

REA·011 · ROBOTICS & AUTOMATION

Uptime Is the Product

Robot Fleet Reliability, the Lifecycle Gap, and the Opportunities Inside the Failures

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Abstract

Deployed robots are fleet assets, and the robotics industry has not yet built the discipline that keeps a fleet earning. What a buyer actually pays for is uptime, not intelligence.

The evidence arrived in little more than a year. Amazon is building a \$100 million Indiana plant to make the physical equipment of its million-robot network, and its maintenance arm, named Reliability and Maintenance Engineering, trains its own robot technicians. UPS ordered 400 trailer-unloading robots from a maker that had about a dozen in the field a year earlier. Attabotics, which had raised about \$200 million, collapsed with systems still running in customers' buildings. And in April 2026, the U.S. mobile-robot safety standard added a part that puts in-service duties on the user.

This paper maps six gaps in the robot lifecycle, from pricing a subscription on a short failure record to retiring a machine with no resale market. It shows that fleet maintenance solved most of them a generation ago, identifies eight businesses and roles hiding inside the gaps, and sets out three futures through 2032. The conclusion is simple. The robot that wins will not be the cleverest one. It will be the one still working on a wet Tuesday in February, three years after the demo.

How to Read This Paper

Every substantive claim is tagged, so the reader always knows how much weight it can bear.

Tag	What it means	How to use it
GROUNDED	Documented fact, linked to a public source	Cite it
ANALYTIC	Inference from grounded facts and established maintenance practice	Test it against your own operation
PROJECTION	A forward estimate with a stated mechanism	Watch the indicators in the final section
SPECULATIVE	A possibility worth naming, not yet in evidence	Hold it loosely

This paper builds on [REA-006, "Own, Lease, or Rent the Robot"](#), which treated the financing decision. Here the question is what happens after the robot arrives: who keeps it running, at what cost, and for how long.

The Signal From Greenwood

Amazon's new Indiana plant is not a robot factory in the glamorous sense. It is a steel shop built to keep a fleet of more than a million machines supplied, and that is exactly why it matters.

GROUNDED. On September 25, 2026, Amazon announced a 585,000-square-foot plant in Greenwood, Indiana: more than \$100 million, 300 jobs, opening by 2028 ([Robotics 24/7](#)). It will combine fabrication, robotic welding, automated powder coating and assembly. The posted roles are CNC operators, welders, powder-coating technicians, assemblers, and manufacturing, quality and controls engineers. Amazon says it has built more than one million robots in the U.S., working in more than 300 facilities and touching 75% of the orders it delivers worldwide.

ANALYTIC. Read that job list again. There is not an AI researcher on it. Greenwood will make the frames, structures and physical equipment of fulfillment, the parts that bend, wear, corrode and get replaced. Nobody integrates backward into welding and powder coat to chase novelty. They do it to control supply, cost and the design-for-service loop on equipment they already cannot run without.

GROUNDED. The same logic runs through Amazon's people. Its maintenance organization is literally named Reliability and Maintenance Engineering, and since 2020 it has run a Department of Labor-validated apprenticeship to grow its own robot technicians ([Amazon Jobs](#)). The program is 12 weeks of paid classroom training followed by 2,000 hours of mentorship under an experienced technician. No prior technical experience is required.

ANALYTIC. Put the pieces together and Amazon has closed the reliability loop on three sides. It builds the machines, it trains the people who fix them, and it owns the failure data from more than 300 sites. That is how a fleet operator thinks, not a technology buyer.

ANALYTIC. Almost no one else buying robots has any of the three. They lease machines they did not design, depend on technicians they did not train, and read failure data through a vendor's portal,

if they see it at all. The distance between Amazon's position and everyone else's is the subject of this paper, and it is where the opportunity lives.

A Robot Is a Fleet Asset

The moment a robot is sold by the hour or the month, its maker stops being a manufacturer and becomes a fleet operator. Most of them have not yet noticed.

