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How we envisage the humanoid era

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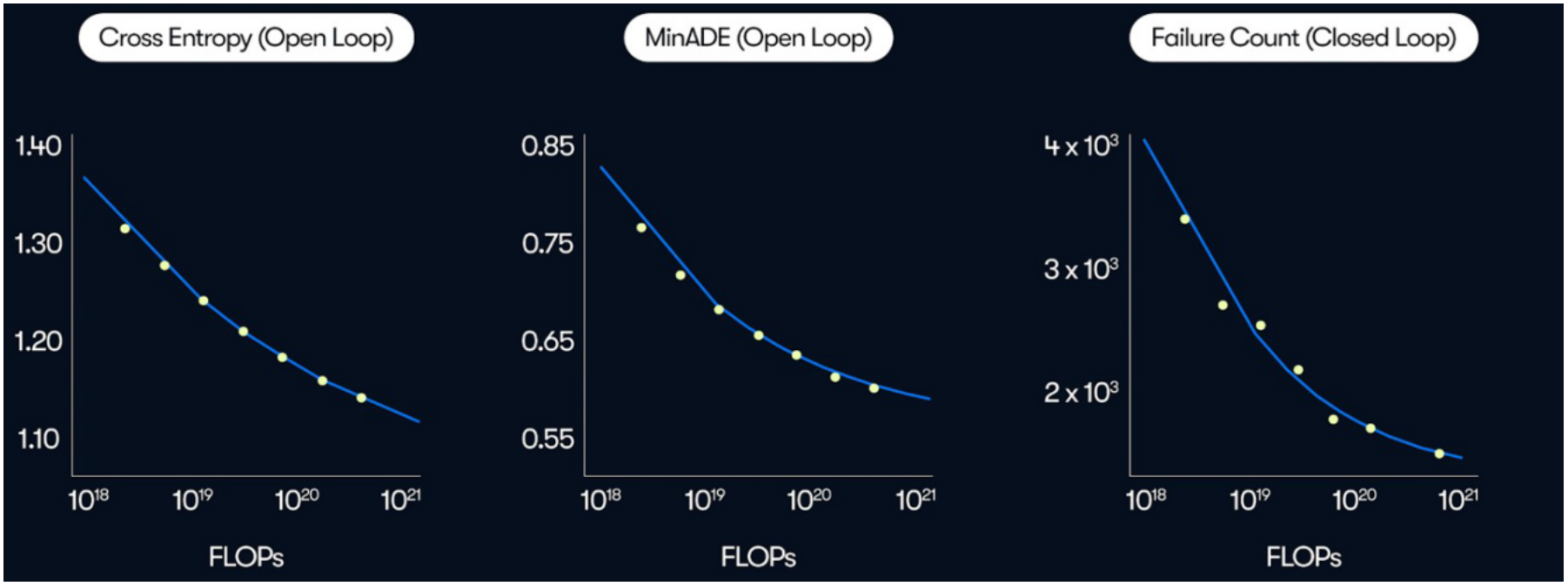
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See the end pages of this presentation for analyst certification and important disclosures, including non-US analyst disclosures.

Early deployment can create a data and learning flywheel

- Early deployment can create a data and learning flywheel: the sooner robots are placed in real environments, the faster performance can improve through iteration
- The 'stranded capex risk' is lower than many assume because humanoids are upgradeable, reducing the risk of stranded capex if tasks evolve

Motion forecasting quality follows a power-law as a function of training compute; self-driving systems require vast datasets, the challenge lies in the diminishing returns of data input



Source: Waymo

Optimize by application, while also factoring in the advantages of purpose-built robots

Humanoids vs Special-purpose robots: a practical fit guide (when each wins)		
	Humanoids fit better in…	**Task-specific robots prosper in…**
Process	Steps aren't fully defined; lots of "do what you see" work	Clear "manuals" exist: steps are clear, stable, and easy to program
Edge cases	Many weird exceptions; environment changes often	Few exceptions; you can control the environment
Value realization	Value comes from doing many tasks over time	Value is immediate from one high-volume task
Throughput	Speed matters less than flexibility	Speed/repeatability is the main goal
Task variety	Many different tasks per shift	One/few tasks repeated at scale
Workspace	Human spaces (mixed objects, clutter, tight areas)	Designed cells/lanes (fixtures, conveyors, marked bins)
Operations	You can iterate (pilot > improve > expand)	You need deterministic performance day 1

Source: J.P. Morgan

Humanoids can handle true last-mile tasks and navigate messier, edge-case-heavy environments



Source: Kia

Diverse robots can be co-located to deliver the highest ROI



Source: Kia

Industrial scale first, before consumer adoption

Stage 1

Ramp up at industrial scale

A phase where deployment of tens of thousands to hundreds of thousands of units leads, with factories and warehouses as the main battleground and use cases where the payback period is predictable.

Stage 2

Expansion into the consumer market

A phase where adoption in homes, retail, and service industries begins in earnest. It ramps up after clearing threshold requirements for safety, price, and reliability.

The key hurdles separating the two stages are:

- Economics: Consumer willingness to pay is likely anchored in the hundreds of dollars per month range (for example, industry commentary ~$500/month from Figure AI and 1X Technology), while current general-purpose humanoid BOMs remain in the tens of thousands to >$100k, making consumer payback unattractive vs commercial use cases.
- Non-economic barriers: Consumers require proven safety, trust, and productization in uncontrolled home environments (kids, pets, unpredictable edge cases), alongside evolving standards and certification.

Strategy implication

The practical playbook is to build a consumer-compatible platform, then harden it in industrial settings until: 1) safety and reliability are proven at scale; and 2) BOM and service economics make consumer pricing viable.

Three bottlenecks define the pace of humanoid scale-up: brain, hands, and supply chain readiness

1 Brain (data)

More important than the robot foundation model is high quality data to close the sim to real gap.

2 Hand (dexterous)

A practical hand with five fingers, many degrees of freedom, and tactile sensors is the toughest technical hurdle.

3 Supply chain readiness

With over 70% overlap with EV components, incumbent auto OEMs have a structural advantage.

Key characteristics of "good data" that closes the sim to real gap

Multimodal synchronization	**Precise action-observation pairs**	**Diversification**	**Contact-rich signals**	**Failure + recovery trajectories**

Robot foundation models

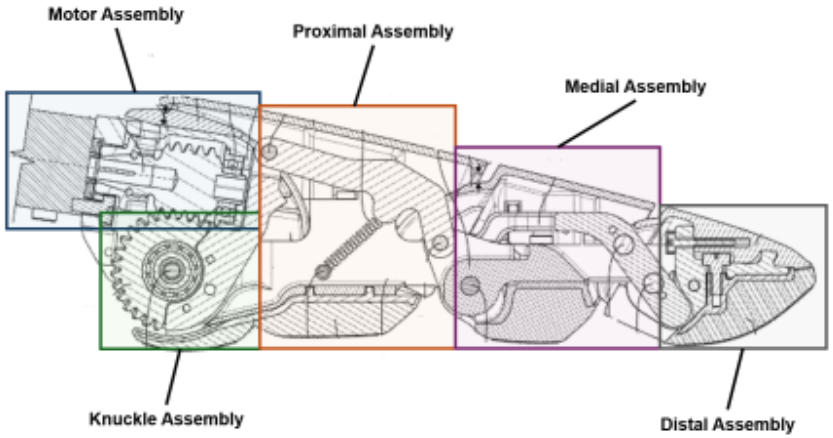
Robot foundation model	Developer	Representative benchmark (LIBERO*)	Model availability
GR00T N1.x	NVIDIA	96.5%	Open-weight
Gemini Robotics	Google DeepMind	n/a	Closed
π0.5	Physical Intelligence	96.85-96.95%	Open-weight
ACT-1	Sunday Robotics	n/a	Closed
OpenVLA-OFT	Stanford/ UC Berkeley	97.1%	Open-weight
SmolVLA	Hugging Face	88.8%	Open-source
OpenHelix	Zhejiang Univ./ Westlake, et al.	n/a	Open-source
X-VLA	Tsinghua/ Shanghai AI Lab, et al.	98.1%	Open-source

*LIBERO: A widely used simulation benchmark for evaluating robot manipulation and VLA models across 40 core tasks, testing spatial understanding, object manipulation, goal following, and long-horizon execution

Source: Company data, J.P. Morgan

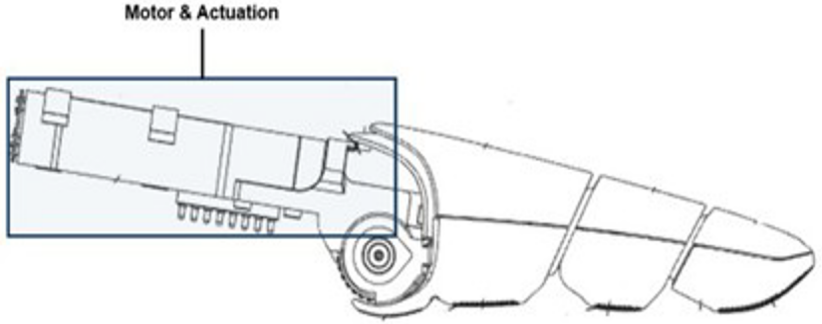
Three bottlenecks define the pace of humanoid scale-up: brain, hands, and supply-chain readiness

Component breakdown of a finger



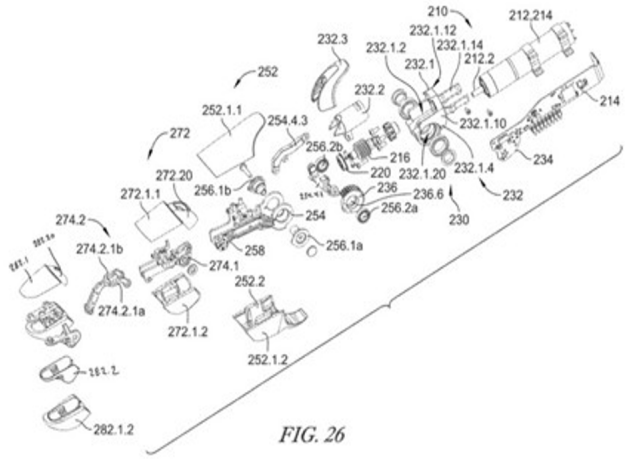
Note: Figure 23A of US 2025/0205908 A1 Patent published on June 26, 2025
Source: Company reports, Google Patents, J.P. Morgan

