February 6, 2025 11:00 AM GMT

Humanoids

The Humanoid 100: Mapping the Humanoid Robot Value Chain

The physical embodiment of AI touches a $60tn TAM, global GDP, and the meaning of work. Morgan Stanley presents the "Humanoid 100" — a global mapping of equities across a range of sectors and regions that may have an important role in bringing robots from the lab to your living room.

alphawise α

As GenAI continues to migrate from the digital world (bits/bytes) to the physical world (atoms/photons) investors are beginning to grasp the enormity of the potential disruption while struggling with "paths to expression" on the theme. In our original Humanoid BluePaper, we introduced the Humanoid 66 — a list of both enablers and beneficiaries that we believed were most exposed at the time. Since then, commercial developments evolved at a rapid pace, especially in China, with many new players announcing their involvement or intentions to become involved. Investor interest seemed to accelerate meaningfully following NVIDIA CEO Jensen Huang's 2025 CES presentation where he devoted roughly 40 minutes to the topic of physical AI and robotics. We are now fielding questions daily from a broad scope of global investors on how to play the "Embodied AI" theme across a number of angles.

Morgan Stanley has worked across dozens of sector teams to help our clients "map" differing stock expressions that are exposed to one of the most rapidly developing verticals of Embodied AI. We do not pretend to present the "Humanoid 100" as an exhaustive list but rather a *starting point in a conversation* that will last many years and is sure to follow some exciting and unpredictable chapters along the way. We invite our clients to challenge our list and offer their own ideas of what should or should not be included as they become ever smarter on the humanoid theme and its adjacencies.

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Tesla Inc (TSLA.O, TSLA US)

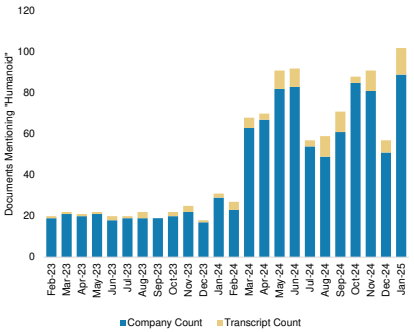
Autos & Shared Mobility | United States of America

Stock Rating	**Overweight**
Industry View	**In-Line**
Price target	**$430.00**
Shr price, close (Feb 4, 2025)	$392.21
Mkt cap, curr (mm)	$1,386,510
52-Week Range	$488.54-138.80

Fiscal Year Ending	**12/23**	**12/24e**	**12/25e**	**12/26e**
EPS ($)**	4.83	2.41	2.70	3.50
Prior EPS ($)**	-	-	-	-
ModelWare EPS ($)	4.31	2.03	2.31	3.10

Unless otherwise noted, all metrics are based on Morgan Stanley ModelWare framework
** = Based on consensus methodology
e = Morgan Stanley Research estimates

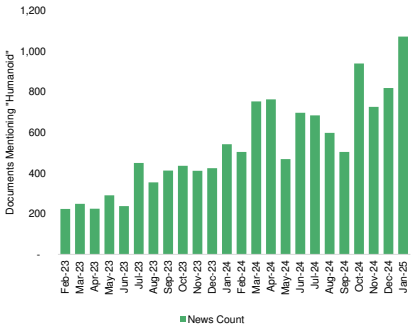
Exhibit 1: Time series of company transcripts mentioning "Humanoid"



Note: 'Company Documents' include filings, presentations, and press releases. Data is global.

Source: AlphaSense, Morgan Stanley Research

Exhibit 2: Time series of news/media reports mentioning "Humanoid"



Note: Data is global.

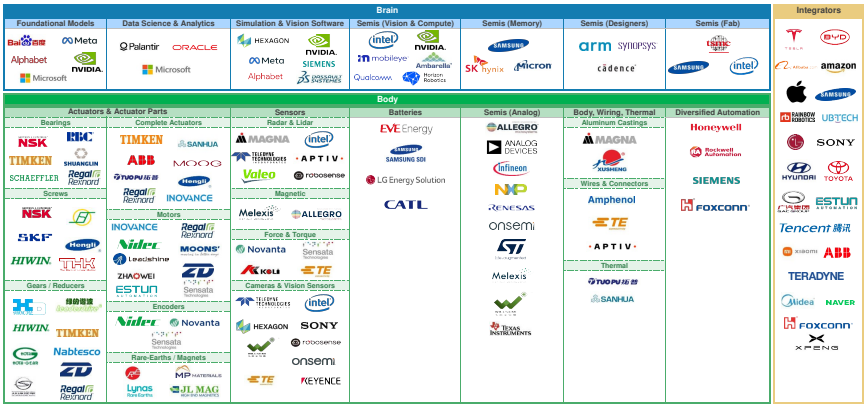
Source: AlphaSense, Morgan Stanley Research

Introducing the Humanoid 100 Stock List: Our Mapping of the Humanoid Value Chain. The "Humanoid 100" is the product of collaboration across Morgan Stanley's global equity research team to create a list of public companies exposed to the humanoid robot theme. Based on feedback from investors over the past 6 to 9 months, we focused more on the 1st derivative "enablers" that we believe will be consequential in building, training, and integrating a humanoid robot ecosystem. We compiled the list through a mix of discussions with our global team of analysts and conversations with subject matter experts on critical technologies and key players, supplemented by our own proprietary research to find the most exposed names globally. We then divided the companies into **Brain** (Semis/Software), **Body** (Industrial Components), and **Integrators** (Developing Full Humanoids). For every company included in the Humanoid 100, we include details on size/stock liquidity, core business competencies, rationale for inclusion, and current humanoid involvement if applicable. Currently, 52% of companies are reported to be currently involved in humanoids, and the remaining 48% are either close competitors of companies known to be involved or ones that our analysts believe have material potential to eventually be involved.

For a copy of the underlying Humanoid 100 database or our US/Chinese Humanoid TAM models, please reach out to your Morgan Stanley representative.

Note: This is a constantly evolving space with an expansive list of hundreds of global companies involved or with reasonable potential to be involved in humanoids. There is a large subset of companies we chose to exclude due to either small size, limited current/potential involvement, or lack of materiality. *However, we expect there to be continued debate on which names and sub-industries may be better positioned on this theme over time. We look forward to a spirited debate and welcome all feedback!*

Exhibit 3: Introducing the Humanoid 100: Morgan Stanley's List of Global Humanoid Enablers

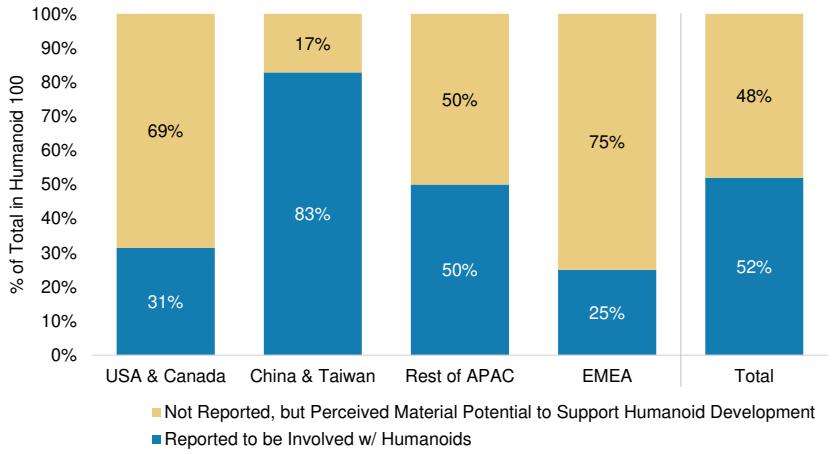


Note: Public companies only. Not all inclusive.

Source: Morgan Stanley Research

One of our goals with the Humanoid 100 is to give investors an accurate view of the current composition of the humanoid value chain. Investors will notice that 73% of the companies *confirmed* to be involved in humanoids and 77% of integrators are based out of Asia (56%/45% out of China, respectively). A common refrain we hear from investors is the lack of Western firms to add to their humanoid portfolio outside of TSLA and NVDA. In our view, this is important information in and of itself as it represents the reality of the current humanoid ecosystem which we expect may need to change materially over time (see the West's current experience with EVs which has significant supply chain overlap with humanoids). Our research suggests China continues to show the most impressive progress in humanoid robotics where startups are benefitting from established supply chains, local adoption opportunities, and strong degrees of national government support.

Exhibit 4: 52% of companies in the Humanoid 100 have been reported to be involved in the humanoid value chain. The remaining 48% have not been reported, but we believe there is material potential for these companies to eventually be involved, if they are not already.

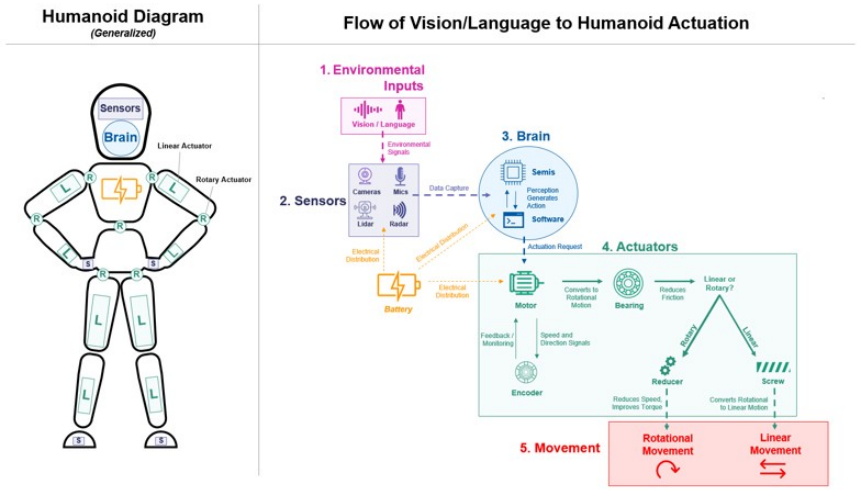


Source: Morgan Stanley Research

Dissecting the Humanoid Anatomy. To make sense of the list and properly construct a portfolio, we believe investors need at least a cursory understanding of

the makeup of the humanoid brain and body. The "brain" is composed of a mix of semiconductors and software, the most relevant being the foundational GenAI models for autonomy and simulation models/digital twins for training. The "body" is primarily composed of sensors (cameras, lidar, force, torque, magnetic, etc.), actuators (composed of motors, encoders, bearings, screws, and reducers), a web of wires and connectors, and a lithium-ion battery generally mounted in the center of the chest. The exterior is generally composed of a mix of aluminum alloys and plastics to minimize weight. *For more technical details of any particular humanoid part, common engineering architectures, and the current technical barriers to manufacturing humanoids, see the "* *Anatomy of a Humanoid* *section from our China Industrial Analyst, Sheng Zhong.*

Exhibit 5: Flow diagram of a humanoid robot: Understanding the interconnections between various components and the general role that each plays in the humanoid.



Source: Morgan Stanley Research

In the remainder of this report, we outline the contents of the Humanoid 100, review the humanoid investment case, dissect the anatomy of a humanoid, outline the latest on humanoid development progress, and review our humanoid TAM models.

Exhibit 6

Company (Ticker)	Country	Analyst	Primary Product	Secondary Product	Confirmed
Valeo (FR-FR)	France	Javier Martinez	ADAS (Radar, etc.)		No
Xusheng (603305-CN)	China	Shelley Wang	Aluminum Castings		No
Magna (MGA-US)	Canada	Adam Jonas	Aluminum Castings	ADAS (Radar, etc.)	No
GAC Group (2238-HK)	China	Joey Xu	Autos	Robotics	Yes
XPENG (XPEV-US)	China	Tim Hsiao	Autos	Robotics, EVTOL	Yes
Hyundai (005380-KR)	Korea	Young Suk Shin	Autos	Robotics	Yes
BYD (002594-CN)	China	Tim Hsiao	Autos	Robotics	Yes
Toyota (7203-JP)	Japan	Shinji Kakiuchi	Autos	Robotics	Yes
Tesla (TSLA-US)	USA	Adam Jonas	Autos	Robotics, Energy Storage	Yes
EVE Energy (300014-CN)	China	Jack Lu	Batteries (Complete)		No
Samsung SDI (096770-KR)	Korea	Shawn Kim	Batteries (Complete)		No
LG Energy Solution (373220-KR)	Korea	Young Suk Shin	Batteries (Complete)		No
CATL (300750-CN)	China	Jack Lu	Batteries (Complete)		No
Shuanglin (300100-CN)	China	NC	Bearings		Yes
Schaeffler (SHA0-DE)	Germany	NC	Bearings	Linear Guides	Yes
NSK (6471-JP)	Japan	Lisa Jiang	Bearings	Screws	No
Timken (TKR-US)	USA	Angel Castillo	Bearings	Reducers, Complete	No

Source: AlphaWise, FactSet, Company Data, Morgan Stanley Research

For Further Reading:

- Artificial Intelligence: Humanoids: Investment Implications of Embodied AI (26 Jun 2024)
- Humanoids: Humanoid Horizons: Is the ChatGPT moment here? (16 Jan 2025)
- Humanoids: Humanoid Horizons: The Journey from Tele-Ops to Full Autonomy (19 Dec 2024)
- Humanoids: Humanoid Horizons: Can the US Keep Pace With China? (9 Oct 2024)
- Humanoids: Humanoid Horizons: New Entrants, New Capital (5 Sep 2024)
- Embodied AI: AI Robotics Disruptors: Physical Intelligence (19 Dec 2024)
- Humanoids: Humanoids: Skild AI Exits Stealth at $1.5Bn Valuation (15 Jul 2024)

Humanoid 100 Covering Analysts

Exhibit 7: Humanoid 100 by Morgan Stanley Covering Analyst. *To discuss a specific company on the list, please reach out to your Morgan Stanley representative or the relevant analyst below.*

Humanoid 100 by Morgan Stanley Analyst

Analyst	Email	Companies Included
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Adam Wood	adam.wood@morganstanley.com	Dassault Systemes | Hexagon
Andy Meng	andy.meng@morganstanley.com	Xiaomi
Angel Castillo	angel.castillo@morganstanley.com	Timken
Brian Nowak	brian.nowak@morganstanley.com	Amazon | Meta | Alphabet Inc.
Carlos De Alba	carlos.de.alba@morganstanley.com	MP Materials
Charlie Chan	charlie.chan@morganstanley.com	Will Semiconductor | TSMC
Chris Snyder	chris.snyder@morganstanley.com	Rockwell Automation | Honeywell
Cindy Huang	cindy.huang@morganstanley.com	Hota
Derrick Yang	derrick.yang@morganstanley.com	Hiwin Technologies
Erik Woodring	erik.woodring@morganstanley.com	Apple
Gary Yu	gary.yu@morganstanley.com	Alibaba | Baidu | Tencent
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Javier Martinez	javier.martinez.olcoz@morganstanley.com	Valeo
Joey Xu	joey.xu@morganstanley.com	GAC Group
Joseph Moore	joseph.moore@morganstanley.com	Texas Instruments | Allegro Microsystems | Onsemi | NXP Semiconductor | Intel | NVIDIA | Micron | Ambarella | Qualcomm | Analog Devices
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Shawn Kim	shawn.kim@morganstanley.com	Samsung SDI | LG Electronics | Samsung Electronics | SK Hynix
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Shoji Sato	shoji.sato@morganstanley.com	Nidec
Tim Hsiao	tim.hsiao@morganstanley.com	XPENG | BYD | Horizon Robotics
Yoshinao Ibara	yoshinao.ibara@morganstanley.com	Keyence
Young Suk Shin	young.shin@morganstanley.com	Hyundai | LG Energy Solution

Source: Morgan Stanley Research

Mapping the Value Chain- Humanoid 100

The Humanoid 100 is Morgan Stanley's list of public companies currently involved in or otherwise materially exposed to the humanoid market. We compiled the list through a mix of discussions with our global team of analysts, conversations with clients on their preferred names to play, and our own proprietary research to find names that are involved in the value chain. We then divided the names into Brain (Semis/Software), Body (Industrial Components), and Integrators (Developing Full Humanoids). For every name in the Humanoid 100, we include details on size/liquidity, core business competencies, rationale for inclusion, and current humanoid involvement if applicable. Currently, 52% of companies are reported to be currently involved in humanoids already, and the remaining 48% are either close competitors of companies known to be involved or ones that our analysts believe have material potential to eventually be involved.

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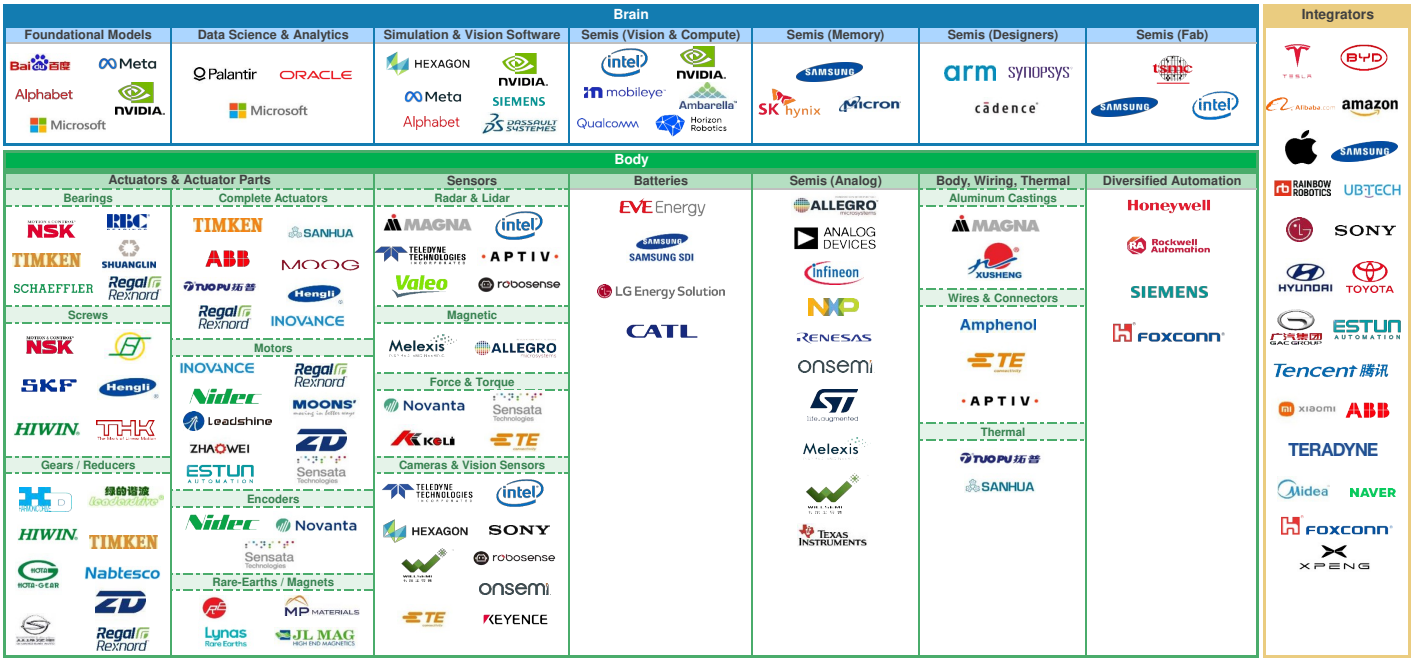
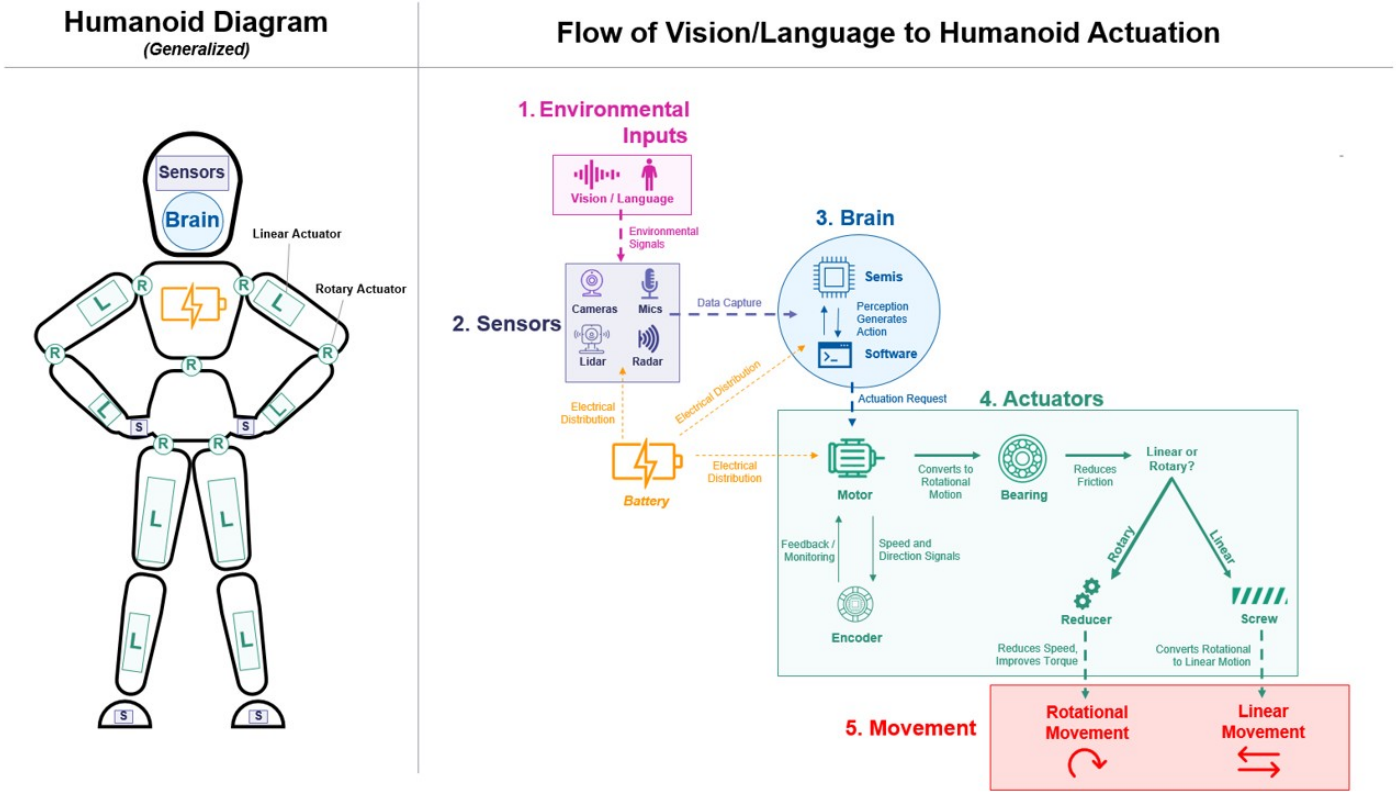


Note: Public companies only. Not all inclusive.

Source: Morgan Stanley Research

Exhibit 9: Flow diagram of a humanoid robot: Understanding the interconnections between various components and the general role that each plays in the humanoid.



Source: Morgan Stanley Research

Humanoid Brain (22 Companies)

Companies in the "Brain" category supply either the semis or the software/AI models necessary to enable humanoid autonomy (including both training and inference).

Foundational Models: These are companies building the Gen-AI models critical to enabling robotic autonomy. Through extensive training on vast sets of real and simulated robotic data, these models allow humanoids to understand natural language, learn from and imitate human action, and perceive their dynamic environments. The most well known is NVIDIA's Project GR00t.

- *Companies in the Humanoid 100:* Alphabet (GOOGL), Baidu (BIDU), Meta (META), Microsoft (MSFT), NVIDIA (NVDA).

Data Science & Analytics: These are companies developing software that allow robotics developers and users to capture and analyze the extensive amounts of sensor data captured at the edge.

- *Companies in the Humanoid 100:* Oracle (ORCL), Palantir (PLTR).

Simulation & Vision Software: Simulation is critical to training robotic models, allowing robots to learn their environments and use cases prior to deployment. These companies develop a range of digital-twin or vision data capture technology used in robotic/

humanoid training.

- *Companies in the Humanoid 100:* Alphabet (GOOGL), Dassault Systemes (DSY-FR), Hexagon (HEXA.B-SE), Meta (META), NVIDIA (NVDA), Siemens (SIE-DE).

Vision & Compute Semis: These are the companies producing semiconductors that are the core of the robot "brain", allowing robots to learn from, perceive, and/or interact with their environments. Vision-focused semis lie at the edge and allow robots to visualize their environments. Compute-focused semis exist either at the edge for real-time AI processing or at a datacenter to train foundational models or build simulations.

- *Companies in the Humanoid 100:* Ambarella (AMBA), Horizon Robotics (9660-HK), Intel (INTC), Mobileye (MBLY), NVIDIA (NVDA), Qualcomm (QCOM).

Memory: These companies produce memory (DRAM, NAND, etc.) necessary in all computing, likely to become more relevant in robotics with further AI penetration.

- *Companies in Humanoid 100:* Micron (MU), SK Hynix (000660-KR), Samsung Electronics (005930-KR).

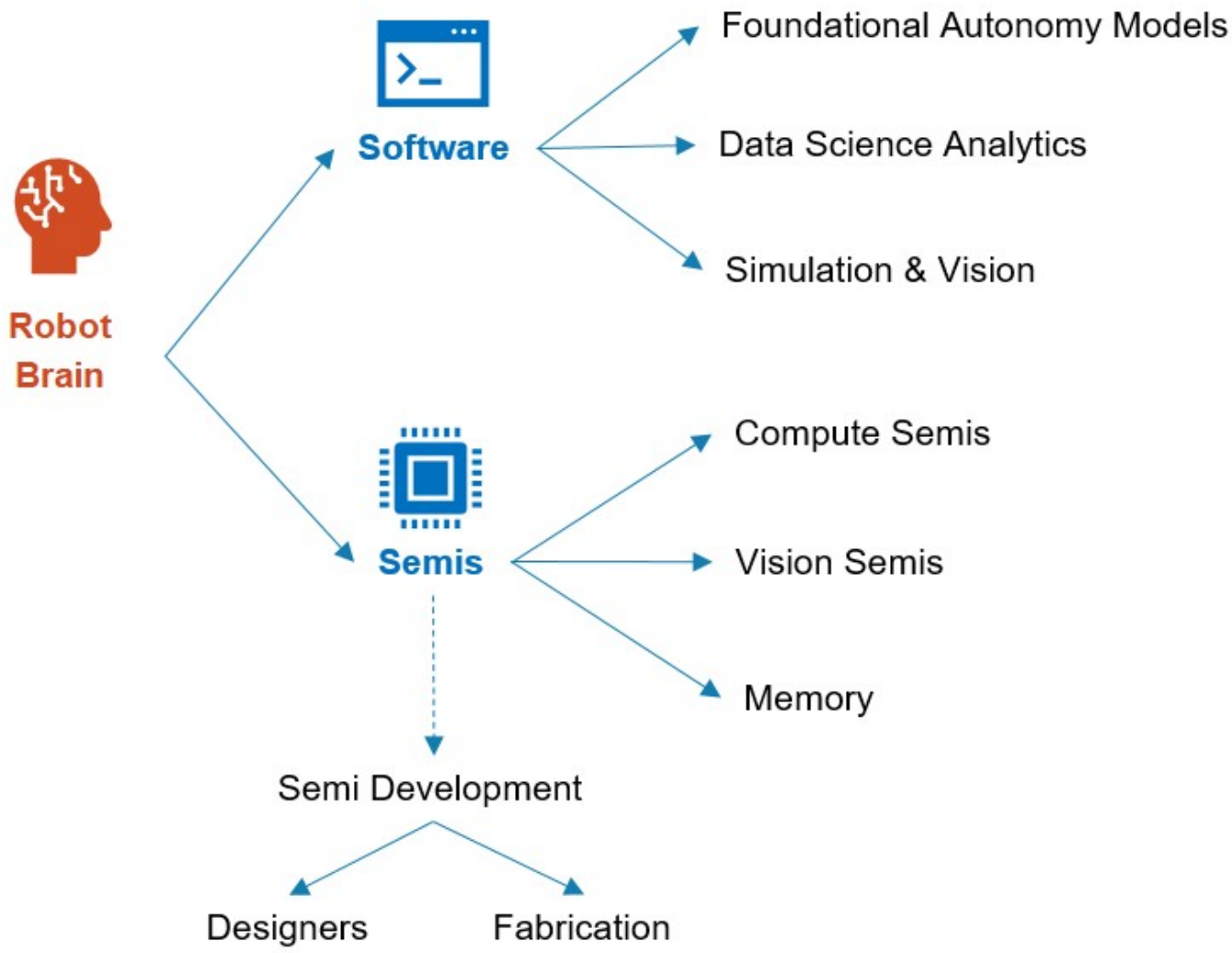
Semi Designers: These are silicon design firms that could benefit from a wave of new humanoid-specific semiconductor development.

- *Companies in the Humanoid 100:* Arm Holdings (ARM), Cadence Design Systems (CDNS), Synopsys (SNPS).

Semi Fabrication: The actual manufacturers of semiconductors, the largest of which is TSMC.

- Companies in the Humanoid 100: Intel (INTC), Samsung Electronics (005930-KR), TSMC (TSM).

Exhibit 10: Dissecting the Humanoid Brain



Source: Morgan Stanley Research

Exhibit 11: Humanoid "Brain" Companies

General					Trading Data			Core Competencies	
Company	Ticker	Country	Analyst	MS Rating	Mkt Cap ($mn)	Price ($)	Float %	Primary Product	Secondary Products
Palantir	PLTR-US	USA	Sanjit Singh	Equal-Weight	236,526	103.83	90%	Data Science & Analytics	
Oracle	ORCL-US	USA	Keith Weiss	Equal-Weight	469,582	167.89	59%	Data Science & Analytics	
Siemens	SIE-DE	Germany	Max Yates	Overweight	164,454	209.53	95%	Diversified Automation	Simulation, Sensors, Vision, Motors
Baidu	BIDU-US	China	Gary Yu	Equal-Weight	25,998	92.88		Foundational Models	
Meta	META-US	USA	Brian Nowak	Overweight	1,784,347	704.19	86%	Foundational Models	Simulation
Alphabet Inc.	GOOGL-US	USA	Brian Nowak	Overweight	2,525,679	206.38	48%	Foundational Models	Simulation
Microsoft	MSFT-US	USA	Keith Weiss	Overweight	3,065,550	412.37	99%	Foundational Models	Data Science & Analytics
Intel	INTC-US	USA	Joseph Moore	Equal-Weight	83,526	19.29	100%	Semis (Compute)	Vision, Lidar, Semis (Fab)
NVIDIA	NVDA-US	USA	Joseph Moore	Overweight	2,905,739	118.65	96%	Semis (Compute)	Foundational Models, Simulation
Synopsys	SNPS-US	USA	Lee Simpson	Overweight	80,980	523.88	100%	Semis (Design)	
Cadence Design Systems	CDNS-US	USA	Lee Simpson	Overweight	82,188	299.67	100%	Semis (Design)	
Arm Holdings	ARM-US	UK	Lee Simpson	Overweight	170,472	162.20	99%	Semis (Design)	
TSMC	TSM-US	Taiwan	Charlie Chan	Overweight	1,058,181	204.05	100%	Semis (Fab)	
Samsung Electronics	005930-KR	Korea	Shawn Kim	Overweight	244,701	36.02	70%	Semis (Memory)	Semis (Fab)
Micron	MU-US	USA	Joseph Moore	Equal-Weight	101,011	90.66	100%	Semis (Memory)	
SK Hynix	000660-KR	Korea	Shawn Kim	Underweight	90,010	130.63	79%	Semis (Memory)	Sensors, Vision
Horizon Robotics	9660-HK	China	Tim Hsiao	Overweight	1,449	0.60		Semis (Vision)	
Ambarella	AMBA-US	USA	Joseph Moore	Overweight	3,187	76.43	94%	Semis (Vision)	
Mobileye	MBLY-US	USA	Adam Jonas	Equal-Weight	12,912	15.92	11%	Semis (Vision)	
Qualcomm	QCOM-US	USA	Joseph Moore	Equal-Weight	191,277	173.04		Semis (Vision)	
Dassault Systemes	DSY-FR	France	Adam Wood	Overweight	55,446	42.22	50%	Simulation	Vision & Reality Capture Software
Hexagon	HEXA.B-SE	Sweden	Adam Wood	Underweight	31,659	11.79	77%	Vision	Simulation, Vision & Reality Capture Sc

KEY
USA & Canada
China & Taiwan
Rest of APAC
EMEA

Note: Pricing as of 2/4/2025 close.

Source: FactSet, Company Data, Morgan Stanley Research

Exhibit 12: Rationale for Inclusion and Current Humanoid Involvement of 'Brain' Companies

General	Rationale / Reported Humanoid Involvement (if known)		
Company	Reported?	Source	Notes / Context
Palantir		Company	Provides software platform for robotics companies to analyze sensor data and do edge computing. Currently working w Sarcos which makes "wearable"/semi-humanoid robots
Oracle		Company	Close collarboration with OpenAI & NVIDIA through Stargate in the US
Siemens		Company	Full suite and stack of automation related products across industries
Baidu	Reported	Company	Have a robobotics research group, partnered with UBTech
Meta	Reported	Company	Overlap with Meta Llama. Meta AI developing foundation models for humanoid control and tactical sensors for robotics.
Alphabet Inc.	Reported	Company	Google Deepmind has a robotics-specific group. Partnered with Apptronik
Microsoft	Reported	Company	Partnered with and financial backer of Figure AI
Intel	Reported	Company	Intel RealSense tracking cameras frequently used on humanoids. Unitree uses for high-end models.
NVIDIA	Reported	Company	Major humanoid push under Project Gr00T. Compute + Simulation. Partnered with vast majority of major humanoid developers
Synopsys		Company	Major semi designer. Could play a role in designing humanoid-specific chips
Cadence Design Systems		Company	Major semi designer. Could play a role in designing humanoid-specific chips
Arm Holdings		Company	Major semi designer. Currently designs SoCs for fusion/compute in robotics. Could play a role in designing humanoid-specific chips.
TSMC		Company, Electronics Weekly	TSMC could provide most leading-edge AI chips for humanoid robots. CEO has indicated that could supply robotics related chips for Tesla depending on price point.
Samsung Electronics	Reported	Company	Largest shareholder of Rainbow Robotics (humanoids). Also creates chips for Tesla Hardware 4
Micron		Company	Leader in US memory making DRAM and NAND, memory which implicitly is necessary in a humanoid performing on-device computation/storage. Invested in READY robotics.
SK Hynix		Company	Leader in memory (particularly HBM), memory which is necssary implicitly for humanoid robots performing on-device computation/requiring storage
Horizon Robotics		Company	Autonomous vehicle technology, plan to ultimately enter humanoid/robotics markets
Ambarella		Company	Provides a relatively cheap and power efficient computer vision SoC, applied to ADAS and industrial robotics
Mobileye		Company	Uses a camera+sensor approach to ADAS, could apply to humanoids
Qualcomm		Company	Has Snapdragon for autos; currently used in industrial and ADAS, could apply to humanoids
Dassault Systemes		Company	Leading provider of digital twin/simulation software frequently applied to robotics and manufacturing.
Hexagon	Reported	Robot Report	Global leader in optical sensor and reality capture/simulation/digital sim tech. Participated in Unitree's Series B round and became an announced partner

KEY
USA & Canada
China & Taiwan
Rest of APAC
EMEA

Source: Company Data, Electronics Weekly, Robot Report, Morgan Stanley Research

Humanoid Body (64 Companies)

Companies in the "body" category supply components enabling humanoid locomotion, electrical distribution, sensing, or structure.

Actuator Parts: Actuators are mechanical devices that convert electrical energy into motion, either linear or rotary. The greater the degrees-of-freedom (DoF) required, the more actuators are needed. Humanoids currently in development are generally capable of between 16 and 60 DoF. Optimus Gen2, in particular, uses 50 DoF, driven by 28 actuators (14 linear, 14 rotary). The latest Optimus hand (likely for Gen3) features 22 DoF vs. 27 DoF in the human hand. Future humanoids will likely have greater and greater DoF over time. Humanoid companies will often design their own proprietary actuators tailored to the specific robot, but will source various components from a web of global suppliers, similar to how automotive companies often design the vehicle architecture but outsource

manufacturing to various auto suppliers. *We outline the primary components below:*

- **Bearings:** Bearings are key to reducing friction in a moving system while maintaining rotary precision. Humanoids use a variety of bearing types, including ball bearings, roller bearings, and needle bearings.
  - *Companies in the Humanoid 100:* NSK (6471-JP), RBC Bearings (RBC), Regal Rexnord (RRX), Schaeffler (SHA0-DE), Timken (TKR).
- **Screws:** Screws are components that convert rotational motion from a motor to linear motion, and thus are a critical component in linear actuators. Currently, both ball and planetary roller screws are used for humanoids, but this is largely due to the limited supply and cost of planetary roller screws. Over time, planetary roller screws should represent the majority of screws used in humanoids.
  - *Companies in the Humanoid 100:* Hengli (601100-CN), Hiwin (2049-TW),NSK (6471-JP), SKF (SKF.b-SE), Shanghai Beiti (603009-CN), THK (6481-JP).
- **Gearing & Reducers:** Reducers, as the name implies, reduce motor speed using various gear wheels to improve torque output and precision. They are a critical component in rotary actuators. Current humanoid designs use either harmonic or planetary reducers.
  - *Companies in the Humanoid 100:* Harmonic Drive System (6324-JP), Hiwin (2049-TW), Hota (1536-TW), LeaderDrive (688017-CN), Nabtesco (6268-JP), Regal Rexnord (RRX), Shuanghuan (002472-CN), Timken (TKR), Zhongda Leader (002896-CN).
- **Motors & Rare Earth Magnets:** Electric motors convert electricity into mechanical energy and are used in all electric actuators. Most motors create motion using rare earth magnets that repel against electrified coils of wire, creating a rotational effect. Humanoids generally use either frameless torque motors (lower technical barriers) or coreless motors (greater technical barriers).
  - *Motor companies in Humanoid 100:* Estun (002747-CN), Leadshine (002979-CN), Moons' Electric (603728-CN), Nidec (6594-JP), Regal Rexnord (RRX), Sensata (ST), Shenzhen Inovance (300124-CN), Zhaowei (003021-CN), Zhongda Leader (002896-CN).
  - *Rare earth magnet companies in Humanoid 100:* JL Mag (6680-HK), Lynas Rare Earths (LYC-AU), MP Materials (MP-US), Northern Rare Earth (600111-CN).
- **Encoders:** Encoders are sensory devices that are fitted on and monitor the speed and output of a motor, sending back a signal to control variables such as position, speed, and torque.
  - *Companies in the Humanoid 100:* Nidec (6594-JP), Novanta (NOVT), Sensata (ST).