The population is arriving now

GROUNDLED. UPS is putting \$120 million into 400 Pickle trailer-unloading robots, deploying across multiple facilities from the second half of 2026 into 2027 ([Sourcing Journal via Yahoo Finance](#)). DHL agreed in 2025 to add 1,000 Boston Dynamics Stretch units. The same report lists UPS robots from Dexterity, Fortna, Plus One, Dane, Geek+, Locus, Crown and Toyota-Raymond.

ANALYTIC. Two things follow. First, by simple division the UPS buy runs about \$300,000 per unloading robot, all-in. That is a tractor-class asset, and it deserves tractor-class lifecycle management. Second, a single operator is now running machines from roughly ten makers. That is a mixed-make fleet, with ten parts catalogs, ten diagnostic portals and ten different ideas of what "due for service" means.

The contract moved the risk, not the work

GROUNDLED. Robots-as-a-service (RaaS) has become a common way to acquire warehouse mobile robots. Locus Robotics sells annual subscriptions with a three-year minimum, licensed per site, with maintenance, support, software updates and target uptime included ([RoboticsTomorrow](#)). inVia goes further, owning, operating and maintaining the robots and pricing by throughput. Formic advertises full maintenance with contracted uptime guarantees ([Warehouse Fieldbook](#)).

GROUNDLED. The fine print draws a line through the middle of the reliability problem. Under Locus's terms the customer supplies smooth floors, power at the chargers and a dedicated internet line. Locus furnishes consumables such as wheels, casters and batteries, but the customer provides trained technicians to install them. Hardware that cannot be fixed on site goes home through a return-material process.

ANALYTIC. That is a full-service lease with the shop work pushed back onto the customer's floor. Anyone who has run leased equipment knows the shape. The lessor owns the asset and the PM schedule, the operator owns the conditions the asset works in, and every breakdown opens an argument about which side caused it. Robotics is relearning that argument from the beginning.

The duty cycle is the tell

ANALYTIC. A mobile robot on two 10-hour shifts, 300 days a year, logs about 6,000 operating hours, with constant starts, stops, turns and charge cycles. A long-haul tractor covering 120,000 miles at a 45 mph average logs closer to 2,700 engine hours. The warehouse robot may out-work the truck that delivers its freight. At that utilization, wear is not an edge case. It is the operating condition.

PROJECTION. As RaaS spreads, vendors will carry a rising share of the world's robot reliability risk on their own balance sheets. The ones that price it from real failure data will outlast the ones that priced it like software margin. See REA-008, "The Skeptic's Field Guide," for how a buyer tells the two apart.

Anatomy of Failure

Robots rarely fail the way the brochures imagine. They don't go rogue. They wear out, get dirty, lose their place, and wait for a part.

GROUNDDED. Pickle Robot's own field history makes the point. Its first commercial unit went live in summer 2023, and by late 2024 it had about 12 robots working. Every customer was then upgraded to a new generation with better wheels, a sturdier conveyor, more sensors and an improved gripper ([DC Velocity](#)). One field lesson stands out. The gripper was built to break away under stress, but reattaching it proved slow enough to drag down unloading, so it was redesigned into a one-minute fix. Pickle's product chief put it simply: some behaviors only show up in the real world.

ANALYTIC. Twelve robots in late 2024, an order for 400 from UPS a year later. The field record behind each machine now in service is short, and much of what will fail at scale has not failed yet. A fleet-wide retrofit of every customer is what trucking calls a campaign. Robotics is running campaigns before it has the failure database that usually justifies one.

GROUNDDED. Mobile-base hardware has its own trap. A U.S. patent filing on a field-replaceable AMR drive explains that motor drives are typically not replaced in the field. The robot goes back to the manufacturer, with significant downtime, and dust entering poorly sealed drives causes premature failures ([U.S. Patent 12,240,550](#)).

GROUNDDED. The contrast is the fixed industrial arm. FANUC recommends preventive maintenance every 11,520 operating hours or one year, including reducer grease replacement, grease sampling by axis and encoder battery changes, according to independent service firm TIE Industrial ([TIE Industrial](#)). Forty years of automotive duty built that discipline. Logistics robots have been in volume service for little more than a decade and are mostly still learning it.

The table maps where field failures come from. The ranking matches what maintenance-software vendors report ([example](#)); treat their percentages as marketing, but the physics is sound.