Component breakdown of a finger



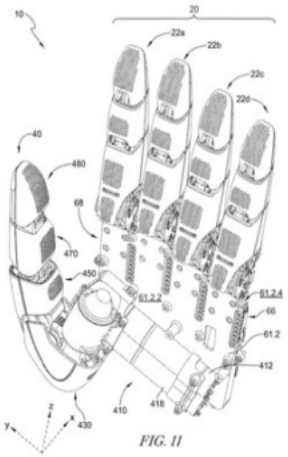
Note: Figure 17 of US 2025/0205908 A1 Patent published on June 26, 2025
Source: Company reports, Google Patents, J.P. Morgan

Breakdown of components within a finger



Note: Figure 26 of US 2025/0205908 A1 Patent published on June 26, 2025
Source: Company reports, Google Patents

Breakdown of components within a finger



Note: Figure 11 of US 2025/0205908 A1 Patent published on June 26, 2025
Source: Company reports, Google Patents

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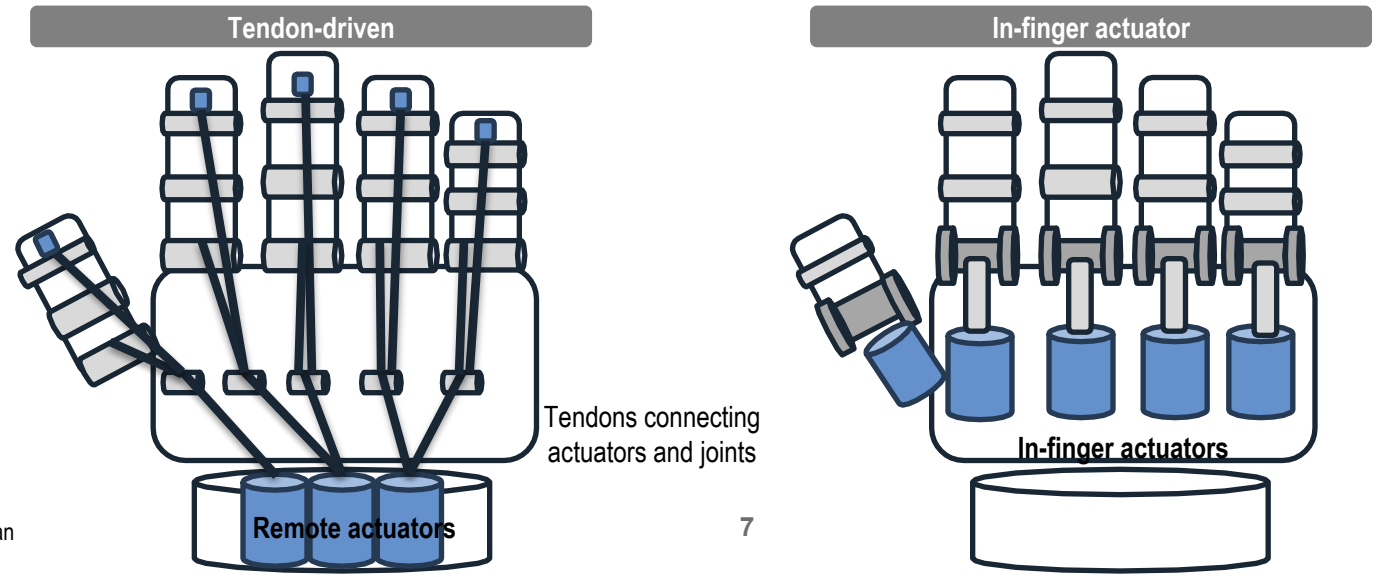
A breakdown of humanoid “hands”

Humanoid hand comparison vs human hand

Product	Company	Mechanism	Price ($)	Finger count	Kapandji score	DOF	Backdrivability	Hand length (mm)	Weight (g)	Fingertip force (N)	Rated load (kg)
Agibot Omnihand Pro	Agibot	Tendon-driven	~14,610	5	10/11	12 active/ 19 total	No	207	750	20	35*
XHAND 1	Robotera	In-finger actuator	~14,500	5	8/11	12	Yes	191	1,100	15	n/a
Allegro V5 Plus	Wonik Robotics	In-finger actuator	~11,000	4	9/11	16	Yes	255	1,024	n/a	15
LEAP Hand V1	Carnegie Mellon Univ.	Tendon-driven	~2,000	4	9/11	16	Yes	232	595	n/a	n/a
Linkerbot L20	Linkerbot	In-finger actuator	~12,200	5	8/11	16	No	264	1,000	10	5
Orca Hand V1	ETH Zurich	Tendon-driven	~7,600	5	9/11	16	Yes	330	1,100	n/a	2
DG-5F-M	Tesollo	In-finger actuator	~21,000	5	10/11	20	Yes	n/a	1,763	97	12
DG-5F-S	Tesollo	In-finger actuator	~21,000	5	10/11	20	Yes	210	880	19	12
Robotis HX5-D20	Robotis	In-finger actuator	~6,699	5	11/11	20	Yes	n/a	1,360	14	15
Wuji Hand V1.1	Wuji Tech	In-finger actuator	~16,000	5	10/11	20	No	201	590	15	20
Figure 03 Hand	Figure AI	In-finger actuator	n/a	5	n/a	20	Yes	n/a	n/a	n/a	20
Brainco Revo3	BrainCo	In-finger actuator	~8,000	5	11/11	21	Yes	n/a	n/a	20	n/a
Sharpa Wave	Sharpa Robotics	In-finger actuator	~52,000	5	9/11	22	Yes	200	1,300	n/a	15
Optimus V3 Hand	Tesla	Tendon-driven	n/a	5	n/a	22	Yes	n/a	n/a	n/a	9
Unitree Dex5-1	Unitree	In-finger actuator	~23,500	5	n/a	16 active/ 20 total	Yes	217	1,100	10	5
1X NEO Hand	1X Technologies	Tendon-driven	~20,000	5	n/a	22	Yes	n/a	n/a	45	9
Human hand (indicative only)				**5**	**11/11**	**20-27**	**Yes**		**400-500**	**10-50**	**30-50**

Source: Company data, J.P. Morgan estimates

Robot hand comparison in image: tendon-driven vs in-finger actuator



Source: J.P. Morgan

J.P.Morgan

Supply-chain readiness: Auto OEMs have a structural advantage

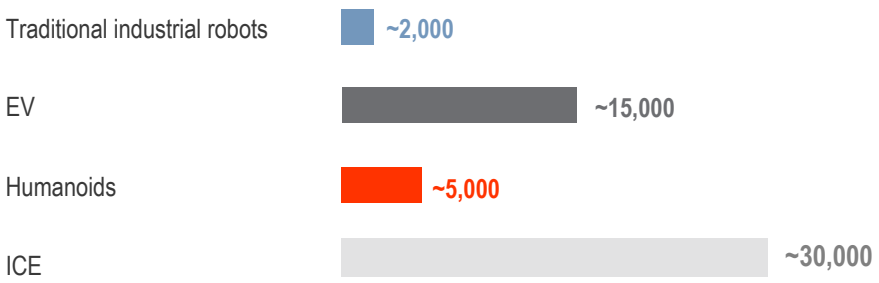
Overlap areas

>70%

Overlap between humanoid and EV supply chains.

- Motors and power electronics
- Battery systems (battery, BMS, converters)
- Cameras and vision systems

Approximate comparison of the number of parts



Areas of Overlap: Humanoids vs EVs/Autonomous Vehicles

Subsystem	Representative EV Components	Representative Humanoid Components
Batteries and Power Systems	400–800V packs; module/pack BMS; liquid cooling plates; HV contactors; DC-DC converters	48–52V packs; compact BMS; heat spreaders; quick swap/back mounted packs
Computing Power Chips	AV/ADAS compute (SoCs/GPUs), safety MCUs, domain controllers, vehicle Ethernet	Head/torso AI module, gait controller, arm/hand controllers, joint MCUs, safety supervisor
Cameras and Vision Systems	Front/rear/side cameras; surround view; HDR sensors; heated housings	Head-mounted stereo; chest RGBD; wrist cameras for grasping; protective domes
Sensors	6-axis IMUs; short range ultrasonics; 77/79 GHz radar; load cells	High-grade torso IMU; foot force/torque; fingertip tactiles; proximity sensors on limbs
LiDAR	Roof/fender solid state LiDAR; long range units	Head or shoulder mounted solid-state LiDAR; short to mid range 360° mapping
Motors, Actuators, and Power Electronics	Traction motors; e axle inverters; EPS/ steer actuators; DC-link caps; gate drivers	Joint BLDCs with harmonic drives; shoulder/hip torque dense actuators; miniature inverters; brake/ clutch modules
Materials, Structures, and Manufacturing	Gigacastings, extruded crash beams, sealed enclosures, automotive connectors	Torso/limb frames, swappable panels, sealed joint housings, quick-service connectors
Software, AI, and Tooling	AV simulators, OTA, safety monitors, telematics, data labeling tools	Robot simulators (locomotion/manipulation), OTA for control stacks, telemetry dashboards, safety supervisors

Source: J.P. Morgan

Appropriate BOM cost for humanoids in the US

- **The ~$120k/unit price point is supported by industry cross checks:** Humanoid OEMs can accelerate adoption by offering RaaS, where customers subscribe to robots for a recurring fee, typically with deployment, maintenance, updates, monitoring, and support bundled in.
- Ultra-low ASP is unlikely to be the sole deciding factor for industrial humanoids.
- Initial BOM is ＄53,000 to ＄63,000 at the several thousand unit scale, with most of the cost in the actuation system.
- With scaled mass production, a 60% to 70% cost reduction is within sight.

