg, Science Robotics, Aug 2025 (DOI: 10.1126/scirobotics.aea7390)

Simulation, video harvesting, and teleoperation each advance the data flywheel · but none alone closes the gap

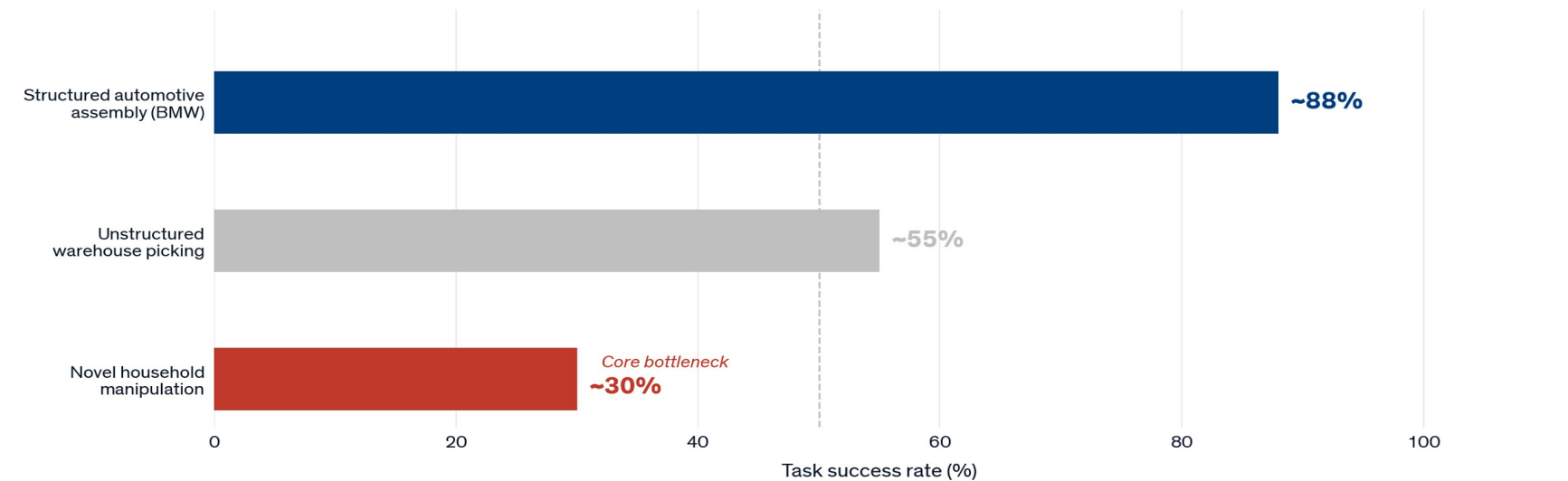
Exhibit 4 Three data-collection strategies · scale versus fidelity · capability scoring



Source: Goldberg, Science Robotics (Aug 2025); NVIDIA GR00T Dreams announcement (May 2025, company claim); SVRC cost estimates (2025–2026, industry estimate); arXiv:2511.19647 · robot data flywheel (Nov 2025)

Locomotion is solved; unstructured manipulation • what homes and hospitals need • succeeds only 30% of the time

Exhibit 5 GlobalSpec, BMW, Fraunhofer IPA • by task context • success-rate estimates



Source: GlobalSpec / Simplicity Product Development (2024–2025, industry estimate); BMW Group press / Figure AI • Spartanburg deployment (Nov 2025); Fraunhofer IPA Benchmark on Unitree G1 (May 2026)