Subsystem	How it fails	What the floor sees	Fleet analogue	Tag
Battery and charging	Capacity fades with cycle count, deep discharge and heat; charging contacts wear	Robots drop out early, chargers queue, the shift runs short of units	Batteries, alternators, charging systems	ANALYTIC
Drive wheels and motors	Tread wears; debris such as shrink wrap and tape fouls wheels; poorly sealed drives take in dust	Position drift, missed stations, emergency stops; the drive ships back to the maker	Tires and wheel ends	GROUNDDED

Subsystem	How it fails	What the floor sees	Fleet analogue	Tag
Perception	LiDAR and camera lenses get dirty; maps go stale after a layout change	Lost localization, phantom obstacles, stop-and-go traffic	Misaligned collision-mitigation radar	ANALYTIC
Manipulation	Grippers, suction cups and reducers wear; breakaway joints trip	Dropped cases, slower cycles, a robot waiting on a reset	Fifth wheels, liftgates, wear items	GROUNDED
Software and updates	A fleet-wide release carries a regression	The whole site slows the morning after an update	An engine-control reflash gone wrong	ANALYTIC
Site and environment	Floors crack, Wi-Fi drops, power sags, dust and temperature swing	Failures blamed on the robot that began in the building	Road conditions, fuel quality, yard surface	GROUNDED

ANALYTIC. Two rows deserve emphasis. Software is the only failure mode that can hit every robot a vendor operates on the same morning, a common-mode risk trucks rarely face. Site is the only one the customer fully controls, and it is the row the RaaS contract quietly hands back.

The Lifecycle Gap

Robotics has engineered the robot. It has not yet engineered the robot's life, and every stage after the purchase order runs partly on improvisation.