Sensors: Humanoids are outfitted with a wide array of sensors to allow humanoids to perceive their environment and collect necessary data. *We outline the primary types below:*

- **Cameras & Vision Sensors:** Captures full images (cameras) or light properties to enable humanoid perception.
  - *Companies in the Humanoid 100:* Analog Devices (ADI), Hexagon (HEXA.B-SE), Intel (INTC), Keyence (6861-JP), Onsemi (ON), Robosense (2498-HK), Sony Group (SONY), TE Connectivity (TEL), Teledyne Technologies (TDY), Will Semiconductor (603501-CN).

- **Radar & Lidar:** Enables depth perception through radio waves (radar) or lasers (Lidar) to detect objects and measure distances.
  - *Companies in the Humanoid 100:* Aptiv (APTV), Intel (INTC), Magna (MGA), Robotsense (2498-HK), Teledyne Technologies (TDY), Valeo (FR-FR).
- **Magnetic:** Detects presence of a magnetic field. Generally in humanoid hands and allows the robot to sense if it is touching something.
  - *Companies in the Humanoid 100:* Allegro Microsystems (ALGM), Melexis (MELE-BE).
- **Force & Torque:** Force sensors allow the humanoid to detect and measure weight and pressure. Torque sensors allow humanoids to assess the torque applied to its actuators.
  - *Companies in the Humanoid 100:* Keli Sensing (603662-CN), Novanta (NOVT), Sensata (ST), TE Connectivity (TEL).

Batteries: Humanoids generally use a battery pack made of cylindrical lithium-ion cells contained within the torso of the robot.

- *Companies in the Humanoid 100:* CATL (300750-CN), EVE Energy (300014-CN), LG Energy Solution (373220-KR), Samsung SDI (096770-KR).

Analog Semis: Work with sensors to help regulate temperature, speed, position, electrical distribution, etc. Many sensors are technically a type of analog semi.

- *Companies in Humanoid 100:* Allegro Microsystems (ALGM), Infineon (IFX-DE), Melexis (MELE-BE), NXP (NXPI), Onsemi (ON), Renesas (6723-JP), ST Micro (STM), Texas Instruments (TXN), Will Semiconductor (603501-CN).

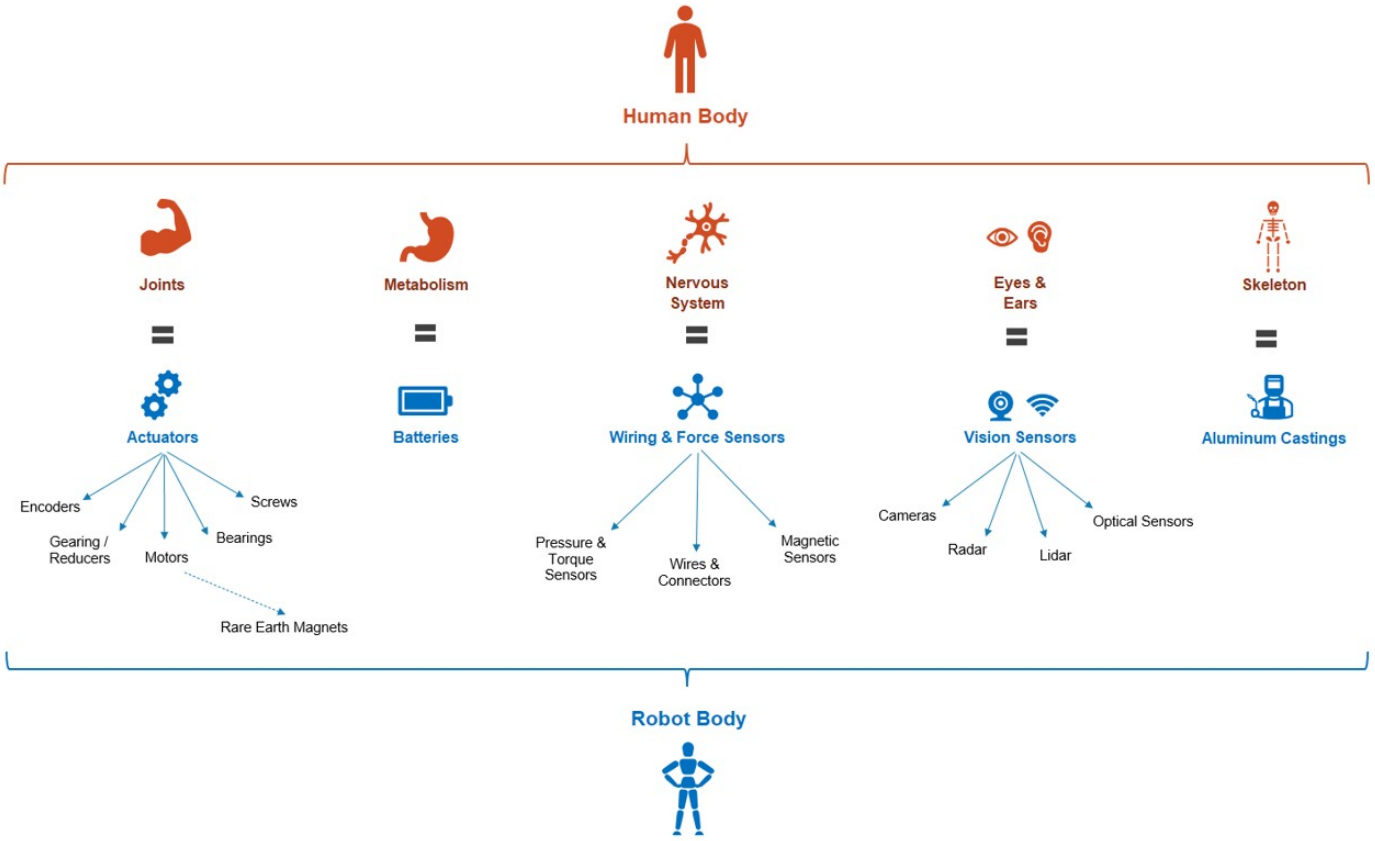
Body, Wiring, Thermal: The structure of the robot and method of power distribution and cooling.

- *Companies in Humanoid 100:* Amphenol (APH), Aptiv (APTV), Magna (MGA), TE Connectivity (TEL), Xusheng (603305-CN), Sanhua (002050-CN), Tuopu (601689-CN).

Diversified Automation Companies: These are companies that provide a wide range of automation/robotics-related solutions such that they were best left in their own category. Potential to supply most necessary components given scale and expertise if there is sufficient demand.

- *Companies in Humanoid 100:* Hon Hai Precision / Foxconn (2317-TW), Honeywell (HON), Rockwell Automation (ROK), Siemens (SIE-DE).

Exhibit 13: Dissecting the Humanoid Body



Source: Morgan Stanley Research

Exhibit 14: Humanoid "Body" Companies

General					Trading Data			Core Competencies	
Company	Ticker	Country	Analyst	MS Rating	Mkt Cap ($mn)	Price ($)	Float %	Primary Product	Secondary Products
Valeo	FR-FR	France	Javier Martinez	Underweight	2,613	10.75	90%	ADAS (Radar, etc.)	
Xusheng	603305-CN	China	Shelley Wang	Equal-Weight	2,050	2.20	36%	Aluminum Castings	
Magna	MGA-US	Canada	Adam Jonas	Equal-Weight	10,850	37.76	93%	Aluminum Castings	ADAS (Radar, etc.)
EVE Energy	300014-CN	China	Jack Lu	Equal-Weight	11,883	5.85	59%	Batteries (Complete)	
Samsung SDI	096770-KR	Korea	Shawn Kim	Equal-Weight	12,802	84.35	63%	Batteries (Complete)	
LG Energy Solution	373220-KR	Korea	Young Suk Shin	Overweight	53,265	227.63	18%	Batteries (Complete)	
CATL	300750-CN	China	Jack Lu	Overweight	155,380	35.38	49%	Batteries (Complete)	
Shuanglin	300100-CN	China	NC		1,987	5.00		Bearings	
Schaeffler	SHA0-DE	Germany	NC		4,070	4.31	96%	Bearings	Linear Guides
NSK	6471-JP	Japan	Lisa Jiang	Equal-Weight	2,018	4.13	77%	Bearings	Screws
Timken	TKR-US	USA	Angel Castillo	Overweight	5,533	78.91	90%	Bearings	Reducers, Complete Actuators
RBC Bearings	RBC-US	USA	Kristine Liwag	Overweight	11,597	368.82	98%	Bearings	
Tuopu	601689-CN	China	Shelley Wang	Overweight	15,241	9.04	38%	Complete Actuators	Thermal (Pumps, Battery Cooling, etc.)
Sanhua	002050-CN	China	Shelley Wang	Equal-Weight	15,706	4.21	48%	Complete Actuators	Thermal (Pumps, Battery Cooling, etc.)
Shenzhen Inovance	300124-CN	China	Sheng Zhong	Overweight	22,265	8.29	57%	Complete Actuators	Motors
Moog	MOG.A	USA	Kristine Liwag	Equal-Weight	5,839	184.82	91%	Complete Actuators	Defense Platforms
Rockwell Automation	ROK-US	USA	Chris Snyder	Overweight	30,557	270.34	100%	Diversified Automation	
Honeywell	HON-US	USA	Chris Snyder	Equal-Weight	145,363	223.55	100%	Diversified Automation	Vision, Avionics
Siemens	SIE-DE	Germany	Max Yates	Overweight	164,454	209.53	95%	Diversified Automation	Simulation, Sensors, Vision, Motors
Hon Hai Precision (Foxconn)	2317-TW	Taiwan	Sharon Shih	Overweight	69,364	4.99	86%	Electronic Components	
Novanta	NOVT-US	USA	NC		5,312	147.87	99%	Encoders	Sensors (Force)
Hota	1536-TW	Taiwan	Cindy Huang	Underweight	497	1.78		Gears/Reducers	
Harmonic Drive Systems	6324-JP	Japan	Lisa Jiang	Equal-Weight	2,776	29.23	61%	Gears/Reducers	
LeaderDrive	688017-CN	China	Sheng Zhong	Underweight	3,657	19.96		Gears/Reducers	
Shuanghuan	002472-CN	China	Sheng Zhong	Overweight	3,970	4.80	80%	Gears/Reducers	
Nabtesco	6268-JP	Japan	Lisa Jiang	Equal-Weight	2,067	17.21	89%	Gears/Reducers	
Zhongda Leader	002896-CN	China	NC		1,197	7.92		Motors	Gears/Reducers
Leadshine	002979-CN	China	NC		1,421	4.71	51%	Motors	
Estun	002747-CN	China	Sheng Zhong	Underweight	2,172	2.50	54%	Motors	Robotics
Zhaowei	003021-CN	China	NC		3,067	12.84	80%	Motors	
Moons Electric	603728-CN	China	NC		3,583	8.58	31%	Motors	
Regal Rexnord	RRX	USA	NC		10,258	154.89	99%	Motors	Bearings, Gears, Complete Actuators
Nidec	6594-JP	Japan	Shoji Sato	Equal-Weight	19,028	16.56	70%	Motors	Encoders
JL Mag	6680-HK	China	Rachel Zhang	Equal-Weight	1,597	1.19	8%	Rare-Earth/Magnets	
MP Materials	MP-US	USA	Carlos De Alba	Equal-Weight	3,994	24.47	72%	Rare-Earth/Magnets	
Lynas Rare Earths	LYC-AU	Australia	Shannon Sinha	Underweight	3,686	3.94	88%	Rare-Earth/Magnets	
Northern Rare Earths	600111-CN	China	NC		10,475	2.90	58%	Rare-Earth/Magnets	
ABB	ABBN-CH	Switzerland	Max Yates	Equal-Weight	100,438	54.48	85%	Robotics	Complete Actuators
Shanghai Beite	603009-CN	China	NC		2,265	6.69		Screws	
THK	6481-JP	Japan	Lisa Jiang	Overweight	2,987	24.36	90%	Screws	Linear guides, Complete Actuators
Hiwin Technologies	2049-TW	Taiwan	Derrick Yang	Equal-Weight	3,277	9.26	79%	Screws	Linear guides, Robotics, Reducers
Jiangsu Hengli	601100-CN	China	Sheng Zhong	Overweight	11,460	8.55	33%	Screws	Complete Actuators
SKF	SKF.b-SE	Sweden	Michael Harleaux	++	9,067	19.91	94%	Screws	
Melexis	MELE-BE	Belgium	Nigel van Putten	Equal-Weight	2,590	64.10	50%	Semis (Analog)	Sensors (Magnetic)
Will Semiconductor	603501-CN	China	Charlie Chan	Equal-Weight	17,421	14.52	56%	Semis (Analog)	Vision
Texas Instruments	TXN-US	USA	Joseph Moore	Underweight	164,710	180.56	100%	Semis (Analog)	
Allegro Microsystems	ALGM-US	USA	Joseph Moore	Equal-Weight	4,408	23.94	66%	Semis (Analog)	Sensors (Magnetic)
STMicroelectronics	STM-US	Switzerland	Lee Simpson	Underweight	19,902	22.37		Semis (Analog)	
Onsemi	ON-US	USA	Joseph Moore	Underweight	21,537	50.58	99%	Semis (Analog)	Vision
Renesas	6723-JP	Japan	Kazuo Yoshikawa	Overweight	23,442	13.08	89%	Semis (Analog)	
Infineon	IFX-DE	Germany	Lee Simpson	Equal-Weight	46,520	35.81		Semis (Analog)	
NXP Semiconductor	NXPI-US	Netherlands	Joseph Moore	Equal-Weight	51,441	202.40	100%	Semis (Analog)	
Intel	INTC-US	USA	Joseph Moore	Equal-Weight	83,526	19.29	100%	Semis (Compute)	Vision, Lidar, Semis (Fab)
Keli Sensing	603662-CN	China	NC		2,955	10.49	99%	Sensors (Force & Torque)	
Sensata	ST-US	USA	NC		3,850	25.74	99%	Sensors (Force & Torque)	Motors, Encoders
Analog Devices	ADI	USA	Joseph Moore	Overweight	102,203	206.01	100%	Semis (Analog)	
Robosense	2498-HK	China	NC		1,957	4.52	69%	Vision	Sensors, Lidar, Controllers
Hexagon	HEXA.B-SE	Sweden	Adam Wood	Underweight	31,659	11.79	77%	Vision	Simulation, Vision & Reality Capture So
Sony Group	SONY-US	Japan	Kazuo Yoshikawa	Overweight	133,800	22.52		Vision	Robotics
Teledyne	TDY-US	USA	Kristine Liwag	Equal-Weight	23,975	514.47	99%	Vision	Lidar
Keyence	6861-JP	Japan	Yoshinao Ibara	Equal-Weight	97,233	400.92	77%	Vision	Sensors (Optical), Sensors (Temp)
Aptiv	APTV-US	USA	Adam Jonas	Underweight	14,431	61.40	99%	Wires/Connectors	ADAS (Radar, etc.)
TE Connectivity	TEL	USA	NC		43,193	144.77		Wires/Connectors	Sensors (Force & Torque, Optical)
Amphenol	APH	USA	NC		84,043	69.71	99%	Wires/Connectors	

KEY
USA & Canada
China & Taiwan
Rest of APAC
EMEA

Note: Pricing as of 2/4/2025 close.

Source: FactSet, Company Data, Morgan Stanley Research

Exhibit 15: Rationale for Inclusion and Current Humanoid Involvement of "Body" Companies

General	Rationale / Reported Humanoid Involvement (if known)		
Company	Reported?	Source	Notes / Context
Valeo		Company	Relevant player in ADAS (ultrasonic sensors, radars, parking assistant software) and Lidar
Xusheng		Company, Global Times	Currently cast parts for Tesla EV's. Could potentially cast parts for humanoid body/components.
Magna		Company	Fourth largest auto supplier in world. Confirmed supplier of Waymo sensor equip. Potential to be applied outside of autos/humanoids.
EVE Energy		Company	Leading global supplier of lithium ion batteries
Samsung SDI		Company	Major global supplier of battery cells.
LG Energy Solution		Company	Supply battery cells to various robotics use cases (such as Bear Robotics)
CATL		Company	Leading Chinese battery manufacturer
Shuanglin	Reported	Company	Create planetary roller screws for linear actuators used on humanoids
Schaeffler	Reported	Company	Leading global producer of bearings used in robotics. Investor and strategic partner of Agility Robotics.
NSK		Company	Makes linear actuators and bearings for robotics
Timken		Company	Makes "TwinSpin" reducer and "DriveSpin" actuators, which currently go into industrial robots (Timken's 2nd largest business)
RBC Bearings		Company	Makes a variety of bearings used in robotics
Tuopu	Reported	Company	Recognized Rmb1.85 million revenue in 2023 from supplying humanoid actuator samples. Primarily autos supplier but aiming to grow robotic parts business.
Sanhua	Reported	Company	Has a robotics actuator business specific to humanoids. Also developing humanoid sensors/motors. Known Tesla auto supplier.
Shenzhen Inovance	Reported	Company	Planning to launch motor and linear actuator business for humanoids in 2025
Moog		Company	Create linear actuators primarily for A&D applications
Rockwell Automation		Company	Variety of products for automation/robotics from sensors/switches/power to analytics/software platform to industrial robotics
Honeywell		Company	Diversified supplier of automation-related components. Makes AMRs and develops vision tech used in industrial applications.
Siemens		Company	Full suite and stack of automation related products across industries
Hon Hai Precision (Foxconn)	Reported	Company, TechInAsia	Partnered with NVIDIA to develop humanoids per Chairman Young Liu. Could also potentially produce relevant electronic components.
Novanta	Reported	Company	Makes full "stack" from encoders to sensors in robots. Inventor and market leader for six-axis force sensors commonly used on humanoids (though sub ATI)
Hota	Reported	DigiTimes	Aug. '24- reportedly trying to enter Tesla humanoid supply chain via Main Drive (JV w Mirle)
Harmonic Drive Systems	Reported	Company	~10% of rev from humanoid related business (from <Y100mn to Y3-3.5bn). As of 5/20/24, 3-4 humanoid customers.
LeaderDrive	Reported	Company	Humanoid >$10% 4Q24 reducer revs, expected to accelerate 2025
Shuanghuan	Reported	Company	Major producer of gear reducers in China. Currently used in humanoid applications.
Nabtesco		Company	Major producer of reduction gearing for industrial robots. Gears used in more than 60% of industrial robots, globally.
Zhongda Leader	Reported	Company	Create planetary gear motors and harmonic reducers used for humanoid robotics
Leadshine	Reported	Company	Investing CNY500 million to develop and manufacture humanoid robot parts at its headquarters in Dongguan.
Estun	Reported	Company	Create precision motors for humanoids, also have their own in-house humanoid (Codriod 01)
Zhaowei	Reported	Company	Create micro hand motors/actuators specific to humanoids
Moons Electric	Reported	Company	Micro motors marketed for humanoid hands ("super-hollow shaft stepper motors" help with hand articulation)
Regal Rexnord		Company	Leading US supplier of electric motors, gearing, linear actuators.
Nidec		Company	Makes motors and controllers for robotics (commercial and industrial and AGVs)
JL Mag	Reported	Company	Investing USD$144mn in Mexico factory citing growing demand for humanoids and EVs. (Duel listed as 300748-SZ)
MP Materials	Reported	Company	Produces Neodymium-iron-boron (NdFeB) magnets, which is then used in robotic applications. CEO speaks about strong potential rare earth demand due to humanoids.
Lynas Rare Earths		Company	Produces rare earth magnetic materials and rare earth permanent magnets for high efficiency motors
Northern Rare Earths		Company	Produces rare earth magnetic materials and rare earth permanent magnets for high efficiency motors
ABB		Company	Makes full stack of products (from motors to electrical/power products to control systems) for robotics - currently industrial and cobots, as well as full bots.
Shanghai Beite	Reported	Company	On 10/14/24, signed agreement to invest Rmb1.85bn in humanoid component plant (planetary roller screws)
THK	Reported	Company	Developed "SEED" linear actuators for humanoid hands. Major producer of ball screws which are a critical component of linear actuators.
Hiwin Technologies	Reported	Company, DigiTimes	Produce ball screws, linear guides which are a core component of humanoid actuators. Reported supplier of Boston Dynamics per Hiwin's Chairman.
Jiangsu Hengli	Reported	Company	Produces a variety of components including planetary roller screws, critical for linear actuators. Disclosed that screws have been sent overseas for humanoid client validation.
SKF		Company	Variety of bearings and seals currently for variety of industries (autos, industrials, etc)
Melexis	Reported	Company	Tractaxis force sensors designed specifically for industrial robots and humanoids
Will Semiconductor	Reported	Company	Will Semi (Omnivision) launched new total camera solution for humanoid robot market in Oct 2024, including a 2MP GS (global shutter) image sensor (OG02B10) and an ASIC ISP (OAX4000)
Texas Instruments	Reported	Company	Makes sensors, system controlers, and motor drivers explicitly advertised for humanoid application
Allegro Microsystems		Company	Sensors, motors, and power control currently in industrial robotic applications.
STMicroelectronics		Company	Power, motor control, sensors used in industrial robots
Onsemi		Company	Power and sensing solutions currently used in AMRs/industrial robots
Renesas		Company	Major supplier of MCU/SoC currently used in robotics
Infineon		Company	Power, motion control, MCU's, currently used in robotics.
NXP Semiconductor		Company	Major producer of auto and robotics motion controllers/MCU's
Intel	Reported	Company	Intel RealSense tracking cameras frequently used on humanoids. Unitree uses for high-end models.
Keli Sensing	Reported	Company	Showcased sensors for humanoids at 2024 China Weighing Fair; six-axis force/torque sensors
Sensata		Company	Full suite of pressure/position/temperature sensors used in industrial/aviation applications
Analog Devices		Company	Analog chips that enable motion control, advanced sensing, and functional safety.
Robosense	Reported	Company	Offers cameras/lidar, sensors, controllers designed specifically for humanoids
Hexagon	Reported	Robot Report	Global leader in optical sensor and reality capture/simulation/digital sim tech. Participated in Unitree's Series B round and became an announced partner
Sony Group	Reported	Company	Self reportedly has the tech to quickly make humanoid robotics once use case determined; has made prototype (QRIO) reported. Also creates cameras used on robotics
Teledyne		Company	FLIR - heat cameras (high quality cameras and sensors for military grade applications like unmanned drones).
Keyence		Company	Machine vision (auto, consumer, industrial robotic applicatoins)
Aptiv		Company	Leading US supplier of wires, connectors, and ADAS sensors.
TE Connectivity		Company	Supplies wires/connectors for robotics, data centers, cars, etc.
Amphenol		Company	Supplies wires/connectors for robotics, cars, etc.

KEY
USA & Canada
China & Taiwan
Rest of APAC
EMEA

Source: Company Data, Global Times, TechInAsia, DigiTimes, Robot Report, Morgan Stanley Research

Humanoid Integrators (22 Companies)

Integrators are companies currently building full humanoid robots or that have the reasonable potential to do so given their expertise in manufacturing other robotics or automation platforms. Most of these companies are larger, mature corporates that also have in-house robotics businesses. We note the vast majority of younger humanoid startups are currently private. *We group the integrators below:*

Autos: There are a number of automotive companies currently developing humanoids, likely due to the engineering and manufacturing overlap combined with potential in-house use cases to reduce labor intensity and improve margins over time.

- *Companies in Humanoid 100:* BYD (002594-CN), GAC Group (2238-HK), Hyundai / Boston Dynamics (005380-KR), Tesla (TSLA), Toyota (7203-JP), XPENG (XPEV).

Consumer Electronics: Similar to automotive companies, these firms likely manufacture (or may manufacture) robots due to their expertise in scale manufacturing and ability to develop electronic architectures for robots using in-house talent. A number of these companies may see humanoids as an extension of household electronics and leverage humanoids as another method to penetrate the home.

- *Companies in Humanoid 100:* Apple (AAPL), Hon Hai Precision / Foxconn (2317-TW), LG Electronics (066570.HK), Samsung Electronics (005930-KR), Sony Group (SONY), Xiaomi (1810-HK).

E-Commerce and Internet: These companies would likely benefit from overlap between humanoid design and their existing technical expertise, and additionally could have in-house use cases to reduce costs over time.

- *Companies in Humanoid 100:* Alibaba (BABA), Amazon (AMZN), Naver (035420-KR), Tencent (700-HK).

Legacy Robotics Companies: These are legacy co-bot manufacturers that have existed for decades but have the potential to eventually develop humanoids if they are not already doing so.

- *Companies in Humanoid 100:* ABB (ABBN-CH), Midea / KUKA (000333-CN), Teradyne (TER).

Humanoid Near-Pure Plays: These are young humanoid developers that are the closest to humanoid-pure plays out of any company on this list.

- *Companies in Humanoid 100:* Rainbow Robotics (277810-KR), UBTech (9880-HK).

Exhibit 16: Humanoid "Integrators"

General					Trading Data			Core Competencies	
Company	Ticker	Country	Analyst	MS Rating	Mkt Cap ($mn)	Price ($)	Float %	Primary Product	Secondary Products
GAC Group	2238-HK	China	Joey Xu	Overweight	4,071	0.40	22%	Autos	Robotics
XPENG	XPEV-US	China	Tim Hsiao	Overweight	13,146	16.99	97%	Autos	Robotics, EVTOL
Hyundai	005380-KR	Korea	Young Suk Shin	Overweight	36,405	137.40	53%	Autos	Robotics
BYD	002594-CN	China	Tim Hsiao	Equal-Weight	109,785	37.79	27%	Autos	Robotics
Toyota	7203-JP	Japan	Shinji Kakiuchi	Equal-Weight	243,296	18.58	71%	Autos	Robotics
Tesla	TSLA-US	USA	Adam Jonas	Overweight	1,261,551	392.21	87%	Autos	Robotics, Energy Storage
LG Electronics	066570-KR	Korea	Shawn Kim	Overweight	9,650	53.59	60%	Consumer Electronics	Robotics
Xiaomi	1810-HK	China	Andy Meng	Overweight	127,127	5.08	66%	Consumer Electronics	Autos
Apple	AAPL-US	USA	Erik Woodring	Overweight	3,497,145	232.80		Consumer Electronics	Robotics
Alibaba	BABA-US	China	Gary Yu	Equal-Weight	245,066	102.35	99%	E-Commerce	
Amazon	AMZN-US	USA	Brian Nowak	Overweight	2,545,261	242.06	89%	E-Commerce; Cloud	Robotics, Satellite Comms
Hon Hai Precision (Foxconn)	2317-TW	Taiwan	Sharon Shih	Overweight	69,364	4.99	86%	Electronic Components	
Naver	035420-KR	Korea	Seyon Park	Equal-Weight	22,239	149.36	96%	Internet	Robotics
Tencent	700-HK	China	Gary Yu	Overweight	491,611	54.04	68%	Internet	Robotics
Estun	002747-CN	China	Sheng Zhong	Underweight	2,172	2.50	54%	Motors	Robotics
Rainbow Robotics	277810-KR	Korea	NC		4,509	232.42	21%	Robotics	
UBTech	9880-HK	China	NC		4,379	10.15	19%	Robotics	
Midea	000333-CN	China	Lillian Lou	Overweight	77,986	10.17	53%	Robotics	
ABB	ABBN-CH	Switzerland	Max Yates	Equal-Weight	100,438	54.48	85%	Robotics	Complete Actuators
Samsung Electronics	005930-KR	Korea	Shawn Kim	Overweight	244,701	36.02	70%	Semis (Memory)	Semis (Fab)
Teradyne	TER-US	USA	Shane Brett	Underweight	18,187	111.67	98%	Testing Equipment	Robotics
Sony Group	SONY-US	Japan	Kazuo Yoshikawa	Overweight	133,800	22.52		Vision	Robotics

KEY
USA & Canada
China & Taiwan
Rest of APAC
EMEA

Note: Pricing as of 2/4/2025 close.

Source: FactSet, Company Data, Morgan Stanley Research

Exhibit 17: Rationale for Inclusion and Current Humanoid Involvement of "Integrators"

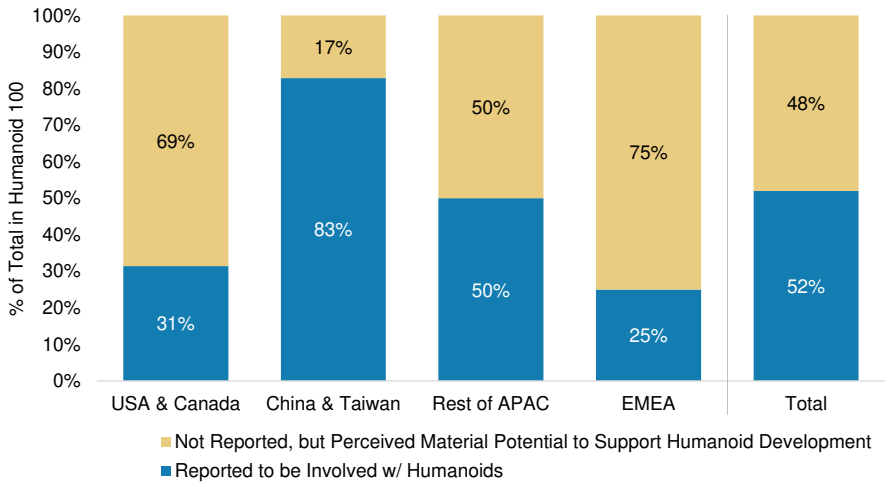
General	Rationale / Reported Humanoid Involvement (if known)		
Company	Reported?	Source	Notes / Context
GAC Group	Reported	Company	Developing GoMate Humanoid
XPENG	Reported	Company	Developing Iron Humanoid
Hyundai	Reported	Company	Developing Atlas Humanoid (Maj. Owner of Boston Dynamics)
BYD	Reported	Company	Internal humanoid project dubbed "Yao Shun Yu"
Toyota	Reported	Company	Developing T-HR3/Punyo Humanoid
Tesla	Reported	Company	Developing Optimus humanoid. CEO Elon Musk expects humanoids to eventually represent the majority of the business and market value
LG Electronics	Reported	Company	Reported to be developing household humanoids
Xiaomi	Reported	Company	Developing CyberOne Humanoid
Apple	Reported	Company, Carnegie Mellon	Reported to be working with Carnegie Mellon on humanoid technology
Alibaba	Reported	Company	Invested in Beijing Xingtong Era Technology Co., a humanoid robot developer, through its subsidiaries in Hangzhou and Chengdu
Amazon	Reported	Company	Amazon is the leader in industrial robotics (750K+); invested in Agility Robotics, testing Agility's bipedal robot Digit for use in warehouse/logistic operations
Hon Hai Precision (Foxconn)	Reported	Company, TechInAsia	Partnered with NVIDIA to develop humanoids per Chairman Young Liu. Could also potentially produce relevant electronic components.
Naver	Reported	Company	Developing Ambidex Humanoid
Tencent	Reported	Company	Have internal robotics lab working on humanoids
Estun	Reported	Company	Create precision motors for humanoids, also have their own in-house humanoid (Codriod 01)
Rainbow Robotics	Reported	Company	Developing RB-Y1 Humanoid. Largest shareholder is Samsung Electronics (35%)
UBTech	Reported	Company	Humanoid pure play. Developing Walker series of humanoids- partnered with BYD, DongFeng, Nio, others
Midea	Reported	Company	Embodied R&D team researching humanoids (owns KUKA)
ABB		Company	Makes full stack of products (from motors to electrical/power products to control systems) for robotics - currently industrial and cobots, as well as full bots.
Samsung Electronics	Reported	Company	Largest shareholder of Rainbow Robotics (humanoids). Also creates chips for Tesla Hardware 4
Teradyne		Company	Primarily make semis test equipment, but also have a co-bot business.
Sony Group	Reported	Company	Self reportedly has the tech to quickly make humanoid robotics once use case determined; has made prototype (QRIO) reported. Also creates cameras used on robotics

KEY
USA & Canada
China & Taiwan
Rest of APAC
EMEA

Source: Company Data, TechInAsia, Carnegie Mellon, Morgan Stanley Research

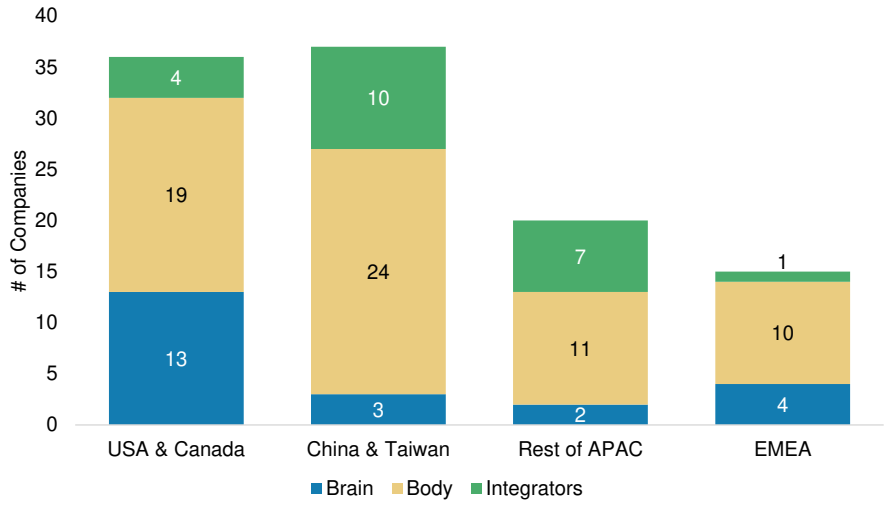
Humanoid 100 Composition

Exhibit 18: 52% of companies in the Humanoid 100 have already been reported to be involved in the humanoid value chain. The remaining 48% have not been reported, but we believe there is material potential for these companies to eventually be involved, if they are not already.



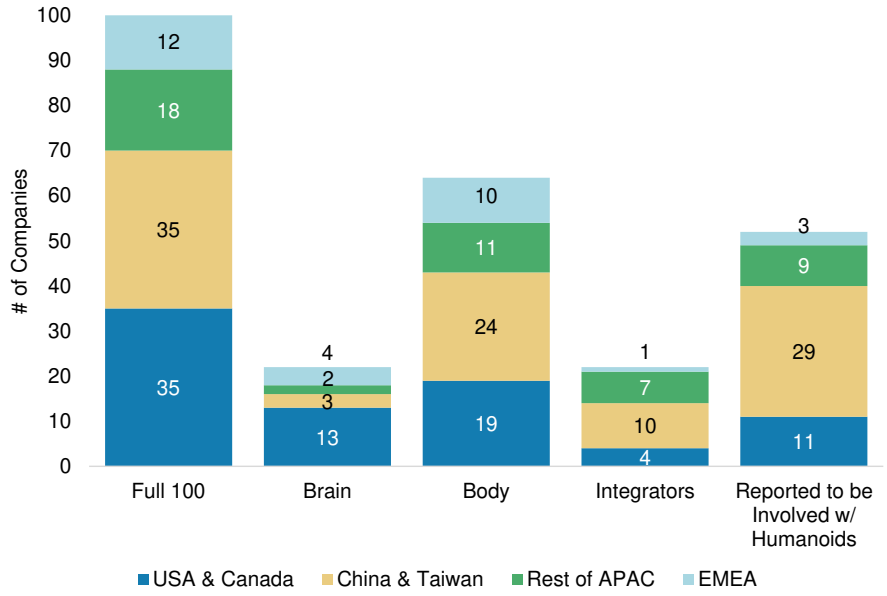
Source: Morgan Stanley Research

Exhibit 19: Humanoid 100 Brain/Body/Integrator Composition by Region



Source: Morgan Stanley Research

Exhibit 20: Humanoid 100 Regional Composition by Major Category

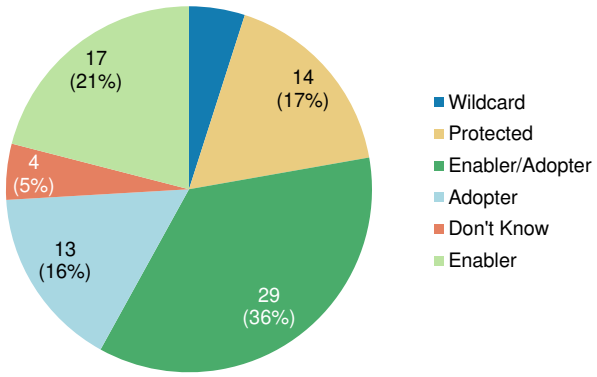


Source: Morgan Stanley Research

Thematics- AI Mapping Survey

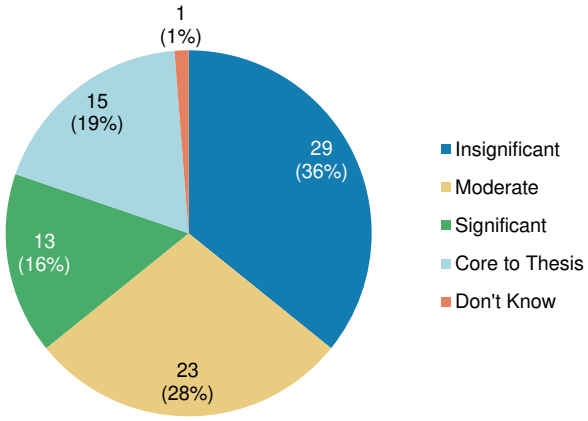
Our Thematics team conducted a survey in June 2024 incorporating results from Morgan Stanley Global Research analysts to map out both the type and degree of AI exposure for all covered names. In the process of putting together our Humanoid 100, we cross-referenced with the AI Mapping Survey results. We'd note that more than half (58%) of our Humanoid 100 are reported as either Enablers in some form (either an Enabler or Enabler/Adopter). For Materiality, the vast majority (65%) of our list has at least Moderate exposure, with 25% classified as at least Significant, and 19% as Core to Thesis.