China holds the supply-chain high ground

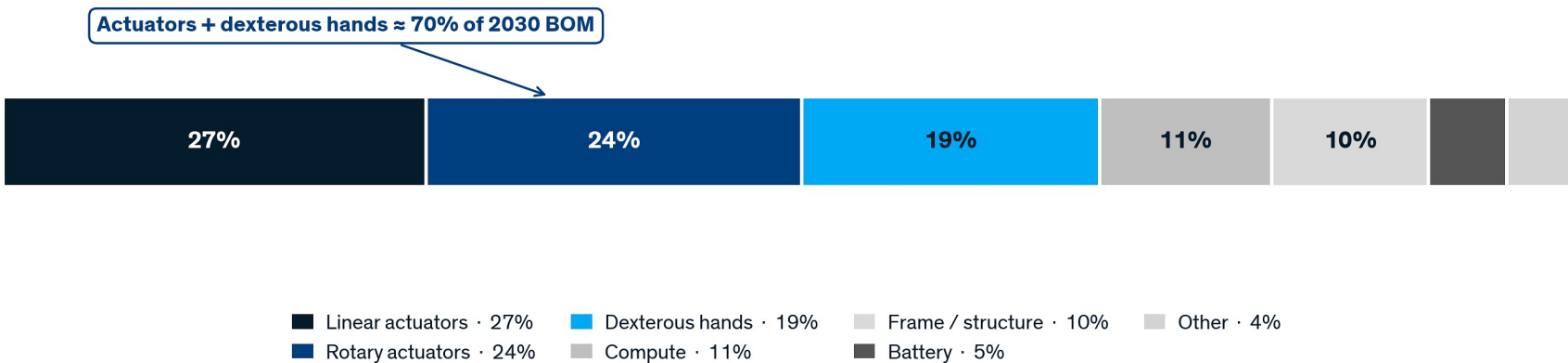
Situation. Humanoid robots are 40–50% actuators by cost, and those actuators depend on rare-earth magnets and precision roller screws.

Complication. China rose to control 94% of rare-earth magnets and fielded 150+ humanoid companies with a \$35K BOM, establishing a cost-and-supply-chain advantage that mirrors the EV playbook.

Question. How durable is China's structural advantage, and what does it mean for non-Chinese players?

Actuators are 40–50% of BOM, sourced from a supply chain where China controls 94% of rare-earth magnets

Exhibit 6 Interact Analysis, J.P. Morgan, IEA · 2030 BOM projection · component cost share

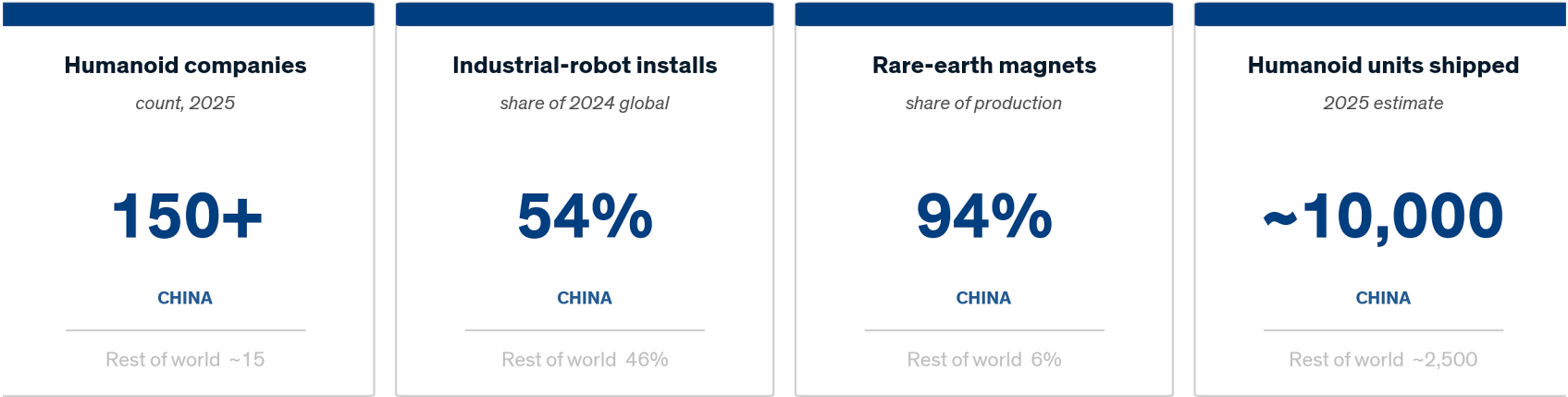


Source: Interact Analysis · joint actuators BOM (Jun 2025); J.P. Morgan via Fast Company (Apr 2025); IEA · China rare earth magnet share (2024); Fortune on BofA Global Research (Mar 2026)