Each stage of a robot's life has a gap no one owns yet

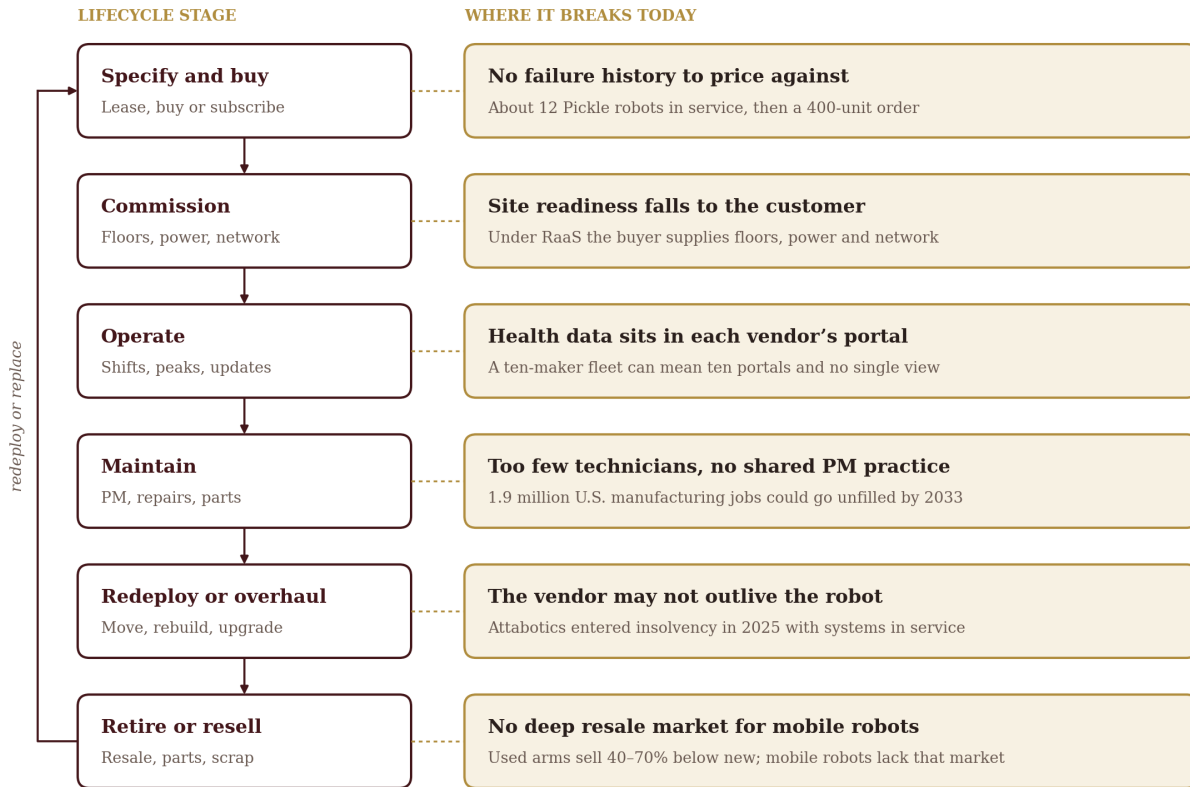


Figure 1. The robot lifecycle: six stages, and where each one breaks today.

The industry's attention sits at the top of this column. The money, over a robot's working life, sits at the bottom.

ANALYTIC. Pricing blind. A RaaS fee is a bet on failure rates. With a dozen units of field history behind a 400-unit order, that bet is being placed on a short record, and someone will eventually pay for the error. If the vendor guessed low, it shows up as margin collapse; if high, as a customer quietly overpaying.

GROUNDLED. Data in silos. Warehouse Fieldbook advises that RaaS contracts spell out who owns operational data, telemetry and incident logs, and what gets exported at termination (Warehouse Fieldbook). It also warns that owned robots can still lock a buyer into vendor-only parts and closed interfaces. **ANALYTIC.** An operator with ten makers on the floor has no fleet-wide view of reliability unless it builds one.

GROUNDLED. Hands on the machine. Deloitte and the Manufacturing Institute estimate U.S. manufacturing could need 3.8 million workers by 2033, with about 1.9 million roles unfilled ([RoboticsTomorrow](#)). The same piece describes a Georgia fulfillment-system builder that now leases its own service mechanics to customers and is hiring 300 more technicians this year. Robo Reliance, a third-party robot service firm, frames the field problem bluntly: a sensor fails at 6 a.m., 900 miles from the nearest company engineer, and every option is expensive ([RoboticsTomorrow](#)).

GROUNDLED. Vendor mortality. Attabotics, a Calgary maker of robotic storage systems, entered insolvency proceedings in July 2025, laid off 192 people, and reported liabilities of \$73.8 million against \$31.6 million in assets ([Warehouse Automation](#), citing [The Logic](#)). Reporting describes an early Nordstrom installation where 12 of 18 robots fell from their tracks or malfunctioned in the first two days. One former staffer recalled, "We hired an army of people just to babysit it." The brand has since been relaunched under new owners, but industry observers warned that systems already installed risked becoming expensive, unsupported hardware.

GROUNDLED. No exit value. Used industrial arms from FANUC, KUKA, ABB and Yaskawa trade in a real secondary market, typically 40 to 70 percent below new ([iGAM](#)). **ANALYTIC.** Mobile robots have nothing comparable yet. Their value is tied to a vendor's software, maps and support, and under RaaS the unit simply goes home at term end, so no residual value forms.

The standard just moved the duty onto the user

GROUNDLED. On April 23, 2026, A3 published the full ANSI/A3 R15.08 series for industrial mobile robots. Part 3, all new, sets safety requirements for the continued safe use of mobile robot applications in day-to-day operations, aimed squarely at users ([A3](#)).

ANALYTIC. That changes who answers for an unmaintained robot. Parts 1 and 2 governed builders and integrators. Part 3 reaches the operator who owns the floor, the shift and the maintenance log, which is the kind of in-service duty motor carriers have lived under for decades.

What Fleet Maintenance Already Solved

Almost nothing in the lifecycle gap is a robotics problem. It is a fleet problem wearing new clothes, and fleet operators solved most of it a generation ago.

ANALYTIC. Trucking, equipment rental and forklift fleets spent decades learning to keep high-utilization machines earning under thin margins and outside scrutiny. The table translates that discipline row by row. The right-hand column is this paper's assessment of where robot fleets stand today.