Exhibit 21: Analyst-Surveyed AI Exposure of Companies in the Humanoid 100



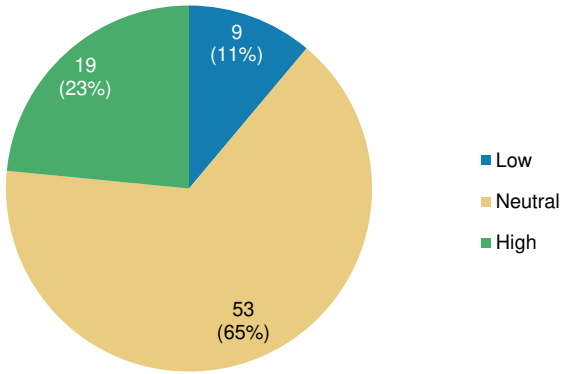
Source: Morgan Stanley Research

Exhibit 22: Analyst-Surveyed AI Materiality of Companies in the Humanoid 100



Source: Morgan Stanley Research

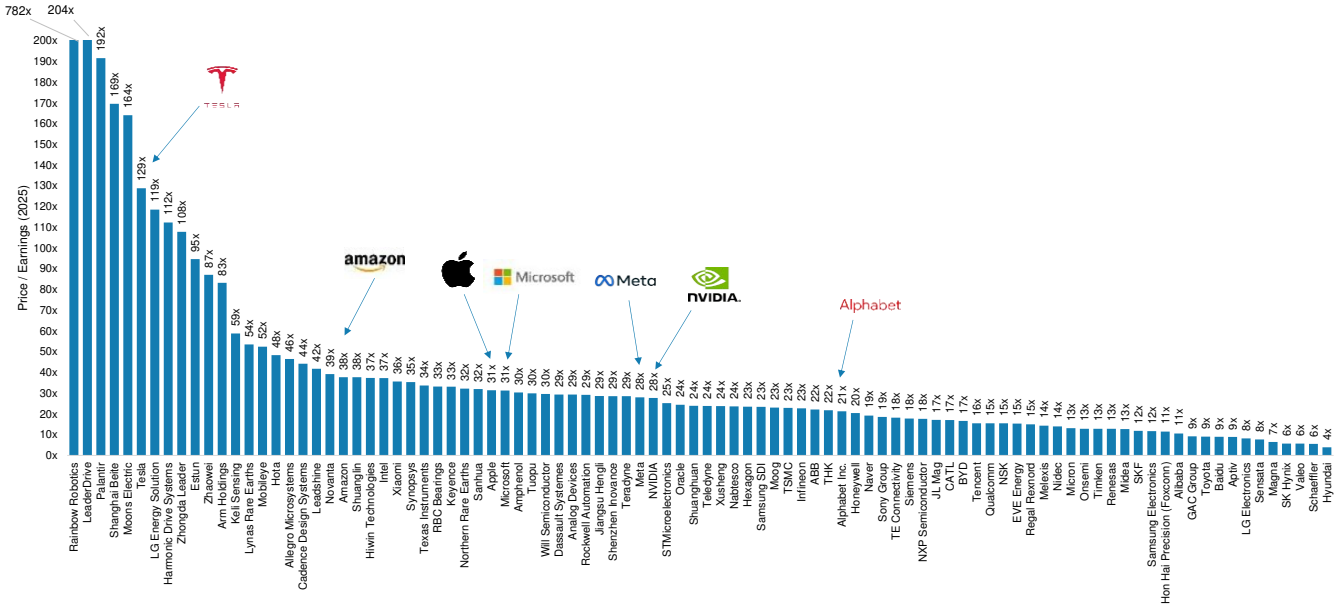
Exhibit 23: Analyst-Surveyed Pricing Power of Companies in the Humanoid 100



Source: Morgan Stanley Research

Valuation & Stock Performance

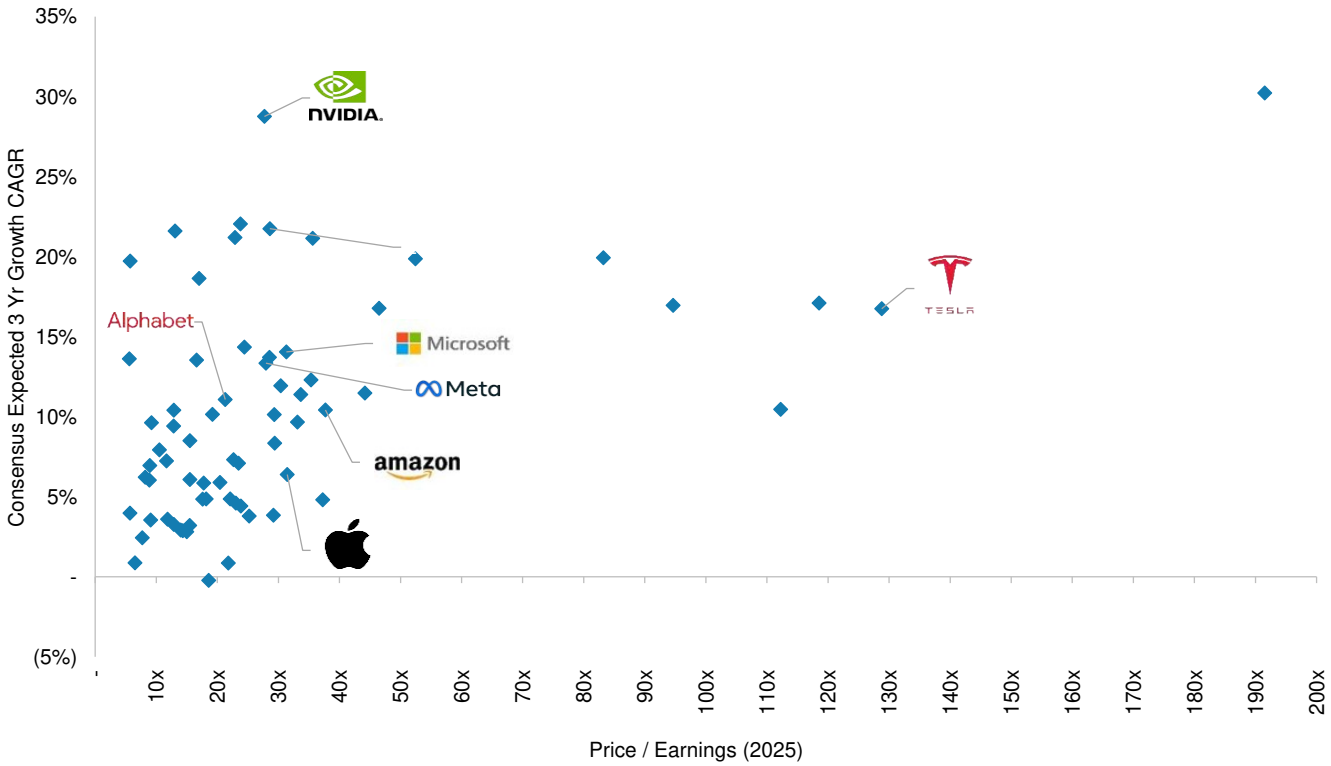
Exhibit 24: P/E Rank of Humanoid 100 (Cons. 2025)



Note: Excludes 6 companies where P/E is negative. Data as of 2/4/2025 close.

Source: FactSet, Morgan Stanley Research

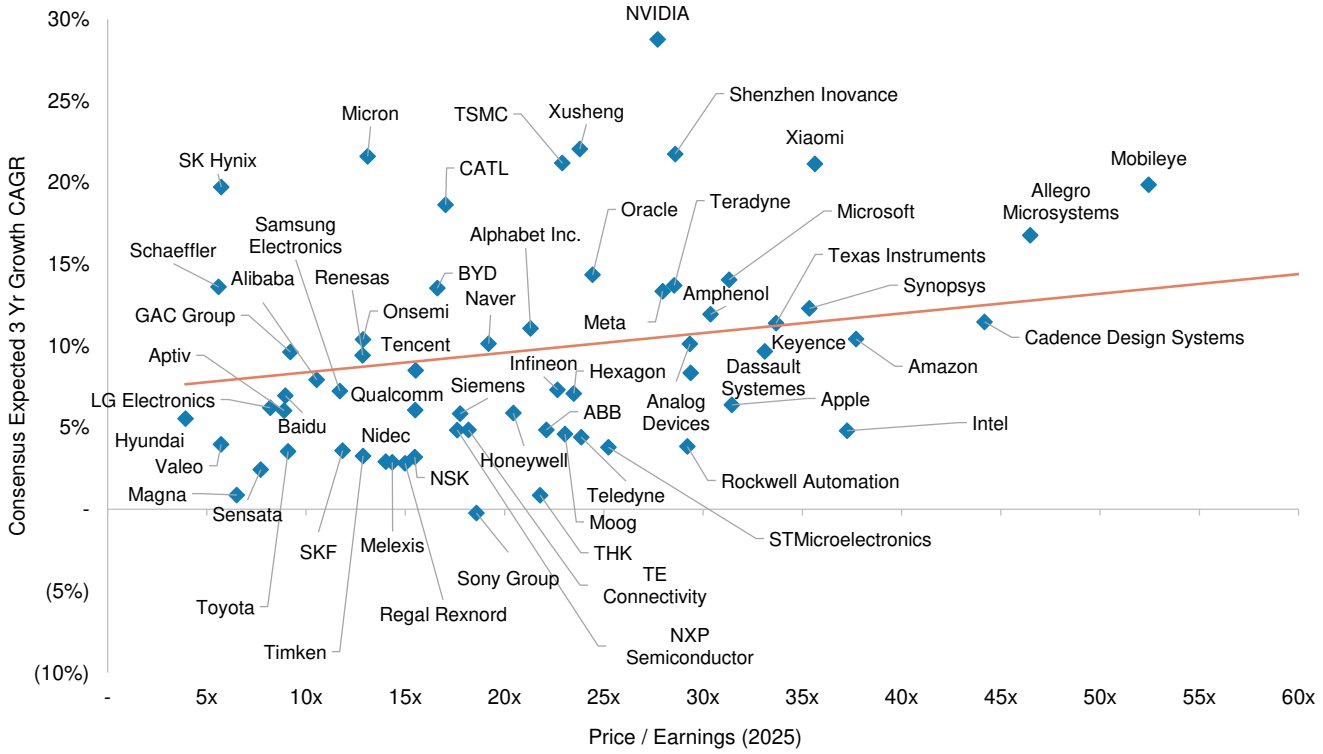
Exhibit 25: P/E vs. Consensus 3 Yr Revenue CAGR (Full Humanoid 100)



Note: Excludes 32 companies where either P/E is negative or consensus estimates are not available. Data as of 2/4/2025 close.

Source: FactSet consensus, Morgan Stanley Research

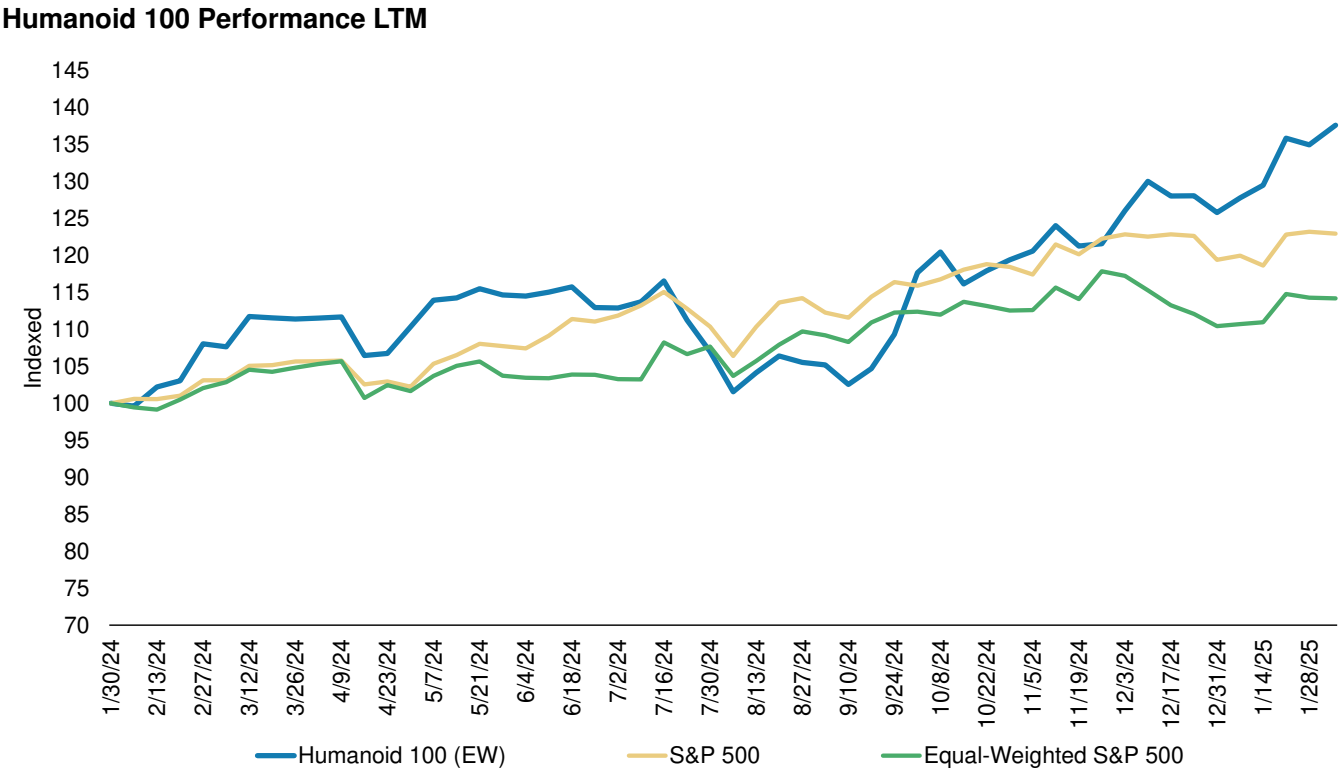
Exhibit 26: P/E vs. Consensus 3 Yr Revenue CAGR (Excluding Outliers)



Note: Data as of 2/4/2025 close.

Source: FactSet consensus, Morgan Stanley Research

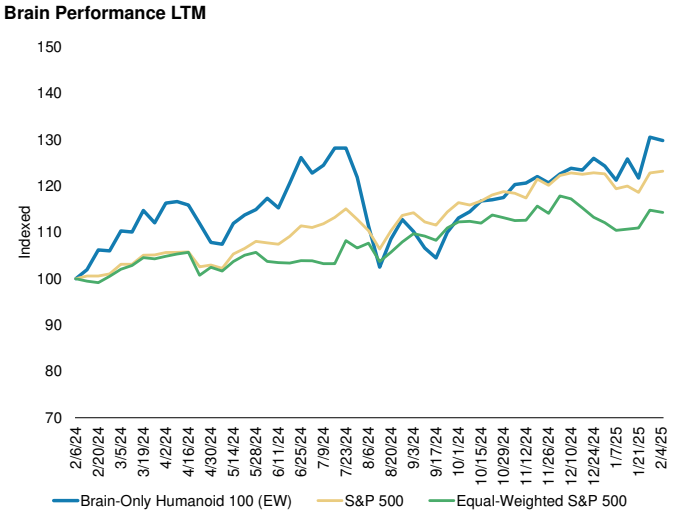
Exhibit 27: LTM Performance of Humanoid 100 vs. the S&P 500



Note: Reflects equal-weighted performance of Humanoid 100 stock list. Data points are weekly. Latest data as of 2/4/2024.

Source: FactSet, Morgan Stanley Research

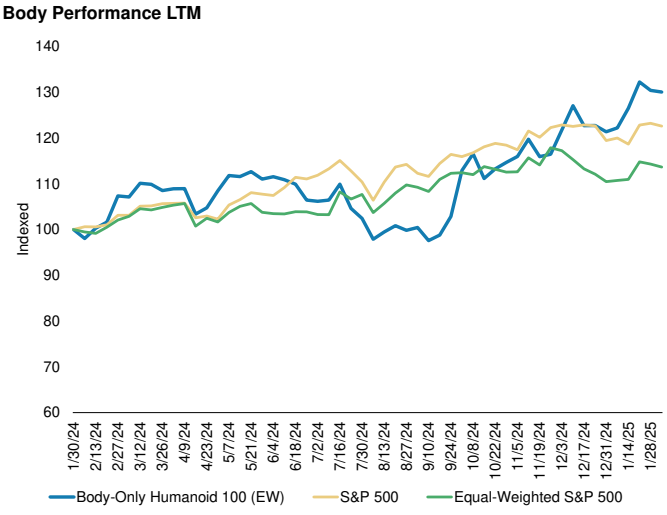
Exhibit 28: LTM Performance of **"Brain"** Companies in the Humanoid 100 vs. the S&P 500



Note: Reflects equal-weighted performance of relevant companies within Humanoid 100 stock list. Data points are weekly. Latest data as of 2/4/2024.

Source: FactSet, Morgan Stanley Research

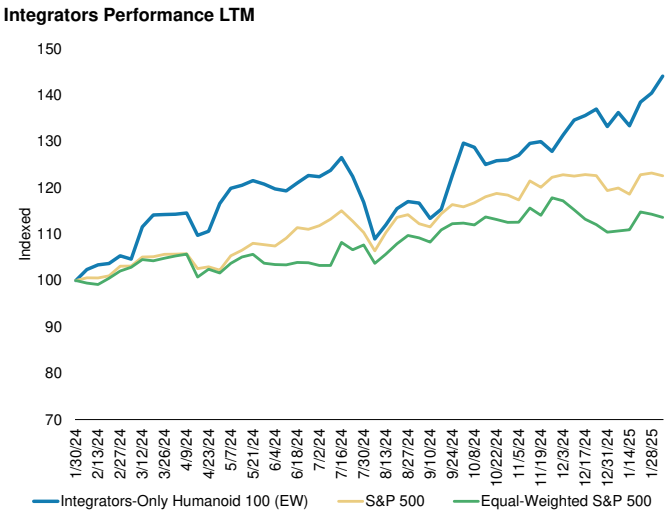
Exhibit 29: LTM Performance of **"Body"** Companies in the Humanoid 100 vs. the S&P 500



Note: Reflects equal-weighted performance of relevant companies within Humanoid 100 stock list. Data points are weekly. Latest data as of 2/4/2024.

Source: FactSet, Morgan Stanley Research

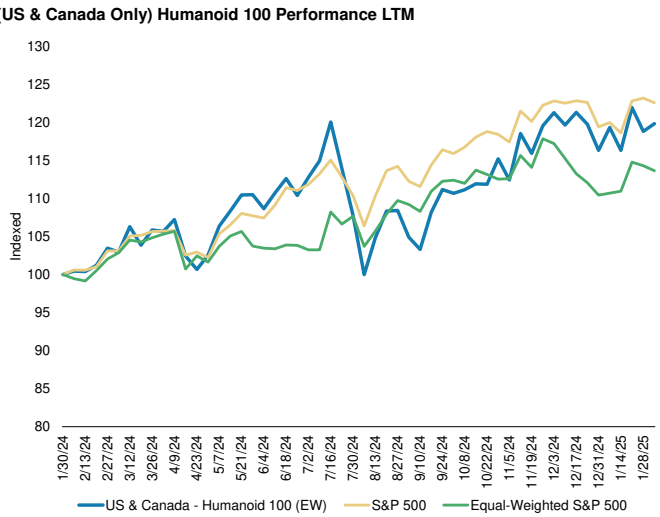
Exhibit 30: LTM Performance of **"Integrator"** Companies in the Humanoid 100 vs. the S&P 500.



Note: Reflects equal-weighted performance of relevant companies within Humanoid 100 stock list. Data points are weekly. Latest data as of 2/4/2024.

Source: FactSet, Morgan Stanley Research

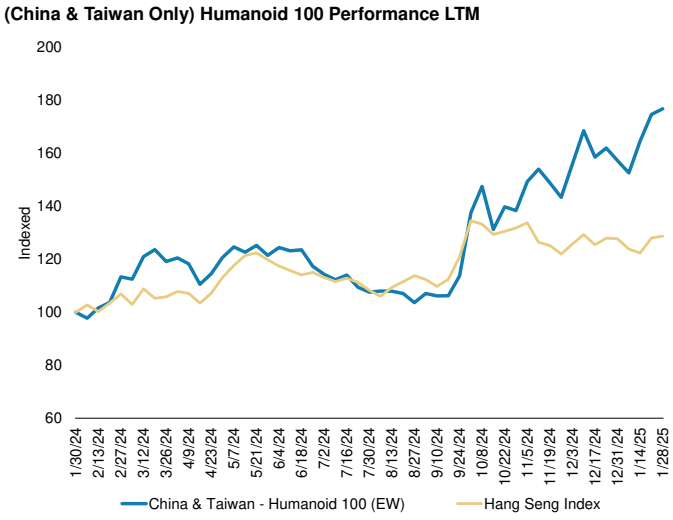
Exhibit 31: LTM Performance of **US & Canadian Companies** in the Humanoid 100 vs. the S&P 500.



Note: Reflects equal-weighted performance of relevant companies within Humanoid 100 stock list. Data points are weekly. Latest data as of 2/4/2024.

Source: FactSet, Morgan Stanley Research

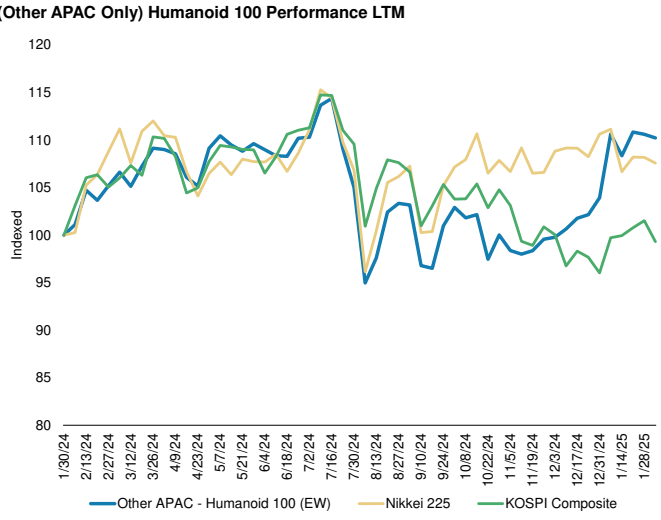
Exhibit 32: LTM Performance of **China & Taiwanese Companies** in the Humanoid 100 vs. the Hang Seng Index.



Note: Reflects equal-weighted performance of relevant companies within Humanoid 100 stock list. Data points are weekly. Latest data as of 2/4/2024.

Source: FactSet, Morgan Stanley Research

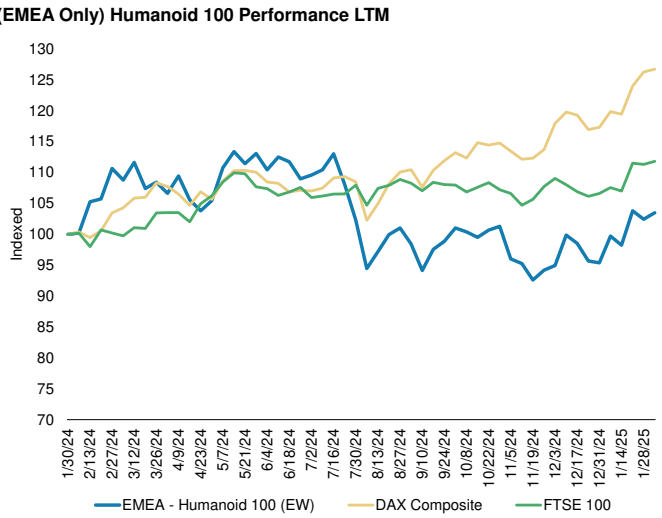
Exhibit 33: LTM Performance of **Other-APAC Companies** in the Humanoid 100 vs. the Nikkei 225 and KOSPI Composite.



Note: Reflects equal-weighted performance of relevant companies within Humanoid 100 stock list. Data points are weekly. Latest data as of 2/4/2024.

Source: FactSet, Morgan Stanley Research

Exhibit 34: LTM Performance of **EMEA Companies** in the Humanoid 100 vs. the DAX Composite and FTSE 100



Note: Reflects equal-weighted performance of relevant companies within Humanoid 100 stock list. Data points are weekly. Latest data as of 2/4/2024.

Source: FactSet, Morgan Stanley Research

The Humanoid Investment Case

The below is an excerpt from our Humanoids BluePaper.

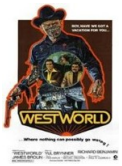
For years, machine learning was limited to self-reinforcing software algorithms. The advancement of large language models (LLMs) and GenAI have made a great leap into the field of robotics, accelerating how physical machines learn — through natural language, imitation, and simulation.

GenAI is transforming how robots "learn" by giving them a chance to observe and imitate behaviors in both the physical and virtual world, connected through natural language and iterated in the datacenter. Similar to how large language models (LLM) help drive ever greater capability of ChatGPT, multi-modal models (MMM) are driving innovation in robotics. AI algorithms can significantly shorten the R&D cycle by automating repetitive asks, enhancing data analysis and predictive capabilities, enabling virtual simulation, and optimizing design and testing processes. As an "AI-adjacent" field, humanoid hardware development can now directly benefit from the increased capital formation and R&D investment into the robotics theme.

AI leaps into the physical/atomic world. AI is all around us. AI listens to you. AI sees your face and body. AI knows where you are right now. AI can read. AI can write. AI can talk. AI can make a picture of cats wearing little cowboy hats playing Canasta. But other than running loads of algos and activating a few switches, *AI rarely ever actually moves.* In nature, "motility" is an organism's ability to move independently under its own energy. According to fossil records, the earliest evidence of motility on earth traces back to bacterial flagella (spindle-like extensions used for locomotion) in the Precambrian era. *The lines between mobile device and robot are beginning to blur.*

Exhibit 35: Top Humanoids from Pop Culture

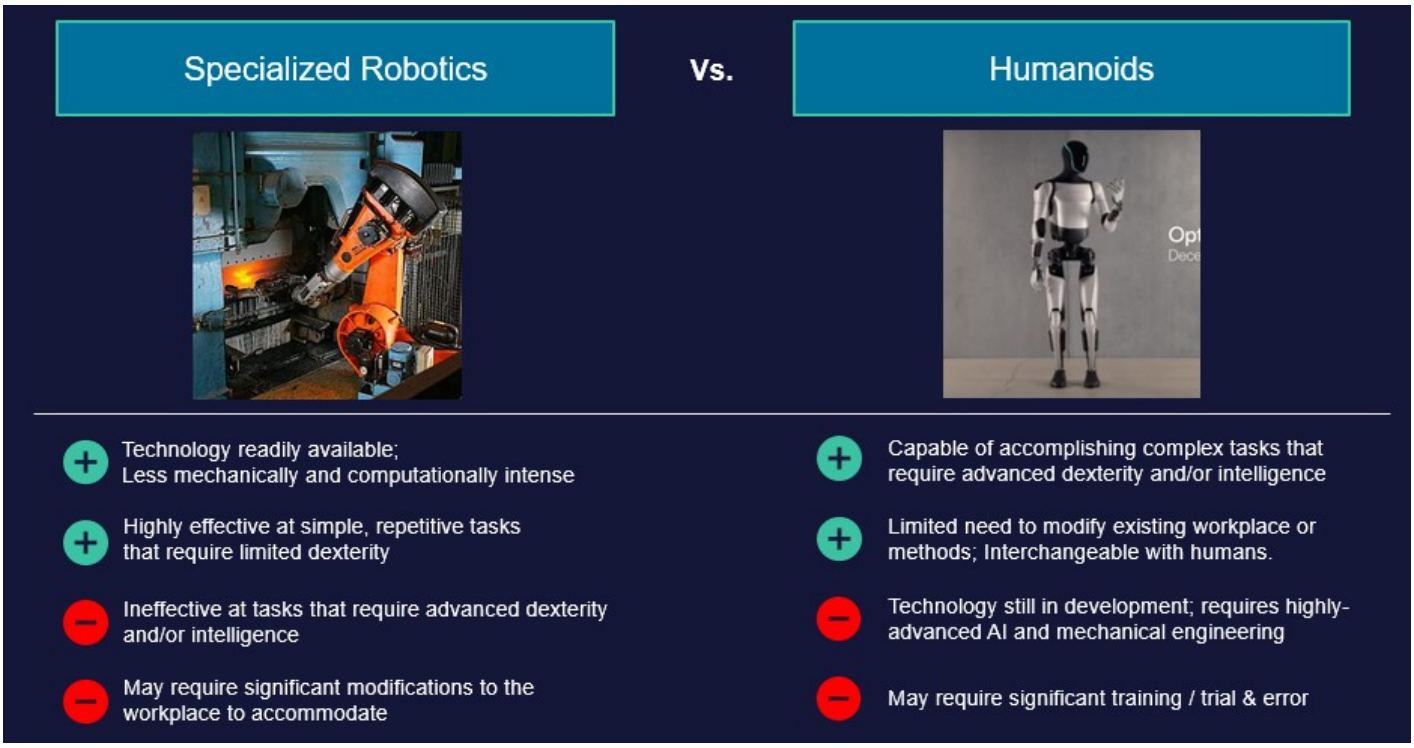
Famous Humanoids from Pop Culture

						
Maria *Metropolis (1927)*	**Gort** *The Day the Earth Stood Still (1951)*	**Astro Boy** *Astro Boy (1952-1968)*	**Robby** *Forbidden Planet (1956)*	**Rosie the Robot** *The Jetsons (1962-1987)*	**Robot** *Lost in Space (1965-1968)*	**Vision** *Avengers #57 (1968)*
						
Androids *Westworld (1973)*	**C-3P0** *Star Wars (1977)*	**Cylons** *Battlestar Galactica (1978)*	**Marvin** *The Hitchhiker's Guide to the Galaxy (1979)*	**Maximilian** *The Black Hole (1979)*	**Twiki** *Buck Rogers (1979-1981)*	**Replicants** *Blade Runner (1982)*
						
T-800 *Terminator (1984)*	**Bishop** *Aliens (1986)*	**Johnny 5** *Short Circuit (1986)*	**Dot Matrix** *Spaceballs (1987)*	**Data** *Star Trek: The Next Generation (1987)*	**RoboCop** *RoboCop (1987)*	**Optimus Prime** *The Transformers (1987)*
						
Tom Servo & Crow *Mystery Science Theater 3000 (1988-1996)*	**The Iron Giant** *The Iron Giant (1999)*	**David** *Artificial Intelligence:AI (2001)*	**Ava** *Ex Machina (2014)*	**Baymax** *Big Hero 6 (2014)*	**IG-11** *The Mandalorian (2019)*	**Dewey** *Finch (2021)*

Source: Wikipedia, Morgan Stanley Research

Why humanoids? Many investors reading this report will ask the question *"why do we need robots shaped like humans?"* There are indeed strong arguments for robotics to take many highly specialized forms (robot arms, snake-shaped robots, robot dogs, robotic dust and as many form factors as you can imagine). However, many robot and AI experts say the strongest argument for robots in a human form factor is that in a world already created for humans, the environment is already "brownfielded" for humanoids. Nvidia CEO Jensen Huang recently stated *"The easiest robot to adapt into the world are humanoid robots because we built the world for us. We also have the most amount of data to train these robots than other types of robots because we have the same physique*." Additionally, think of the great variety of tasks that humans are able to perform with our bare hands or using tools and the multitude of machines designed for human hands and fingers.

Exhibit 36: Pros and Cons of Humanoids vs. Specialized Robotics



Source: Tesla, Wikipedia, Morgan Stanley Research

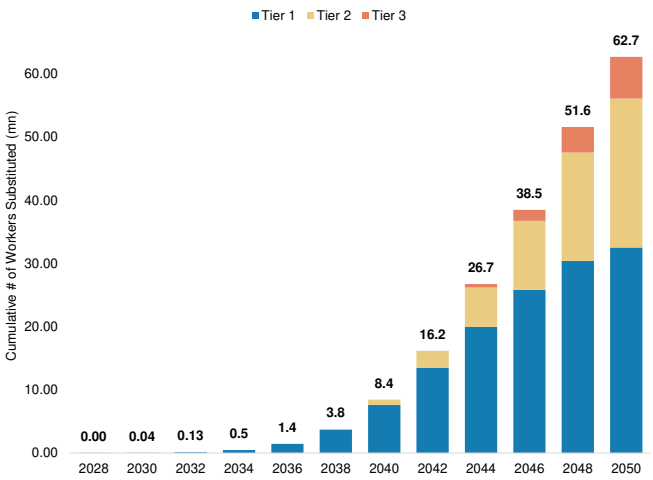
> "Robots look like people because … the most important reason, is that we built the world for ourselves, and so the workstations of a factory, the manufacturing line of a factory, was really created for people."
>
> Jensen Huang

Framing the TAM. As of November 2023, the US labor force stands at around 162 million people. At an average salary of $59,428, the US labor market is worth just shy of $10 trillion annually. According to Statista, there are approximately 3.4 billion people employed worldwide. Assuming a $9k/worker annual salary implies approximately a $30 trillion global labor market (roughly 30% of global GDP). Given the thousands of individual jobs performed by humans, the TAM exercise required a far more detailed analysis across job stratification to understand the path of humanoid substitution gated by economic paybacks, supporting supply chain/infrastructure, and other factors. As such, we built a proprietary Morgan Stanley Humanoid TAM model to address a more realistically available subset within the "theoretical $30 trillion universe" over time. In our US TAM model, we forecast a humanoid population (cumulative/installed base) of 8 million units by 2040 ($357 billion wage impact) and 63 million units by 2050 ($3 trillion wage impact). While our analysis does not currently consider a humanoid installed base greater than the existing human labor pool, there are scenarios where the economic benefits of the technology could make this a reality.

At his most recent AGM, Tesla CEO Elon Musk expressed his belief that humanoids will eventually outnumber humans by two-to-one or more: *"I think the ratio of humanoid*

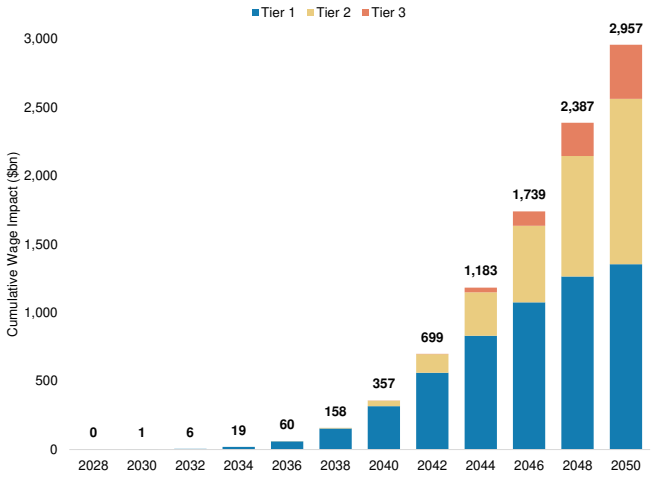
robots to humans will probably be at least two-to-one, something like that. One-to-one for sure. So, which means like somewhere on the order of 10 billion humanoid robots. Maybe, maybe, maybe 20 billion or 30 billion."

Exhibit 37: Cumulative Number of US Jobs with Humanoid Optionality, 2028-50 (mn)



Source: Bureau of Labor Statistics, Morgan Stanley Research

Exhibit 38: Cumulative US Wage Impact, 2028-50 ($bn)



Source: Bureau of Labor Statistics, Morgan Stanley Research

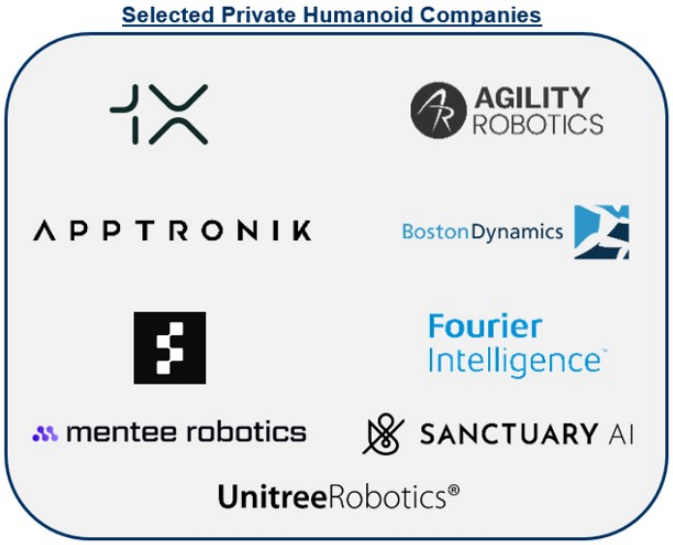
One billion humanoid robots by the 2040s? Tesla CEO Elon Musk has been increasingly focused on Optimus (Palo Alto engineering center) in recent months, per his comments. Tesla first unveiled its humanoid robot, Optimus, on September 30, 2022. The bipedal robot included 28 actuators in two categories: 1) rotary actuators, consisting of harmonic reducers, ball bearings and sensors, for rotating motions such as shoulders and elbows; 2) linear actuators, comprising planetary rollers, ball bearings and sensors for linear motions like human muscles. Twelve actuators for two hands. Many more details have been kept internally at the company. In January of this year, Elon Musk said he expected to see over 1 billion humanoid robots in operation by the 2040s. At Tesla's June 13th 2024 annual shareholder meeting, Mr. Musk stated he expects to have at least 1,000 Optimus robots working at Tesla next year, and that "*things are gonna scale up very rapidly from there.*" In the same meeting, Mr. Musk expressed his confidence that humanoid robots will eventually outnumber human beings and "probably be 20 billion or more" (no timeline shared).