A $120,000 ASP is competitive even when viewed in terms of time cost

Humanoid ASP	**120,000**
Hourly cost (2-year deployment, 20 operating hours/day)	**8.2**
US minimum wage (hourly)	~7-17, depending on states
Average US manufacturing production worker hourly wage	~30

Source: J.P. Morgan estimates

Humanoid initial production BOM vs Scaled production BOM

Category	Sub-components	Quantity	Est. unit cost	Total cost	% of BOM (ex-hands)
Actuation (ex-hands)	Actuators (includes motor, reducer, controller, encoder)	30	700	21,000	49%
Dexterous hand modules		2	5,000 - 10,000	10,000 - 20,000	
Compute	NVIDIA Jetson AGX Thor	1	3,000	3,000	7%
Vision	Depth cameras + Modules	8	300	2,400	6%
	LiDAR (optional)	1	500	500	1%
Sensing	IMUs (Inertial Measurement Unit): torso, upper torso, head	3	100	300	1%
	6-axis F/T (force/torque) sensors: wrists, ankles (optional)	4	1,000	4,000	9%
Power	2.5kwh Li-ion battery, BMS, DC/DC converter, charging interface	1	3,000	3,000	7%
Electrical & Connectivity	Wiring harnesses, Communication board, I/O switches, Cooling	Set		4,000	9%
Structure	Frame, Joints, Shell (machined/3D)	Set		5,000	12%
Initial production BOM				**53,200 - 63,200**	
Scaled production BOM	**~60-70% cost reductions through volume ramp, design optimization**			**~21,000 - 25,000**	

Source: Company data, J.P. Morgan estimates

Korea supply chain: We prefer Hyundai Motor

- Hyundai Motor Group is expected to start mass production with humanoid manufacturing capacity of about 30k units per year from 2028.
- The right strategy is to start with industrial use cases to establish scale and validate reliability, then expand into broader markets.
- It meets 2 of the 3 key factors: (1) brain (data collection from the robotics training center in Georgia); and (2) supply chain (it already has a stable EV supply chain that can be repurposed for humanoid components). By contrast, hand technology is likely to be acquired through M&A, but urgency is low for now and the near-term approach is to rely on grippers.
- From an investment perspective, we prefer Hyundai Motor as the robot OEM over Hyundai Mobis, a components supplier (e.g., actuators). As the robot OEM, Hyundai Motor can lead development and integration and has discretion to set component specifications, which could leave Mobis in a subordinate position as an actuator supplier to Hyundai Motor.

Peer valuation comparison table

Company	Ticker	JPM rating	Price Local currency	Mkt. cap ($bn)	P/E (x) 27E	P/E (x) 28E	P/B (x) 27E	P/B (x) 28E	P/S (x) 27E	P/S (x) 28E	OPM 27E	OPM 28E	Rev growth 27E	Rev growth 28E
Hyundai Motor	005380 KS	OW	387,000	58.7	8	7	0.7	0.7	0.4	0.4	7%	7%	3%	5%
Kia	000270 KS	OW	126,000	36.8	5	5	0.7	0.6	0.4	0.4	9%	9%	9%	5%
Humanod/ Collaborative robot OEMs														
Doosan Robotics	454910 KS	NC	69,300	3.3	n/a	n/a	15.0	14.8	46.2	22.7	-21%	-2%	46%	56%
Unitree	688836 CH	NC	524	32.0	189	97	28.5	22.1	41.6	24.2	27%	28%	n/a	72%
UBTech	9880 HK	OW	85	5.6	223	37	4.7	3.9	6.4	3.7	2%	10%	101%	46%
Dobot Robotics	2432 HK	NC	23	1.2	n/a	174	3.5	3.4	6.9	4.9	-6%	5%	54%	43%
Robotics supply chain market leaders														
Harmonic Drive Systems	6324 JP	NC	5,700	3.5	82	56	6.4	5.9	7.3	6.4	12%	15%	6%	28%
Leader Harmonic Drive	688017 CH	OW	293	7.6	185	126	13.7	12.7	40.1	28.3	22%	23%	58%	50%
Orbbec	688322 CH	OW	95	5.7	78	48	8.8	7.5	15.6	10.5	19%	22%	50%	74%
Haozhi Industrial	300503 CH	NC	65	3.0	32	26	9.2	7.3	5.9	4.8	21%	22%	74%	32%
Zhaowei Machinery & Electronic	003021 CH	NC	71	3.0	56	47	3.5	3.3	8.6	7.2	14%	14%	-2%	14%
Fortior Technology	688279 CH	NC	185	2.9	40	28	3.6	3.3	12.8	9.7	36%	38%	40%	33%
Traditional industrial robot OEMs														
ABB	ABBN SW	NC	81	175.2	27	24	8.0	6.8	4.3	3.9	20%	21%	12%	12%
Fanuc	6954 JT	NC	5,797	37.3	26	24	2.8	2.7	5.9	5.5	24%	24%	7%	15%
Yaskawa	6506 JT	NC	4,456	7.8	25	20	2.3	2.1	2.0	1.9	10%	12%	-1%	12%
Innovance	300124 CH	OW	57	23.9	21	17	3.4	2.9	2.5	2.1	12%	13%	17%	17%
Traditional auto parts suppliers expanding into actuators														
Schaeffler	SHA0 GR	N	7	8.2	14	8	2.3	2.1	0.3	0.3	5%	7%	-1%	3%
Hyundai Mobis	012330 KS	OW	418,000	28.3	8	7	0.7	0.6	0.5	0.5	6%	6%	6%	6%
Mando	204320 KS	N	48,600	1.7	10	8	0.8	0.7	0.2	0.2	4%	5%	4%	6%
Sanhua Intelligent Controls	002050 CH	OW	36	21.2	29	25	4.0	3.6	3.7	3.2	16%	16%	5%	15%
Hengli Hydraulic	601100 CH	OW	102	19.8	32	27	6.0	5.2	8.4	7.2	28%	29%	28%	19%
Shuanghuan Driveline	002472 CH	NC	37	4.8	19	16	2.5	2.2	2.7	2.4	17%	17%	8%	14%

Based on Bloomberg consensus estimates. Based on 8 Sep 2026 prices
Source: Bloomberg Finance L.P., J.P. Moran estimates

N.A. SMid Cap industrials: outlook for the US humanoid market

Executive Summary

- **Market backdrop:** The US automation market is creating a significant investment opportunity, supported by a recovery in the near-term cycle alongside structural growth and corporate transformation initiatives.
- **Structural theme:** As a core pillar of structural growth, robotics is an engine underpinning the resurgence of US manufacturing. Adoption of Physical AI is accelerating, and humanoids are transitioning from pilot programs toward the deployment phase.
- **Scale (units and TAM):** US humanoid production is expected to expand from fewer than 6k units in 2026E to more than 300k units by 2030E. Actuators and motion TAM is projected to grow to roughly $4bn by 2030E.
- **Supply and demand:** We expect demand to exceed supply, with manufacturing, logistics, and warehousing leading the ramp, implying an enterprise led adoption curve as the base case.
- **Path to win:** Humanoids have high actuator density, and actuation and motion form the key cost pool in the BOM. Within our coverage, we see RRX, TKR, and ALNT as relatively attractive ways to capture this component value pool.