Fleet discipline	What it does	Robot-fleet equivalent	Where robotics stands
PM by meter, not calendar	Services the machine on actual use	PM by operating hours, charge cycles and pick counts	Mature on industrial arms; uneven on mobile fleets
Pre-shift inspection	Catches damage before the machine works	Shift-start walkaround of wheels, lenses, bumpers and charge contacts	Ad hoc; R15.08-3 now puts in-service duty on users

Fleet discipline	What it does	Robot-fleet equivalent	Where robotics stands
Out-of-service criteria	Defines when a unit must be pulled, removing judgment calls	Pull thresholds for battery health, tread wear and sensor calibration age	Set vendor by vendor, if at all
Tread depth and wheel-end checks	Measures wear before it becomes failure	Wheel tread gauging and drive-current trending	Possible today; rarely standardized
Fault codes and oil analysis	Reads the machine's condition from its own data	Motor-current signatures, controller logs, error clusters by floor location	Data exists; it sits in vendor portals
Campaign and warranty recovery	Makes the maker pay for its defects	Tracking retrofits, return authorizations and uptime credits	Only as strong as the contract's remedy clause
Cost per mile	One number that compares every unit and option	Cost per operating hour or per useful pick	Pricing is quote-based and hard to compare
Planned replacement cycle	Trades units before repair cost climbs	Refresh at the battery or drive-overhaul point	No resale data to set the cycle
Mixed-make parts strategy	Keeps common wear parts on the shelf	Cross-vendor spares for wheels, batteries and contacts	Ten makers, ten catalogs
Qualified-technician files	Proves the person who did the work was competent	Platform certification before a technician touches the robot	Emerging; some field-service firms certify per platform

GROUNDLED. Several rows already have proof points. FANUC's recommended PM interval for its arms is meter-based. Warehouse Fieldbook urges buyers to compare automation by cost per useful transaction and to treat an SLA without a remedy as weak. Robo Reliance trains and certifies its technicians on each client's platform before dispatch.

ANALYTIC. What is missing is not knowledge but transfer. The people who know how to run a meter-based PM program across a mixed-make fleet already exist. They run trucks, rental yards and forklift operations, while robotics companies have recruited mostly from engineering and software. That is the opening this paper is really about.

Where the Failures Create Opportunity

Every gap in the lifecycle is a job no one is doing yet, and a job no one is doing is a business waiting for an owner.

The table sorts eight openings from most proven to most speculative. "Proof it's real" names the evidence; the tag says how much weight it bears.

Opportunity	Gap it closes	Who pays	Barrier to entry	Proof it's real	Tag
Multi-platform robot field service	Too few hands on the machine	Robot makers and operators	A trained, certified local technician network	Robo Reliance; a Georgia builder hiring 300 service technicians	GROUNDED
Fleet health analytics across vendors	Data locked in ten portals	Operators	Data rights and integrations	A truck-fleet maintenance platform now schedules robot PM by hours or cycles	GROUNDED
Reliability and lifecycle engineering inside RaaS vendors	Pricing on a short failure record	The vendor's own balance sheet	Credibility with engineers; access to field data	Pickle's fleet-wide retrofit of every customer	ANALYTIC
Independent SLA and uptime audits	Remedies no one enforces	Buyers and CFOs	Independence and a defensible method	Buyer guides warning that SLAs without remedies are weak	ANALYTIC
R15.08-3 compliance programs	New in-service duties on users	Operators and their insurers	Command of the standard; records discipline	Part 3 published April 23, 2026	PROJECTION
Refurbishment and redeployment of mobile robots	No exit value	Operators, lessors, used-equipment dealers	Software licenses that don't transfer	A 40 to 70 percent-off market already exists for arms	PROJECTION
Orphan-fleet support and software escrow	Vendors that fail mid-life	Operators	Parts stock, source access, legal standing	Attabotics; Tesco buying hardware but writing its own software	PROJECTION
Loss data for insurers	Risk no one has priced	Insurers and reinsurers	Claims history that barely exists	Attabotics fires, one traced in filings to a charger fault	SPECULATIVE

The disputes are already here

GROUNDED. Where machines fail, lawyers follow. Indiana-based Bastian Solutions, which resold Attabotics systems, sued its supplier after an end customer, Accelerate360, alleged the system failed to perform. The complaint claimed a software update had made the system unworkable and that staff failed to show up at the site ([Warehouse Automation, citing The Logic](#)). An Indiana federal judge ruled for Attabotics at the end of 2024, finding Bastian had not proved a breach.