> We aren't dealing with ordinary machines here... In some cases, they have been designed by other computers. We don't know exactly how they work.
>
> Chief Supervisor, *Westworld*

A dynamic, fast changing competitive landscape. Beyond Tesla, dozens of startups and established firms have engaged in humanoid robotics development on the back of the rapid growth of GenAI in 2022/2023. We note even before NVIDIA's keynote speech in March 2024 — which left little to the imagination about the company's intentions for

physical AI — robotics were a recurring AI theme, including at the Morgan Stanley TMT Conference last March. After a number of false starts, an array of venture investors and companies across are betting on the promise of embodied AI. Humanoid startups Figure AI and Agility Robotics were valued at $2.6 billion and $1.2 billion, respectively, in private funding rounds last year, with the broader theme attracting major investors including OpenAI, Softbank, Tiger Global, Amazon, NVIDIA, and Microsoft among others. Additionally, major public companies, across industries ranging from automotive to consumer electronics, are actively involved in humanoid development, while others are actively partnered with humanoid startups to explore potential future use cases.

Exhibit 39: Selection of Private Humanoid Companies/Startups



Note: This list is only a selection of private efforts. There is an increasing number of humanoid and humanoid adjacent firms being formed, which may not be included in this exhibit. However, we include here as investors cannot invest directly in Boston Dynamics.

Source: Company Websites, Morgan Stanley Research

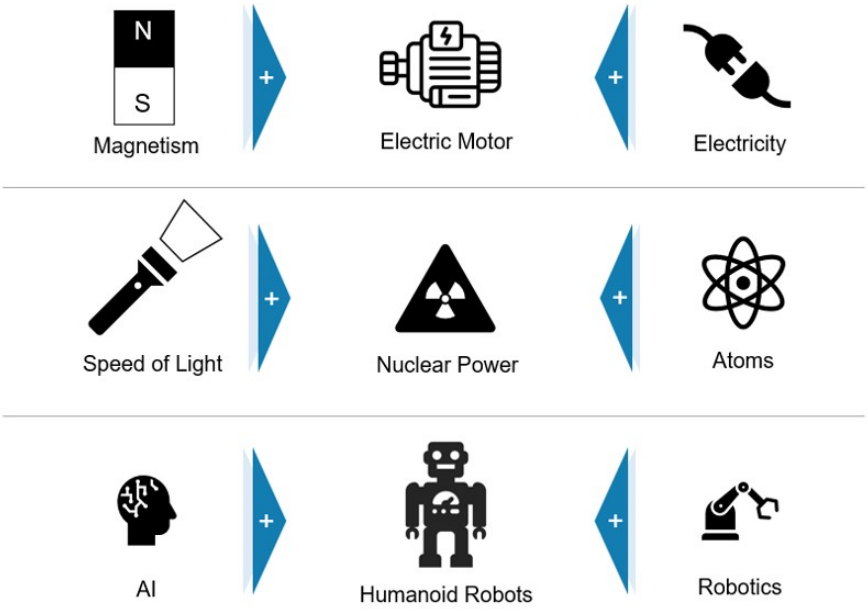
Exhibit 40: Selection of Public Companies Involved in Humanoid Development or Exploring Implementing Humanoids in the Workplace.

Note: Not all-inclusive.

Source: Company Websites, Morgan Stanley Research

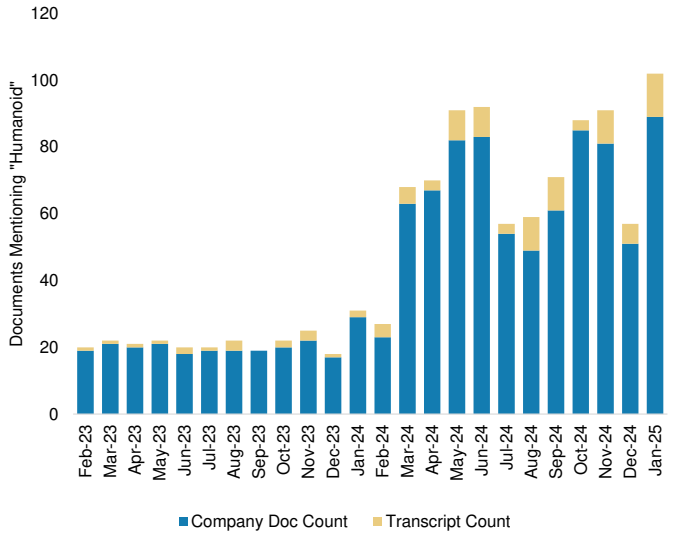
Robotics having a ChatGPT "moment." According to Vincent Vanhoucke (Senior Director for Robotics at Google DeepMind), experts in the robotics community refer to two years ago as "the good old days" as he explains how LLMs and genAI have very abruptly flung the field of robotics from an isolated "robot island" firmly onto the "AI flywheel." The science of LLM (large language models) and generative AI had long been seen as completely separate from the world of robotics (actuation). These worlds are colliding and the impacts are profound. We've been here before. In 1821, Michael Faraday ran an electric current through a wire suspended over a magnet in a glass… observing the rotation of the wire. This marked not only the discovery of how electrical energy can create mechanical movement (the first electric motor) but it also connected two areas of science that until then seemed unrelated — electricity and magnetism. Albert Einstein found connections between the properties of physical matter and light that were previously never conceived (e=mc^2). Might we be on the verge of unlocking the relationship between gen AI and robotics?

Exhibit 41: Seemingly Unrelated Areas of Science Can Combine With Profound Effect



Source: Morgan Stanley Research

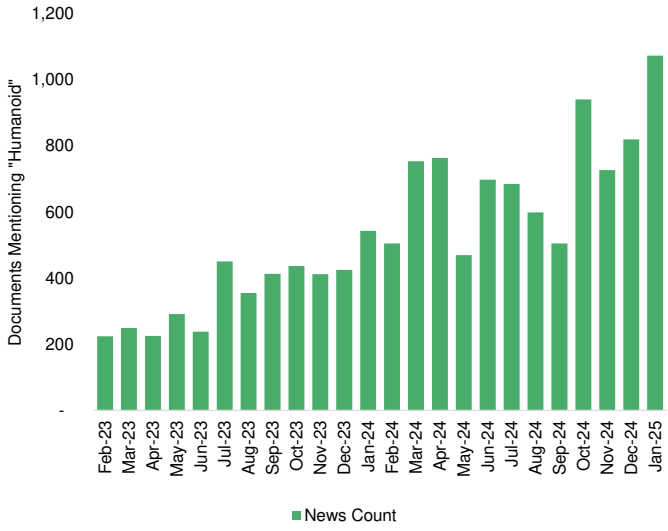
Exhibit 42: Public Company Documents and Transcripts Mentioning "Humanoid"



Note: 'Company Documents' include filings, presentations, and press releases. Data is global.

Source: AlphaSense, Morgan Stanley Research

Exhibit 43: News Reports Mentioning "Humanoid"



Note: Data is global.

Source: AlphaSense, Morgan Stanley Research

Cybernetic collective robotic learning. Imagine for a moment a humanoid robot standing in front of a kitchen island on which an onion sits on a small plate next to a paring knife. Now imagine a large warehouse with 1,000 humanoid robots each standing next to a kitchen island with the onion on a plate next to a knife. As each trial and error accumulates among the group, the entire population learns at the collective rate of the best robot at any point in time. The aggregated learning of the cybernetic collective "spools up" to achieve an accelerated frontier of group learning. When the physical practice is completed with a "winning" robot having peeled its onion better than the other 999, best practices can then be shared and further improved through hundreds of millions

of trials among their digital twins in a simulated 'Omniverse.'

Exhibit 44: With NVIDIA Project GR00T, humanoid robots train in a simulated version of reality called "Omniverse." The below image shows digital twins of Apptronik, Agility, and Unitree robots in training.

Source: NVIDIA

Have you seen or interacted with a robot today? Some of you may have. Most of you reading this at the beginning of 2025 likely have not. This rather nostalgic period of human technological history is quickly passing. The ongoing LLM/Gen AI revolution is in the early days of crossing over into robotics. LLM and robotics were long seen as vastly different areas of science. But there may be far more overlap in how the advancement of LLM accelerates the training and learning of the robot — whether it is a "car shaped" robot or a human shaped one. The AI brain is searching for its robot "body."

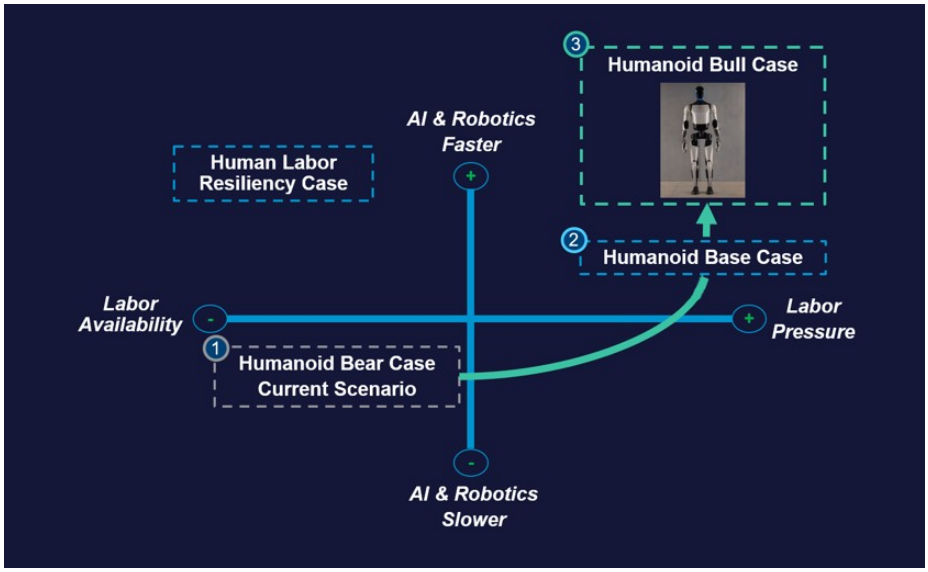
Humanoid vs. autonomous cars. Autonomous vehicles (AVs) are robots. Rather simple robots, in the form factor of a car. By simple, we mean there are only three primary actuation outputs of a robotaxi: (1) steering wheel, (2) accelerator pedal angle and (3) brake pedal. However, the operating domain is extremely complex — public roads riddled with unpredictable elements. We believe that the humanoid time to commercialization will materialize faster than AVs given the variability of the AV operating environment (real world) and corresponding safety implications (human passengers, pedestrians) vs. the humanoid form factor, which can learn in a geo-fenced domain (warehouse/factory closed work cells). *Even though humanoids have more physical outputs, the difficult operating domain, safety concerns, and regulatory scrutiny that autonomous vehicles face pushes their adoption curve out to the right in our view.*

> Barf: "It looks like the Temple of Doom."
>
> Dot Matrix: "Well it sure ain't Temple Beth Israel."
>
> *Space Balls*

Key drivers of humanoid adoption: The story of humanoid robotics involves an

understanding of three primary domains: AI, robots and people. At various stages, advancements in AI (multi-modal models, neural-net training, compute) may progress faster than the physical science of robotics (i.e., optics, actuation, battery, manufacturing) which may march along its own path of potentially non-linear improvement. All the while, a number of drivers of labor factors across industries and regions will significantly determine economic payback periods, adoption rates and social acceptance.

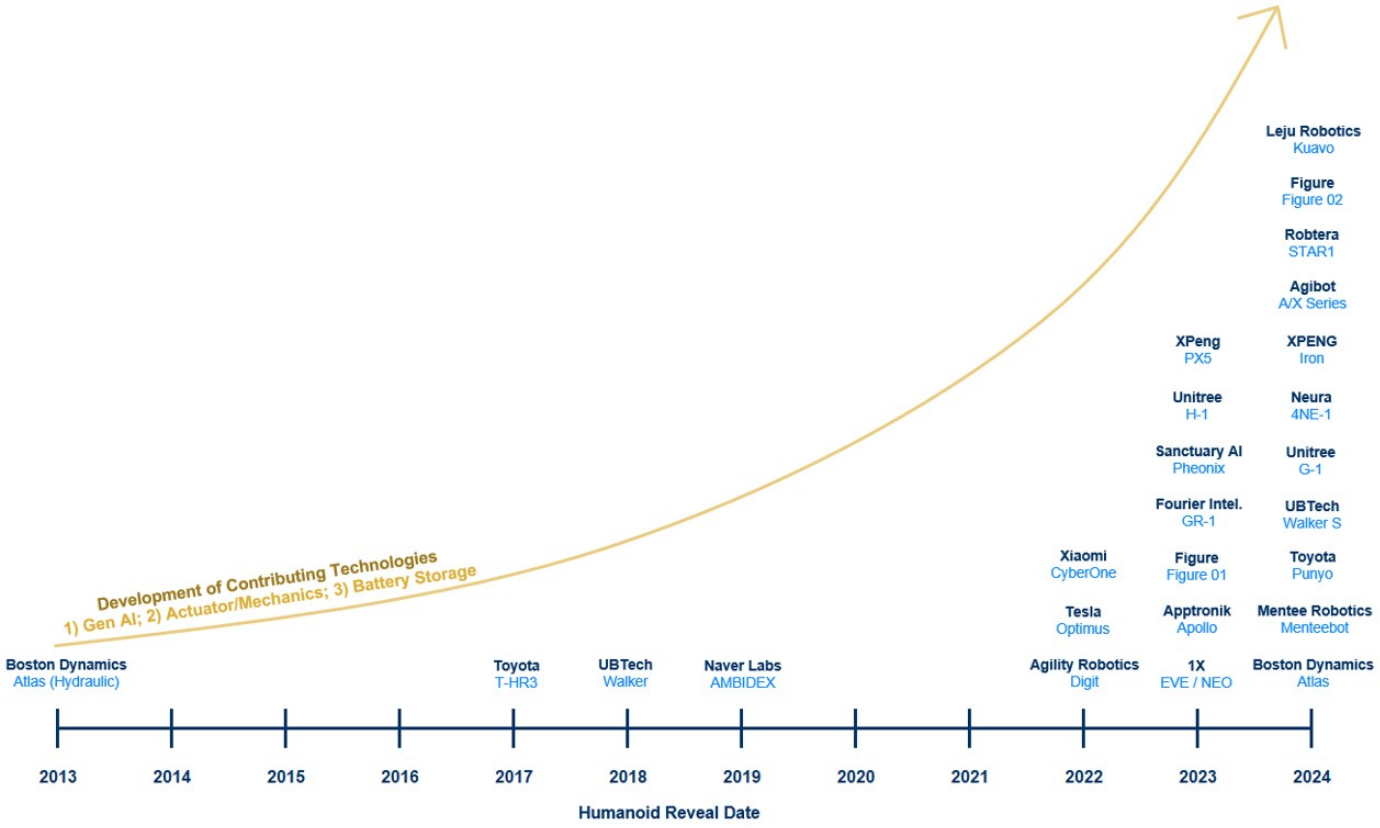
Exhibit 45: Labor Availability vs. AI & Robotics Acceleration



Source: Morgan Stanley Research

While advanced humanoid development remains in its early stages, we believe the path of progress over the past few years in the adjacent areas of 1) gen AI, 2) actuators & mechanics, and 3) battery storage are proving to be significant contributors to humanoid development. Further advancements in these 3 areas will be key to achieving humanoid commercialization.

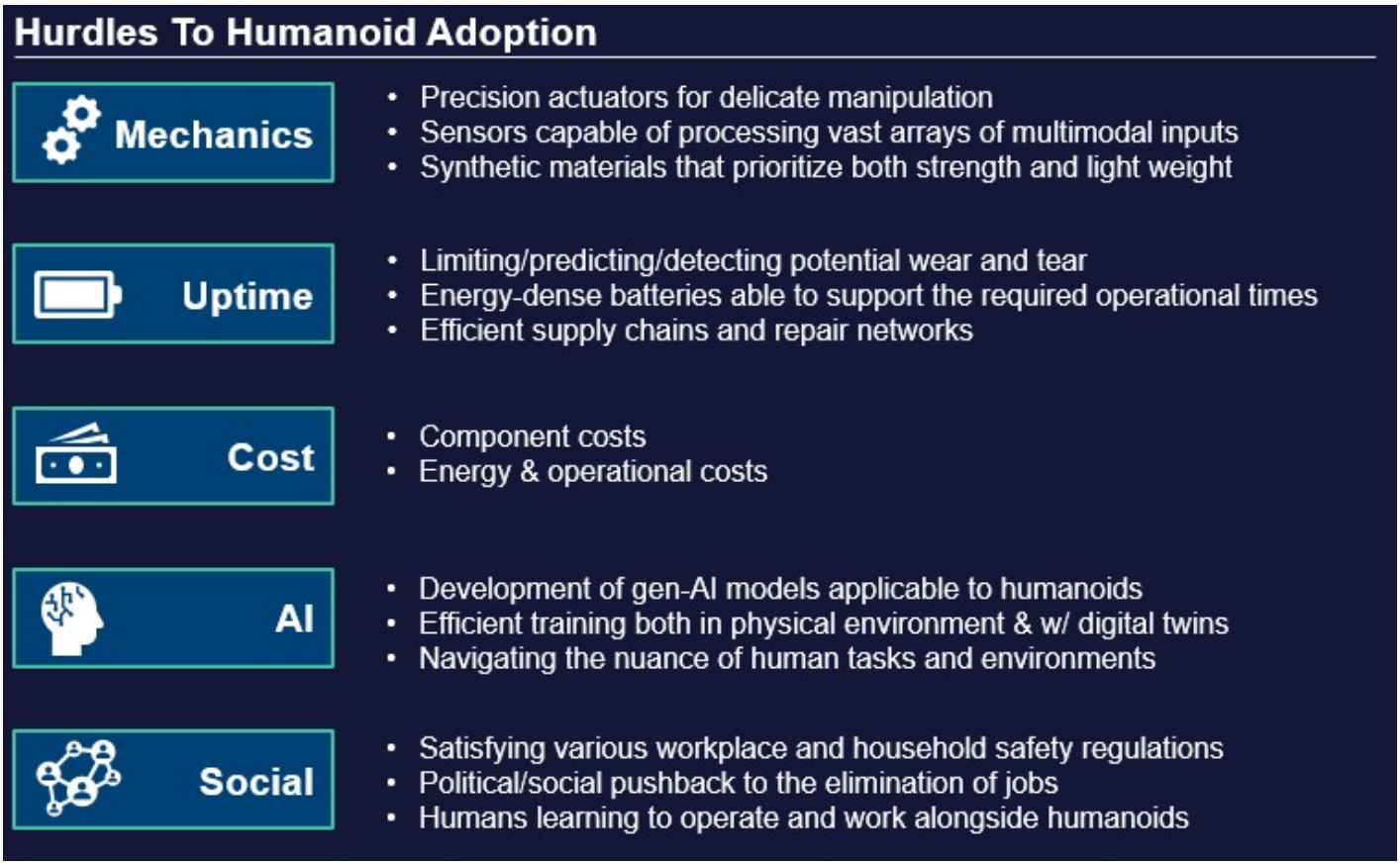
Exhibit 46: As contributing technologies have advanced over the past decade, intelligent humanoid development has continually increased in relevance.



Source: Company Data, Morgan Stanley Research

A number of gating factors must also be considered. Widespread commercialization of humanoid robots at scale must overcome a host of technological challenges as well as a wide range of societal/policy/safety impediments along the way. On the tech side, creating humanoids able to navigate the nuances/complexities of human environments will likely require continued advancements in gen-AI as well as efforts to tailor these advanced models specifically for humanoids. Additionally, further refinement of precision actuators, sensors, and battery capacity will be critical to improving the scope of tasks that can be executed by humanoids. Despite decades of modern robotics development, the sudden and rapid rise of GenAI models may create scenarios where the "mental" capabilities of humanoids surpass the physical capabilities, opening the door to a range of potential hardware bottlenecks that will need to be addressed as humanoids become exponentially "smarter." The social/policy/safety considerations as they relate to AVs helps us understand the range of potential hurdles for humanoids. However, we believe the ability to train humanoids using digital twins or in closed-off, geo-fenced work cells, as opposed to public streets, gives humanoids a relative advantage in approaching potential safety regulations.

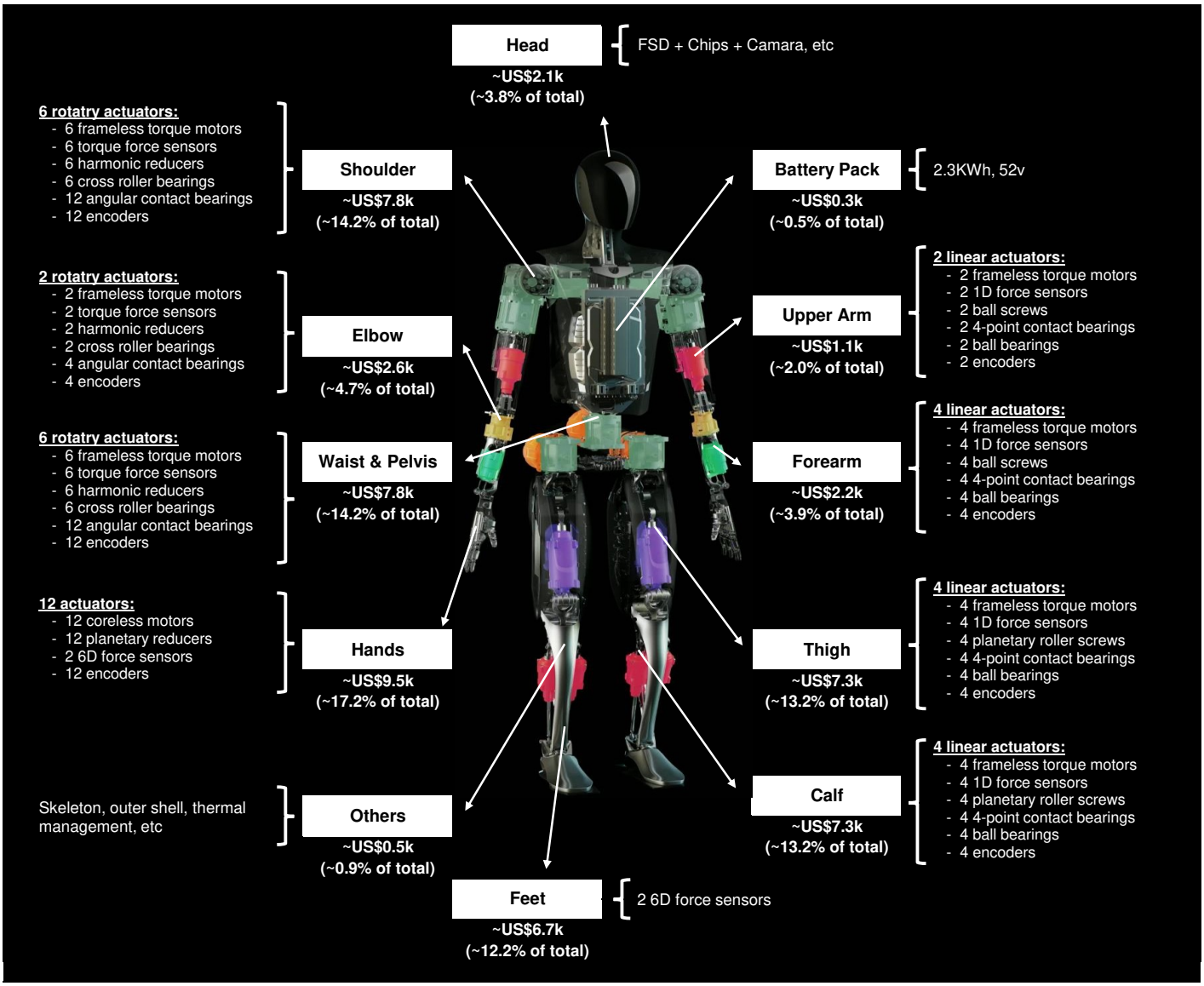
Exhibit 47: Potential Hurdles to Humanoid Adoption



Source: Morgan Stanley Research

Leveraging the Morgan Stanley Asia Industrials cortex, we assess the humanoid bill-of-materials (BOM) and map the key enablers within the humanoid supply chain. From China Industrials (Sheng Zhong) to Japan Industrials (Lisa Jiang) and China Auto Suppliers (Shelley Wang), we dive into the inner-workings of a humanoid, breaking down component costs and the potential for future cost reduction. Per our estimates, building humanoid robots could range from $10k to $300k depending upon configuration and downstream application. For example, per primary component supplier price quotes and proprietary analyses, we estimate Tesla Optimus Gen2's current BoM is $50-60k per unit (ex-software). However, with the benefit of scale, the introduction of AI algorithms to significantly shorten the R&D cycle, and the utilization of cost effective components from China, we see opportunities for significant cost reduction to achieve CEO Elon Musk's targeted Optimus selling price of ~$20k.

Exhibit 48: We estimate current total ex-software BoM for Tesla Optimus at $50-60k per unit.



Source: Tesla, Morgan Stanley Research.

Anatomy of a Humanoid

The below is an excerpt from our Humanoids BluePaper.

What Goes into a Humanoid Robot?

Sheng Zhong- China Industrials

As the embodiment of AI, humanoid robots are designed to think and act like humans. AI enables robotic "brain function," underpinning the robot's intelligence level, and the range of potential use cases. Mechanical parts enable the body function, underpin manipulation, and the BoM reduction potential. We believe future AI+machinery improvement will decide the pace of humanoid adoption.

The operating system (AI+motion control system) is the most valuable part of a humanoid robot since it underpins the humanoid's intelligence level, including multimodal perception, logical thinking, and motion control. The AI chip (mostly provided by AI chip players such as NVIDIA, though we note Tesla reuses its autopilot algorithm for Optimus) perceives input information and generates instructions after logical thinking. The motion control system, which receives the instructions from the AI chip, controls the joints to perform commands sent from the AI chip with high precision and stability and also, in return, provides real-time feedback to the AI chip.

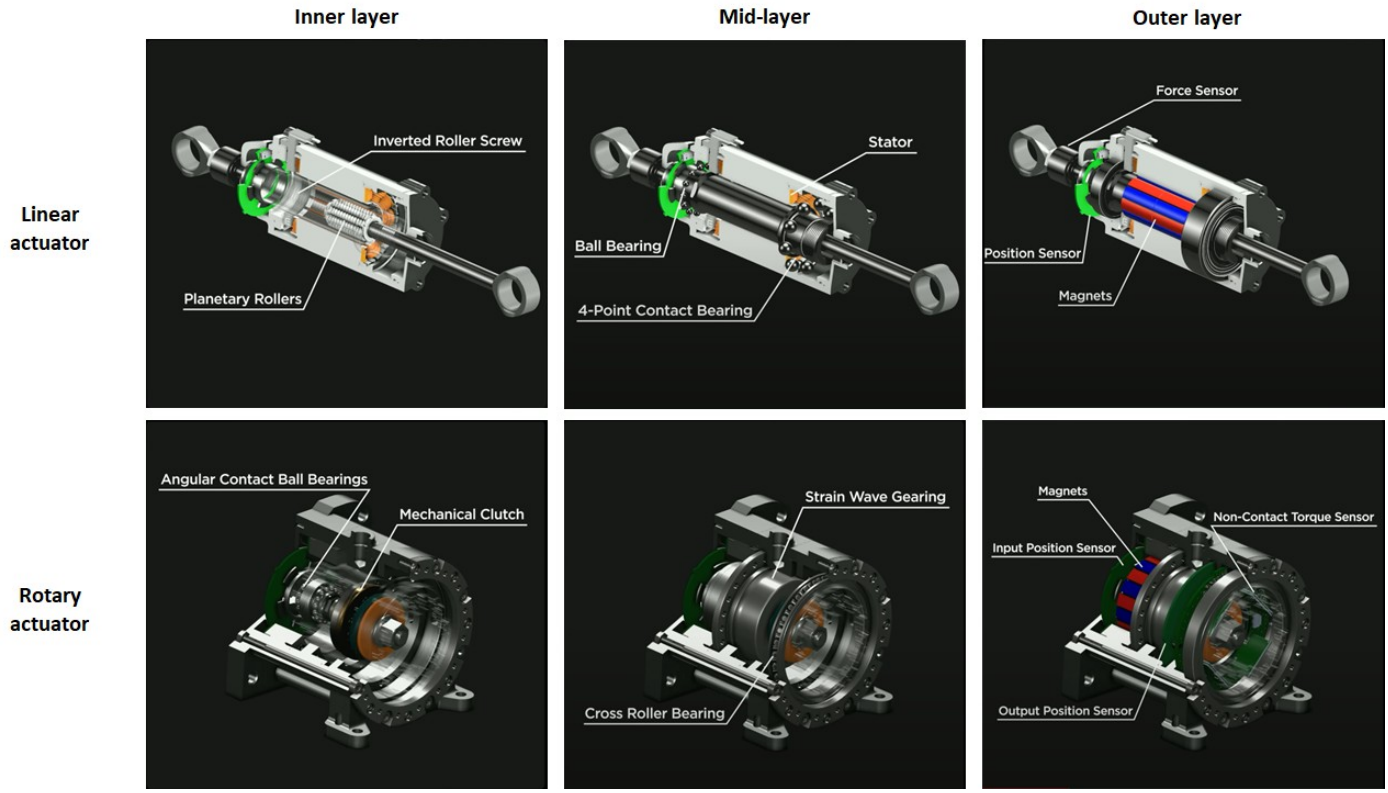
AI algorithms can empower the humanoid's operating system mainly by improving scalability, precision, and stability. In the long term, OEMs with the leading operating systems could drive both the direction of humanoid technological advancement and the pace of humanoid mass production. Currently, humanoid AI algorithms are still in the beginning stages of development, requiring lots of on-site validations, algorithm iterations, and hardware run-in for perfection. We believe AI algorithms can empower the humanoid operating system by improving its:

- *Scalability:* The humanoid operating system, integrated by humanoid OEMs, is usually specifically designed for a model or series in different scenarios. AI algorithms can improve versatility of the operating system, thus accelerating penetration of humanoid robots in different downstream applications.
- *Precision:* AI algorithms can effectively improve motion control precision with real-time monitoring capabilities, autonomous learning and task optimization, and unsupervised simulation and testing.
- *Stability:* Integrated with a variety of high-precision sensors, AI algorithms can improve the humanoid operating system's stability with processing massive multi-dimensional sensor data, providing more granular data analysis, and indicating potential failures by early identification of anomalies.

Humanoid actuators are core to performing human-like motions, acting as the robotic-equivalent to human joints/muscles. Over time, humanoids will need greater amounts of actuators to facilitate greater degrees-of-freedom. Hardware plans can significantly vary across different humanoids in terms of degrees-of-freedom (DoF), hands design, sensor sensitivity, etc. *We include an overview of notable "humanoid hardware" below:*

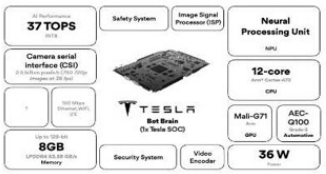
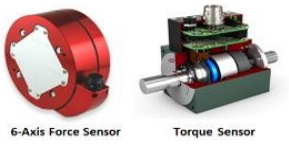
- The **"bot brain,"** or central computer, is a system-on-chip (SoC) that processes the wide array of inputs and outputs used to drive all the hardware used on the robot (cameras, WiFi module, audio, etc.). For Tesla, the design for the bot brain is largely derived from Tesla FSD hardware and software.
- The **humanoid body** is mainly composed of actuators and supporting systems (battery pack, structural parts, thermal system, etc.).
    - **Actuators** are devices that enable motion in a system, both rotational or linear (similar to human joints). The greater the degrees-of-freedom required, the more actuators that are needed. Currently, humanoids in development generally are capable of between 16 and 60 DoF. Optimus Gen2, in particular, uses 50 DoF, driven by 28 actuators (14 linear, 14 rotary). The actuators themselves are comprised of a combination of screws, reducers, motors, sensors, ball bearings, and encoders.
    - **Structural parts** are supporting material around the humanoid body, such as the skeleton and outer shell. The Optimus Gen2 loses 10kg without sacrificing its structure and performance, primarily from the use of lightweight material such as PEEK (Polyether Ether Ketone) and high power density actuators. PEEK is a synthetic material often used as a metal substitute due to its excellent strength and light weight, which helps to reduce overall energy consumption while preserving performance.

Exhibit 49: Linear and rotary actuators are comprised of screws, reducers, motors, sensors, bearings and encoders (shown below are Tesla Optimus actuator designs).



Source: Tesla 2022 AI Day, Morgan Stanley Research

Exhibit 50: Overview of Key Parts Used in a Humanoid Robot

Key Parts		Overview	
Brain			
AI Chip and Software		The bot brain is based on an AI chip with additional inputs and outputs for telecommunication, audio, security and safety.	
Body Parts			
Linear or Rotary Actuator	Screw	A screw is a mechanical component that converts motor-end rotary motion into linear motion. Considering cost and technology maturity, current humanoids are more suitable for using both ball screws and planetary roller screws but should, over time, fully shift to planetary roller screws with technology breakthrough and cost reduction.	
	Reducer	A reducer is used for reducing motor speed and improving the torque output and motion accuracy of humanoid's joints. Humanoids mainly use harmonic and planetary reducers, but RV reducers could be an alternative.	
	Motor	A motor is used to generate driving torque, and is installed on the joint of the humanoid to control motion. The higher degrees-of-freedom, the more motors used. Tesla's Optimus mainly applies frameless torque motors for body parts and coreless motors for hands.	
	Sensor	Humanoids require sensors to sense the surrounding environment and objects. Commonly used sensors are vision sensors, force sensors, inertial sensors, temperature sensors, etc. The core sensor of a humanoid is the force sensor, which converts the magnitude of the force into a relevant electrical signal.	
	Bearing	A bearing is a supporting part for mechanical rotary motion. It ensures rotary precision by primarily supporting the mechanical rotary, and serving to fix and reduce friction to ensure the accuracy of the rotary.	
	Encoder	Encoders are connected to the motor to monitor its status and send the signal back to the actuator, which aggregates, analyzes, and corrects the feedback signal to precisely control output variables such as actuator position, speed, and torque.	
Structural Parts		Structural parts are mainly made from PEEK (Polyether Ether Ketone), a lightweight material to reduce energy consumption. PEEK is a specialty polymeric material with excellent properties such as heat resistance, abrasion resistance and radiation resistance. PEEK has gradually replaced the use of metal materials in mid-to-high end robotics due to its excellent performance.	

Source: Morgan Stanley Research

Exhibit 51: Humanoid motion can be driven by electric, hydraulic or pneumatic drive system, but electric driven designs are becoming increasingly mainstream due to greater precision and faster reaction times.

Drive type	Introduction		Applicable scenarios	Key components	Pros	Cons	Key players
Electric drive	The motor drives the humanoid's joint rotation or other motions		Mature and widely used	DC/AC servo motor, stepping motor, electromagnet	Highly controlled precision, fast response speed, reliable and able to achieve complex movement and motion	High power consumption, weight limitations, large space requirement, need to prevent problems such as overheating and overloading	For most humanoid companies
Hydraulic drive	To produce high pressure liquid through liquid compression pump, and then works on the output mechanism to generate force		Apply to large-size, heavy loads and humanoids for emergency or speciality use	Reciprocating oil cylinder, hydraulic motor	Higher torque, fast motion, high stability, and able to achieve large loads and complex motion	Complex design and high maintenance requirement	BostonDynamics
Pneumatic drive	Use pneumatic actuators to convert the pressure of compressed air into mechanical energy to drive joint and limb movement		Suitable for mid-to-small loads humaniods	Reciprocating oil cylinder, hydraulic motor	Clean, zero pollution, easy to operate, low cost and easy to maintain	Limited torque and stability, unable to achieve large loads and complex movements	FESTO

Source: Morgan Stanley Research

Exhibit 52: Hardware Design of Selected Humanoid Models

Hardware Design for Selected Humanoid Models									
Region	Company	Humanoid Model	Degrees-of-Freedom	Actuator Type	Core Part Type				Human-like Hands
					Reducer	Motor	Force Sensor	Encoder per Actuator	
USA	**Tesla**	Optimus	50	Rotary + Linear	Harmonic Reducer + Planetary Roller Screw	Frameless Torque Motor	Equipped	2 Per Rotary Actuator + 1 Per Linear Actuator	Coreless Motor + Precise Planetary Gearbox
USA	**Agility Robotics**	Digit	16	Unspecified	Harmonic Reducer / Cycloidal-Pin Gear Speed Reducer	Brush/Brushless DC Motor	Unspecified	Unspecified	Unspecified
Norway	**1X Technologies**	EVE	25	Unspecified	Unspecified	DD motor	Unspecified	Unspecified	No Hands
China	**UBTech**	Walker X	41	Rotary	Harmonic Reducer	Frameless Torque Motor	Equipped	2	Unspecified
China	**Unitree**	G-1	20-43	Rotary	Planetary Reducer	Frameless Torque Motor	Unspecified	2	Coreless Motor + Planetary Reducer
China	**Xiaomi**	CyberOne	21	Rotary	Planetary Reducer	Frameless Torque Motor	Not Equipped	1	Unspecified
China	**XPeng**	PX5	Unspecified	Unspecified	Harmonic Reducer + Planetary Reducer	Unspecified	Unspecified	Equipped	Coreless Motor + Connecting Rod

Note: Hardware design of other key humanoid models such as Figure 01 from Figure AI, Phoenix from Sanctuary AI, Atlas from Boston Dynamics is not public.