SMid Cap Industrials: Coverage Overview

North America SMid Cap Industrials Coverage- Tomohiko Sano

Sub-Segment	Ticker	Company	Rating	Price ($) 09/02/2026	PT ($)	Upside/ Downside	Market Cap ($M)	Enterprise Value ($M)	P/E (x)			EV/EBITDA (x)			FCF Yield			Profitability Ratios (FY1)			Revenue Growth CAGR			EPS Growth CAGR			Stock Performance		
									A	FY1	FY2	A	FY1	FY2	A	FY1	FY2	ROIC	ROE	ROA	1Y	3Y	5Y	1Y	3Y	5Y	1-Mo	1-Yr	3-Yr
SPECIALTY	APG	APi Group	OW	39.09	50	27.9%	16,893	18,463	26.5	22.2	19.7	17.7	15.7	13.5	4.0%	3.8%	5.2%	11%	11%	4%	12.7%	6.5%	17.7%	20.0%	18.6%	15.7%	-1.5%	12.2%	106.4%
	GPGI	GPGI Inc.	N	13.31	15	12.7%	3,857	3,613	13.1	13.3	10.5	20.6	10.1	8.2	-1.4%	1.6%	4.9%	-3%	-3%	3%	337.1%	72.9%	50.6%	-1.6%	1.2%	N/A	1.1%	-29.9%	150.0%
	MATX	Matson Inc.	OW	220.35	270	22.5%	6,589	7,668	15.9	13.7	12.8	10.9	8.9	7.7	2.2%	2.1%	8.3%	12%	16%	10%	8.3%	5.4%	8.7%	15.9%	24.4%	29.2%	8.8%	115.4%	147.4%
	MSA	MSA Safety	N	186.88	220	17.7%	7,210	8,233	23.9	20.5	18.7	16.5	15.0	12.9	4.0%	3.9%	5.2%	24%	37%	16%	3.7%	7.1%	6.8%	2.9%	12.0%	12.0%	-1.8%	10.5%	1.0%
	NPO	Enpro	OW	288.00	430	49.3%	6,096	7,562	42.2	34.9	30.7	27.5	22.5	19.5	2.2%	2.4%	3.3%	8%	8%	5%	15.4%	7.6%	5.7%	20.9%	13.7%	13.6%	-8.3%	33.8%	109.3%
	NWPX	NWPX Infrastructure	N	109.50	130	18.7%	1,055	1,141	31.3	20.5	20.9	17.6	12.4	11.7	4.3%	6.1%	6.8%	12%	11%	8%	12.9%	10.1%	15.7%	41.8%	34.2%	21.2%	-11.0%	112.9%	227.1%
	PRM	Perimeter Solutions	OW	30.54	45	47.3%	4,999	6,097	23.3	22.0	19.1	15.2	14.8	12.7	4.5%	3.0%	5.6%	0%	-1%	-2%	35.2%	39.9%	19.5%	5.8%	92.9%	28.6%	-0.2%	35.6%	416.8%
	ROL	Rollins Inc.	N	35.52	45	26.7%	17,090	18,385	32.3	31.5	28.7	21.5	20.6	18.6	3.7%	3.7%	4.4%	24%	36%	17%	11.0%	11.7%	11.7%	13.6%	14.5%	15.6%	-6.5%	-37.3%	-9.8%
	SCI	Service Corp. International	OW	81.33	100	23.0%	11,111	16,771	21.6	20.1	18.2	12.7	12.1	11.4	4.7%	6.1%	5.6%	12%	35%	3%	2.9%	1.6%	4.2%	9.0%	0.4%	5.7%	-5.6%	4.2%	27.5%
	VRRM	Verra Mobility	N	4.17	6	44.1%	633	1,891	4.2	4.8	4.9	4.5	4.9	4.7	15.2%	12.1%	15.9%	5%	13%	2%	11.4%	9.7%	20.0%	7.2%	9.1%	20.0%	-21.3%	-83.2%	-76.3%
AUTOMATION	ALNT	Allient	OW	87.62	120	37.0%	1,490	2,052	47.0	38.0	30.3	24.0	21.2	17.1	2.9%	2.2%	2.7%	8%	10%	6%	4.6%	3.3%	8.6%	45.9%	4.9%	10.5%	0.2%	93.8%	144.5%
	CGNX	Cognex	OW	60.23	75	24.5%	10,132	9,724	57.6	33.7	27.1	45.4	26.3	20.8	2.4%	3.3%	4.1%	33%	16%	13%	16.8%	11.5%	2.3%	70.6%	33.2%	3.1%	-7.7%	36.1%	26.9%
	GTES	Gates Industrial Corp	OW	24.78	34	37.2%	6,273	8,363	17.4	15.9	13.9	10.9	9.8	8.2	5.4%	5.9%	7.9%	10%	11%	6%	1.0%	-1.1%	4.3%	8.6%	9.6%	16.6%	-11.4%	-1.1%	99.4%
	HLIO	Helios Technologies	OW	71.13	110	54.6%	2,344	2,640	27.5	22.0	19.7	16.4	13.7	11.9	4.4%	5.2%	4.5%	8%	10%	6%	8.1%	2.8%	0.9%	24.9%	11.0%	-5.5%	-8.7%	34.7%	20.1%
	RRX	Regal Rexnord	OW	157.64	240	52.2%	10,498	14,755	16.2	14.8	12.0	11.3	10.5	8.6	5.2%	6.1%	7.8%	6%	6%	3%	-1.6%	4.4%	15.3%	6.0%	-3.5%	10.9%	-23.2%	7.9%	-4.4%
	TKR	Timken	OW	119.14	160	34.3%	8,256	9,920	22.3	19.4	16.9	12.5	11.0	9.7	4.8%	4.7%	6.2%	10%	10%	5%	0.2%	0.6%	5.5%	-7.8%	-4.0%	5.4%	-13.4%	55.8%	51.9%
BUILDING PRODUCTS	ADIG	ADI Global	N	20.67	25	20.9%	1,569	2,926	8.9	15.2	14.6	9.9	9.2	7.6	1.2%	2.1%	10.1%	2%	2%	1%	4.0%	11.7%	8.0%	-41.1%	-11.9%	N/A	2.7%	N/A	N/A
	ALH	Alliance Laundry	OW	22.32	32	43.4%	4,437	5,287	22.1	16.6	14.9	12.1	11.6	10.8	3.9%	5.4%	7.3%	16%	38%	8%	13.3%	7.5%	N/A	7.6%	7.0%	N/A	-15.4%	N/A	N/A
	ALLE	Allegion	N	151.30	170	12.4%	12,866	15,711	20.0	18.3	16.6	15.6	13.9	12.3	4.9%	5.2%	5.8%	18%	29%	13%	7.8%	7.5%	8.4%	8.1%	12.7%	9.7%	-3.9%	-9.9%	31.9%
	AOS	A.O. Smith	UW	58.54	60	2.5%	6,442	9,016	16.6	17.1	15.7	11.1	11.4	10.2	6.0%	6.0%	6.8%	23%	26%	15%	0.3%	0.7%	5.8%	3.4%	7.1%	12.3%	-2.7%	-16.8%	-20.4%
	AWI	Armstrong World Industries	OW	168.92	220	30.2%	7,139	8,109	23.8	21.1	18.7	14.6	13.0	11.3	4.5%	5.1%	5.4%	25%	36%	17%	12.2%	9.6%	11.6%	17.8%	16.2%	15.4%	-3.3%	-13.3%	119.5%
	CSL	Carlisle	OW	336.09	450	33.9%	13,347	16,578	18.4	16.9	14.5	14.0	13.0	11.1	6.3%	5.2%	7.0%	23%	57%	13%	0.3%	-2.7%	4.8%	-4.0%	2.8%	18.3%	-6.6%	-11.2%	25.1%
	CSW	CSW Industrials	OW	298.65	380	27.2%	4,866	4,887	37.3	30.2	24.4	21.4	22.5	16.7	3.0%	2.5%	4.2%	9%	11%	6%	10.8%	11.9%	17.9%	20.1%	24.2%	21.4%	-6.4%	12.0%	61.2%
	REZI	Resideo Technologies	N	19.28	30	55.6%	2,927	5,555	7.5	8.6	9.9	6.7	6.5	6.9	-41.1%	37.4%	11.3%	6%	7%	3%	-28.6%	-5.1%	-1.8%	-13.5%	2.7%	N/A	-19.2%	-17.5%	62.2%
E&C	BWMN	Bowman Consulting Group	UW	42.61	43	0.9%	739	945	25.2	24.9	18.3	13.0	9.5	7.6	4.7%	7.9%	-1.7%	4%	3%	2%	14.9%	23.3%	32.1%	40.4%	7.2%	N/A	58.7%	1.4%	49.6%
	EXPO	Exponent	OW	69.48	90	29.5%	3,304	3,320	28.1	24.9	21.9	19.3	17.0	14.6	3.5%	3.4%	3.8%	28%	35%	33%	4.2%	4.3%	7.8%	-1.8%	2.1%	5.7%	3.9%	-3.4%	-23.2%
	LMB	Limbach Holdings	UW	46.94	50	6.5%	560	589	10.0	10.6	9.4	7.2	6.8	5.1	7.7%	16.2%	12.5%	28%	16%	8%	24.7%	9.2%	2.6%	25.3%	92.0%	44.3%	-34.5%	-57.7%	27.8%
	ORN	Orion Holdings Group	OW	9.23	16	73.4%	374	436	644.8	38.9	17.2	9.6	6.8	5.1	-2.8%	35.1%	7.0%	6%	5%	1%	7.0%	4.4%	3.7%	-87.7%	N/A	-49.8%	-5.7%	25.3%	96.7%
	TIC	TIC Solutions	N	9.25	11	18.9%	2,019	3,316	37.1	18.5	16.2	14.2	9.6	8.6	3.0%	2.1%	9.2%	3%	5%	3%	39.4%	18.1%	N/A	-53.7%	N.M.	N.M.	26.5%	-17.1%	N/A
AEROSPACE, DEFENSE & NUCLEAR	ATRL CN	AtkinsRéalis	OW	83.72	120	43.3%	13,387	14,744	24.3	20.6	15.8	14.6	11.8	9.1	2.0%	0.4%	4.4%	10%	12%	5%	10.6%	12.1%	10.5%	18.2%	28.0%	26.9%	-3.6%	-10.2%	93.7%
	BWXT	BWX Technologies	OW	158.75	230	44.9%	14,545	16,320	40.2	33.9	31.4	28.5	24.5	21.8	2.0%	2.4%	2.5%	10%	28%	9%	19.0%	15.1%	12.4%	18.7%	16.3%	18.3%	-5.9%	-0.8%	114.6%
	CDRE	Cadre Holdings Inc.	OW	28.76	45	56.5%	1,232	1,766	33.6	33.5	23.1	15.0	12.6	11.1	7.1%	8.6%	9.5%	9%	16%	10%	24.6%	16.4%	13.5%	0.4%	0.0%	-6.1%	-6.7%	-6.9%	10.5%
	ESE	ESCO Technologies	OW	265.33	420	58.3%	6,874	7,619	48.2	34.8	32.8	29.8	23.0	20.8	2.2%	3.1%	1.9%	8%	9%	3%	19.6%	11.1%	12.4%	38.7%	31.2%	25.6%	-15.8%	31.9%	148.7%
	MIR	Mirion Technologies	OW	15.57	22	41.3%	3,787	4,872	33.7	29.8	25.0	21.4	17.5	14.2	2.6%	3.8%	5.0%	3%	2%	1%	22.6%	12.3%	13.2%	13.2%	15.4%	N/A	3.9%	-24.5%	82.0%
	MOG/A	Moog Inc.	OW	367.09	520	41.7%	10,441	13,878	47.3	35.1	35.3	26.1	20.9	19.9	1.0%	2.3%	1.5%	15%	17%	8%	13.9%	9.9%	9.0%	34.8%	24.0%	19.1%	-5.8%	87.2%	207.2%
POWER INFRASTRUCTURE	BELFB	Bel Fuse	OW	241.90	380	57.1%	2,983	3,122	34.2	23.6	19.5	22.1	15.2	12.8	2.2%	3.0%	6.1%	20%	12%	9%	20.1%	8.2%	11.7%	44.8%	15.3%	59.7%	-11.1%	77.9%	363.3%
	CECO	CECO Environmental	OW	70.17	130	85.3%	4,110	2,997	86.1	29.5	21.0	33.2	16.6	10.7	-0.2%	10.2%	5.6%	20%	2%	4%	73.8%	35.2%	33.6%	192.0%	51.4%	36.5%	6.5%	54.2%	402.3%
	HPS/A CN	Hammond Power Solutions	OW	218.05	430	97.2%	1,990	3,579	43.6	25.5	21.2	26.8	16.7	13.2	-0.2%	1.4%	4.8%	18%	19%	8%	53.4%	24.7%	33.7%	71.2%	N/A	N/A	-13.0%	84.5%	287.0%
	POWL	Powell Industries	OW	172.10	300	74.3%	6,270	6,999	41.2	38.7	27.8	31.1	29.0	19.9	6.2%	1.1%	1.6%	22%	27%	16%	9.1%	27.5%	16.3%	20.8%	134.6%	59.8%	-17.5%	95.7%	510.3%
	VMI	Valmont Industries	OW	468.21	620	32.4%	9,039	10,440	25.5	21.1	18.9	16.0	13.4	11.8	3.2%	3.4%	3.9%	19%	24%	13%	0.7%	-1.9%	7.2%	11.1%	11.4%	18.5%	-2.8%	27.8%	82.9%
Coverage Average:						37.9%	$6,244	$7,507	44.5	23.4	19.7	18.0	14.5	12.3	2.5%	6.1%	5.8%	13%	17%	8%	21.4%	11.6%	12.4%	16.7%	20.6%	16.8%	-4.7%	18.7%	112.7%

Note: Price as of 9/1/26
Source: Company data, J.P. Morgan estimates, Bloomberg Finance L.P.