China fields 150+ humanoid companies, leads global robot deployment, and has committed \$140B · running the EV playbook

Exhibit 7

IFR, NDRC, Omdia · China versus rest of world · 2024 to 2025 figures



Source: IFR World Robotics 2025 · China 54% of global installs; SCMP / NDRC · 150+ companies (Nov 2025); Omdia / SCMP · AgiBot unit shipments (2025); CNB C · World Humanoid Robot Games (Aug 2025); IFR · China 1T yuan state fund, NPC Mar 2025

Pilots are real but supervised • ROI is not yet understood

Situation. Factory and warehouse settings are already built for industrial robots; humanoids promise to extend automation to the unstructured margins.

Complication. Current deployments • BMW, GXO, Amazon/Agility, Mercedes/Apptroik • remained limited, supervised, and off-hours, and one major pilot was wound down mid-2024 for missing its commercialization timeline.

Question. What do the best-documented pilots actually reveal about where humanoids work and where they fail?

Five pilots confirm value in narrow structured tasks · and one wind-down reveals the true ROI benchmark

Exhibit 8 BMW, GXO, Amazon, Mercedes, Hyundai · public disclosures · pilot-status review

PARTNER	STATUS	SUPERVISION	KEY FINDING
BMW x Figure AI	Ongoing	Supervised + off-hours	1,250+ hrs, 90K+ parts. Structured scripted tasks.
GXO Logistics	Ongoing	Supervised	Cold-chain beachhead. Auditing required.
Amazon / Agility	Wind-down 2024	N/A	Partnership ended Jul 2024. Timeline missed.
Mercedes / Aptronik	Ongoing	Data coll.	Data-collection phase only. No production output yet.
Hyundai / Boston Dyn.	Ongoing	Limited	Mfg. Innovation Center. Early-stage pilot.

Note: Figure AI reports 24-hr autonomous runs (May 2026, vendor claim). BMW and GXO public testimony describes supervised deployments.

Source: BMW Group press · Figure AI Spartanburg (Nov 2025); GXO Logistics public remarks (2026); TechCrunch · Amazon / Agility pilot ended (Apr 2024); PR Newswire · Aptronik / Mercedes-Benz agreement (Mar 2024); Hyundai / Boston Dynamics Atlas (press)



The cold-storage beachhead reframes the value proposition: humanoids replace hazard, not headcount

Exhibit 9

GXO Logistics, public remarks 2026 · cold-chain freezer · executive testimony

“We are able to deploy the humanoids in that environment where they can really work for an entire battery life, completing tasks without putting our teammates in an uncomfortable situation, working in that cold environment for a long time.”

Patrick Kelleher, Chief Executive, GXO Logistics

Source: GXO Logistics, public remarks (2026)