Source: Company data, Morgans Stanley Research

A Worldwide Supply Chain

Sheng Zhong- China Industrials

Screws, motors, reducers and sensors are the key components in machinery manufacturing. While the high-end component markets are dominated by Europe, US and Japan companies, Chinese companies are competitive in low/midrange products where they aim to provide valuable products. However, there is still a large gap between the low/midrange vs. high-end products in terms of precision, stability, payload, and

production process optimization capabilities.

Screws are components that convert rotary motion and linear motion into one another. They are widely used in CNC machine tools, manufacturing equipment, robots, precision instruments, and other downstream applications. Humanoids, such as Tesla Optimus, mainly use ball screws and planetary roller screws for linear actuators to perform high-precision motions. However, these components have high barriers to entry and expensive production equipment and raw materials. Today, high-end screw manufacturing is dominated by Europe (Rollvis, SKF, etc.) and Japanese companies (NSK, etc.). There is also still a wide gap in efficiency, payload, and precision between high-end Western/Japanese producers and Chinese companies. However, some Chinese companies (Hengli, Best, etc.) have started to penetrate the higher-end market and have proceeded to demo validation for humanoid OEMs.

Motors are used to generate driving torque and are mounted on the humanoid joints to control motion. On humanoids, frameless torque motors are widely used for both linear and rotary actuators to facilitate manipulation due to their small size, compact structure, light weight, small rotating inertia, and low starting voltage. Coreless motors are generally used in human-like hands, featuring higher energy-saving, low voice, high useful life, and high torque.

- *Frameless torque motors have a relatively low technology barrier.* Germany's Kollmorgen (private) dominates in high-end frameless torque motor for high-end applications, while Chinese products are widely used for other low/midrange applications. Kinco (not covered) is the leading Chinese supplier and one of few that can provide high-quality frameless torque motors.
- *On the other hand, coreless motors have a much higher technology barrier*, with concentrated applications in medical and military equipment (drones, etc.). Currently, foreign suppliers account for >85% market share in China. Chinese companies entered the market in the 2010s, but there is still a large performance gap between domestic and imported products on no-load speed and rated torque. However, we note that for coreless motors used on humanoid hands, Chinese companies such as Moon's have already penetrated the humanoid supply chain and are running demo validation for OEMs.

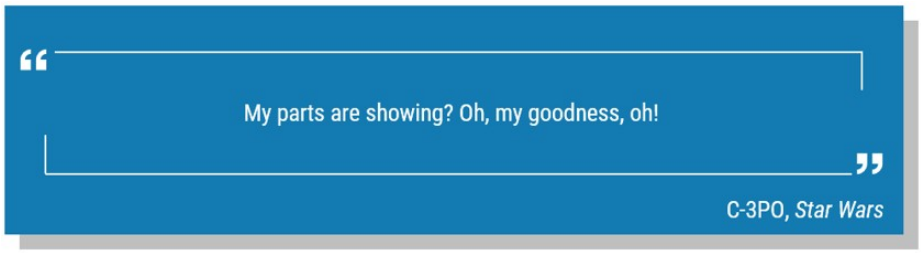
Reducers are used both for reducing motor speed and for improving the torque output and motion accuracy of humanoid joints. Planetary reducers, harmonic reducers, and RV reducers are the three primary categories of reducers. Different humanoid design require different type/quantity of reducers. All three of these primary reducer categories are dominated by Japanese companies (Harmonic Drive, Shimpo, subsidiary of Nidec, Nabtesco, etc.). Today, Chinese companies still have a large performance disadvantage on both precision and stability. However, we note that leading Chinese players, such as Leaderdrive, have sent harmonic reducers for demo humanoids.

Sensors, including vision sensors, force sensors, inertial sensors, temperature sensors, etc., are the essential hardware for humanoid's multimodal perception both internally (perception of its own position) and externally (perception of touch, vision, hearing, etc.). Force sensors are more vital sensors for humanoids to achieve smooth and real-time force adjustments under various scenarios. Six-axis force sensors, the most complex force sensors, can measure payloads from any direction and bear payloads 5-20x higher than

rated measurement ranges. ATI, a subsidiary of Novanta, (NOVT- Not Covered), is the inventor of the six-axis force sensor and dominates the market, while most Chinese companies still lag without long-term accumulation in sensor calibration and decoupling. Other first movers such as Kunwei (Private) and Sunrise Instruments (Private) have begun to penetrate the sensor supply chain for humanoids.

Assessing the Humanoid Bill-of-Materials

Sheng Zhong-China Industrials



There is a wide range of potential BoM costs for humanoids, largely depending on design complexity, material, and market positioning. Under our estimates, building humanoid robots could range from $10k to $300k given different configuration and downstream application requirements. For instance, China's Unitree announced its G-1 humanoid would be priced at ~$16k with a simplified algorithm module, halved degrees-of-freedom, lack of linear actuators, shorter battery life, and lower carrying capacity. In contrast, with an estimated selling price at $250k in 2025, Agility Robotics's Digit is specifically designed for logistics, featuring a high power capacity and payload, high man-machine interaction intelligence, and a higher degree of balance/stability.

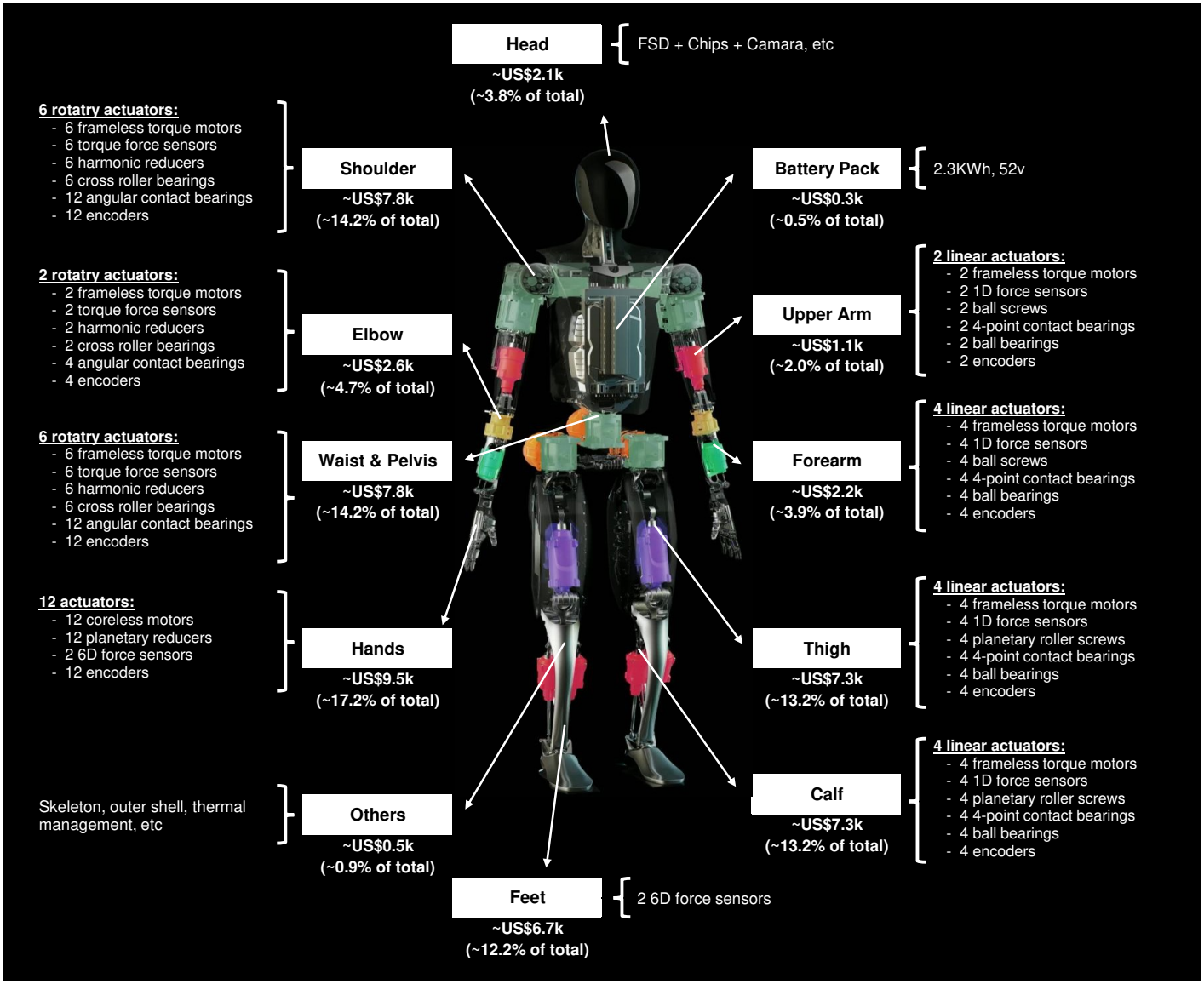
Using Tesla's Optimus Gen2 as an example, we estimate the current total ex-software BoM at $50-60k per unit, using price quotes from various component suppliers. However, we note this is using quoted prices for individual components used to create the robot. For a player building humanoids at scale, such as Tesla, the BoM could likely be significantly lower given various relationship, bundling, and/or bulk discounts with the various component suppliers. In our view, Tesla's Optimus has significant opportunity for cost reduction to achieve CEO Elon Musk's targeted selling price of ~$20k.

We breakdown the BoM for Optimus Gen2 by function:

- The *"Bot brain"* is based on a Tesla SoC and additional outputs and inputs (eg. wifi, camera, audio, etc.). For the "brain" itself, we estimate the hardware cost is ~$2k/humanoid (~4% of total). Note, this excludes any potential software cost (e.g., FSD training costs).
- All body motion is driven by 28 actuators (14 linear actuators and 14 rotary actuators). The upper body (shoulder, elbow, arm, hands and waist) requires 16 actuators which we estimate could cost ~$26k/humanoid (~47% of total), and lower body (pelvis, legs, feet) requires 12 actuators which cost ~$26k/humanoid (~48% of total).
- Other supporting systems including the battery and various structural parts cost ~$419/humanoid, (~0.8% of total)

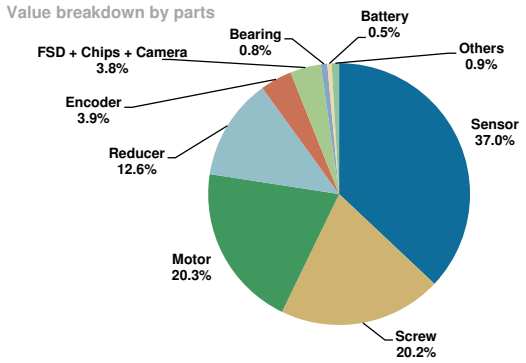
When breaking the components down by product type, the key five parts of sensors/ screws/motors/reducers/bearings cost ~$20k/$11k/$11k/$7k/$434 per humanoid, accounting for ~37%/20%/20%/13%/ 0.8% of the total BoM.

Exhibit 53: We estimate current total ex-software BoM for Tesla Optimus at $50-60k per unit.



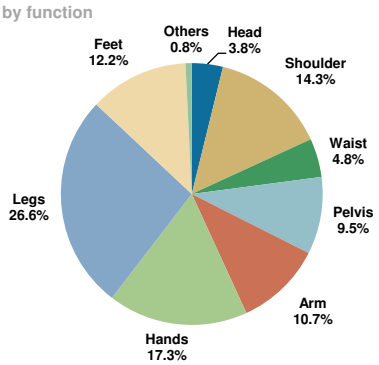
Source: Tesla, Morgan Stanley Research.

Exhibit 54: Optimus Gen2 BoM breakdown by parts



Source: Morgan Stanley Research estimates.

Exhibit 55: Optimus Gen2 BoM breakdown by function

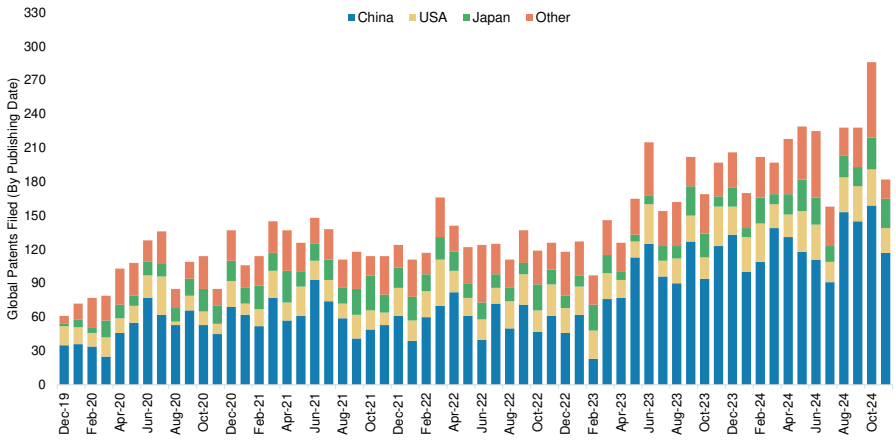


Source: Morgan Stanley Research estimates.

Tracking Humanoid Progress

Patent Filings

Exhibit 56: Monthly Global Patent Application Filings Mentioning "Humanoid" (Latest Data as of 11/19/2024)



Note: Ordered by publishing date. We included latest data available via Google Patents, which is as of Nov 2024. Source: Google Patents, Morgan Stanley Research

Exhibit 57: Global Patent Filings Mentioning "Humanoid" by Office Over the Past 5 Years

Patent Filings Mentioning "Humanoid" By Office (Past 5 Years)

Rank	Patent Office	# Count
1	China	5,688
2	United States	1,483
3	Japan	1,195
4	World Intellectual Property Organization (WIPO)	1,123
5	South Korea	368
6	European Patent Office (EPO)	237
7	Taiwan	192
8	Germany	71
9	Canada	26
10	Poland	23
11	Australia	22
12	Brazil	21
13	France	20
14	Great Britain	18
15	Italy	15
16	Turkey	14
17	Spain	9
18	Eurasian Patent Organisation (EAPO)	9
19	Romania	7
20	Sweden	5

Note: Exhibit limited to top 20.

Source: Google Patents, Morgan Stanley Research

Exhibit 58: Top Filers of US Patent Applications Mentioning "Humanoid" Over the Past 5 Years

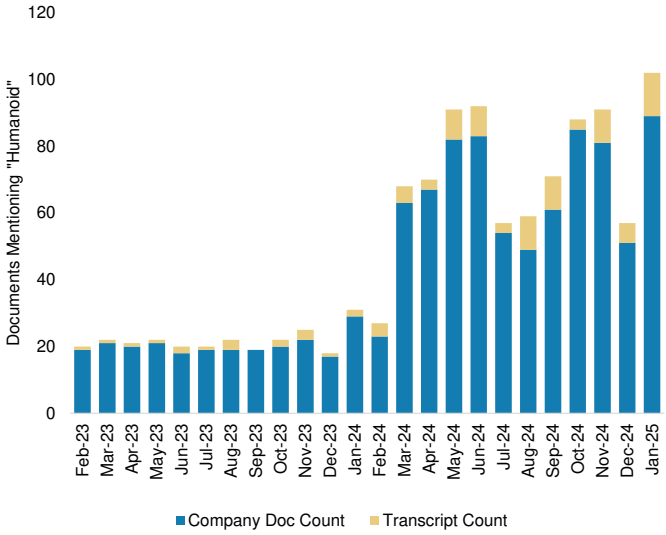
Top US "Humanoid" Patent Filers (Past 5 Years)

Rank	Patent Assignee	# Count
1	Boston Dynamics, Inc.	61
2	Ubtech Robotics Corp Ltd	59
3	Sanctuary Cognitive Systems Corporation	51
4	Sony Group Corporation	48
5	Weta Digital Limited	46
6	Sony Interactive Entertainment Inc.	42
7	Sony Corporation	41
8	Google Llc	39
9	Roblox Corporation	38
10	Honda Motor Co., Ltd.	34
11	Fuji Xerox Co., Ltd.	33
12	Kawasaki Jukogyo Kabushiki Kaisha	32
13	Unity Technologies Sf	31
14	Toyota Jidosha Kabushiki Kaisha	28
15	Nuance Communications, Inc.	28
16	Samsung Electronics Co., Ltd.	26
17	Synergy Blue, Llc	25
18	X Development Llc	23
19	International Business Machines Corporation	23
20	Sarcos Corp.	21

Note: Exhibit limited to top 20. Source: US Patent Office data via Google Patents, Morgan Stanley Research

Humanoid Company & News Mentions

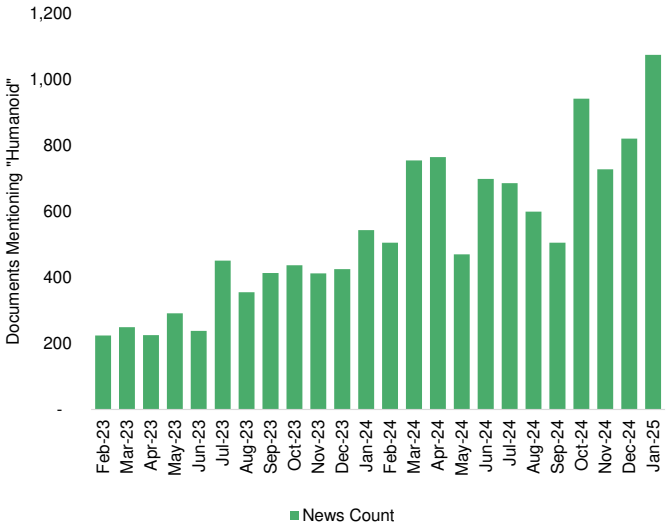
Exhibit 59: Public Company Documents and Transcripts Mentioning "Humanoid"



Note: 'Company Documents' include filings, presentations, and press releases. Data is global.

Source: AlphaSense, Morgan Stanley Research

Exhibit 60: News Reports Mentioning "Humanoid"



Note: Data is global.

Source: AlphaSense, Morgan Stanley Research

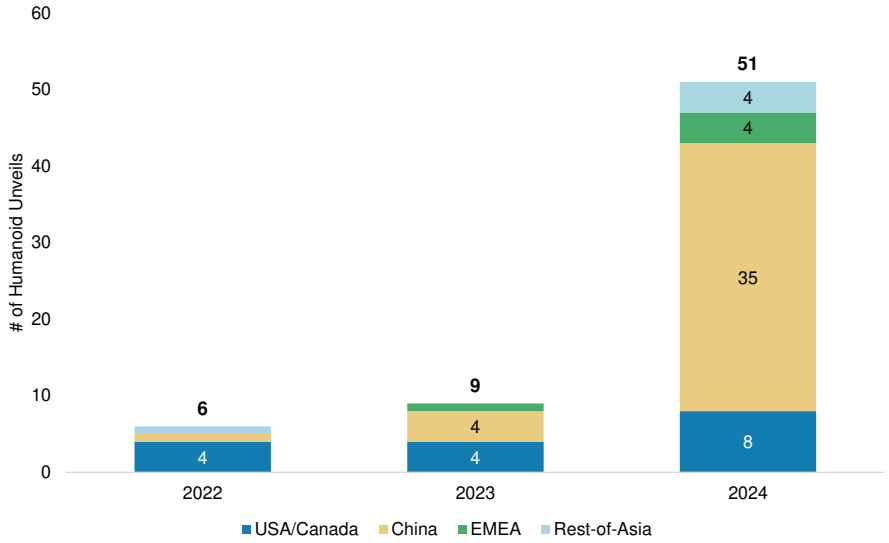
Humanoid Unveils

Exhibit 61: Notable Humanoid Unveils since 2022 (Blue = USA; Yellow = China; Green = EMEA; Red = Rest-of-Asia).

Humanoid Tracker				
Company	**Robot**	**Country**	**Year Unveiled**	**Primary Use-Case**
Agility	Digit	USA	2022	Industrial/Logistics
Tesla	Optimus Gen 1	USA	2022	General Purpose
Mirsee Robotics	Beomni	Canada	2022	Service
Xiaomi	CyberOne	China	2022	Service
Tokyo Robotics	Torobo	Japan	2022	Research Platform
IHMC	Nadia	USA	2022	Research Platform
1X	EVE	Norway	2023	Service
Apptronik	Apollo	USA	2023	General Purpose
Figure	01	USA	2023	General Purpose
Fourier	GR-1	China	2023	General Purpose
Kawasaki Heavy	Kaleido 7th Gen	Japan	2024	Research Platform
Sanctuary	Pheonix	Canada	2023	General Purpose
Tesla	Optimus Gen 2	USA	2023	General Purpose
XPENG	PX5	China	2023	General Purpose
Kepler	Forerunner K1	China	2023	Industrial/Logistics
Unitree	H-1	China	2023	General Purpose
1X	NEO	Norway	2024	Service
Boston Dynamics	Atlas (Electric)	USA	2024	General Purpose
Figure	02	USA	2024	General Purpose
Fourier	GR-2	China	2024	General Purpose
Mentee	Menteebot	Israel	2024	General Purpose
Toyota Research Institute	Punyo	Japan	2024	Research Platform
Unitree	G-1	China	2024	General Purpose
Agibot/Zhiyuan	A1	China	2024	General Purpose
Agibot/Zhiyuan	A2	China	2024	Service
Agibot/Zhiyuan	A2-Max	China	2024	Industrial/Logistics
Agibot/Zhiyuan	A2-W	China	2024	Industrial/Logistics
Agibot/Zhiyuan	X1	China	2024	Research Platform
Kind Humanoid	Mona	USA	2024	General Purpose
UBTech	Walker S	China	2024	Industrial/Logistics
UBTech	Walker S1	China	2024	Industrial/Logistics
Neura	4NE-1	Germany	2024	Service
Robotera	STAR1	China	2024	General Purpose
Robotera	XBot-L	China	2024	General Purpose
Leju Robot	Kuavo	China	2024	General Purpose
Kepler	Forerunner K2	China	2024	Industrial/Logistics
XPENG	Iron	China	2024	Industrial/Logistics
Addverb	Addverb Humanoid	India	2024	General Purpose
Borg Robotics	Borg 1	USA	2024	General Purpose
Astribot	S1	China	2024	Service
EngineAI	SE01	China	2024	General Purpose
PUDU	D7	China	2024	General Purpose
PUDU	DH11	China	2024	General Purpose
Deep Robotics	DR01	China	2024	General Purpose
LIMX Dynamics	CL-1	China	2024	General Purpose
Leju Robotics	Kuavo	China	2024	Research Platform
JAKA Robotics	K-1	China	2024	Industrial/Logistics
Tencent Robotics	Five	China	2024	Service
Weave Robotics	Isaac	USA	2024	Service
Laser Robotics	Hector V2	USA	2024	Research Platform
PNDbotics	Adam	China	2024	General Purpose
SUPCON	Navigator	China	2024	General Purpose
Noetix Robotics	Dora	China	2024	General Purpose
PaXini Tech	TORA-ONE	China	2024	General Purpose
Pollen Robotics	Reachy 2	France	2024	General Purpose
Booster Robotics	T1	China	2024	Research Platform
Galbot	G1	China	2024	Service
Boardwalk Robotics	Alex	USA	2024	Industrial/Logistics
Westwood Robotics	THEMIS	USA	2024	General Purpose
MagicLab	MagicBot	China	2024	General Purpose
BHRIC	Tiangong	China	2024	General Purpose
Dataa Robotics	XR4	China	2024	General Purpose
Rainbow Robotics	RB-Y1	Korea	2024	Industrial/Logistics
PUDU	D9	China	2024	General Purpose
EngineAI	PM01	China	2024	General Purpose
GAC	GoMate	China	2024	General Purpose
Lumos Robotics	LS1	China	2025	General Purpose

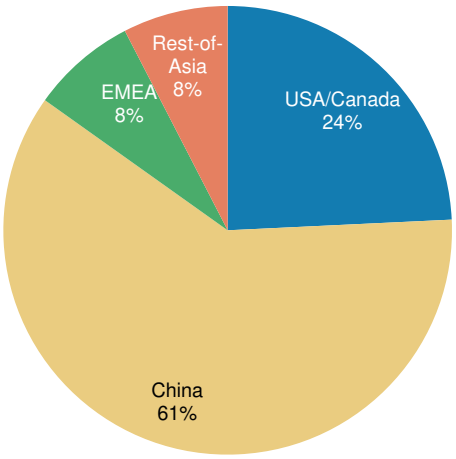
Note: Includes all notable public humanoid unveils based on our knowledge, but there may still be some that have not been captured here. Source: Company announcements, Morgan Stanley Research

Exhibit 62: Humanoid Unveils by Year and Country



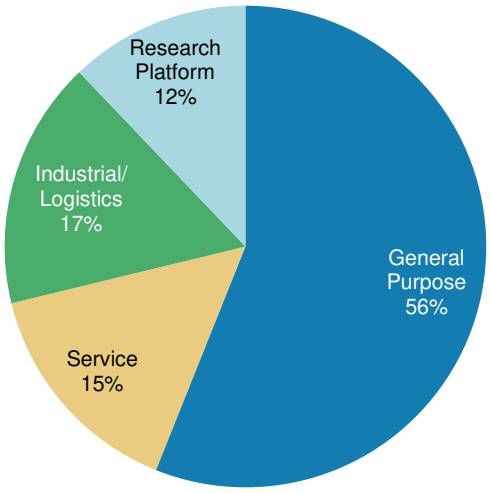
Note: Includes all notable public humanoid unveils based on our knowledge, but there may still be some that have not been captured here. See prior exhibit for details. Source: Company data, Morgan Stanley Research

Exhibit 63: Humanoid Unveils Since 2022 by Country



Source: Company announcements (from companies listed in Exhibit 15 above), Morgan Stanley Research

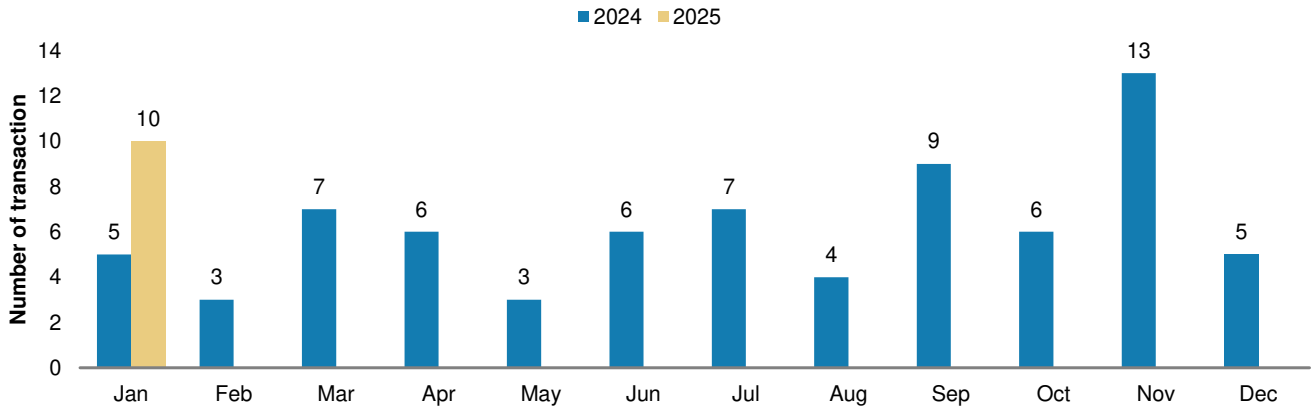
Exhibit 64: Humanoid Unveils Since 2022 by Primary Use Case



Source: Company announcements (from companies listed in Exhibit 15 above), Morgan Stanley Research

China Financing Activity

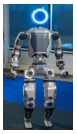
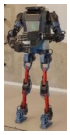
Exhibit 65: Monthly China Humanoid Company Funding Activity



Source: GGII, company announcements, Morgan Stanley Research

Overview of Major Humanoid Robots

Exhibit 66: Notable Humanoids w/ Specs (1/2)

Robot Name	NEO	A2	Digit	Apollo	Atlas (Electric)	Figure 02	GR-2	Menteebot
Company Name	1X Technologies	AgiBot/Zhiyuan	Agility Robotics	Apptronik	Boston Dynamics	Figure	Fourier Intelligence	Mentee Robotics
Picture								
Year Revealed	2023	2024	2022	2023	2024	2024	2024	2024
Primary Purpose	General	Service/Leisure	Industrial/Logistics	Industrial/Logistics	Industrial/Logistics	Industrial/Logistics	General	General
Status	Prototype	In Production	Prototype	Prototype	Prototype	Prototype	In Production	Prototype
Height	5' 5"		5' 9"	5' 8"		5' 6"	5' 4"	5' 9"
Weight	66 lbs	152 lbs	99 lbs	160 lbs		154 lbs	139 lbs	154 lbs
Maximum Speed	2.5 - 7.5 mph		3.4 mph			2.7 mph	3.1 mph	3.4 mph
Carrying Capacity	44 lbs		35 lbs	55 lbs		44 lbs		55 lbs
Battery Life	2 - 4 Hours	2 Hours	2.25 Hours	4 Hours		5 Hours	2 Hours	5 Hours
Degrees of Freedom	55	40	16			16 (Hands Only)	53	40
AI Partners	NVIDIA, OpenAI		NVIDIA	NVIDIA	NVIDIA	NVIDIA, OpenAI	NVIDIA	
Customers/Testers	Everon		Amazon, GXO	Mercedes Benz, GXO		BMW		

Key

Overview	Dimensions	Capabilities	Notable Partners

Source: Company data, Morgan Stanley Research

Exhibit 67: Notable Humanoids w/ Specs (2/2)

Robot Name	4NE-1	STAR1	Pheonix	T-HR3 / Punyo	Optimus Gen 2	Walker S	G-1	Iron
Company Name	Neura Robotics	RobotEra	Sanctuary AI	Toyota	Tesla	UBTECH	Unitree	XPENG
Picture								
Year Revealed	2024	2024	2023	2017	2023	2018	2024	2024
Primary Purpose	General	General	General	General Use	Industrial/Logistics	Industrial/Logistics	General	Industrial/Logistics
Status	Prototype	Prototype	Prototype	Prototype	Prototype	In Production	In Production	Prototype
Height	5' 11"	5' 7"	5' 7"	5' 1"	5' 8"	5' 7"	4' 2"	5' 8"
Weight	176 lbs	139 lbs	155 lbs	165 lbs	160 lbs	143 lbs	77 lbs	154 lbs
Maximum Speed	1.9 mph		3.0 mph		5.0 mph		4.5 mph	
Carrying Capacity	33 lbs		55 lbs		45 lbs		7 lbs	
Battery Life						2.5 Hours	2 Hours	
Degrees of Freedom		55	75	32	50	41	43	60
AI Partners	NVIDIA		NVIDIA			Baidu	NVIDIA	NVIDIA
Partners/Testers		Alibaba	Magna			BYD, Geely		

Key

Overview	Dimensions	Capabilities	Notable Partners

Source: Company data, Morgan Stanley Research

US & China Humanoid TAM/Adoption Estimates

Note: The underlying Excel file for the TAM model discussed in this section is available upon request. Please reach out to your Morgan Stanley sales representative to obtain the model.

US Humanoid TAM Estimates

As part of our Humanoid BluePaper published last June, we conducted a bottom-up analysis on the US labor market to assess each occupation's "humanoidability" and estimate the humanoid TAM (US Only). We started by gathering all 831 US civilian occupations using the Bureau of Labor Statistics' May 2023 Occupational Employment and Wage Statistics Survey. Working with our economics team, we assigned one of four 'values' to measure the humanoid optionality of each occupation as follows:

- **Strong Potential (46% of occupations)**
  - *These are jobs that are predominately unskilled and most likely to be perceived as boring, dangerous, and/or repetitive. Extremely unlikely to be performed by an AI model due to physical requirements of the job.*
  - For the purposes of our TAM model, we assume 70% of employees in these positions are substitutable with humanoids (i.e., 70% optionality factor).
- **Moderate Potential (9% of occupations)**
  - *These are jobs that are often physical in nature or which require a physical presence but are not necessarily unskilled or obviously perceived as boring, dangerous and/or repetitive.*
  - For the purposes of our TAM model, we assume 50% of employees in these positions are substitutable with humanoids (i.e., 50% optionality factor).
- **Lower Potential (19% of occupations)**
  - *These are jobs that require complex human-to-human interaction or specialized skills not likely to be easily replicated by a robot (Ex: doctors, supervisors, engineers, etc.). A notable amount of these jobs are also more likely to be performed by an AI model rather than humanoid robots due to limited physical requirements.*
  - For the purposes of our TAM model, we assume 30% of employees in these positions are substitutable with humanoids (i.e., 30% optionality factor).
- **Limited Potential/NA (26% of occupations)**
  - *These are jobs that require a significant amount of complex human-to-human interaction or could more feasibly be performed by an AI model rather than a humanoid robot due to limited physical requirements.*
  - For the purposes of our TAM model, we assume none of the employees in these positions are substitutable with humanoids (i.e., 0% optionality factor).

Using the humanoid substitution risk framework, we multiplied the # of employees in each occupation by the relevant humanoid optionality factor and then by the median annual wage for the given occupation.

Note, this analysis is an illustrative effort to depict how humanoids could potentially be adopted in certain industries and how the TAM could be captured over time. Our "timeline" analysis also does not account for the possibility that the introduction of

humanoids could create new sectors, expand existing sectors, or create new job opportunities for humans.For simplicity, the analysis also assumes no growth in the total size of the US labor market and its existing industries.

Based on our analysis, we believe ~75% of occupations and ~40% of employees in the US have some degree of "humanoidability." This amounts to an estimated addressable market of ~$3 trillion, or ~63 million humanoid units in the US alone. While this estimate considers only the US, we note that a TAM based on the global labor market could be greater by multitudes of magnitude.