SMid Cap Industrials: Sub-Sectors

Specialty

Key Themes:
- Market Penetration within Untapped TAM
- Infrastructure Investments
- Safety

Automation

Key Themes:
- Electrification
- Humanoids
- U.S. Reshoring/Robotics
- Labor Shortage

Building Products

Key Themes:
- Resi vs Non-Resi
- Repair & Remodeling
- Emission Reduction Targets

E&C

Key Themes:
- Electrification
- Data Centers
- Broad Infrastructure Investment

Power Infra.

Key Themes:
- Electrification
- Data Centers
- Broad Infrastructure Investment

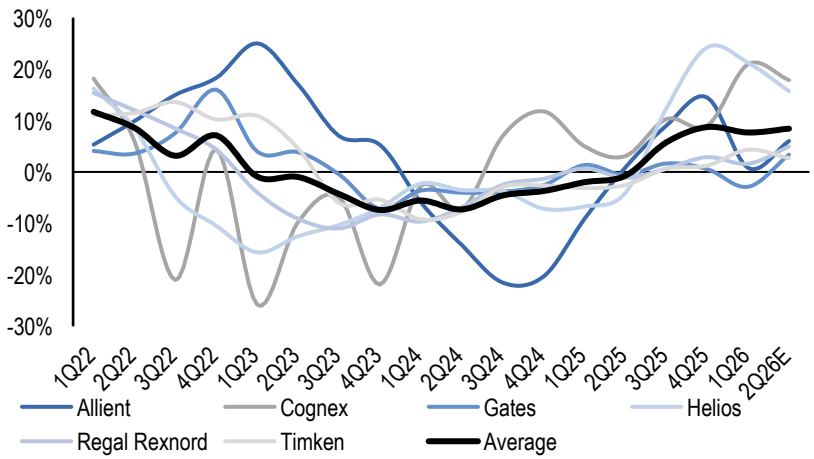
A&D & Nuclear

Key Themes:
- U.S. Defense Spending
- Data Centers
- Nuclear Power Growth

Short-Cycle: Mother Machines Signal Revival

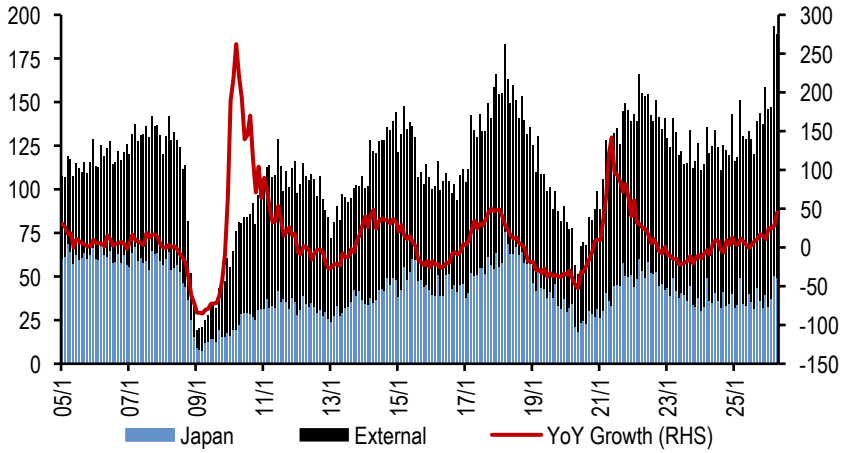
- **Machine Tool Order Strength**: Machine tool orders, often called "mother machines" showed a robust 45.1% YoY increase, marking four consecutive months of 20%+ growth. Seasonally adjusted figures show 9.5% MoM rise.
- **Potential Risks:** While activity is strong, escalating supply chain pressure (prices paid highest since July 22), soaring delivery times, and surging Global Supply Chain Pressure Index, raise risk of front-loaded demand.
- **Order Volume & Commentary Support Strength:** Order activity and commentary from our coverage has been encouraging with orders: RRX (AMC +17% YoY), ALNT (+49% YoY), HLIO (12Ms of +DD orders), TKR (up QoQ/YoY), GTES (book-to-bill >1)

Organic Growth Reaccelerating Across Automation



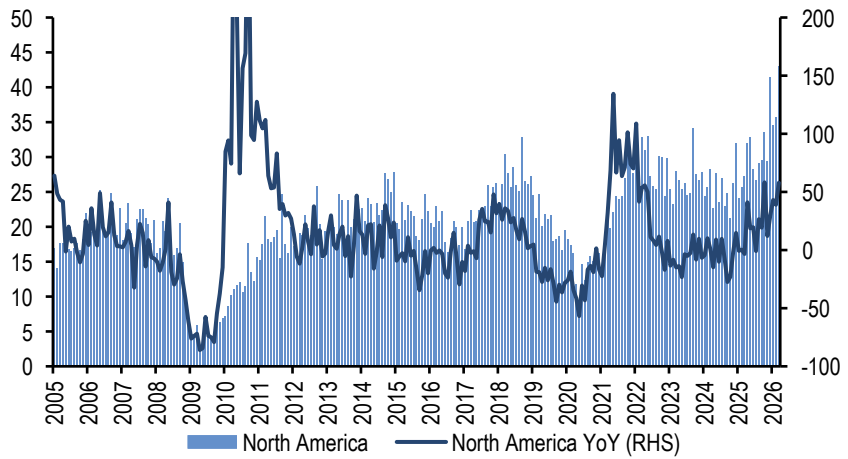
Source: Company data.

Machine Order Growth Inflecting Positively Globally...



Source: JMTBA

… With NA Orders Growing >20% YoY for 4 Months



Source: JMTBA

J.P.Morgan

Robotics Overview: The Engine of the US Manufacturing Resurgence

- **Industrial Robotics**
  - Industrial robots are expanding beyond automotive into logistics, electronics, and high-mix manufacturing, addressing bottlenecks in throughput, quality, and safety.
  - Our coverage exposure includes RRX in actuation and motion systems, TKR in precision reducers and bearings, ALNT in configurable motors and drives, and CGNX as a vision backbone for guidance and inspection.
- **Humanoids:**
  - Humanoid robots are transitioning from research labs to pilot deployments in warehouses and factories, performing repetitive and physically demanding tasks.
  - RRX, TKR, and ALNT are most levered to humanoid robotics, supplying products such as high-torque motors, drives, precision gear reducers, and frameless torque motors. RRX & TKR see a ~$100M opportunity funnel.
- **Surgical Robotics:**
  - Surgical robots are transforming healthcare by enabling highly precise, minimally invasive procedures across specialties.
  - RRX and ALNT are exposed through actuation, supplying servo and torque motor solutions for robotic arm articulation and instrument positioning, and TKR provides miniature precision gearing and bearings for micron-level accuracy.

Snapshot of Coverage Exposure

Company	Humanoid Robotics	Industrial Robotics	Surgical Robotics
RRX	Positioned as a multi-axis motion supplier across humanoid joint architectures through frameless motors and integrated drive systems. Early design-in activity reflects strength in actuation + control.	Broad exposure across the automation stack, supplying servo motors, drives, and linear motion systems used in robot arms and expanded workcells.	Participates in surgical arm actuation through precision servo systems enabling vibration-free instrument positioning.
TKR	Core supplier of precision transmission components including harmonic and cycloidal reducers used in humanoid limb joints.	High direct robot content via reducers, actuators, and bearings embedded within articulated joints. Also exposed to linear motion adjacencies through RTUs expanding reach.	Exposure in micro-mechanical transmission, including miniature gearboxes and bearings enabling micron-level surgical precision.
ALNT	Frameless torque motors align with humanoid joint architectures. Limited commentary from management.	Participates in high-performance motion niches including robot actuation, cobot joints, and mobile robotics drive systems.	Supplies torque motors and frameless actuation systems embedded within surgical robotic arms and instrument articulation modules.
CGNX	Limited direct exposure	Core positioning in vision-guided robotics, supplying vision systems enabling bin picking, guidance, and inspection.	Limited direct exposure
GTES	Limited direct exposure	Indirect but scalable exposure through synchronous conveyor systems supporting automation infrastructure.	Limited direct exposure
HLIO	Limited direct exposure	Benefits from automation infrastructure and robotics-adjacent machinery rather than articulated robot arms themselves; core exposure in electro-hydraulic motion.	Limited direct exposure