RESOLUTION

Underwrite supply chain and narrow use-cases, not the headline TAM

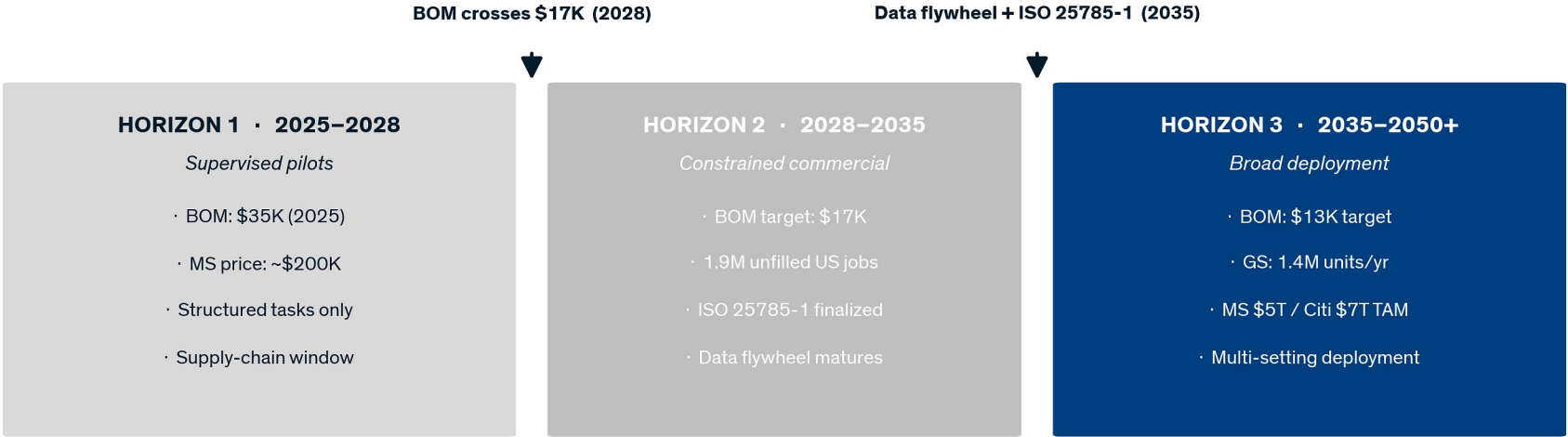
Situation. Capital is not the bottleneck; underwrite the supply chain and narrow first use-cases, not the headline TAM.

Complication. The multi-trillion 2050 headline is real but not directly investable as a single thesis today.

Question. Where should the committee concentrate underwriting now?

Three investment horizons: supervised pilots now, constrained commercial by 2028, broad deployment after 2035

Exhibit 10 BofA, Morgan Stanley, Goldman Sachs · 2025 to 2050 · scenario projection



Source: Fortune on BofA Global Research (Mar 2026); Morgan Stanley (Apr 2025); Goldman Sachs (Feb 2024); Deloitte / Manufacturing Institute · 1.9M jobs by 2033 (2024); ISO committee draft on humanoid co-working safety (not finalized)

Three investment imperatives: fund supply chain, the data flywheel, and the narrow beachhead • not the 2050 headline

Humanoid robots crossed from demo to pilot, but a data-and-dexterity gap • not capital • gates the path to scale.

M o v e	O w n e r	W h e n	C a p i t a l
Map actuator supply-chain exposure; find non-Chinese reducer and motor plays before the 2028 cost-convergence window	Portfolio + industrials research	Q3 2026	Research time
Back one foundation-model-for-robotics company whose deployment model generates proprietary training data at scale	Growth equity team	Q4 2026	2–3% of AUM
Underwrite structured first-use-case operators (cold chain, hazardous work) where value is conditions-based, not cost-based	Industrials team	2027	Existing budget

Allocations are indicative, sized for committee discussion rather than commitment.

Three toughest questions the committee will raise • pre-empted

Anticipated before they come up.

If China makes humanoids 60% cheaper than US/EU competitors, does the labor-substitution thesis simply play out in China first, and stay there?

China's domestic deployment is real but not accessible to this committee. The play for non-Chinese investors is to fund supply-chain independence and back Western OEMs whose cost curve is converging with Chinese BOM targets by 2030.

Has any humanoid robot ever operated autonomously for a full shift without human supervision?

Figure AI reports 24-hour autonomous runs as of May 2026, but these are vendor claims; BMW and GXO publicly describe supervised, limited-duration deployments. The vendor-versus-customer gap is the credibility signal.

Is the data gap solvable in two or three years by scaling teleoperation farms and synthetic data?

NVIDIA claims 20× gains from GR00T Dreams, but no independent lab has reproduced them. Goldberg's 100,000:1 ratio means even a 100× improvement leaves 1,000:1. The data gap is structural, not near-term solvable.

Source: Goldman Sachs (Feb 2024); Goldberg, Science Robotics (Aug 2025); Figure AI press (May 2026); NVIDIA GR00T Dreams (May 2025)

THE THESIS

Capital is not the bottleneck; underwrite the supply chain and narrow first use-cases, not the headline TAM.