Exhibit 68: Humanoid Substitution and US Wage Impact by Tier, 2030-50

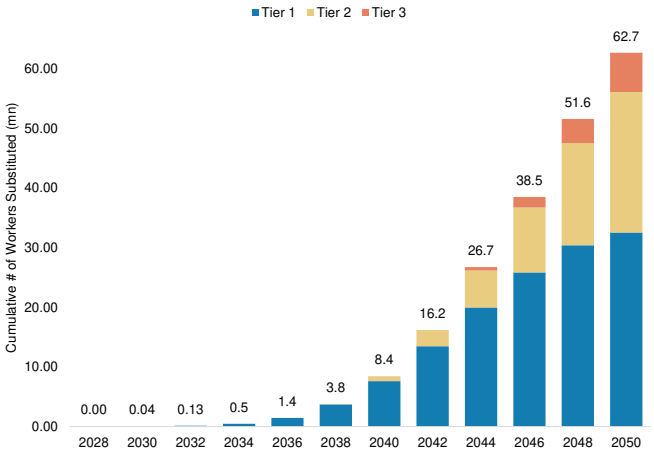
	% of Workers Substituted											
Substitutability Tier	**2028**	**2030**	**2032**	**2034**	**2036**	**2038**	**2040**	**2042**	**2044**	**2046**	**2048**	**2050**
1	0.01%	0.10%	0.30%	1.00%	3.00%	7.00%	12.00%	18.00%	20.00%	18.00%	14.00%	6.59%
2	0.00%	0.00%	0.00%	0.00%	0.01%	0.30%	3.00%	8.00%	15.00%	20.00%	26.50%	27.20%
3	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.50%	8.00%	18.00%	35.00%	38.49%

			# of Humanoid Units Adopted (mn)											
Tier	**#**	**Industry**	**2028**	**2030**	**2032**	**2034**	**2036**	**2038**	**2040**	**2042**	**2044**	**2046**	**2048**	**2050**
1	1	Construction and Extraction	0.0	0.0	0.0	0.0	0.1	0.3	0.5	0.8	0.9	0.8	0.6	0.3
1	2	Production	0.0	0.0	0.0	0.1	0.2	0.4	0.7	1.1	1.2	1.1	0.8	0.4
1	3	Farming, Fishing, and Forestry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0
1	4	Building and Grounds Cleaning and Maintenance	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.5	0.6	0.5	0.4	0.2
1	5	Installation, Maintenance, and Repair	0.0	0.0	0.0	0.0	0.1	0.3	0.5	0.7	0.8	0.7	0.6	0.3
1	6	Healthcare Support	0.0	0.0	0.0	0.0	0.1	0.3	0.6	0.8	0.9	0.8	0.6	0.3
1	7	Food Preparation and Serving Related	0.0	0.0	0.0	0.1	0.3	0.6	1.0	1.5	1.7	1.5	1.2	0.6
1	8	Personal Care and Service	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.3	0.3	0.1
1	**Substitutions, Annual (mn)**		**0.00**	**0.03**	**0.10**	**0.33**	**0.98**	**2.28**	**3.90**	**5.86**	**6.51**	**5.86**	**4.55**	**2.14**
1	**Cumulative Humanoid Units Adopted**		**0.00**	**0.04**	**0.13**	**0.46**	**1.43**	**3.71**	**7.62**	**13.47**	**19.98**	**25.84**	**30.39**	**32.54**
1	*% of 2050 Total*		*0%*	*0%*	*0%*	*1%*	*4%*	*11%*	*23%*	*41%*	*61%*	*79%*	*93%*	*100%*
2	9	Protective Service	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.6
2	10	Transportation and Material Moving	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	1.1	1.5	2.0	2.1
2	11	Sales and Related	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.9	1.2	1.5	1.6
2	12	Healthcare Practitioners and Technical	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.6	0.8	1.0	1.0
2	13	Life, Physical, and Social Science	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
2	14	Architecture and Engineering	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2
2	15	Educational Instruction and Libraries	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.6	0.8	0.8
2	**Substitutions, Annual (mn)**		**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.7**	**1.9**	**3.5**	**4.7**	**6.2**	**6.4**
2	**Cumulative Humanoid Units Adopted**		**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.8**	**2.7**	**6.2**	**10.9**	**17.2**	**23.6**
2	*% of 2050 Total*		*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*3%*	*11%*	*26%*	*46%*	*73%*	*100%*
3	16	Office and Administrative Support	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.8	1.6	1.7
3	17	Management	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.5
3	18	Arts, Design, Entertainment, Sports, and Media	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
3	19	Business and Financial Operations	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2
3	20	Legal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	21	Community and Social Service	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	**Substitutions, Annual (mn)**		**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.5**	**1.2**	**2.3**	**2.5**
3	**Cumulative Humanoid Units Adopted**		**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.6**	**1.7**	**4.0**	**6.6**
3	*% of 2050 Total*		*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*1%*	*9%*	*27%*	*62%*	*100%*
N/A	22	Computer and Mathematical	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Total Humanoid Units Adopted, Annual (mn)		**0.00**	**0.03**	**0.10**	**0.33**	**0.98**	**2.35**	**4.61**	**7.77**	**10.57**	**11.75**	**13.10**	**11.09**
	Cumulative Humanoid Units Adopted (mn)		**0.00**	**0.04**	**0.13**	**0.46**	**1.44**	**3.79**	**8.40**	**16.17**	**26.74**	**38.49**	**51.60**	**62.68**
	% of 2050 Cumulative		*0.0%*	*0.1%*	*0.2%*	*0.7%*	*2.3%*	*6.0%*	*13.4%*	*25.8%*	*42.7%*	*61.4%*	*82.3%*	*100.0%*

			Wage Impact ($tn)											
Tier	**#**	**Industry**	**2028**	**2030**	**2032**	**2034**	**2036**	**2038**	**2040**	**2042**	**2044**	**2046**	**2048**	**2050**
1	1	Construction and Extraction	0.0	0.2	0.7	2.5	7.4	17.3	29.6	44.4	49.4	44.4	34.6	16.3
1	2	Production	0.0	0.3	0.8	2.7	8.0	18.6	31.9	47.9	53.2	47.9	37.2	17.5
1	3	Farming, Fishing, and Forestry	0.0	0.0	0.0	0.1	0.3	0.8	1.3	1.9	2.2	1.9	1.5	0.7
1	4	Building and Grounds Cleaning and Maintenance	0.0	0.1	0.3	1.1	3.2	7.5	12.9	19.4	21.5	19.4	15.1	7.1
1	5	Installation, Maintenance, and Repair	0.0	0.2	0.6	2.2	6.5	15.1	25.9	38.8	43.1	38.8	30.2	14.2
1	6	Healthcare Support	0.0	0.2	0.5	1.7	5.2	12.2	20.9	31.3	34.8	31.3	24.4	11.5
1	7	Food Preparation and Serving Related	0.0	0.3	0.8	2.7	8.1	18.8	32.3	48.5	53.8	48.5	37.7	17.7
1	8	Personal Care and Service	0.0	0.1	0.2	0.6	1.9	4.5	7.7	11.5	12.8	11.5	8.9	4.2
1	**Wage Impact, Annual ($bn)**		**0**	**1**	**4**	**14**	**41**	**95**	**162**	**244**	**271**	**244**	**190**	**89**
1	**Cumulative Wage Impact ($bn)**		**0**	**1**	**6**	**19**	**60**	**154**	**317**	**561**	**831**	**1,075**	**1,265**	**1,354**
1	*% of 2050 Total*		*0%*	*0%*	*0%*	*1%*	*4%*	*11%*	*23%*	*41%*	*61%*	*79%*	*93%*	*100%*
2	9	Protective Service	0.0	0.0	0.0	0.0	0.0	0.3	3.1	8.3	15.6	20.8	27.5	28.2
2	10	Transportation and Material Moving	0.0	0.0	0.0	0.0	0.0	0.9	9.4	25.1	47.0	62.7	83.1	85.3
2	11	Sales and Related	0.0	0.0	0.0	0.0	0.0	0.6	5.9	15.8	29.7	39.5	52.4	53.8
2	12	Healthcare Practitioners and Technical	0.0	0.0	0.0	0.0	0.0	0.9	9.1	24.3	45.6	60.8	80.5	82.6
2	13	Life, Physical, and Social Science	0.0	0.0	0.0	0.0	0.0	0.1	1.1	3.0	5.7	7.6	10.1	10.4
2	14	Architecture and Engineering	0.0	0.0	0.0	0.0	0.0	0.2	2.3	6.0	11.3	15.1	20.0	20.5
2	15	Educational Instruction and Libraries	0.0	0.0	0.0	0.0	0.0	0.5	5.3	14.1	26.4	35.1	46.5	47.8
2	**Wage Impact, Annual ($bn)**		**0**	**0**	**0**	**0**	**0**	**4**	**36**	**97**	**181**	**242**	**320**	**329**
2	**Cumulative Wage Impact ($bn)**		**0**	**0**	**0**	**0**	**0**	**4**	**40**	**137**	**318**	**559**	**880**	**1,208**
2	*% of 2050 Total*		*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*3%*	*10%*	*23%*	*41%*	*65%*	*89%*
3	16	Office and Administrative Support	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	15.5	34.9	67.9	74.7
3	17	Management	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	11.1	24.9	48.5	53.3
3	18	Arts, Design, Entertainment, Sports, and Media	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.7	3.3	3.7
3	19	Business and Financial Operations	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	4.0	9.1	17.7	19.5
3	20	Legal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.5	0.6
3	21	Community and Social Service	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.4
3	**Wage Impact, Annual ($bn)**		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**32**	**71**	**138**	**152**
3	**Cumulative Wage Impact ($bn)**		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**34**	**105**	**243**	**395**
3	*% of 2050 Total*		*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*2%*	*8%*	*18%*	*29%*
N/A	22	Computer and Mathematical	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Total Wage Impact, Annual ($bn)		**0**	**1**	**4**	**14**	**41**	**98**	**199**	**342**	**484**	**556**	**648**	**570**
	Cumulative Wage Impact ($bn)		**0**	**1**	**6**	**19**	**60**	**158**	**357**	**699**	**1,183**	**1,739**	**2,387**	**2,957**
	% of 2050 Cumulative		*0.0%*	*0.1%*	*0.2%*	*0.6%*	*2.0%*	*5.4%*	*12.1%*	*23.6%*	*40.0%*	*58.8%*	*80.7%*	*100.0%*

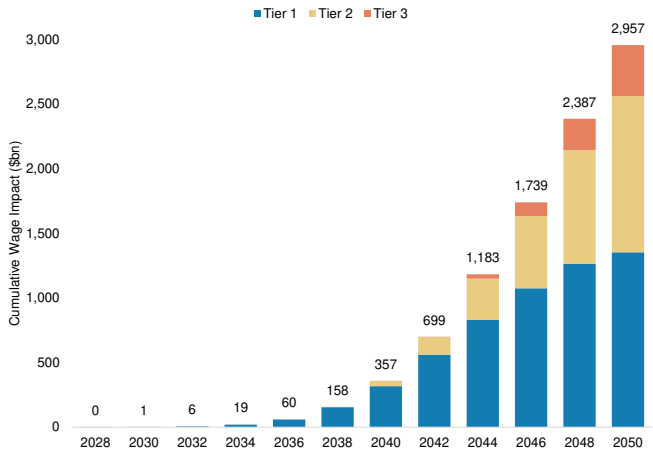
Source: Bureau of Labor Statistics, Morgan Stanley Research

Exhibit 69: Cumulative US Humanoid Adoption, 2028-50 (Millions of Humanoids)



Source: Bureau of Labor Statistics, Morgan Stanley Research

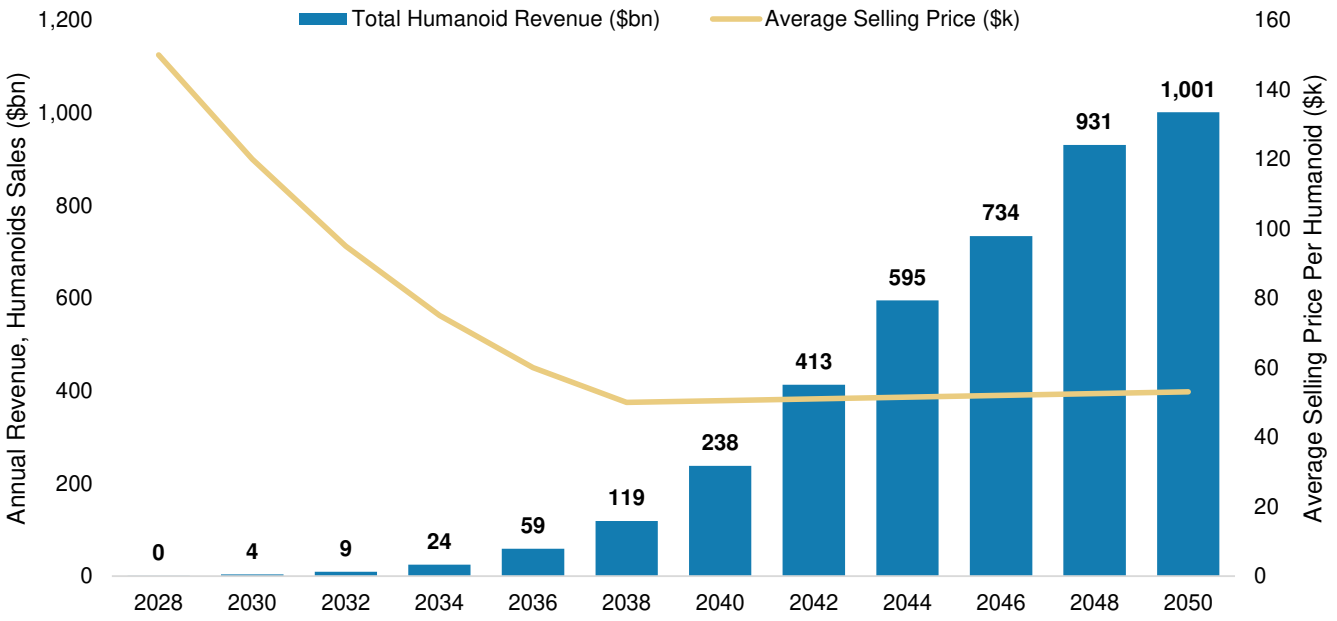
Exhibit 70: Cumulative US Wage Impact, 2028-50 ($Billion)



Source: Bureau of Labor Statistics, Morgan Stanley Research

Overlaying an average selling price per humanoid and a replacement rate assumption onto our units adoption analysis, we estimate the total revenue generated by the US humanoids market each year. We assume an initial average selling price per humanoid in 2028 of $150k each, which declines to $50k by ~2040. Post-2040, we assume a modest price increase of 0-1% per year driven by inflation offset by further technological advancements. We also assume a replacement rate of 8 years per humanoid. Based on these assumptions, we estimate that the US humanoids market could generate ~$4 billion total revenue by 2030, ~$240 billion total revenue by 2040, and ~$1 trillion total revenue by 2050 (with rapid acceleration in revenue growth occurring in 2040-50).

Exhibit 71: US Humanoids Market, Total Revenue ($bns)



Source: Bureau of Labor Statistics, Morgan Stanley Research. Assumes 8-year replacement cycle.

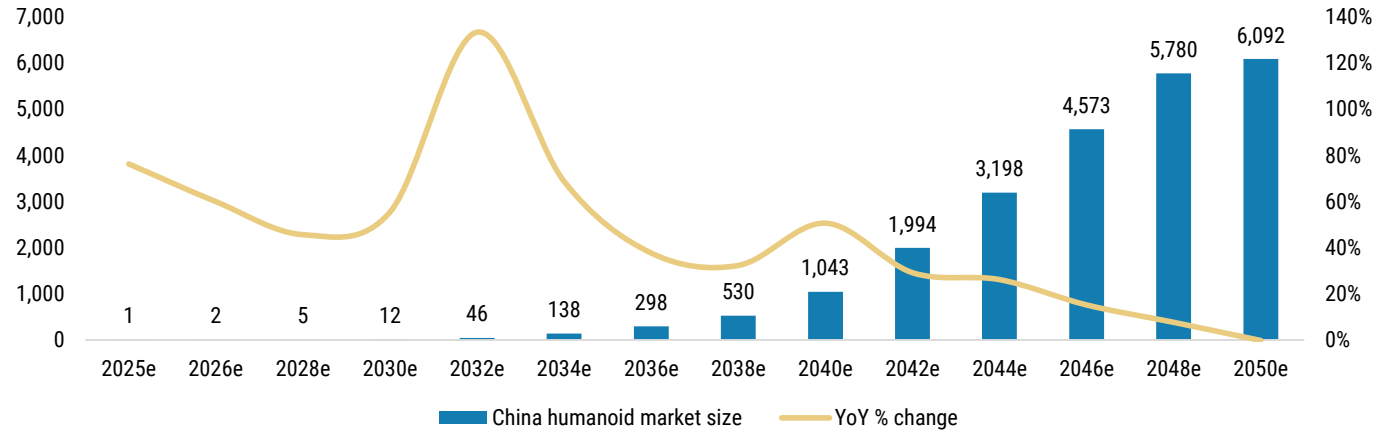
China Humanoid TAM Estimates

Sheng Zhong

We introduce our China Humanoid market forecast model to assess the market potential in China, expecting the market to reach Rmb12bn/Rmb216bn/Rmb6tr by 2030e/35e/40e/50e, with volume to reach 1.5mn/7.4mn/59mn by 2030e/35e/50e, respectively. We factor in China's low cost of labor and massive population, estimating a lower adoptability compared to US similar industry.

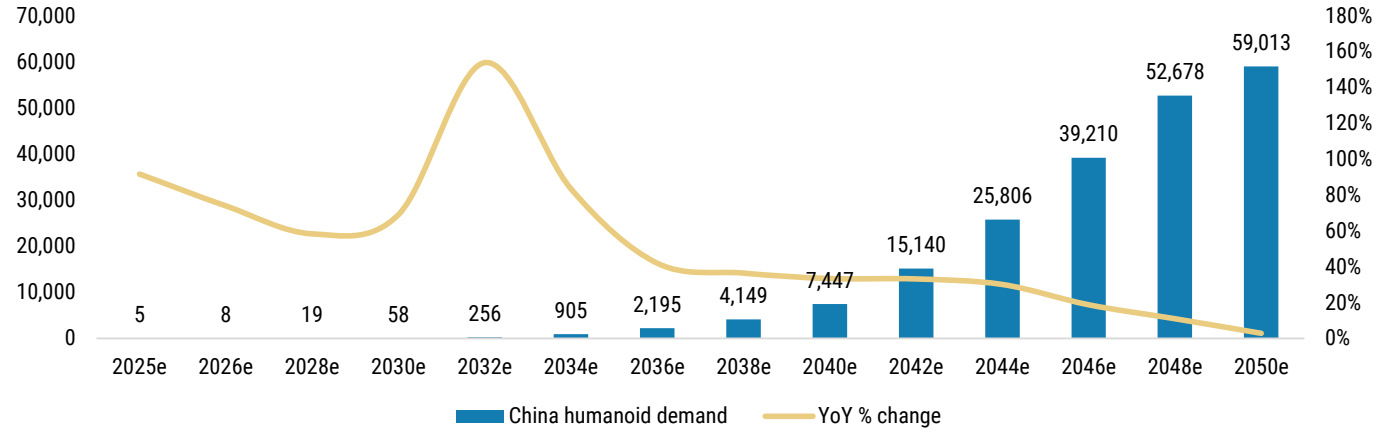
Also, we believe a significant price cut is critical for humanoid to become a mass market product, we anticipate the ASP and BOM to decrease at CAGR of 8% and 11%, respectively. While the incremental volume could bring meaningful growth, there is short-term margin pressure to upstream manufacturers in China.

Exhibit 72: China humanoid market size (Rmb'bn)



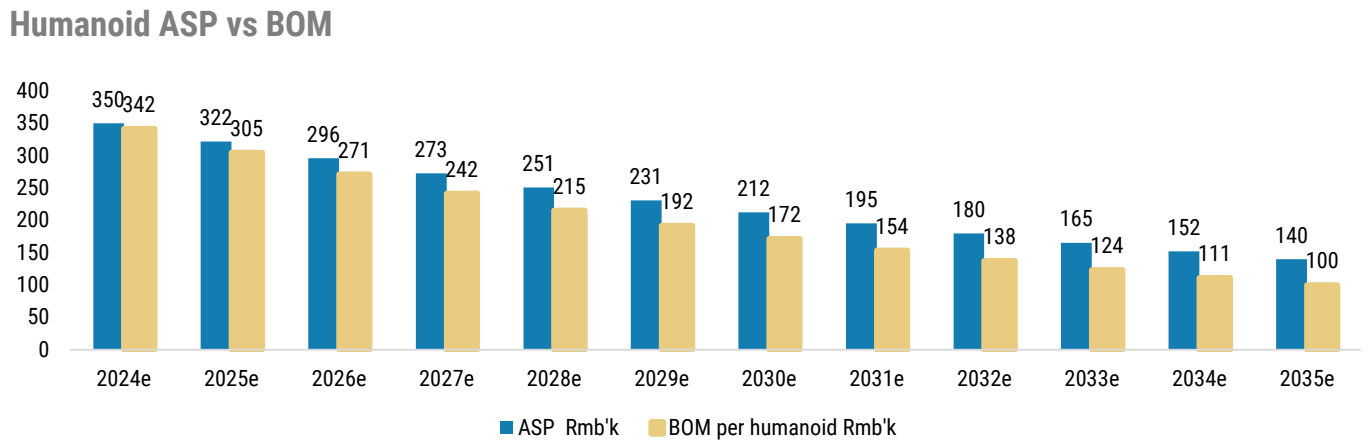
Source: Morgan Stanley Research

Exhibit 73: China new humanoid adoption ('k unit)



Source: Morgan Stanley Research

Exhibit 74: China humanoid ASP vs. BOM



Source: Morgan Stanley Research

Valuation Methodology and Risks

Tesla Inc (TSLA.O)

Our PT of $430 is comprised of 5 components: **(1)** $86/share for core Tesla Auto business on 5.2mm units in 2030, 9.0% WACC, 14x 2030 exit EBITDA multiple, exit EBITDA margin of 16.1%. **(2)** Network Services at $172, 65% attach rate at $200 ARPU by 2040 **(3)** Tesla Mobility at $90 on DCF with ~7.5mn cars at ~$1.46/mile by 2040. **(4)** Energy at $65/share, & **(5)** Tesla as a 3rd party supplier at $17/share.

Risks to Upside

- Disclosure on service revs
- Increased FSD attach rate
- Cost milestones on new battery
- New model intro (Cybertruck, multivan, Semi)
- 3rd party battery win
- Geographic penetration & new capacity

Risks to Downside

- Competition: legacy OEMs/Chinese players/big tech
- Execution risk: multiple factory ramps
- Market does not recognize Dojo-enabled services op, lower than expected attach rate & RPU
- China risk
- Dilution
- Valuation

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(Shanghai), Valeo SE, Vanguard International Semiconductor, Varonis Systems, Inc., VAT Group AG, Vertex Inc., Vertiv Holdings Co., Visteon Corporation, Volkswagen, Volvo, W.W. Grainger Inc., Want Want China Holdings Ltd, Wartsila Oyj Abp, Webtoon Entertainment Inc, Weilong Delicious Global Holdings Ltd, Weir Group PLC, WeRide Inc, Western Digital, Westinghouse Air Brake Technologies Corp, WH Group, Whitehaven Coal Ltd, WillScot Holdings Corporation, Winbond Electronics Corp, Wistron Corporation, Wiwynn Corp, Wix.Com Ltd, Wolfspeed, INC, Workday Inc, WPG Holdings, Xerox Corp, Xiaomi Corp, Yageo Corp., Yaskawa Electric, Yelp Inc, Yihai International Holding Ltd, Yunnan Energy New Material Co Ltd, Zeekr Intelligent Technology Holding Ltd, Zeta Global Holdings Corp, Zhejiang Huayou Cobalt Co Ltd, Zhen Ding, Zhongji Innolight Co Ltd, Zhongsheng Group Holdings, Zijin Mining Group, Zillow Group Inc, ZJLD Group, Zoom Video Communications Inc, ZOZO, Zscaler Inc.

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Corp Ltd, Cummins Inc, CyberArk Software Ltd, Daikin Industries, Daimler Truck Holding AG, Dassault Systemes SA, Datadog, Inc., Deere & Co., Dell Technologies Inc., Dentsu, DigitalOcean Holdings Inc, DocuSign Inc, DoorDash Inc, Dynatrace Inc, Eaton Corporation PLC, eBay Inc, EHang Holdings Ltd, Electronic Arts Inc, Emerson Electric Co, Eoptolink Technology Inc Ltd, Etsy Inc, Exclusive Networks, Expedia Inc., Ferrari NV, Five9 Inc, Ford Motor Company, Fortinet Inc., Fortive Corp, Foxconn Technology, Freeport-McMoRan Inc, Freshworks Inc, Ganfeng Lithium Co. Ltd., Garmin Ltd, Gates Industrial Corporation PLC, Geely Automobile Holdings, Gen Digital Inc., General Motors Company, Giga-Byte Technology Co. Ltd., GlobalFoundries Inc, GoDaddy Inc, GoerTek Inc, Goodyear Tire & Rubber Company, GoPro Inc, Gree Electric Appliances Inc of Zhuhai, Haidilao International Holding Ltd, Haier Smart Home Co Ltd, Haitian International Holdings Limited, Harmonic Drive Systems, Health and Happiness (H&H), Hengan International Group, Hertz Global Holdings Inc, Hesai Group, Hewlett Packard Enterprise, Hexagon AB, Hexcel Corp, Hitachi Construction Machinery, Hon Hai Precision, Honeywell International Inc, Howmet, HP Inc., HTC Corporation, Hubbell Inc., HubSpot, Inc., Hyundai Motor, IBM, Infineon Technologies AG, Ingersoll Rand INC, Ingram Micro, Innolux, Integral Ad Science Holding Corp., Intel Corporation, Intuit, Jamf Holding Corp, Japan Aviation Electronics Industry, Joby Aviation Inc, Johnson Controls International Plc, Keyence, King Yuan Electronics Co Ltd, KION Group AG, Kubota, Kyocera, Lear Corporation, LegalZoom.com Inc, Legrand, Lenovo, Logitech International SA, LY Corporation, Marvell Technology Group Ltd, MediaTek, Mercari, Mercedes-Benz Group AG, Meta Platforms Inc, Michelin, Microchip Technology Inc., Micron Technology Inc., Microsoft, Midea Group Co Ltd., Minth Group Limited, MongoDB Inc, Nanya Technology Corp., Naver Corp, NCR Voyix Corp., NetApp Inc, Netmarble Games Corp, NICE Ltd., Nihon Dempa Kogyo, Ningbo Joyson Electronic Corp, NIO Inc., Nissan Motor, Nongfu Spring Co Ltd, Novatek, Nutanix Inc, Nuvoton Technology Corporation, NVIDIA Corp., NXP Semiconductor NV, ON Semiconductor Corp., OneStream Inc, Opendoor Technologies Inc, Opmobility SE, Oracle Corporation, Oshkosh Corp, Otis Worldwide Corp, OVH GROUPE SAS, PagerDuty, Inc., Palantir Technologies Inc., Palo Alto Networks Inc, Peloton Interactive, Inc., PetroChina, Pinterest Inc, Pirelli & C SpA, Playtika Holding Corp, Pop Mart International Group, Porsche AG, Prysmian SpA, Pure Storage Inc, Qorvo Inc, Qualcomm Inc., Qualys Inc, Quanta Computer Inc., Rakuten Group, RBC Bearings Inc., Realtek Semiconductor, Reddit Inc, Renault, Renesas Electronics, REPT Battero Energy Co, Resideo Technologies Inc, Revolve Group Inc, RingCentral Inc, Rio Tinto Limited, Rivian Automotive, Inc., Rockwell Automation, Rotork PLC, RTX Corp, Sabre Corp, Sage, Salesforce, Inc., Samsonite International, Samsung SDI, Sansan, SAP SE, Schneider Electric, ServiceNow Inc, ServiceTitan Inc, Shopify Inc, Siemens, Siemens Energy AG, Signify NV, Silicon Laboratories Inc., Silicon Motion, Sinotruk (Hong Kong) Limited, SMIC, Snap Inc., Snowflake Inc., Softbank Group, Solarwinds Corp, Sonos Inc., South32 Ltd, Spirit AeroSystems Holdings Inc, StandardAero Inc., Stanley Black & Decker Inc, Stella International Holdings Ltd, Stellantis, SUBARU, Summit Materials Inc, Synopsys Inc., Take-Two Interactive Software, TeamViewer SE, Techtronic Industries Co Ltd, Teck Resources Limited, Tenable Holdings Inc, Terex Corp., **Tesla Inc**, Texas Instruments, Tianqi Lithium Industries Inc., Tietoevry Oyj, Timken Co, Toast, Inc., Topsports International Holdings Ltd, Toyota Motor, TransDigm Group Inc., Traton SE, TSMC, Twilio Inc, Uber Technologies Inc, Udemy Inc, UiPath Inc, UMC, Uni-President China, United Rentals Inc., Unity Software Inc, Universal Scientific Ind. (Shanghai), Varonis Systems, Inc., Vertiv Holdings Co., Vestas Wind Systems A/S, Virgin Galactic Holdings Inc, Visteon Corporation, Volkswagen, Volvo, Vulcan Materials Company, W.W. Grainger Inc., Wanhua Chemical, Western Digital, Westinghouse Air Brake Technologies Corp, WH Group, WillScot Holdings Corporation, Winbond Electronics Corp, Wix.Com Ltd, Wolfspeed, INC, Workday Inc, WW International Inc, Xerox Corp, Xiaomi Corp, Xinyi Glass Holding Limited, Yageo Corp., Yanjing Brewery, Yihai International Holding Ltd, Yue Yuen Industrial Hldg, Yum China Holdings Inc., Zeta Global Holdings Corp, Zhongsheng Group Holdings, Zijin Mining Group, Zillow Group Inc, Zoom Video Communications Inc, Zscaler Inc.

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Global Stock Ratings Distribution

(as of January 31, 2025)

The Stock Ratings described below apply to Morgan Stanley's Fundamental Equity Research and do not apply to Debt Research produced by the Firm.

For disclosure purposes only (in accordance with FINRA requirements), we include the category headings of Buy, Hold, and Sell alongside our ratings of Overweight, Equal-weight, Not-Rated and Underweight. Morgan Stanley does not assign ratings of Buy, Hold or Sell to the stocks we cover. Overweight, Equal-weight, Not-Rated and Underweight are not the equivalent of buy, hold, and sell but represent recommended relative weightings (see definitions below). To satisfy regulatory requirements, we correspond Overweight, our most positive stock rating, with a buy recommendation; we correspond Equal-weight and Not-Rated to hold and Underweight to sell recommendations, respectively.

	Coverage Universe		Investment Banking Clients (IBC)			Other Material Investment Services Clients (MISC)	
Stock Rating Category	Count	% of Total	Count	% of Total IBC	% of Rating Category	Count	% of Total Other MISC
Overweight/Buy	1492	39%	383	46%	26%	685	40%
Equal-weight/Hold	1688	45%	367	44%	22%	805	47%
Not-Rated/Hold	4	0%	0	0%	0%	1	0%
Underweight/Sell	608	16%	81	10%	13%	231	13%
Total	3,792		831			1722	

Data include common stock and ADRs currently assigned ratings. Investment Banking Clients are companies from whom Morgan Stanley received investment banking compensation in the last 12 months. Due to rounding off of decimals, the percentages provided in the "% of total" column may not add up to exactly 100 percent.

Analyst Stock Ratings

Overweight (O or Over) - The stock's total return is expected to exceed the total return of the relevant country MSCI Index or the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis over the next 12-18 months.

Equal-weight (E or Equal) - The stock's total return is expected to be in line with the total return of the relevant country MSCI Index or the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis over the next 12-18 months.

Not-Rated (NR) - Currently the analyst does not have adequate conviction about the stock's total return relative to the relevant country MSCI Index or the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

Underweight (U or Under) - The stock's total return is expected to be below the total return of the relevant country MSCI Index or the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

Unless otherwise specified, the time frame for price targets included in Morgan Stanley Research is 12 to 18 months.

Analyst Industry Views

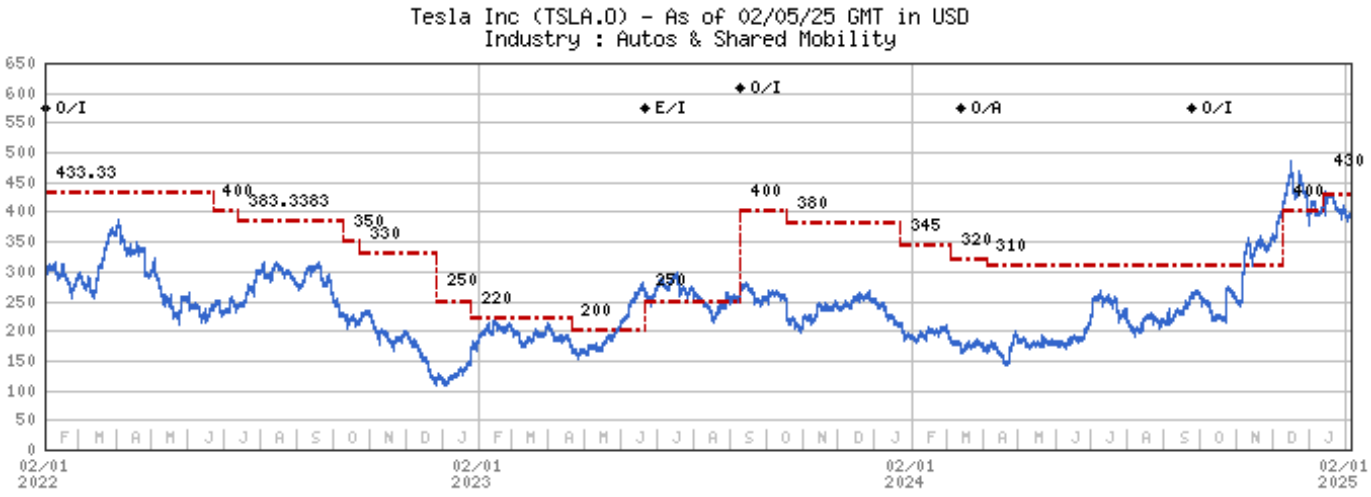
Attractive (A): The analyst expects the performance of his or her industry coverage universe over the next 12-18 months to be attractive vs. the relevant broad market benchmark, as indicated below.

In-Line (I): The analyst expects the performance of his or her industry coverage universe over the next 12-18 months to be in line with the relevant broad market benchmark, as indicated below.

Cautious (C): The analyst views the performance of his or her industry coverage universe over the next 12-18 months with caution vs. the relevant broad market benchmark, as indicated below.

Benchmarks for each region are as follows: North America - S&P 500; Latin America - relevant MSCI country index or MSCI Latin America Index; Europe - MSCI Europe; Japan - TOPIX; Asia - relevant MSCI country index or MSCI sub-regional index or MSCI AC Asia Pacific ex Japan Index.

Stock Price, Price Target and Rating History (See Rating Definitions)



Stock Rating History: 2/1/20 : U/C; 3/19/20 : E/C; 3/24/20 : E/I; 6/12/20 : U/I; 8/13/20 : E/I; 11/18/20 : O/I; 6/22/23 : E/I; 9/10/23 : O/I; 3/13/24 : O/A; 9/25/24 : O/I

Price Target History: 1/16/20 : 24; 2/18/20 : 33.33; 3/12/20 : 32; 3/19/20 : 30.67; 3/24/20 : 29.33; 5/4/20 : 45.33; 6/12/20 : 43.33; 7/7/20 : 49.33; 7/29/20 : 70; 8/13/20 : 90.67; 10/15/20 : 111; 10/22/20 : 120; 11/18/20 : 180; 1/5/21 : 270; 2/1/21 : 293.33; 4/22/21 : 300; 10/24/21 : 400; 1/10/22 : 433.33; 6/22/22 : 400; 7/14/22 : 383.33; 8/25/22 : 383; 10/10/22 : 350; 10/24/22 : 330; 12/28/22 : 250; 1/25/23 : 220; 4/20/23 : 200; 6/22/23 : 250; 9/10/23 : 400; 10/19/23 : 380; 1/22/24 : 345; 3/5/24 : 320; 4/4/24 : 310; 12/10/24 : 400; 1/13/25 : 430

Source: Morgan Stanley Research Date Format : MM/DD/YY Price Target No Price Target Assigned (NA)
Stock Price (Not Covered by Current Analyst) Stock Price (Covered by Current Analyst)
Stock and Industry Ratings (abbreviations below) appear as ◆ Stock Rating/Industry View
Stock Ratings: Overweight (O) Equal-weight (E) Underweight (U) Not-Rated (NR) No Rating Available (NA)
Industry View: Attractive (A) In-line (I) Cautious (C) No Rating (NR)

Effective January 13, 2014, the stocks covered by Morgan Stanley Asia Pacific will be rated relative to the analyst's industry (or industry team's) coverage.

Effective January 13, 2014, the industry view benchmarks for Morgan Stanley Asia Pacific are as follows: relevant MSCI country index or MSCI sub-regional index or MSCI AC Asia Pacific ex Japan Index.

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INDUSTRY COVERAGE: Autos & Shared Mobility

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Adam Jonas, CFA		
Adient PLC (ADNT.N)	U (03/17/2021)	$17.14
American Axle & Manufacturing Holdings Inc (AXL.N)	O (02/28/2022)	$5.12
Aptiv Plc (APTV.N)	U (02/06/2024)	$61.27
Asbury Automotive Group Inc (ABG.N)	E (09/25/2024)	$304.24
AutoNation Inc. (AN.N)	O (09/25/2024)	$194.63
Avis Budget Group Inc (CAR.O)	O (06/20/2023)	$88.00
BorgWarner Inc. (BWA.N)	O (05/15/2023)	$31.17
Carmax Inc (KMX.N)	O (07/10/2018)	$83.88
Carvana Co (CVNA.N)	E (11/05/2024)	$255.98
Ferrari NV (RACE.N)	O (05/09/2019)	$464.19
Ford Motor Company (F.N)	E (09/25/2024)	$10.01
General Motors Company (GM.N)	E (12/10/2024)	$47.81
Group 1 Automotive, Inc (GPI.N)	O (09/25/2024)	$471.63
Hertz Global Holdings Inc (HTZ.O)	E (02/08/2024)	$4.22
Lear Corporation (LEA.N)	O (05/10/2024)	$93.44
Lithia Motors Inc. (LAD.N)	E (09/25/2024)	$383.22
Lucid Group Inc (LCID.O)	U (09/13/2021)	$2.91
Magna International Inc. (MGA.N)	E (09/25/2024)	$38.89
Mobileye Global Inc (MBLY.O)	E (08/02/2024)	$16.15
Penske Automotive Group, Inc (PAG.N)	O (09/25/2024)	$170.09
PHINIA INC (PHIN.N)	E (09/25/2024)	$51.45
Quantumscape Corp (QS.N)	NR (11/21/2024)	$4.99
Rivian Automotive, Inc. (RIVN.O)	E (09/25/2024)	$12.77

Sonic Automotive Inc (SAH.N)	E (09/25/2024)	$75.03
Tesla Inc (TSLA.O)	O (09/10/2023)	$378.17
Visteon Corporation (VC.O)	E (06/01/2022)	$82.51
Shaqeal A Kirunda		
Goodyear Tire & Rubber Company (GT.O)	E (06/13/2024)	$8.65

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* Historical prices are not split adjusted.

INDUSTRY COVERAGE: Semiconductors

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Joseph Moore		
Advanced Micro Devices (AMD.O)	E (06/09/2024)	$112.01
Aeva Technologies Inc (AEVA.O)	E (07/19/2021)	$4.01
Allegro Microsystems Inc (ALGM.O)	E (11/07/2024)	$24.61
Ambarella Inc (AMBA.O)	O (03/29/2016)	$78.76
Amkor Technology Inc (AMKR.O)	E (11/08/2023)	$24.90
Analog Devices Inc. (ADI.O)	O (11/16/2023)	$209.80
Astera Labs Inc (ALAB.O)	E (01/20/2025)	$106.57
Broadcom Inc. (AVGO.O)	O (06/09/2024)	$232.00
GlobalFoundries Inc (GFS.O)	E (10/28/2024)	$40.58
Intel Corporation (INTC.O)	E (02/22/2023)	$19.65
IonQ Inc (IONQ.N)	E (04/25/2023)	$42.32
Marvell Technology Group Ltd (MRVL.O)	E (09/14/2015)	$116.46
Microchip Technology Inc. (MCHP.O)	E (07/10/2024)	$53.50
Micron Technology Inc. (MU.O)	E (05/20/2024)	$93.60
Navitas Semiconductor Corp (NVTS.O)	E (08/28/2023)	$3.14
NVIDIA Corp. (NVDA.O)	O (03/16/2023)	$124.83
NXP Semiconductor NV (NXPI.O)	E (04/08/2021)	$213.24
ON Semiconductor Corp. (ON.O)	U (07/10/2024)	$51.72
Qorvo Inc (QRVO.O)	O (01/20/2025)	$82.59
Qualcomm Inc. (QCOM.O)	E (12/07/2023)	$175.86
Silicon Laboratories Inc. (SLAB.O)	E (01/19/2021)	$149.06
Skyworks Solutions Inc (SWKS.O)	E (11/28/2018)	$87.08
Texas Instruments (TXN.O)	U (04/13/2020)	$181.59
Western Digital (WDC.O)	O (01/23/2020)	$64.72
Wolfspeed, INC (WOLF.N)	E (12/07/2020)	$5.80
Lee Simpson		
Arm Holdings plc (ARM.O)	O (07/19/2024)	$173.26
Cadence Design Systems Inc (CDNS.O)	O (02/14/2024)	$302.65
Synopsys Inc. (SNPS.O)	O (11/10/2023)	$528.42

Stock Ratings are subject to change. Please see latest research for each company.
* Historical prices are not split adjusted.