Installation of Industrial Robots by Industry

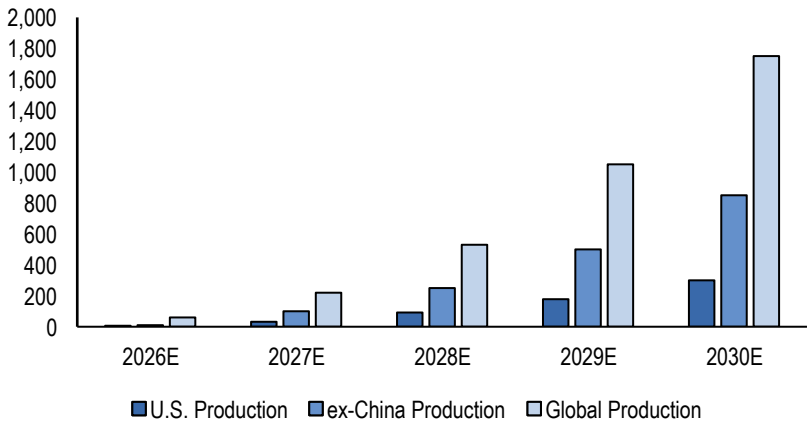
	Primary Function	Major Constraints	Key Components
Perception Stack	Enable robots to see, localize, and inspect objects in real time	Lighting variability, cycle-time latency, pose and location estimation accuracy	2D / 3D machine vision cameras, Depth sensing systems , AI vision software, Calibration & robot alignment tools
Control & Drive Systems	Coordinate robot motion across multiple axes safely and precisely	Multi-axis synchronization, latency, safety certification	Servo drives, Motion controllers, Safety-rated control systems, Power distribution & thermal management
Actuation System	Generate rotational or linear motion at each robotic joint/axis	Must provide high torque density and positional precision for industrial duty cycles	Servo motors / frameless torque motors, Brushless DC motors, Integrated actuator modules, Motor feedback encoders
Transmission & Joint Mechanics	Convert motor output into usable torque while maintaining accuracy and rigidity in each joint	Must deliver high reduction ratios with minimal backlash	Harmonic and cycloidal reducers, Planetary gearboxes, Precision bearings, Couplings and shaft interfaces
Linear Motion & Work Envelope	Extend the robot work envelope and enable multi-station servicing through guided linear travel	Must maintain positional repeatability and structural rigidity under high dynamic loads	Linear rails and guides, Linear actuators, Belt-driven track systems, Rack-and-pinion drives
Material Handling Infrastructure	Transport raw materials, work-in-progress, and finished goods into and out of cobot cells	Must sustain continuous high-throughput operation with minimal maintenance and downtime	Conveyor and synchronous timing belts, Pulleys and sprockets, Conveyor drive motors, Couplings and bushings
Mobile Robotics & Logistics	Autonomously transport materials between workcells, warehouses, and production zones	Balance energy efficiency, traction control, and navigation precision	Wheel drive motors, Steering actuators, Gear transmissions and bearings, Belt-driven drive interfaces

Source: Company data, J.P. Morgan, UBTECH.

U.S. Humanoid TAM: Unmasking the Real Market Potential

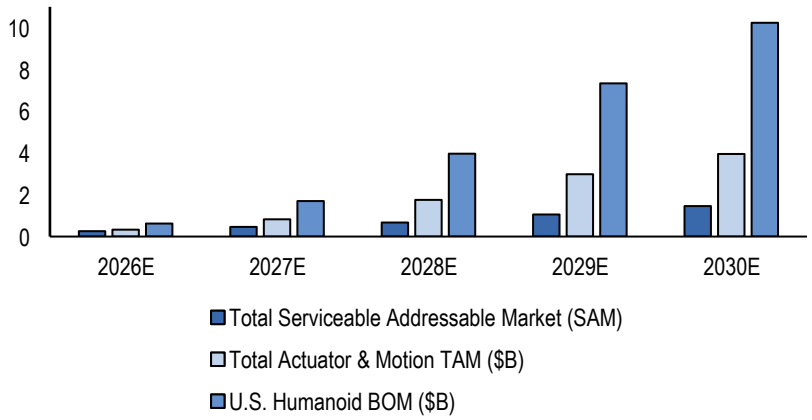
- **Bottom-up framework:** Our U.S. humanoid TAM is built from a unit production ramp across U.S./Western humanoid OEMs, anchored to disclosed factory capacity, guidance statements, and production milestones, with utilization ramps where disclosure is limited
- **Scale inflection (units)**: Base-case U.S. humanoid production scales from <6k units (2026E) to >300k (2030E), implying a meaningful volume base to drive component demand
- **Global context / share**: Under this framework, the U.S. represents >300k units by 2030E (~17% of Karen's global TAM), and broadly consistent with the Rajat Gupta's B2B + B2C global TAM.
- **BOM translation (why TAM matters for coverage):** Our unit build is translated into a BOM framework using company-specific COGS assumptions, with focus on actuation and motion content as the most direct value pool for our coverage universe
- **Actuator & motion TAM scales to ~$4bn** by 2030E, with actuator/motion content stepping down from ~53% of BOM to ~39% as production matures
- **Serviceable Obtainable Market**: Bridging TAM to SOM, we account for content variations, competitive intensity, and OEM insourcing and we estimate ~$500M SOM by 2030.

U.S. Humanoid Robotics Production by Top Players



Note: Units in thousands
Source: J.P. Morgan estimates

U.S. Humanoid Actuators & Motion TAM, SAM, COGS



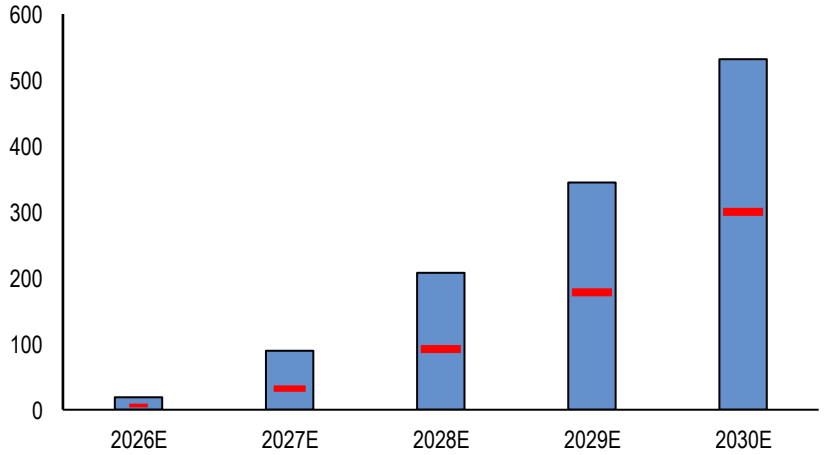
Note: In billions ($)
Source: J.P. Morgan Estimates

J.P.Morgan

U.S. Humanoid TAM: Demand Much Higher Than Supply

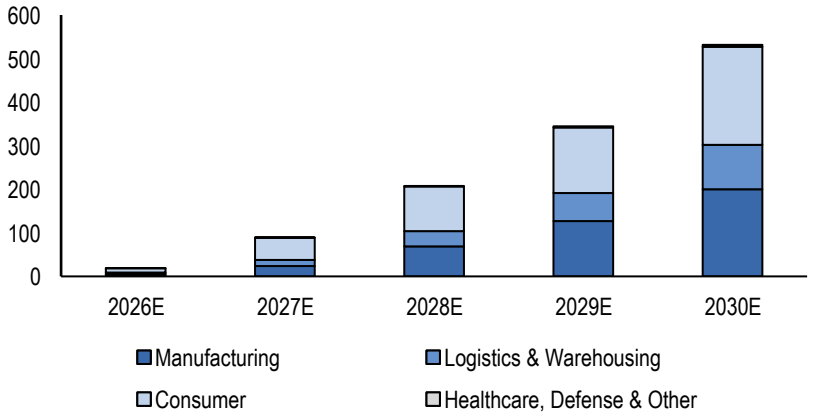
- **Labor Shortages & Augmentation vs Replacement:** We believe Enterprise upside is driven through labor shortages (rather than labor replacement) with humanoids unlikely a 1-to-1 solution currently.
- **Demand > Capacity:** Our product estimates (~300k production by 2030E) remain well below our demand estimates (>500k by 2030E).
- **Manufacturing, Logistics, & Warehousing Driven**: Even when removing consumer from our estimates, Manufacturing, Logistics, & Warehousing demand remain above our current production estimates.

U.S. Humanoid Robot Demand vs Production Capacity



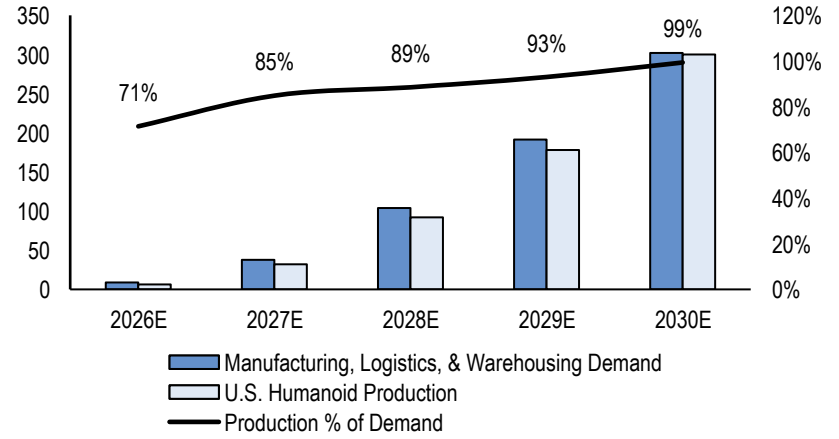
Note: Red = estimated U.S. Humanoid Robot Units Production (k)
Source: J.P. Morgan estimates