ANALYTIC. Read that case as a preview. Its questions were the questions of fleet maintenance. Was the update the cause? Was the site ready? Did the service crew show up? Who held the records? Robot contract disputes will need experts who can answer those questions from operating experience, not from the lab.

Who is positioned to capture these

ANALYTIC. The engineers who design robots will build the machines. The openings above go to people who know how to keep machines working for money: reliability engineers from mobile equipment, fleet maintenance managers, compliance professionals who have lived under in-service rules, and operators who have priced a lease against a breakdown. Most of these roles can be done as advisory, fractional or independent work, because the scarce input is judgment, not presence on one floor.

Three Futures, 2026–2032

The robot population will grow in every scenario. What differs is who learns to keep it running, and how much pain it takes to learn.

PROJECTION. Likelihoods are this paper's judgment, not a model output. They are offered to be argued with.

Scenario	What happens	Signal it is arriving	Where the opportunity concentrates	Likelihood
The Fleet Matures	RaaS vendors build real reliability organizations. Third-party service networks scale, and R15.08-3 turns robot inspection into routine practice.	Uptime credits and data-export clauses become standard contract language; vendors hire maintenance leaders from other fleets	Reliability engineering, compliance programs, field-service networks	45%
The Reliability Reckoning	Another wave of vendor failures strands fleets mid-life. RaaS is repriced, insurers start asking hard questions, and buyers demand audits.	A second Attabotics-scale insolvency; insurers add robot-maintenance questions to renewals	Orphan-fleet support, independent audits, expert testimony, loss data	35%

Scenario	What happens	Signal it is arriving	Where the opportunity concentrates	Likelihood
Vertical Giants	Amazon-scale operators internalize everything: machines, technicians and data. The mid-market lags, and independent service stays thin.	Large operators announce in-house robot manufacturing or technician academies; third-party service firms struggle to reach density	Inside the giants' own reliability organizations; consulting for the mid-market left behind	20%

ANALYTIC. Verdict. The two leading rows may be a sequence rather than rivals. Industries usually mature after a reckoning teaches buyers what an unpriced failure costs. In each of the three futures, the scarce skill is the same: keeping a mixed population of machines earning past the warranty. Anyone who can do that is positioned in every column.

What to Watch

Eight indicators will show which future is arriving, most of them before the press notices.

- **The UPS and DHL rollouts.** About 400 Pickle units and 1,000 more Stretch units are entering service through 2027. Watch for reported uptime, retrofit campaigns, and whether either operator brings maintenance in-house.
- **RaaS contract language.** Uptime defined at the throughput level rather than the robot level, service credits with teeth, and data export at termination would all signal maturing buyers.
- **R15.08-3 in practice.** Watch for documented inspection programs, insurer questionnaires that cite the standard, and the first incident where it is invoked after the fact.
- **The next vendor failure.** What happens to its installed fleet matters more than the failure itself: who buys the assets, who supports the robots, and whether customers had escrow.
- **Field-service density.** Multi-platform service firms reaching enough local robots to keep technicians busy is the tipping point for independent maintenance.
- **Used mobile-robot prices.** The first steady resale prices for AMRs would mean residual value is finally forming, and lifecycle planning becomes possible.
- **Technician pipelines.** The scale of apprenticeships like Amazon's, and wage pressure on robot technicians, will show whether the hands-on-the-machine gap is closing or widening.
- **Greenwood itself.** When the plant opens by 2028, its output mix will reveal how much of Amazon's robot budget is spent on new machines and how much on keeping the old ones running.

Sources

All pages were opened on October 1, 2026, except where noted. Vendor and trade-press material is used for what it documents, not for its marketing claims.

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Related Applied Futures Research papers: REA-005, "The Pilot Trap"; REA-006, "Own, Lease, or Rent the Robot"; REA-008, "The Skeptic's Field Guide: Evaluating Robotics Vendors."