INDUSTRY COVERAGE: Japan Semiconductors

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Kazuo Yoshikawa, CFA		
Anritsu (6754.T)	E (08/30/2024)	¥1,415
Horiba (6856.T)	U (11/13/2024)	¥9,603
HOYA (7741.T)	E (10/30/2023)	¥19,315
KIOXIA Holdings (285A.T)	E (01/20/2025)	¥1,735
Renesas Electronics (6723.T)	O (11/26/2019)	¥2,048
Rigaku Holdings (268A.T)	E (12/03/2024)	¥956
Rohm (6963.T)	U (11/19/2021)	¥1,467

Shimadzu (7701.T)	U (02/03/2025)	¥4,163
Socionext (6526.T)	E (01/27/2025)	¥2,078

Stock Ratings are subject to change. Please see latest research for each company.
* Historical prices are not split adjusted.

INDUSTRY COVERAGE: Greater China Technology Semiconductors

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Charlie Chan		
ACM Research Inc (ACMR.O)	O (03/07/2023)	$20.85
Advanced Micro-Fabrication Equipment Inc (688012.SS)	O (11/06/2023)	Rmb181.94
Alchip Technologies Ltd (3661.TW)	O (05/14/2021)	NT$3,345.00
Andes Technology Corp (6533.TW)	O (08/04/2022)	NT$428.00
ASE Technology Holding Co. Ltd. (3711.TW)	O (09/15/2024)	NT$161.50
Global Unichip Corp (3443.TW)	O (07/27/2024)	NT$1,350.00
King Yuan Electronics Co Ltd (2449.TW)	O (03/03/2023)	NT$101.50
M31 Technology Corp (6643.TWO)	E (09/23/2024)	NT$664.00
MediaTek (2454.TW)	O (09/12/2023)	NT$1,525.00
Nanya Technology Corp. (2408.TW)	U (11/06/2023)	NT$27.50
Phison Electronics Corp (8299.TWO)	E (05/13/2024)	NT$475.50
Silergy Corp. (6415.TW)	E (08/28/2024)	NT$383.50
SMIC (0981.HK)	U (02/22/2023)	HK$44.70
TSMC (2330.TW)	O (02/07/2022)	NT$1,110.00
UMC (2303.TW)	E (10/28/2024)	NT$40.10
Vanguard International Semiconductor (5347.TWO)	U (08/05/2024)	NT$88.20
Will Semiconductor Co Ltd Shanghai (603501.SS)	E (10/28/2024)	Rmb110.59
Daisy Dai, CFA		
ASMPT Ltd (0522.HK)	E (11/20/2024)	HK$72.40
China Resources Microelectronics Limited (688396.SS)	U (09/02/2024)	Rmb45.59
Elan Microelectronics Corp (2458.TW)	O (04/29/2024)	NT$157.50
Empyrean Technology Co Ltd (301269.SZ)	E (01/17/2025)	Rmb109.09
Hangzhou Silan Microelectronics Co. Ltd. (600460.SS)	E (04/09/2024)	Rmb25.77
JCET Group Co Ltd (600584.SS)	U (09/25/2024)	Rmb39.59
Shanghai Anlogic Infotech Co Ltd (688107.SS)	E (05/14/2024)	Rmb26.69
Shanghai Fudan Microelectronics (1385.HK)	E (10/18/2022)	HK$16.80
Unigroup Guoxin Microelectronics Co Ltd (002049.SZ)	U (01/10/2023)	Rmb60.80
Universal Scientific Ind. (Shanghai) (601231.SS)	E (10/23/2024)	Rmb15.35
Yangjie Technology (300373.SZ)	O (06/10/2022)	Rmb43.50
Daniel Yen, CFA		
AP Memory Technology Corp (6531.TW)	E (09/15/2024)	NT$310.00
ASMedia Technology Inc (5269.TW)	O (01/23/2024)	NT$2,050.00
Aspeed Technology (5274.TWO)	E (09/15/2024)	NT$3,420.00
Egis Technology Inc (6462.TWO)	E (03/26/2024)	NT$162.50
Espressif Systems (688018.SS)	O (05/15/2023)	Rmb249.21
GigaDevice Semiconductor Beijing Inc (603986.SS)	E (01/22/2025)	Rmb135.35
Macronix International Co Ltd (2337.TW)	U (10/19/2021)	NT$18.75
Montage Technology Co Ltd (688008.SS)	O (11/08/2023)	Rmb69.40
Novatek (3034.TW)	O (03/18/2024)	NT$539.00
Nuvoton Technology Corporation (4919.TW)	O (10/29/2024)	NT$92.30
Parade Technologies Ltd (4966.TWO)	U (06/04/2024)	NT$707.00
Realtek Semiconductor (2379.TW)	U (09/15/2024)	NT$566.00
Shenzhen Goodix Technology Co Ltd (603160.SS)	E (06/12/2024)	Rmb79.96
Sino Wealth Electronic (300327.SZ)	E (03/18/2024)	Rmb23.68
Winbond Electronics Corp (2344.TW)	U (09/15/2024)	NT$14.20
WPG Holdings (3702.TW)	E (11/16/2023)	NT$70.30

Duan Liu		
Dosilicon Co Ltd (688110.SS)	U (09/06/2024)	Rmb25.61
Shenzhen Longsys Electronics Co Ltd (301308.SZ)	E (01/20/2025)	Rmb85.55
Ray Wu, CFA		
Advanced Wireless Semiconductor Co (8086.TWO)	E (10/24/2024)	NT$90.80
AllRing Tech Co. (6187.TWO)	O (08/27/2024)	NT$395.00
GlobalWafers Co Ltd (6488.TWO)	E (02/22/2023)	NT$326.00
Gudeng Precision (3680.TWO)	O (08/27/2024)	NT$446.50
Hua Hong Semiconductor Ltd (1347.HK)	O (06/13/2024)	HK$25.30
Maxscend Microelectronics Co Ltd (300782.SZ)	U (01/11/2021)	Rmb79.55
NAURA Technology Group Co Ltd (002371.SZ)	O (11/06/2023)	Rmb378.03
Powerchip Semiconductor Manufacturing Co (6770.TW)	E (06/13/2024)	NT$18.55
RichWave Technology Corp. (4968.TW)	O (07/05/2024)	NT$209.50
SG Micro Corp. (300661.SZ)	O (06/17/2024)	Rmb88.54
SICC Co Ltd (688234.SS)	O (09/18/2023)	Rmb56.61
Silicon Motion (SIMO.O)	O (05/06/2024)	$56.62
StarPower Semiconductor Ltd (603290.SS)	O (03/01/2022)	Rmb85.97
WIN Semiconductors Corp (3105.TWO)	O (06/28/2024)	NT$101.00
Tiffany Yeh		
FOCI Fiber Optic Communications Inc (3363.TWO)	O (01/15/2025)	NT$297.50

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INDUSTRY COVERAGE: China Industrials

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Chelsea Wang		
China Railway Group (601390.SS)	E (05/12/2022)	Rmb5.82
China Railway Group (0390.HK)	O (09/01/2017)	HK$3.74
China State Construction Engineering (601668.SS)	O (04/24/2023)	Rmb5.51
Han's Laser (002008.SZ)	E (10/25/2024)	Rmb25.95
Hefei Meyer Optoelectronic Technology (002690.SZ)	O (08/30/2024)	Rmb14.35
iRay Technology Company Limited (688301.SS)	E (01/16/2025)	Rmb100.10
Shanghai BOCHU Electronic Technology (688188.SS)	O (08/22/2024)	Rmb193.34
Shenzhen Envicool Technology Co Ltd (002837.SZ)	O (08/19/2024)	Rmb37.16
Sheng Zhong		
Centre Testing International Group (300012.SZ)	E (11/18/2024)	Rmb12.43
CRRC Corp Ltd (1766.HK)	O (07/03/2024)	HK$4.88
CRRC Corp Ltd (601766.SS)	E (06/30/2022)	Rmb7.33
DR Laser (300776.SZ)	E (12/17/2021)	Rmb60.25
Estun Automation Co Ltd (002747.SZ)	U (06/30/2022)	Rmb19.10
Haitian International Holdings Limited (1882.HK)	O (01/08/2025)	HK$21.20
Hongfa Technology Co Ltd (600885.SS)	O (05/23/2023)	Rmb34.11
Jiangsu Guomao Reducer Co Ltd (603915.SS)	U (01/08/2025)	Rmb13.63
Jiangsu Hengli Hydraulic Co.Ltd (601100.SS)	O (05/23/2023)	Rmb63.38
Jingsheng Mechanical & Electrical Co (300316.SZ)	U (01/08/2025)	Rmb30.54
Leader Harmonious Drive Systems (688017.SS)	U (05/23/2023)	Rmb163.12
LK Technology Holdings Ltd (0558.HK)	E (07/08/2024)	HK$2.63
Qingdao Gaoce Technology Co Ltd (688556.SS)	U (09/15/2023)	Rmb10.04
Sany Heavy Industry Co., Ltd. (600031.SS)	O (01/08/2025)	Rmb15.81
Shenzhen Inovance Technology (300124.SZ)	O (01/04/2022)	Rmb63.10
Shenzhen SC New Energy Technology Corp (300724.SZ)	E (07/03/2024)	Rmb61.44
Sinotruk (Hong Kong) Limited (3808.HK)	O (12/13/2022)	HK$22.30
Suzhou Maxwell Technologies Co Ltd (300751.SZ)	U (09/15/2023)	Rmb92.19

Times Electric (3898.HK)	O (08/30/2022)	HK$29.55
WeiChai Power (2338.HK)	O (01/05/2024)	HK$12.88
WeiChai Power (000338.SZ)	O (01/05/2024)	Rmb13.97
Wuxi Autowell Technology Co Ltd (688516.SS)	E (01/08/2025)	Rmb40.49
Wuxi Lead Intelligent (300450.SZ)	E (01/08/2025)	Rmb19.08
Zhejiang Dingli Machinery Co Ltd. (603338.SS)	O (08/28/2024)	Rmb67.46
Zhejiang Hangke Technology (688006.SS)	E (01/08/2025)	Rmb17.71
Zhejiang Shuanghuan Driveline Co. Ltd. (002472.SZ)	O (08/25/2023)	Rmb35.85
Zoomlion Heavy Industry (1157.HK)	E (01/05/2024)	HK$5.49
Zoomlion Heavy Industry (000157.SZ)	E (05/23/2023)	Rmb6.98

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INDUSTRY COVERAGE: Factory Automation

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Lisa Jiang		
CKD (6407.T)	E (10/22/2024)	¥2,491
Daifuku (6383.T)	E (05/06/2022)	¥3,074
Harmonic Drive Systems (6324.T)	E (05/06/2022)	¥4,470
Misumi Group (9962.T)	O (06/20/2023)	¥2,300
Nabtesco (6268.T)	E (10/27/2023)	¥2,661
Omron (6645.T)	U (01/07/2025)	¥4,948
THK (6481.T)	O (03/07/2024)	¥3,800
Yaskawa Electric (6506.T)	E (01/07/2025)	¥4,183
Yoshinao Ibara		
Fanuc (6954.T)	O (10/15/2021)	¥4,380
Keyence (6861.T)	E (01/14/2025)	¥62,360
SMC (6273.T)	U (01/14/2025)	¥56,370

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INDUSTRY COVERAGE: General Machinery

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Lisa Jiang		
Amada (6113.T)	O (02/28/2024)	¥1,562
DMG Mori (6141.T)	U (01/16/2025)	¥2,351
Hoshizaki (6465.T)	O (06/20/2022)	¥5,482
Isuzu Motors (7202.T)	E (11/30/2023)	¥2,030
Makita (6586.T)	E (04/04/2022)	¥4,491
NSK (6471.T)	E (08/20/2024)	¥637
Okuma (6103.T)	O (01/16/2025)	¥3,470
Tadano (6395.T)	E (06/06/2022)	¥1,108
Takeuchi Mfg. (6432.T)	E (07/19/2024)	¥5,340
Masatoshi Terashi		
Yamaha Motor (7272.T)	O (12/06/2022)	¥1,202
Yoshinao Ibara		
Daikin Industries (6367.T)	U (11/27/2020)	¥17,760
Hitachi Construction Machinery (6305.T)	O (02/28/2024)	¥3,729
Komatsu (6301.T)	O (12/01/2017)	¥4,568
Kubota (6326.T)	E (09/09/2024)	¥1,893
Shimano (7309.T)	E (05/29/2014)	¥20,705

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INDUSTRY COVERAGE: S. Korea Technology

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Ryan Kim		
Ecopro BM (247540.KQ)	U (03/20/2023)	W123,600
Fadu Inc (440110.KQ)	E (11/09/2023)	W14,110
Hanmi Semiconductor Co. Ltd. (042700.KS)	O (08/16/2024)	W109,000
Isu Petasys Co. Ltd. (007660.KS)	O (02/03/2025)	W37,800
L&F Co Ltd (066970.KS)	O (02/22/2024)	W83,100
Leeno Industrial Inc. (058470.KQ)	E (11/13/2024)	W203,000
Lotte Energy Materials Corp (020150.KS)	E (04/10/2024)	W21,250
POSCO FUTURE M (003670.KS)	O (09/01/2024)	W131,500
SK IE Technology (361610.KS)	E (02/02/2024)	W23,550
Wonik IPS Co Ltd (240810.KQ)	O (09/07/2020)	W21,600
Shawn Kim		
LG Display (034220.KS)	++	W9,140
LG Electronics (066570.KS)	O (01/04/2022)	W79,900
LG Innotek (011070.KS)	O (07/15/2024)	W147,100
Samsung Electro-Mechanics (009150.KS)	O (12/18/2024)	W131,000
Samsung Electronics (005935.KS)	O (11/18/2019)	W43,900
Samsung Electronics (005930.KS)	O (11/18/2019)	W52,900
Samsung SDI (006400.KS)	E (12/18/2024)	W212,500
Seoul Semiconductor (046890.KQ)	U (04/04/2018)	W7,210
SK hynix (000660.KS)	U (09/15/2024)	W198,800

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INDUSTRY COVERAGE: Technology - European Semiconductors

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Lee Simpson		
ASML Holding NV (ASML.AS)	E (09/20/2024)	€706.10
Infineon Technologies AG (IFXGn.DE)	E (10/20/2024)	€35.50
STMicroelectronics NV (STMPA.PA)	U (11/03/2024)	€21.20
Nigel van Putten		
Aixtron SE (AIXGn.DE)	E (05/25/2023)	€13.67
ASM International NV (ASMI.AS)	O (06/19/2024)	€549.80
BE Semiconductor Industries NV (BESI.AS)	O (11/07/2022)	€119.80
Melexis N.V. (MLXS.BR)	E (06/13/2023)	€54.10
Nordic Semiconductor ASA (NOD.OL)	U (09/05/2024)	NKr 136.10
Soitec SA (SOIT.PA)	E (05/27/2024)	€82.10
VAT Group AG (VACN.S)	U (09/20/2024)	SFr 340.70

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INDUSTRY COVERAGE: Greater China Technology Hardware

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Andy Meng, CFA		
AAC Technologies Holdings (2018.HK)	O (01/29/2024)	HK$44.15
Accelink Technologies Co. Ltd. (002281.SZ)	U (05/12/2022)	Rmb47.77
BYD Electronics (0285.HK)	O (04/28/2023)	HK$44.95
China TransInfo Technology Co Ltd (002373.SZ)	E (07/18/2023)	Rmb8.69
Dahua Technology Co. Ltd. (002236.SZ)	E (12/12/2024)	Rmb15.70
Eoptolink Technology Inc Ltd (300502.SZ)	E (05/16/2024)	Rmb102.51

Genius Electronic Optical Co. Ltd. (3406.TW)	O (05/16/2023)	NT$469.00
Gosuncn Technology Group Co Ltd (300098.SZ)	U (11/07/2022)	Rmb5.28
HIKVision Digital Technology (002415.SZ)	E (12/12/2024)	Rmb30.00
Largan Precision (3008.TW)	E (10/09/2024)	NT$2,810.00
LianChuang Electronic Technology Co Ltd (002036.SZ)	U (06/12/2024)	Rmb9.23
OFILM Group Co Ltd (002456.SZ)	U (06/12/2024)	Rmb12.07
Q Technology (Group) Company Ltd (1478.HK)	E (11/10/2023)	HK$7.90
Quectel Wireless Solutions Co Ltd (603236.SS)	E (10/09/2024)	Rmb85.95
Shenzhen Transsion Holdings Co Ltd (688036.SS)	O (10/24/2023)	Rmb107.51
Sunny Optical (2382.HK)	O (05/16/2023)	HK$72.35
Suzhou TFC Optical Communication Co Ltd. (300394.SZ)	E (10/09/2024)	Rmb83.79
Wingtech Technology Co Ltd (600745.SS)	E (11/10/2023)	Rmb34.32
Xiaomi Corp (1810.HK)	O (04/14/2021)	HK$39.65
Yangtze Optical Fibre and Cable JSC Ltd (601869.SS)	U (10/13/2021)	Rmb37.62
Yangtze Optical Fibre and Cable JSC Ltd (6869.HK)	E (04/20/2023)	HK$15.10
Yongxin Optics Co Ltd (603297.SS)	E (11/15/2022)	Rmb91.31
YuTong Optical Technology Co Ltd (300790.SZ)	E (04/05/2022)	Rmb20.71
Zhejiang Crystal-Optech Co Ltd (002273.SZ)	O (11/15/2022)	Rmb22.01
Zhongji Innolight Co Ltd (300308.SZ)	O (11/06/2023)	Rmb98.25
ZTE Corporation (0763.HK)	E (03/11/2024)	HK$29.40
ZTE Corporation (000063.SZ)	U (07/02/2021)	Rmb42.56
Derrick Yang		
Accton Technology Corporation (2345.TW)	O (06/06/2024)	NT$759.00
Advantech (2395.TW)	O (01/20/2021)	NT$412.50
AirTAC International (1590.TW)	E (08/04/2022)	NT$874.00
AU Optronics (2409.TW)	E (09/15/2024)	NT$13.95
BOE Technology (000725.SZ)	O (09/06/2019)	Rmb4.51
BOE Varitronix Ltd (0710.HK)	O (06/20/2023)	HK$7.68
Chroma Ate Inc. (2360.TW)	O (10/05/2021)	NT$329.50
E Ink Holdings Inc. (8069.TWO)	O (06/10/2024)	NT$286.50
Ennostar Inc (3714.TW)	U (09/23/2022)	NT$43.65
GIS Holding Limited (6456.TW)	E (05/06/2023)	NT$51.70
Hiwin Technologies Corp. (2049.TW)	E (08/11/2023)	NT$315.00
Innolux (3481.TW)	O (09/15/2024)	NT$13.60
King Slide Works Co. Ltd. (2059.TW)	O (11/08/2023)	NT$1,410.00
Lens Technology (300433.SZ)	E (07/22/2020)	Rmb25.69
Leyard Optoelectronic Co Ltd (300296.SZ)	E (11/03/2020)	Rmb6.15
Radiant Opto-Electronics Corporation (6176.TW)	E (03/01/2024)	NT$200.00
Sanan Optoelectronics (600703.SS)	U (08/21/2023)	Rmb11.74
TCL Corp. (000100.SZ)	++	Rmb5.06
Tianma Microelectronics (000050.SZ)	U (01/24/2018)	Rmb8.46
Wuhan Jingce Electronic Group Co Ltd (300567.SZ)	E (11/26/2021)	Rmb60.50
Howard Kao		
Acer Inc. (2353.TW)	E (05/01/2023)	NT$38.20
Asustek Computer Inc. (2357.TW)	O (05/22/2024)	NT$657.00
Compal Electronics (2324.TW)	E (05/01/2023)	NT$37.80
Giga-Byte Technology Co. Ltd. (2376.TW)	O (12/15/2022)	NT$251.50
Gold Circuit Electronics Ltd. (2368.TW)	O (10/06/2022)	NT$218.00
Guangdong Fenghua Adv. Tech. (Hldg) Co (000636.SZ)	E (05/12/2021)	Rmb14.46
Inspur Electronic Information (000977.SZ)	E (08/28/2023)	Rmb55.71
Kinsus Interconnect Tech. (3189.TW)	U (12/21/2022)	NT$95.10
Lenovo (0992.HK)	O (02/05/2025)	HK$10.94
Lotes Co. Ltd. (3533.TW)	O (10/06/2022)	NT$1,785.00
Nan Ya PCB (8046.TW)	U (12/21/2022)	NT$127.00
Pegatron Corporation (4938.TW)	E (03/07/2022)	NT$96.00

Quanta Computer Inc. (2382.TW)	O (05/01/2023)	NT$240.00
Shengyi Technology Co Ltd. (600183.SS)	E (05/26/2022)	Rmb26.84
Shennan Circuits Co Ltd (002916.SZ)	E (08/24/2023)	Rmb121.90
Unimicron (3037.TW)	U (02/22/2023)	NT$123.00
Wistron Corporation (3231.TW)	O (07/12/2023)	NT$102.00
Wiwynn Corp (6669.TW)	O (07/29/2024)	NT$2,095.00
Yageo Corp. (2327.TW)	++	NT$569.00
Zhen Ding (4958.TW)	E (08/02/2022)	NT$116.50
Sharon Shih		
Asia Vital Components Co. Ltd. (3017.TW)	O (07/30/2024)	NT$526.00
Auras Technology Co Ltd (3324.TWO)	E (05/04/2023)	NT$571.00
Catcher Technology (2474.TW)	E (05/22/2024)	NT$196.50
Delta Electronics Inc. (2308.TW)	O (07/13/2017)	NT$405.50
Foxconn Industrial Internet Co. Ltd. (601138.SS)	O (07/10/2019)	Rmb20.00
Foxconn Technology (2354.TW)	O (11/06/2024)	NT$72.40
GoerTek Inc (002241.SZ)	E (12/05/2022)	Rmb27.78
Guangzhou Shiyuan Electronic Tech Co Ltd (002841.SZ)	E (10/28/2021)	Rmb37.61
Hon Hai Precision (2317.TW)	O (03/15/2024)	NT$171.00
HTC Corporation (2498.TW)	E (12/06/2023)	NT$48.05
LandMark Optoelectronics Corporation (3081.TWO)	E (01/09/2025)	NT$453.00
Lingyi Itech Guangdong Co (002600.SZ)	E (08/28/2023)	Rmb8.88
Lite-On Technology (2301.TW)	E (01/15/2025)	NT$108.50
Luxshare Precision Industry Co., Ltd. (002475.SZ)	O (10/24/2016)	Rmb40.42
Sunonwealth Electric Machine Industry Co (2421.TW)	E (02/23/2024)	NT$93.00
Tong Hsing (6271.TW)	E (03/18/2019)	NT$124.50
Visual Photonics Epitaxy Co Ltd (2455.TW)	E (09/11/2023)	NT$155.00

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INDUSTRY COVERAGE: China Autos & Shared Mobility

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Cindy Huang		
EHang Holdings Ltd (EH.O)	O (05/06/2024)	$16.97
Joey Xu, CFA		
Anhui Jianghuai Automobile (600418.SS)	E (08/19/2023)	Rmb40.08
BAIC Motor (1958.HK)	U (03/12/2021)	HK$2.21
Brilliance China Automotive (1114.HK)	O (04/03/2024)	HK$3.88
Chongqing Changan Automobile (000625.SZ)	O (02/02/2024)	Rmb12.69
Chongqing Changan Automobile (200625.SZ)	O (11/18/2020)	HK$3.59
Dongfeng Motor Group (0489.HK)	E (05/12/2023)	HK$2.97
Guangzhou Automobile Group (601238.SS)	U (10/23/2019)	Rmb8.79
Guangzhou Automobile Group (2238.HK)	O (05/05/2020)	HK$3.09
Huayu Automotive (600741.SS)	O (09/08/2020)	Rmb16.43
Jiangsu Changshu Automotive Trim Group (603035.SS)	E (08/14/2023)	Rmb14.02
Ningbo Huaxiang Electronic Co., Ltd. (002048.SZ)	O (08/14/2023)	Rmb12.48
SAIC Motor Corp. Ltd. (600104.SS)	O (11/25/2021)	Rmb17.05
Zhengzhou Yutong Bus Co (600066.SS)	E (09/22/2023)	Rmb27.96
Shelley Wang, CFA		
Beijing Jingwei Hirain Technologies (688326.SS)	U (09/27/2024)	Rmb86.94
Bethel Automotive Safety Systems Co Ltd (603596.SS)	O (12/11/2023)	Rmb50.28
Changzhou Xingyu Automotive Lighting Sys (601799.SS)	O (09/27/2024)	Rmb130.85
China MeiDong Auto Holdings Ltd (1268.HK)	E (01/08/2024)	HK$2.35
China Yongda Automobiles Services (3669.HK)	E (08/13/2024)	HK$2.62
Foryou Corporation (002906.SZ)	O (03/06/2024)	Rmb30.71

Huizhou Desay SV Automotive Co Ltd (002920.SZ)	E (03/06/2024)	Rmb113.88
Keboda (603786.SS)	O (01/17/2024)	Rmb61.95
NavInfo Co Ltd (002405.SZ)	U (03/06/2024)	Rmb9.05
Ningbo Joyson Electronic Corp (600699.SS)	O (08/01/2023)	Rmb17.88
Ningbo Tuopu Group Co Ltd (601689.SS)	O (03/06/2024)	Rmb67.94
Ningbo Xusheng Group Co Ltd (603305.SS)	E (01/10/2023)	Rmb15.67
Suzhou Recodeal Interconnect System (688800.SS)	U (09/27/2024)	Rmb58.59
TUHU Car Inc (9690.HK)	O (07/29/2024)	HK$15.60
Wencan Group Co Ltd (603348.SS)	U (08/01/2023)	Rmb23.17
Zhejiang Sanhua Intelligent Controls (002050.SZ)	E (08/15/2022)	Rmb32.56
Zhongsheng Group Holdings (0881.HK)	O (10/12/2021)	HK$13.32
Tim Hsiao		
BAIC BluePark New Energy (600733.SS)	U (08/07/2024)	Rmb8.17
BYD Company Limited (002594.SZ)	E (02/08/2022)	Rmb282.80
BYD Company Limited (1211.HK)	E (02/08/2022)	HK$283.20
Fuyao Glass Industry Group (600660.SS)	E (12/01/2016)	Rmb59.35
Fuyao Glass Industry Group (3606.HK)	E (12/01/2016)	HK$52.95
Geely Automobile Holdings (0175.HK)	O (06/26/2024)	HK$15.46
Great Wall Motor Company Limited (601633.SS)	U (03/16/2022)	Rmb24.57
Great Wall Motor Company Limited (2333.HK)	E (01/08/2024)	HK$12.10
Hesai Group (HSAI.O)	E (01/13/2025)	$13.89
Horizon Robotics (9660.HK)	O (12/02/2024)	HK$4.78
Li Auto Inc. (LI.O)	O (08/24/2020)	$23.37
Li Auto Inc. (2015.HK)	O (11/16/2021)	HK$90.40
Minth Group Limited (0425.HK)	O (08/24/2015)	HK$14.92
Nexteer Automotive Group (1316.HK)	O (10/22/2020)	HK$3.60
NIO Inc. (9866.HK)	O (10/03/2022)	HK$33.15
NIO Inc. (NIO.N)	O (08/26/2020)	$4.20
WeRide Inc (WRD.O)	O (11/19/2024)	$13.80
XPeng Inc. (9868.HK)	O (11/16/2021)	HK$64.85
XPeng Inc. (XPEV.N)	O (01/29/2021)	$16.55
Zeekr Intelligent Technology Holding Ltd (ZK.N)	O (06/04/2024)	$25.14

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INDUSTRY COVERAGE: China Energy & Chemicals

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Albert Li		
Yantai Jereh Oilfield Services Group (002353.SZ)	O (03/17/2021)	Rmb38.92
Jack Lu		
Beijing Easpring Material Technology Co (300073.SZ)	E (01/03/2022)	Rmb37.05
Bluestar Adisseo Co (600299.SS)	O (06/29/2020)	Rmb11.45
China Oilfield Services Ltd. (2883.HK)	O (05/08/2023)	HK$6.92
China Oilfield Services Ltd. (601808.SS)	O (10/30/2023)	Rmb14.40
China Petroleum & Chemical Corp. (600028.SS)	E (08/19/2024)	Rmb6.02
China Petroleum & Chemical Corp. (0386.HK)	E (08/19/2024)	HK$4.29
CNOOC (0883.HK)	O (03/17/2021)	HK$18.56
Contemporary Amperex Technology Co. Ltd. (300750.SZ)	O (03/10/2024)	Rmb252.12
EVE Energy Co Ltd (300014.SZ)	E (05/31/2022)	Rmb42.38
Gotion High Tech Co Ltd (002074.SZ)	E (04/17/2023)	Rmb20.91
Guangzhou Tinci Materials Technology Co (002709.SZ)	E (06/18/2024)	Rmb18.22
Hengli Petrochemical Co Ltd (600346.SS)	++	Rmb14.99
Ningbo Ronbay New Energy Technology (688005.SS)	E (06/07/2023)	Rmb31.88
PetroChina (601857.SS)	O (08/19/2024)	Rmb8.15

PetroChina (0857.HK)	O (03/17/2021)	HK$6.01
REPT Battero Energy Co (0666.HK)	U (01/24/2024)	HK$11.00
Rongsheng Petrochemical Co Ltd (002493.SZ)	U (08/19/2024)	Rmb8.88
Shanghai Putailai New Energy Tech Co Ltd (603659.SS)	E (08/06/2021)	Rmb14.66
Shenzhen Dynanonic Co Ltd (300769.SZ)	E (06/07/2023)	Rmb32.51
Shenzhen Senior Technology Material Co (300568.SZ)	O (11/29/2023)	Rmb9.83
Yunnan Energy New Material Co Ltd (002812.SZ)	E (06/07/2023)	Rmb29.16
Kaylee Xu		
Beijing SinoHytec Co Ltd (688339.SS)	O (08/17/2023)	Rmb21.81
Jiangsu Cnano Technology Co Ltd (688116.SS)	E (06/07/2023)	Rmb40.28
Shandong Sinocera Functional Material (300285.SZ)	O (07/25/2024)	Rmb17.26
Shenzhen Capchem Technology Co Ltd (300037.SZ)	E (06/07/2023)	Rmb32.92
Sunresin New Materials Co Ltd (300487.SZ)	E (10/25/2024)	Rmb48.23
Wanhua Chemical (600309.SS)	E (11/25/2024)	Rmb67.73

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INDUSTRY COVERAGE: Electronic Components

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Shoji Sato		
ALPS ALPINE (6770.T)	U (10/11/2024)	¥1,614
Hamamatsu Photonics (6965.T)	E (09/20/2024)	¥1,872
Hirose Electric (6806.T)	O (07/10/2024)	¥18,130
Ibiden (4062.T)	E (01/22/2025)	¥3,800
IRISO Electronics (6908.T)	E (08/02/2022)	¥2,981
Japan Aviation Electronics Industry (6807.T)	E (01/17/2024)	¥2,812
Kyocera (6971.T)	E (06/25/2020)	¥1,633
Mabuchi Motor (6592.T)	E (11/03/2022)	¥2,065
Minebea Mitsumi (6479.T)	E (04/10/2024)	¥2,447
Murata Manufacturing (6981.T)	O (04/11/2022)	¥2,451
Nichicon (6996.T)	E (11/10/2021)	¥1,020
Nidec (6594.T)	E (01/24/2023)	¥2,560
Nippon Chemi-Con (6997.T)	U (09/20/2024)	¥991
Niterra (5334.T)	O (01/17/2024)	¥4,734
Shinko Electric Industries (6967.T)	++	¥5,840
Taiyo Yuden (6976.T)	E (10/19/2023)	¥2,159
TDK (6762.T)	O (08/02/2022)	¥1,669
Sota Harashima		
CMK (6958.T)	O (03/07/2024)	¥453
Daishinku (6962.T)	E (03/07/2024)	¥597
KOA (6999.T)	E (05/08/2024)	¥924
Meiko Electronics (6787.T)	O (10/18/2024)	¥8,410
Nihon Dempa Kogyo (6779.T)	E (03/07/2024)	¥838

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INDUSTRY COVERAGE: S. Korea Telecoms, Media & Internet

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Seyon Park		
Coupang Inc (CPNG.N)	O (06/29/2022)	$24.01
DoubleU Games Co Ltd (192080.KS)	O (05/10/2024)	W49,000
JYP Entertainment (035900.KQ)	E (07/15/2024)	W79,300
Kakao Corp (035720.KS)	E (10/01/2021)	W43,200

Krafton Inc (259960.KS)	O (02/13/2024)	W376,000
KT Corp (030200.KS)	O (09/12/2023)	W46,450
LG Uplus Corp (032640.KS)	U (06/19/2024)	W10,190
Naver Corp (035420.KS)	E (04/19/2024)	W229,000
NCSOFT Corp (036570.KS)	O (10/25/2024)	W173,500
Netmarble Games Corp (251270.KS)	U (12/11/2018)	W45,000
Pearl Abyss Corp (263750.KQ)	E (09/13/2024)	W29,400
SK Telecom Co Ltd (017670.KS)	O (08/27/2019)	W55,800
SM Entertainment (041510.KQ)	E (01/07/2025)	W87,900
YG Entertainment (122870.KQ)	E (01/07/2025)	W51,700

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INDUSTRY COVERAGE: Internet

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Brian Nowak, CFA		
Airbnb Inc (ABNB.O)	U (12/06/2022)	$129.60
Alphabet Inc. (GOOGL.O)	O (08/11/2015)	$191.33
Amazon.com Inc (AMZN.O)	O (04/24/2015)	$236.17
Booking Holdings Inc (BKNG.O)	E (01/09/2019)	$4,699.39
DoorDash Inc (DASH.O)	O (02/21/2024)	$195.99
Expedia Inc. (EXPE.O)	E (01/09/2019)	$169.73
Instacart (CART.O)	E (01/29/2024)	$48.49
Lyft Inc (LYFT.O)	E (10/24/2019)	$13.42
Meta Platforms Inc (META.O)	O (03/20/2023)	$704.87
Nextdoor Holdings Inc (KIND.N)	E (02/24/2022)	$2.75
Pinterest Inc (PINS.N)	E (03/28/2022)	$33.30
Reddit Inc (RDDT.N)	O (12/08/2024)	$221.16
Snap Inc. (SNAP.N)	E (07/22/2024)	$10.63
Uber Technologies Inc (UBER.N)	O (06/04/2019)	$64.48
Matthew Cost		
AppLovin Corp (APP.O)	E (11/27/2022)	$368.27
Compass, Inc. (COMP.N)	E (07/20/2022)	$7.51
Criteo SA (CRTO.O)	E (01/26/2016)	$45.17
DoubleVerify Holdings Inc (DV.N)	E (06/25/2024)	$22.06
Electronic Arts Inc (EA.O)	E (08/04/2021)	$130.47
Innovid Corp (CTV.N)	E (01/17/2023)	$3.15
Integral Ad Science Holding Corp. (IAS.O)	E (04/16/2024)	$10.67
Opendoor Technologies Inc (OPEN.O)	E (07/24/2023)	$1.38
Playtika Holding Corp (PLTK.O)	E (11/27/2022)	$7.30
Roblox Corporation (RBLX.N)	O (11/04/2024)	$75.47
Shutterstock Inc (SSTK.N)	E (07/28/2022)	$30.05
Take-Two Interactive Software (TTWO.O)	O (02/01/2018)	$184.92
Trade Desk Inc (TTD.O)	O (06/01/2023)	$114.34
Unity Software Inc (U.N)	O (09/02/2024)	$21.11
Webtoon Entertainment Inc (WBTN.O)	E (07/22/2024)	$13.46
Yelp Inc (YELP.N)	U (01/10/2019)	$39.82
Zillow Group Inc (Z.O)	E (04/18/2018)	$85.90
Nathan Feather		
Bumble Inc. (BMBL.O)	E (03/08/2021)	$8.32
Chewy Inc (CHWY.N)	O (10/31/2023)	$38.51
eBay Inc (EBAY.O)	O (04/18/2024)	$67.39
Etsy Inc (ETSY.O)	U (04/18/2024)	$55.26
FIGS, Inc. (FIGS.N)	E (02/29/2024)	$5.53

Match Group Inc (MTCH.O)	E (04/18/2024)	$33.58
Peloton Interactive, Inc. (PTON.O)	E (03/14/2022)	$7.58
Revolve Group Inc (RVLV.N)	E (10/20/2024)	$30.71
WW International Inc (WW.O)	E (07/26/2024)	$0.90

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INDUSTRY COVERAGE: Internet & Media