End Market Demand Breakdown



Note: In thousands
Source: J.P. Morgan estimates

Production vs Enterprise Demand



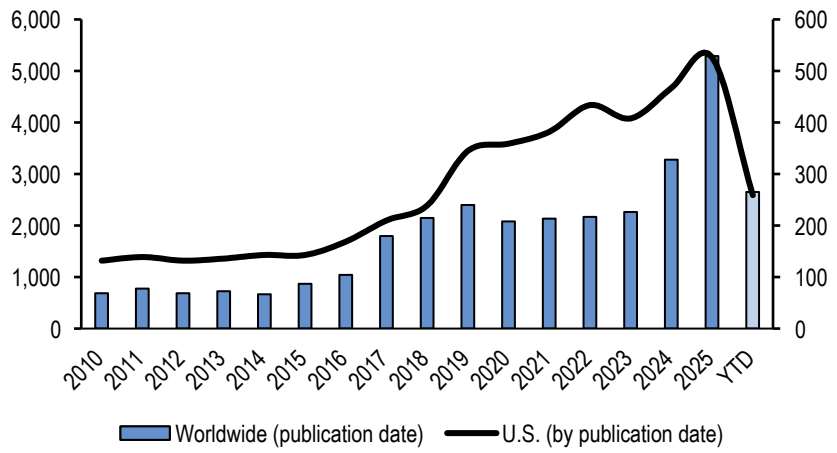
Note: In thousands
Source: J.P. Morgan estimates

Note: SOM = Serviceable Obtainable Market, SAM = Serviceable Available Market, TAM = Total Addressable Market

Patent Pulse: Tracking Innovation in U.S. Humanoids

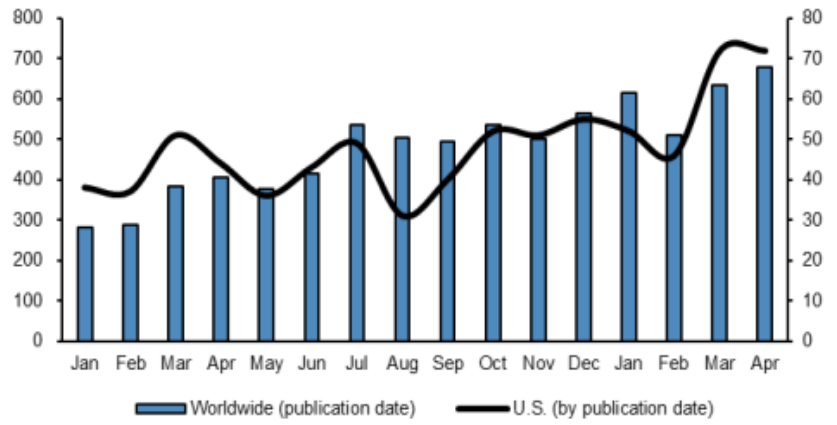
- **Acceleration in Patent Publications:** Patent activity signals a real innovation acceleration with YTD U.S. publications referencing “humanoid” up >180% and global publications up >300% since 2015
- **Momentum remains strong into 2026:** Global patent publications surged ~61% YoY in 2025 and are up ~80% YTD, while U.S. publications are up ~40% YTD
- **IP leadership is not just OEMs:** There is a meaningful rise of component manufacturers and end users as major sources of innovation, implying value creation is distributed across the supply chain
- **Competitive takeaways:** Even within U.S. Patent Office publications, international companies account for a substantial portion of humanoid patent activity supporting a more diversified supply chain within the U.S. market

Global Patents that Mention “Humanoid Robot”



Source: Google Patents, J.P. Morgan

Global Patents that Mention “Humanoid Robot” Monthly

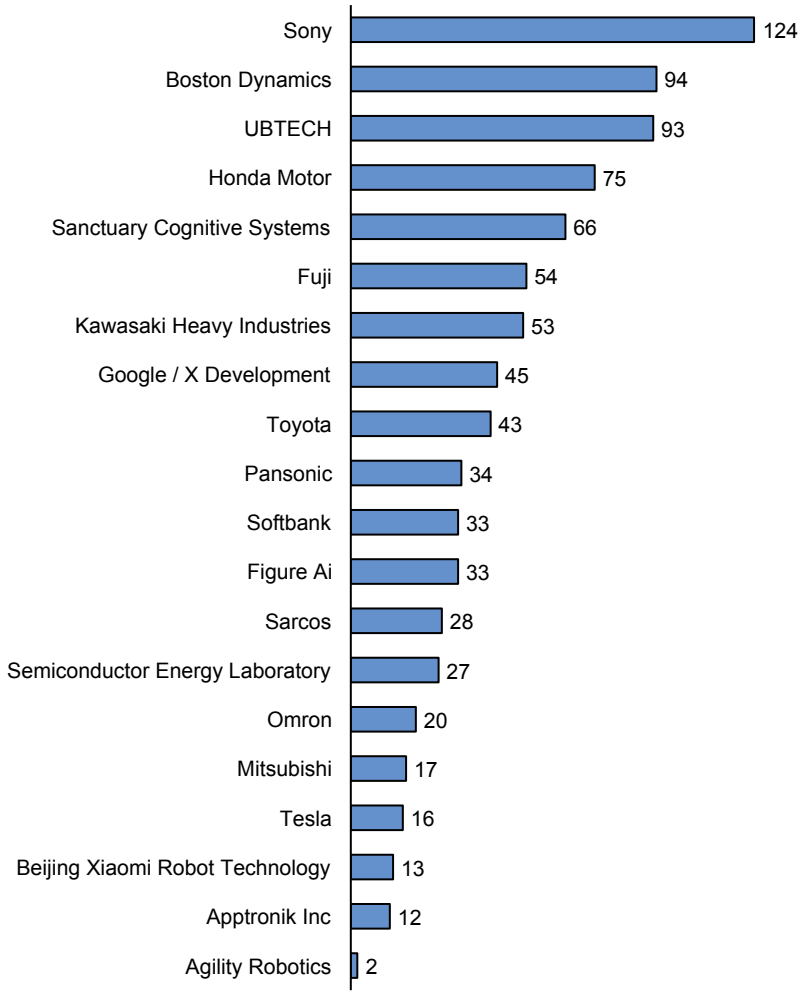


Source: Google Patents, J.P. Morgan

Note: Patent date = publication, deduplicated by publication, and type = patent; U.S. Patent Refers to Patent Office; Date as of 7/2/26.

Patent Pulse: Tracking Innovation in U.S. Humanoids

Patents that Mention "Humanoid Robot" Since 2020



Note: Patent Office = WO, U.S.

Source: Google Patents

Source: Date as of 4/13/26

Patent Portfolio of U.S. Humanoid Companies Since 2020

Company	Publications	Families
Boston Dynamics	421	98
Sanctuary AI	263	74
Google / X Development	195	83
Tesla	83	18
Figure AI	54	33
Apptronik	36	18
Agility Robotics	33	19

Source: Google Patents, J.P. Morgan

Excluding U.S. Humanoid Companies Since 2020

Company	Publications	Families
UBTECH Robotics	626	458
Kawasaki Heavy Industries	235	149
Toyota	146	64
Xiaomi Corp	142	60
AgiBot	129	97
Leju Robotics	123	96
Fourier Robotics	96	68
XPENG Robotics	34	31
Rainbow Robotics	34	9
Noetix Robotics	32	30
Tokyo Robotics	27	14
Unitree Robotics	21	14

Note: Publications & Families where the patent mentions "Humanoid" since 2020; Patent date = publication; type = patent; Date as of 4/13/26

Source: Google Patents, J.P. Morgan

Humanoid Robotics: Creating the Humanoid Body

- **Science Behind Smooth and Safe Robot Movement**: Smooth/safe motion is driven by actuation and controls plus thermal management, sensor/perception stacks, and safety features (collision detection, fall avoidance, speed/separation monitoring).
- **Design complexity is creating a component upcycle**: Robots with 20-50+ axes increase demand for motors, drives, reducers, bearings, and feedback. Performance is increasingly constrained by torque density/weight/heat/energy dissipation and higher back-drivability/passive compliance standards
- **Humanoid economics are joint/BOM-driven (not just software-led)**: Value concentrates in the multi-axis actuation stack (arms/legs/drives), favoring suppliers with precision joint ownership that can pair performance with manufacturability and cost-down, supported by scalable production and a durable service ecosystem as OEMs lock partners early and platforms scale

Recent Commentary from Our Coverage

Recent Commentary from our Coverage:

"We are participating in that as well. We share in that excitement. We're working with OEMs on key programs. And we're certainly looking forward to success in that market. ***But I would say that's still early.*** It's still at a prototyping and the designing phase."

– Timken 4Q25 Earnings Call

"We are gaining momentum here. So much so that our humanoid offering ***could start moving the needle*** on our enterprise sales growth rate over the next few years." "We continue to ***gain traction with humanoid OEMs*** and selling our sub-assembled AXI solutions. And so from a perspective of our expectations is double-digit growth in robotics." "There's also ***lots of potential in humanoids and that's gaining traction.***"

– Regal Rexnord 1Q25 and 4Q25 Earnings Calls

Source: Company data

Deconstructing a Humanoid's Bill of Materials

	Primary Function	Major Constraints	Key Components
Head & Neck	Environmental awareness, interaction	Low inertia, fast response, tight packaging, minimal thermal load	Compact rotary actuators, High-resolution encoders, Lightweight bearings optimized for low radial loads
Arms & Shoulders	Manipulation, reach, task execution	High torque density, smooth velocity control, low backlash, thermal stability.	High-torque servo motors, frameless torque motors, Harmonic or cycloidal reducers, High-load bearings capable of mixed axial/radial forces, Multi-axis drives
Hands & Fingers	Grasping, fine manipulation	Miniaturization, low inertia, high positional resolution, force sensitivity.	Micro motors, miniature gearing, strain-wave gearing, high-res encoders, lightweight bearings
Legs & Hips	Locomotion, balance, load-bearing	Extreme torque, fatigue resistance, safety, backdrivability.	Large-fr precisio
Torso	Coordination, rotation, balance	Structural rigidity, synchronization, reliability.	Servo m bearings
Feet & Interface	Contact sensing, balance correction	Precision sensing, durability, safety.	Ankle be forstab
Nervous System		Latency, synchronization, safety, thermal management.	Motor d thermal

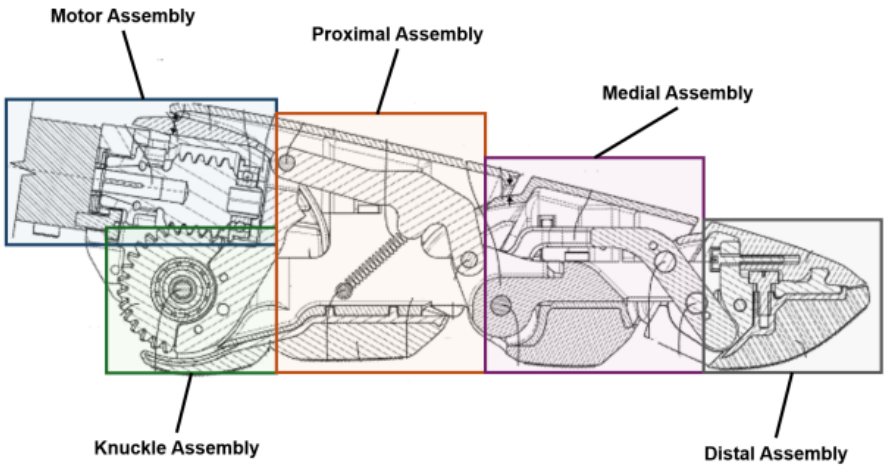
Source: Company data, J.P. Morgan

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更多资料请加V

Inside the Machine: Unpacking U.S. Humanoid Components

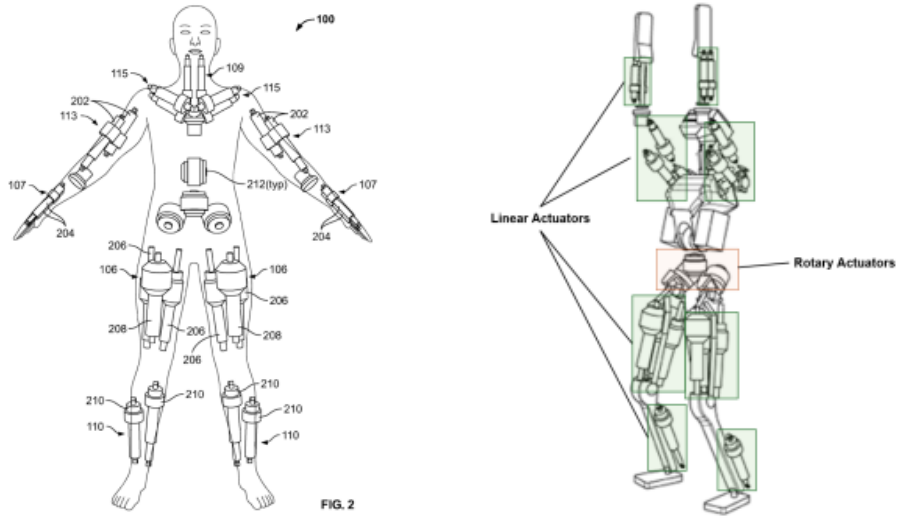
- **Humanoids are actuator-dense systems:** a typical robot may require ~20 to 40+ actuator assemblies depending on degrees of freedom, making actuation/motion a primary BOM cost pool
- **Example architectures show large spec-in surface area**: Agility's Digit has 26 actuators across arms/legs, with each actuator including a cycloidal drive, motor, and two encoders
- **Component opportunity** is concentrated in motors/drives, reducers/gearing, bearings, and encoders

Component Breakdown of Figure AI Finger



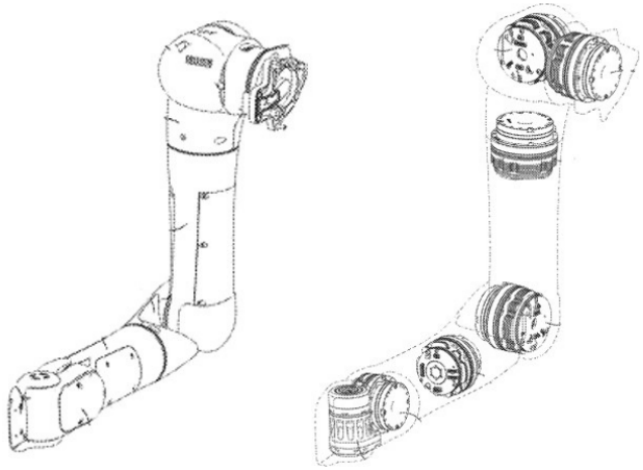
Source: Company reports, Google Patents, J.P. Morgan

Breakdown of Actuators Within a Humanoid



Source: Company reports, Google Patents, J.P. Morgan

Agility Actuator Breakdown in Robotic Arm



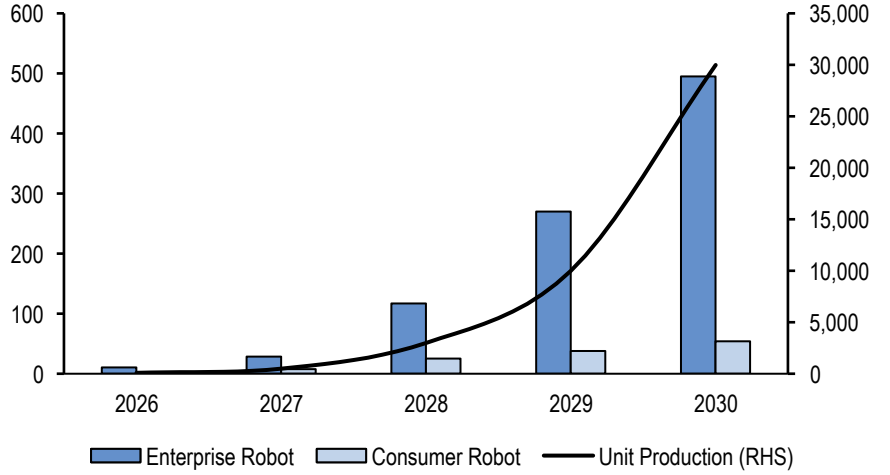
Source: Company reports, Google Patents, J.P. Morgan

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Humanoid Robotics: Enterprise vs Consumer Opportunity

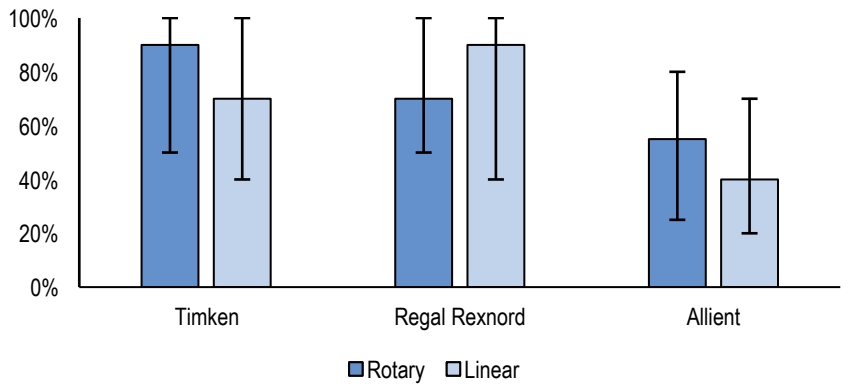
- **Bifurcated Humanoid Market: Favor Enterprise:** We believe in a bifurcated humanoid market, with the largest upside for our coverage in Enterprise.
- **Single OEM Component Wins Drive Upside:** We estimate a single enterprise company can generate ~$500M in revenue for our coverage.
- **Content Potential:** We estimate TKR and RRX can contribute 70-80% of the entire actuation stack for an OEM (~25-40% of BOM), while ALNT can contribute to ~20-50% of the actuation stack. Favor TKR > RRX > ALNT, with the greatest upside potential from ALNT.

Enterprise vs Consumer Revenue Model



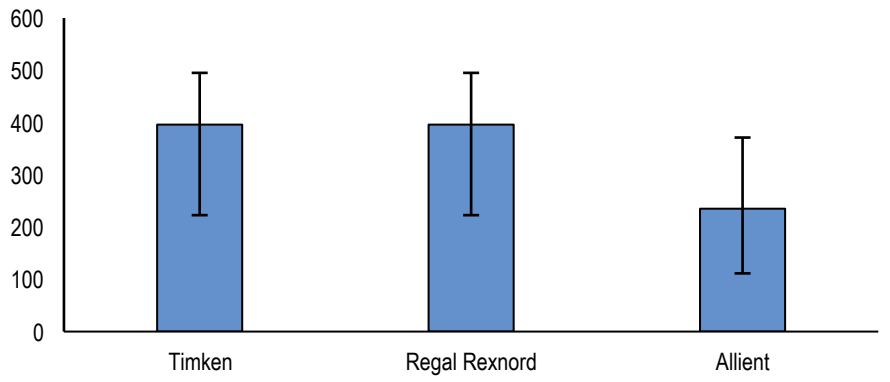
Note: Actuation & Motion revenue ($M)
Source: J.P. Morgan estimates

Est. Humanoid Actuation & Motion Content Win Potential



Source: J.P. Morgan estimates

Est. Revenue Potential for 2030 Enterprise Content Win



Source: J.P. Morgan estimates.

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Our Coverage Companies: Components & Offerings

- **RRX Kollmorgen & Portescap**: Portescap supplies high-torque, lightweight DC/BLDC miniature motors enabling human-like dexterity (hands/fingers/wrists). Kollmorgen TBM2G frameless servos deliver high torque-density, precise multi-jointing actuation (limbs/torso)
- **TKR Cone Drive and SPINEA:** Cone Drive provides strain wave solutions for powerful, highly accurate movement in small space. SPINEA produces cycloidal drives and its TwinSpin bearing + reducer for smooth, ultra-precise positioning in factory automation
- **Allient** provides high torque-density direct-drive motors/actuators for ultra-precise joint motion supporting a full, plug-and-play motion stack

TBM2G Frameless Motors (Kollmorgen)



Source: Company reports

Allient Components Offering



Source: Company reports

SPINEA Cycloidal Gearing



Source: Company reports