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Luyuan Yang, CFA		
Appier Group (4180.T)	E (10/23/2024)	¥1,549
RAKUS (3923.T)	O (10/23/2024)	¥1,954
Sansan (4443.T)	E (10/23/2024)	¥2,449
Masato Araki		
BASE (4477.T)	E (07/10/2024)	¥358
CyberAgent (4751.T)	E (01/12/2024)	¥1,156
dely (299A.T)	O (01/08/2025)	¥1,345
Digital Garage (4819.T)	E (01/12/2024)	¥4,000
freee (4478.T)	E (09/25/2024)	¥3,335
Macromill (3978.T)	++	¥1,267
Plaid (4165.T)	U (07/10/2024)	¥836
Plus Alpha Consulting (4071.T)	O (01/12/2024)	¥1,778
Septeni Holdings (4293.T)	E (07/10/2024)	¥396
ValueCommerce (2491.T)	O (04/12/2024)	¥706
Tetsuro Tsusaka, CFA		
Askul (2678.T)	U (12/06/2024)	¥1,680
Dentsu (4324.T)	U (08/15/2023)	¥3,465
Hakuhodo DY Holdings (2433.T)	E (07/23/2018)	¥1,141
Kakaku.com (2371.T)	O (03/15/2024)	¥2,490
LY Corporation (4689.T)	O (09/11/2024)	¥474
Mercari (4385.T)	E (03/28/2022)	¥1,871
MonotaRO (3064.T)	E (12/06/2024)	¥2,993
Rakuten Group (4755.T)	O (03/15/2024)	¥965
Recruit Holdings (6098.T)	O (11/16/2014)	¥10,865
Shift (3697.T)	E (11/29/2022)	¥1,455
Softbank Group (9984.T)	E (04/25/2023)	¥9,671
ZOZO (3092.T)	U (12/06/2024)	¥5,013

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INDUSTRY COVERAGE: Multi-Industry

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Christopher Snyder, CFA		
3M Co. (MMM.N)	U (09/06/2024)	$152.45
Acuity Brands Inc. (AYI.N)	O (01/14/2025)	$324.11
Allegion Public Limited Company (ALLE.N)	E (01/06/2025)	$129.07
Carrier Global Corp. (CARR.N)	E (09/06/2024)	$64.56
Eaton Corporation PLC (ETN.N)	O (09/06/2024)	$315.25
Emerson Electric Co (EMR.N)	U (09/06/2024)	$124.76
Fastenal Co. (FAST.O)	E (09/06/2024)	$73.54
Fortive Corp (FTV.N)	O (09/06/2024)	$79.49
Gates Industrial Corporation PLC (GTES.N)	E (09/06/2024)	$20.77
Honeywell International Inc (HON.O)	E (09/06/2024)	$222.35

Hubbell Inc. (HUBB.N)	E (09/06/2024)	$400.07
Ingersoll Rand INC (IR.N)	E (09/06/2024)	$92.46
Johnson Controls International Plc (JCI.N)	O (09/06/2024)	$86.01
Lennox International Inc (LII.N)	U (01/06/2025)	$585.03
Otis Worldwide Corp (OTIS.N)	E (09/06/2024)	$94.55
Rockwell Automation (ROK.N)	O (09/06/2024)	$270.56
Stanley Black & Decker Inc (SWK.N)	E (09/06/2024)	$85.62
Trane Technologies PLC (TT.N)	O (09/06/2024)	$357.82
Vertiv Holdings Co. (VRT.N)	O (01/06/2025)	$119.04
W.W. Grainger Inc. (GWW.N)	E (09/06/2024)	$1,042.92

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INDUSTRY COVERAGE: Aerospace

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Kristine T Liwag		
AerCap Holdings NV (AER.N)	E (06/07/2024)	$96.55
Boeing Co. (BA.N)	E (01/10/2023)	$181.84
CAE Inc. (CAE.TO)	E (08/16/2024)	C$33.93
Curtiss-Wright Corp. (CW.N)	O (08/06/2023)	$350.93
FTAI Aviation Ltd (FTAI.O)	O (01/11/2024)	$116.95
Heico Corp (HEI.N)	E (06/04/2024)	$236.45
Hexcel Corp (HXL.N)	U (02/22/2024)	$64.18
Howmet (HWM.N)	O (12/03/2021)	$127.80
Joby Aviation Inc (JOBY.N)	O (09/23/2021)	$8.05
Loar Holdings Inc (LOAR.N)	E (05/20/2024)	$76.62
Moog Inc. (MOGa.N)	E (11/22/2023)	$193.33
RBC Bearings Inc. (RBC.N)	O (12/03/2021)	$369.50
Rocket Lab USA Inc (RKLB.O)	E (07/15/2024)	$28.60
RTX Corp (RTX.N)	E (07/26/2023)	$129.16
Spirit AeroSystems Holdings Inc (SPR.N)	++	$35.01
StandardAero Inc. (SARO.N)	E (10/28/2024)	$27.17
Teledyne Technologies Inc. (TDY.N)	E (12/12/2022)	$515.48
TransDigm Group Inc. (TDG.N)	O (09/10/2021)	$1,291.51
Virgin Galactic Holdings Inc (SPCE.N)	U (11/22/2023)	$4.56

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INDUSTRY COVERAGE: Capital Goods

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Arthur Sitbon, CFA		
ITM Power (ITM.L)	E (10/29/2024)	35p
Luke Holbrook		
AutoStore Holdings Ltd-W/I (AUTO.OL)	U (11/03/2023)	NKr 9.90
Max R Yates		
ABB (ABBN.S)	E (12/09/2024)	SFr 49.03
Alfa Laval AB (ALFA.ST)	U (11/11/2024)	SKr 473.60
Alstom (ALSO.PA)	E (12/07/2022)	€19.21
Assa Abloy AB (ASSAb.ST)	E (03/16/2020)	SKr 329.50
GEA Group AG (G1AG.DE)	O (09/26/2024)	€51.50
Halma PLC (HLMA.L)	E (11/22/2018)	2,940p
KION Group AG (KGX.DE)	E (03/10/2023)	€34.08
Knorr Bremse AG (KBX.DE)	E (07/07/2021)	€76.00

Kone Oyj (KNEBV.HE)	U (12/09/2024)	€49.43
Legrand (LEGD.PA)	O (03/28/2024)	€94.46
Prysmian SpA (PRY.MI)	E (11/05/2024)	€62.78
Rexel S.A. (RXL.PA)	O (12/09/2024)	€24.87
Rotork PLC (ROR.L)	O (06/18/2021)	337p
Schindler Holding AG (SCHP.S)	E (10/02/2023)	SFr 259.00
Schneider Electric (SCHN.PA)	E (05/29/2024)	€232.40
Siemens (SIEGn.DE)	O (11/28/2023)	€201.25
Siemens Energy AG (ENR1n.DE)	O (04/03/2023)	€55.50
Signify NV (LIGHT.AS)	E (12/09/2024)	€20.80
Spirax Group PLC (SPX.L)	O (12/09/2024)	7,765p
Vestas Wind Systems A/S (VWS.CO)	E (05/05/2020)	DKr 109.50
Wartsila Oyj Abp (WRT1V.HE)	E (11/11/2024)	€19.29
Michael L Harleaux		
Atlas Copco (ATCOa.ST)	E (12/09/2024)	SKr 184.80
Epiroc AB (EPIRa.ST)	U (12/09/2024)	SKr 207.00
Metso Corporation (METSO.HE)	E (12/07/2022)	€9.24
Sandvik (SAND.ST)	E (12/12/2023)	SKr 223.60
SKF (SKFb.ST)	++	SKr 214.10
Weir Group PLC (WEIR.L)	O (12/09/2024)	2,358p

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INDUSTRY COVERAGE: S. Korea Autos & Shared Mobility

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Young Suk Shin		
Hankook Tire & Technology Co Ltd (161390.KS)	E (11/01/2023)	W37,750
Hanon Systems (018880.KS)	U (01/14/2022)	W4,245
Hyundai MOBIS (012330.KS)	O (01/24/2025)	W251,500
Hyundai Motor (005380.KS)	O (11/27/2024)	W204,500
Kia Corp. (000270.KS)	O (04/26/2022)	W98,100
LG Energy Solution (373220.KS)	O (09/01/2024)	W345,000
Mando (204320.KS)	E (02/05/2024)	W42,300
SNT Motiv Co. Ltd. (064960.KS)	E (07/05/2024)	W25,650

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INDUSTRY COVERAGE: Autos & Shared Mobility

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Hiroto Segawa		
Mazda Motor (7261.T)	E (04/25/2023)	¥1,044
Mitsubishi Motors (7211.T)	E (09/26/2024)	¥367
SUBARU (7270.T)	U (10/25/2022)	¥2,631
Suzuki Motor (7269.T)	O (12/09/2024)	¥1,938
Shinji Kakiuchi		
Honda Motor (7267.T)	O (09/07/2023)	¥1,500
Nissan Motor (7201.T)	E (01/23/2023)	¥387
Toyota Motor (7203.T)	E (07/11/2023)	¥2,963

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INDUSTRY COVERAGE: Autos & Shared Mobility

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Javier Martinez de Olcoz Cerdan		
Autoliv (ALV.N)	E (09/24/2021)	$94.45
BMW (BMWG.DE)	O (11/12/2024)	€76.32
Forvia (FRVIA.PA)	E (03/19/2024)	€9.76
Mercedes-Benz Group AG (MBGn.DE)	O (05/20/2024)	€56.65
Opmobility SE (OPM.PA)	O (09/26/2024)	€10.37
Porsche AG (P911_p.DE)	U (05/20/2024)	€59.30
Renault (RENA.PA)	O (05/04/2023)	€47.77
Stellantis (STLAM.MI)	O (02/04/2021)	€12.55
Stellantis (STLA.N)	O (03/10/2021)	$12.93
Valeo SE (VLOF.PA)	U (03/19/2024)	€10.30
Volkswagen (VOWG_p.DE)	U (05/20/2024)	€93.38
Shaqeal A Kirunda		
Aramis Autos (ARAMI.PA)	E (08/04/2023)	€7.76
AUTO1 Group SE (AG1G.DE)	E (03/26/2024)	€17.95
Continental AG (CONG.DE)	O (03/19/2024)	€65.42
Daimler Truck Holding AG (DTGGe.DE)	O (01/28/2022)	€40.21
Iveco Group NV (IVG.MI)	E (01/05/2023)	€11.39
Michelin (MICP.PA)	O (10/03/2018)	€32.58
Pirelli & C SpA (PIRC.MI)	O (02/03/2023)	€5.54
Traton SE (8TRA.DE)	E (09/29/2022)	€29.60
Volvo (VOLVb.ST)	O (01/09/2025)	SKr 305.20

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INDUSTRY COVERAGE: Software

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Chris Quintero		
BILL Holdings Inc (BILL.N)	O (01/16/2025)	$97.03
Blackline Inc (BL.O)	O (09/29/2024)	$65.64
E2open Parent Holdings Inc (ETWO.N)	E (01/17/2024)	$2.92
OneStream Inc (OS.O)	O (01/16/2025)	$29.86
Vertex Inc. (VERX.O)	O (01/17/2024)	$58.16
Elizabeth Porter, CFA		
Amplitude Inc. (AMPL.O)	E (01/13/2025)	$12.30
Autodesk (ADSK.O)	O (08/23/2024)	$311.36
Freshworks Inc (FRSH.O)	E (10/18/2021)	$18.50
GoDaddy Inc (GDDY.N)	E (07/19/2021)	$209.87
HubSpot, Inc. (HUBS.N)	O (03/21/2023)	$779.71
Klaviyo, Inc (KVYO.N)	E (10/16/2023)	$48.61
LegalZoom.com Inc (LZ.O)	U (07/28/2022)	$9.16
Liveramp Holdings Inc (RAMP.N)	E (01/13/2025)	$34.51
Matterport Inc (MTTR.O)	E (04/19/2022)	$5.30
Semrush Holdings Inc -A (SEMR.N)	O (01/13/2025)	$17.42
Sprinklr Inc (CXM.N)	E (07/19/2021)	$8.93
Sprout Social Inc (SPT.O)	E (11/17/2020)	$33.37
Wix.Com Ltd (WIX.O)	O (01/13/2025)	$224.85
Zeta Global Holdings Corp (ZETA.N)	E (08/01/2024)	$18.78
ZoomInfo Technologies Inc (ZI.O)	E (02/01/2024)	$10.46
Hamza Fodderwala		
Check Point Software Technologies Ltd. (CHKP.O)	E (10/16/2023)	$216.99
Cloudflare Inc (NET.N)	O (12/02/2024)	$144.29

CrowdStrike Holdings Inc (CRWD.O)	O (01/09/2024)	$417.22
CyberArk Software Ltd (CYBR.O)	E (01/09/2024)	$380.34
Fortinet Inc. (FTNT.O)	O (10/07/2022)	$105.07
Gen Digital Inc. (GEN.O)	E (06/07/2024)	$27.51
Jamf Holding Corp (JAMF.O)	E (10/13/2024)	$15.45
Okta, Inc. (OKTA.O)	O (12/02/2024)	$97.45
Palo Alto Networks Inc (PANW.O)	O (10/10/2017)	$186.85
Qualys Inc (QLYS.O)	U (02/09/2021)	$145.97
Rapid7 Inc (RPD.O)	E (08/11/2015)	$39.28
Secureworks Corp (SCWX.O)	++	$8.51
SentinelOne, Inc. (S.N)	E (12/02/2024)	$24.10
Tenable Holdings Inc (TENB.O)	E (12/02/2024)	$43.21
Varonis Systems, Inc. (VRNS.O)	O (10/16/2023)	$43.37
Zscaler Inc (ZS.O)	E (01/12/2023)	$204.99
Josh Baer, CFA		
Asana Inc (ASAN.N)	E (10/26/2020)	$22.15
BigCommerce Holdings, Inc. (BIGC.O)	E (05/11/2021)	$6.48
Box Inc (BOX.N)	E (05/21/2024)	$34.22
CCC Intelligent Solutions Holdings Inc (CCCS.O)	O (11/13/2024)	$11.07
Chegg Inc (CHGG.N)	U (01/14/2025)	$1.49
Coursera, Inc. (COUR.N)	O (04/26/2021)	$7.68
DigitalOcean Holdings Inc (DOCN.N)	O (01/16/2025)	$42.95
Docebo Inc. (DCBO.O)	O (08/17/2023)	$42.34
DocuSign Inc (DOCU.O)	E (01/16/2024)	$96.89
Lightspeed POS Inc. (LSPD.N)	E (02/18/2021)	$14.50
Sabre Corp (SABR.O)	E (03/16/2021)	$3.41
ServiceTitan Inc (TTAN.O)	E (01/06/2025)	$103.63
Toast, Inc. (TOST.N)	O (12/16/2021)	$41.32
Udemy Inc (UDMY.O)	U (09/27/2024)	$7.55
Keith Weiss, CFA		
Adobe Inc. (ADBE.O)	O (07/31/2023)	$437.63
Akamai Technologies, Inc. (AKAM.O)	E (04/29/2020)	$100.89
Atlassian Corporation PLC (TEAM.O)	O (01/13/2020)	$320.80
Intuit (INTU.O)	E (08/13/2024)	$588.26
Microsoft (MSFT.O)	O (01/13/2016)	$413.29
Oracle Corporation (ORCL.N)	E (01/15/2019)	$171.66
Salesforce, Inc. (CRM.N)	O (12/21/2023)	$347.93
Samsara Inc (IOT.N)	E (03/23/2023)	$54.00
ServiceNow Inc (NOW.N)	E (10/21/2024)	$1,027.06
Shopify Inc (SHOP.N)	O (04/19/2024)	$121.73
Snowflake Inc. (SNOW.N)	E (02/29/2024)	$188.93
Workday Inc (WDAY.O)	O (04/14/2020)	$276.17
Meta A Marshall		
8x8 Inc (EGHT.O)	U (06/14/2024)	$2.69
Five9 Inc (FIVN.O)	E (10/10/2022)	$42.82
NICE Ltd. (NICE.O)	O (10/16/2023)	$173.15
RingCentral Inc (RNG.N)	E (08/08/2023)	$34.97
Twilio Inc (TWLO.N)	E (06/14/2024)	$147.11
Zoom Video Communications Inc (ZM.O)	E (10/11/2022)	$85.99
Roy D Campbell		
Karooooo Ltd (KARO.O)	O (04/27/2021)	$46.64
Sanjit K Singh		
Appian Corp (APPN.O)	E (12/03/2021)	$35.36
C3.ai (AI.N)	U (01/04/2021)	$34.19

Confluent, Inc. (CFLT.O)	E (01/16/2025)	$29.37
Couchbase, Inc. (BASE.O)	E (08/16/2021)	$18.84
Datadog, Inc. (DDOG.O)	E (01/16/2025)	$144.85
Domo Inc (DOMO.O)	E (01/20/2023)	$8.73
Dynatrace Inc (DT.N)	E (02/13/2024)	$60.43
Elastic NV (ESTC.N)	O (12/16/2024)	$114.73
Fastly Inc. (FSLY.N)	E (04/20/2023)	$10.23
GitLab Inc (GTLB.O)	O (10/09/2024)	$73.14
HashiCorp (HCP.O)	E (04/29/2024)	$34.12
JFrog Ltd. (FROG.O)	O (12/21/2023)	$36.31
MongoDB Inc (MDB.O)	O (04/12/2023)	$282.03
PagerDuty, Inc. (PD.N)	E (01/24/2024)	$19.19
Palantir Technologies Inc. (PLTR.O)	E (02/04/2025)	$101.36
Solarwinds Corp (SWI.N)	E (11/13/2018)	$15.18
UiPath Inc (PATH.N)	E (09/07/2022)	$14.88

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INDUSTRY COVERAGE: Technology - Software & Services

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Adam Wood		
Amadeus IT Holdings S.A. (AMA.MC)	O (12/16/2015)	€72.00
Atos SA (ATOS.PA)	U (12/08/2021)	€0.00
Capgemini (CAPP.PA)	E (12/12/2022)	€178.50
Computacenter PLC (CCC.L)	E (03/09/2021)	2,248p
Dassault Systemes SA (DAST.PA)	O (09/26/2019)	€41.03
Exclusive Networks (EXN.PA)	++	€18.94
Hexagon AB (HEXAb.ST)	U (03/20/2020)	SKr 126.50
Indra (IDR.MC)	E (03/25/2022)	€16.60
Sage (SGE.L)	O (12/08/2021)	1,329p
SAP SE (SAPG.DE)	O (03/20/2020)	€270.80
Softcat PLC (SCTS.L)	E (12/08/2021)	1,578p
Softwareone Holding AG (SWON.S)	E (03/04/2022)	SFr 6.03
Temenos Group AG (TEMN.S)	U (12/15/2017)	SFr 77.75
Trustpilot (TRST.L)	E (01/14/2025)	355p
George W Webb		
IONOS Group SE (IOSn.DE)	O (08/15/2024)	€24.00
Nemetschek SE (NEKG.DE)	E (07/13/2022)	€119.30
Netcompany Group A/S (NETCG.CO)	E (01/26/2023)	DKr 278.00
OVH GROUPE SAS (OVH.PA)	E (10/25/2023)	€8.03
TeamViewer SE (TMV.DE)	E (05/08/2024)	€11.62
Laura C Metayer		
CompuGroup Medical SE & Co KgaA (COP1n.DE)	E (01/14/2025)	€22.82
Sinch AB (SINCH.ST)	E (01/14/2025)	SKr 24.14
Sopra Steria Group (SOPR.PA)	E (07/28/2023)	€176.30
Mark Hyatt		
Fortnox AB (FNOX.ST)	U (10/06/2023)	SKr 78.06
Tietoevry Oyj (TIETO.HE)	O (05/15/2024)	€18.42

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INDUSTRY COVERAGE: Machinery & Construction

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)

Angel Castillo		
AGCO Corp (AGCO.N)	E (12/03/2024)	$103.31
Allison Transmission Holdings Inc (ALSN.N)	E (01/08/2024)	$114.38
Caterpillar Inc (CAT.N)	U (10/14/2024)	$358.85
CNH Industrial NV (CNH.N)	O (12/17/2024)	$12.57
Cummins Inc (CMI.N)	O (01/08/2024)	$369.91
Deere & Co. (DE.N)	O (01/08/2024)	$467.68
Donaldson Company Inc. (DCI.N)	U (01/08/2024)	$70.15
Kennametal Inc. (KMT.N)	E (01/08/2024)	$22.67
Lincoln Electric Holdings Inc (LECO.O)	U (01/08/2024)	$192.11
Martin Marietta Materials Inc (MLM.N)	O (01/08/2024)	$539.96
Oshkosh Corp (OSK.N)	E (01/08/2024)	$110.68
PACCAR Inc (PCAR.O)	O (01/08/2024)	$106.99
REV Group Inc. (REVG.N)	E (06/11/2024)	$34.37
Summit Materials Inc (SUM.N)		$52.33
Terex Corp. (TEX.N)	U (01/08/2024)	$47.99
Timken Co (TKR.N)	O (12/17/2024)	$81.64
United Rentals Inc. (URI.N)	E (01/08/2024)	$738.18
Vulcan Materials Company (VMC.N)	E (01/08/2024)	$274.33
Westinghouse Air Brake Technologies Corp (WAB.N)	O (01/08/2024)	$207.24
WillScot Holdings Corporation (WSC.O)	O (12/17/2024)	$35.88

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INDUSTRY COVERAGE: Metals & Mining

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Carlos De Alba		
Alcoa Corp (AA.N)	O (06/20/2024)	$36.03
Freeport-McMoRan Inc (FCX.N)	O (06/20/2024)	$36.68
Ivanhoe Mines Ltd (IVN.TO)	O (09/18/2024)	C$15.97
MP Materials Corp (MP.N)	E (03/13/2024)	$23.56
Teck Resources Limited (TECK.N)	O (09/15/2022)	$42.50
Ioannis Masvoulas, CFA		
First Quantum Minerals Ltd (FM.TO)	E (07/08/2024)	C$19.19

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INDUSTRY COVERAGE: IT Hardware

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Erik W Woodring		
Apple, Inc. (AAPL.O)	O (05/26/2009)	$232.47
CDW Corporation (CDW.O)	E (12/12/2023)	$206.13
Cricut Inc (CRCT.O)	U (08/12/2021)	$5.71
Dell Technologies Inc. (DELL.N)	O (05/01/2023)	$104.45
Garmin Ltd (GRMN.N)	U (10/07/2024)	$218.85
GoPro Inc (GPRO.O)	U (12/12/2023)	$1.09
HP Inc. (HPQ.N)	E (08/19/2024)	$32.57
IBM (IBM.N)	E (01/18/2023)	$263.30
Ingram Micro (INGM.N)	O (01/16/2025)	$24.67
Kornit Digital Ltd. (KRNT.O)	O (08/10/2023)	$29.53
Logitech International SA (LOGI.O)	E (01/23/2025)	$100.57
NCR Voyix Corp. (VYX.N)	E (09/19/2022)	$12.96
Resideo Technologies Inc (REZI.N)	E (03/16/2021)	$21.85

Seagate Technology (STX.O)	O (03/26/2024)	$95.43
SmartRent, Inc. (SMRT.N)	++	$1.44
Sonos Inc. (SONO.O)	U (09/26/2024)	$14.26
Teradata (TDC.N)	E (02/13/2024)	$31.65
Xerox Corp (XRX.O)	++	$8.40
Meta A Marshall		
Hewlett Packard Enterprise (HPE.N)	O (12/05/2024)	$21.36
NetApp Inc (NTAP.O)	E (07/26/2023)	$123.72
Nutanix Inc (NTNX.O)	O (10/28/2024)	$71.59
Pure Storage Inc (PSTG.N)	E (06/11/2024)	$69.96

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INDUSTRY COVERAGE: China/Hong Kong Consumer

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Carol Xia		
Angel Yeast Co. Ltd. (600298.SS)	E (03/01/2024)	Rmb34.10
Bosideng International Holdings Limited (3998.HK)	O (11/27/2024)	HK$3.74
Chacha Food Co Ltd (002557.SZ)	O (07/19/2024)	Rmb26.80
Foshan Haitian Flavouring and Food (603288.SS)	++	Rmb40.51
Jonjee Hi-Tech (600872.SS)	U (12/18/2024)	Rmb20.78
Weilong Delicious Global Holdings Ltd (9985.HK)	O (07/19/2024)	HK$7.32
Yihai International Holding Ltd (1579.HK)	E (03/01/2024)	HK$13.74
Dustin Wei		
ANTA Sports Products (2020.HK)	O (04/12/2019)	HK$82.25
C&S Paper Co Ltd (002511.SZ)	U (09/22/2021)	Rmb6.54
Giant Biogene Holding Co Ltd (2367.HK)	O (08/08/2024)	HK$58.00
Health and Happiness (H&H) (1112.HK)	E (07/12/2021)	HK$8.25
Hengan International Group (1044.HK)	E (05/06/2021)	HK$20.80
Li Ning (2331.HK)	O (10/09/2019)	HK$16.20
Pop Mart International Group (9992.HK)	O (05/17/2021)	HK$101.30
Proya Cosmetics Co. Ltd. (603605.SS)	O (10/12/2021)	Rmb81.76
Samsonite International (1910.HK)	O (06/15/2020)	HK$22.90
Shanghai Jahwa United Co. Ltd. (600315.SS)	U (07/07/2023)	Rmb15.60
Sun Art Retail Group Limited (6808.HK)	E (03/05/2019)	HK$1.77
Topsports International Holdings Ltd (6110.HK)	O (11/13/2019)	HK$2.94
Yonghui Superstores (601933.SS)	U (05/18/2023)	Rmb5.20
Zhou Hei Ya International Holdings (1458.HK)	E (08/02/2022)	HK$1.74
Hildy Ling		
Beijing Roborock Technology Co Ltd (688169.SS)	O (09/25/2024)	Rmb223.55
China Tourism Group Duty Free (1880.HK)	E (12/13/2023)	HK$46.50
China Tourism Group Duty Free (601888.SS)	E (12/13/2023)	Rmb60.22
Chow Tai Fook Jewellery Group Ltd (1929.HK)	E (11/25/2022)	HK$7.10
Chow Tai Seng Jewellery Co Ltd (002867.SZ)	E (08/26/2024)	Rmb12.12
Ecovacs Robotics Co Ltd (603486.SS)	E (10/30/2023)	Rmb44.13
Haidilao International Holding Ltd (6862.HK)	O (05/26/2021)	HK$14.42
Hangzhou Robam Appliances Co Ltd (002508.SZ)	U (02/21/2024)	Rmb20.45
Jiumaojiu International Holdings Ltd (9922.HK)	U (01/20/2025)	HK$2.70
Joyoung Co Ltd (002242.SZ)	U (09/25/2024)	Rmb9.76
Lao Feng Xiang Co Ltd (600612.SS)	U (06/04/2021)	Rmb50.88
Oppein Home Group Inc. (603833.SS)	U (02/21/2024)	Rmb64.12
Suofeiya Home Collection Co. Ltd (002572.SZ)	U (02/21/2024)	Rmb15.64
Super Hi (HDL.O)	E (01/14/2025)	$24.25
Zhejiang Supor Co. Ltd. (002032.SZ)	E (01/17/2022)	Rmb52.05

Lillian Lou		
Anhui Gujing Distillery Company Limited (000596.SZ)	E (11/22/2022)	Rmb157.32
Budweiser Brewing Company APAC Ltd (1876.HK)	O (11/04/2019)	HK$7.22
China Mengniu Dairy (2319.HK)	O (09/14/2017)	HK$14.98
China Resources Beer Holdings Co Ltd (0291.HK)	O (12/11/2018)	HK$23.55
Chongqing Brewery Co. Ltd. (600132.SS)	U (07/30/2021)	Rmb54.47
Gree Electric Appliances Inc of Zhuhai (000651.SZ)	O (04/14/2020)	Rmb43.83
Haier Smart Home Co Ltd (600690.SS)	E (01/17/2022)	Rmb26.61
Haier Smart Home Co Ltd (6690.HK)	E (01/17/2022)	HK$24.95
Helens International Holdings Co Ltd (9869.HK)	U (10/31/2023)	HK$2.07
Kweichow Moutai Company Ltd. (600519.SS)	O (10/17/2014)	Rmb1,403.80
Luzhou Lao Jiao Co. Ltd (000568.SZ)	E (01/23/2019)	Rmb113.81
Midea Group Co Ltd. (0300.HK)	O (11/01/2024)	HK$72.65
Midea Group Co Ltd. (000333.SZ)	O (01/17/2022)	Rmb72.21
Nayuki Holdings Ltd (2150.HK)	U (11/01/2024)	HK$1.23
Nongfu Spring Co Ltd (9633.HK)	E (07/30/2021)	HK$34.85
Shanxi Xinghuacun Fen Wine Factory Co. (600809.SS)	O (10/28/2020)	Rmb169.75
Shuanghui Development (000895.SZ)	U (03/16/2021)	Rmb25.82
Tsingtao Brewery Co Ltd (0168.HK)	E (11/01/2024)	HK$49.00
Tsingtao Brewery Co Ltd (600600.SS)	E (02/28/2024)	Rmb67.50
WH Group (0288.HK)	++	HK$6.25
Wuliangye Yibin Company Ltd. (000858.SZ)	E (08/15/2024)	Rmb125.01
Yanghe Brewery (002304.SZ)	U (01/05/2021)	Rmb77.12
Yanjing Brewery (000729.SZ)	U (09/02/2015)	Rmb11.10
Yili Industrial (600887.SS)	O (01/29/2014)	Rmb26.85
Yum China Holdings Inc. (YUMC.N)	O (03/20/2018)	$45.52
Terence Cheng		
Chervon Holdings Ltd. (2285.HK)	E (04/12/2024)	HK$19.04
Crystal International Group Ltd. (2232.HK)	O (01/26/2024)	HK$4.71
Gongniu Group Co Ltd (603195.SS)	O (05/08/2023)	Rmb70.70
Hangzhou Greatstar Industrial Co Ltd (002444.SZ)	E (10/26/2022)	Rmb31.77
Huali Industrial Group Co (300979.SZ)	E (10/09/2024)	Rmb71.30
Shenzhou International Group Holdings (2313.HK)	O (07/13/2017)	HK$58.80
Stella International Holdings Ltd (1836.HK)	O (05/21/2020)	HK$17.82
Techtronic Industries Co Ltd (0669.HK)	O (12/05/2019)	HK$99.15
Yue Yuen Industrial Hldg (0551.HK)	E (09/14/2021)	HK$17.14
Wilkins Tong		
China Foods Limited (0506.HK)	E (04/17/2024)	HK$2.64
Tingyi (Cayman Islands) (0322.HK)	O (08/24/2022)	HK$11.66
Uni-President China (0220.HK)	U (09/11/2024)	HK$7.76
Want Want China Holdings Ltd (0151.HK)	E (11/29/2023)	HK$4.66
ZJLD Group (6979.HK)	O (08/15/2024)	HK$6.48

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INDUSTRY COVERAGE: Greater China Materials

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Chris Jiang		
Anhui Honglu Steel Construction (002541.SZ)	O (01/02/2024)	Rmb15.73
CGN Mining Co Ltd (1164.HK)	O (01/18/2023)	HK$1.66
Shenzhen Kedali Industry Co Ltd (002850.SZ)	O (08/21/2023)	Rmb112.78
Hannah Yang, CFA		
China Hongqiao Group (1378.HK)	O (09/15/2023)	HK$12.88

Flat Glass Group Co Ltd (6865.HK)	O (07/30/2020)	HK$11.42
Flat Glass Group Co Ltd (601865.SS)	O (07/30/2020)	Rmb19.24
MMG Ltd (1208.HK)	O (12/16/2024)	HK$2.62
Shandong Pharmaceutical Glass Co. Ltd. (600529.SS)	O (01/04/2021)	Rmb23.80
Xinyi Glass Holding Limited (0868.HK)	U (05/14/2024)	HK$7.14
Zhongfu Shenying Carbon Fiber Co Ltd (688295.SS)	O (08/25/2023)	Rmb17.78
Zhuzhou Kibing Group Co Ltd (601636.SS)	U (07/04/2022)	Rmb5.64
Rachel L Zhang		
Aluminum Corp. of China Ltd. (601600.SS)	O (11/30/2020)	Rmb7.84
Aluminum Corp. of China Ltd. (2600.HK)	O (11/30/2020)	HK$5.09
Baoshan Iron & Steel (600019.SS)	O (01/16/2016)	Rmb6.72
Beijing New Building Materials (000786.SZ)	O (04/09/2024)	Rmb30.02
Beijing Oriental Yuhong Waterproof Techn (002271.SZ)	E (09/25/2024)	Rmb12.01
Chengxin Lithium Group Co. Ltd. (002240.SZ)	U (09/21/2023)	Rmb12.90
China Jushi (600176.SS)	O (12/22/2020)	Rmb10.86
China Lesso Group Holdings Ltd (2128.HK)	E (09/04/2023)	HK$3.25
China Steel Corp. (2002.TW)	O (01/20/2025)	NT$19.60
CMOC Group Ltd (3993.HK)	O (09/24/2019)	HK$5.94
CMOC Group Ltd (603993.SS)	O (06/21/2024)	Rmb7.22
Ganfeng Lithium Co. Ltd. (002460.SZ)	E (06/16/2020)	Rmb33.00
Ganfeng Lithium Co. Ltd. (1772.HK)	O (06/16/2020)	HK$19.64
GEM Co Ltd (002340.SZ)	U (09/21/2023)	Rmb6.41
Henan Liliang Diamond Co. Ltd (301071.SZ)	O (06/14/2022)	Rmb32.63
Jiangsu Dingsheng New Materials (603876.SS)	E (08/21/2023)	Rmb8.53
Jiangxi Copper (0358.HK)	U (12/16/2024)	HK$12.52
Jiangxi Copper (600362.SS)	U (12/16/2024)	Rmb21.01
JL Mag Rare-Earth Co. Ltd (6680.HK)	E (04/09/2024)	HK$9.36
JL Mag Rare-Earth Co. Ltd (300748.SZ)	E (05/26/2022)	Rmb20.58
Nine Dragons Paper (2689.HK)	E (01/04/2023)	HK$3.08
Shandong Nanshan Aluminium Co. (600219.SS)	O (11/30/2020)	Rmb4.02
Sinomine Resource Group Co Ltd (002738.SZ)	E (09/21/2023)	Rmb37.12
Tianqi Lithium Industries Inc. (9696.HK)	E (12/16/2024)	HK$22.60
Tianqi Lithium Industries Inc. (002466.SZ)	E (12/16/2024)	Rmb30.69
Weixing New Building Materials (002372.SZ)	O (10/20/2022)	Rmb11.99
Yongxing Special Materials Technology (002756.SZ)	E (11/25/2022)	Rmb38.23
Zhejiang Huayou Cobalt Co Ltd (603799.SS)	E (12/14/2023)	Rmb29.66
Sara Chan		
FangDa Carbon New Material Co. Ltd. (600516.SS)	U (12/16/2024)	Rmb4.55
Shandong Gold Mining Co. Ltd (600547.SS)	U (11/06/2018)	Rmb25.93
Shandong Gold Mining Co. Ltd (1787.HK)	O (12/12/2024)	HK$15.82
Zhaojin Mining Industry (1818.HK)	O (06/21/2024)	HK$13.64
Zijin Mining Group (2899.HK)	O (07/09/2019)	HK$15.46
Zijin Mining Group (601899.SS)	O (07/13/2022)	Rmb16.47

Stock Ratings are subject to change. Please see latest research for each company.
* Historical prices are not split adjusted.

INDUSTRY COVERAGE: Australia Materials

COMPANY (TICKER)	RATING (AS OF)	PRICE* (02/05/2025)
Rahul Anand, CFA		
BHP Group Ltd (BHPB.L)	O (09/19/2024)	2,000p
BHP Group Ltd (BHGJ.J)	O (09/19/2024)	ZAc 46,688
BHP Group Ltd (BHP.AX)	O (09/19/2024)	A$40.13
Deterra Royalties Ltd (DRR.AX)	E (06/21/2024)	A$4.12
Evolution Mining (EVN.AX)	E (09/19/2024)	A$5.88

Fortescue Metals Group Ltd. (FMG.AX)	E (09/19/2024)	A$18.99
IGO Ltd (IGO.AX)	U (03/28/2024)	A$4.95
Iluka Resources Ltd (ILU.AX)	E (12/10/2020)	A$4.53
Mineral Resources Limited (MIN.AX)	O (05/01/2024)	A$34.48
Northern Star Resources (NST.AX)	E (12/16/2024)	A$17.78
Pilbara Minerals Ltd (PLS.AX)	O (12/16/2024)	A$2.33
Rio Tinto Limited (RIO.AX)	O (12/09/2021)	A$119.18
Sandfire Resources Ltd (SFR.AX)	U (12/16/2024)	A$10.06
South32 Ltd (S32.AX)	O (12/16/2024)	A$3.45
South32 Ltd (S32J.J)	O (12/16/2024)	ZAc 4,062
Whitehaven Coal Ltd (WHC.AX)	O (03/27/2018)	A$6.25
Shannon J Sinha		
29Metals Ltd (29M.AX)	E (10/24/2024)	A$0.21
Boss Energy Ltd (BOE.AX)	E (04/06/2024)	A$3.39
Lynas Rare Earths (LYC.AX)	U (03/13/2024)	A$6.44
Nickel Industries (NIC.AX)	O (11/01/2024)	A$0.75
Paladin Energy Ltd (PDN.AX)	O (04/06/2024)	A$8.92
Regis Resources (RRL.AX)	E (10/24/2024)	A$3.26
Syrah Resources (SYR.AX)	E (11/01/2024)	A$0.24

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