FutureBridge

VALUE PROPOSITION

BUILDING THE FUTURE

The Rise, Impact, and Future of Robotics in Construction and Industrial Services

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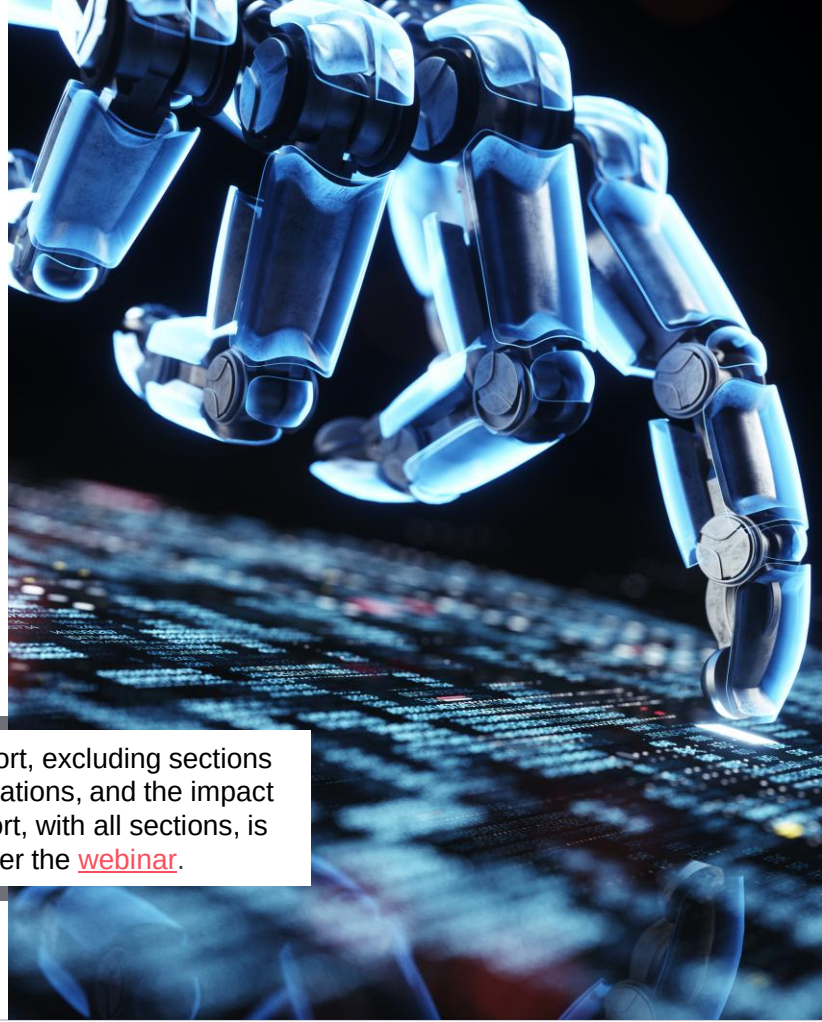


This is a redacted version of the report, excluding sections on industry trends, technical specifications, and the impact of robots on processes. The full report, with all sections, is available upon request at no cost after the webinar.

Join the WEBINAR to uncover all details.

01 Automation and Need for Robotics in Construction and Industrial Services

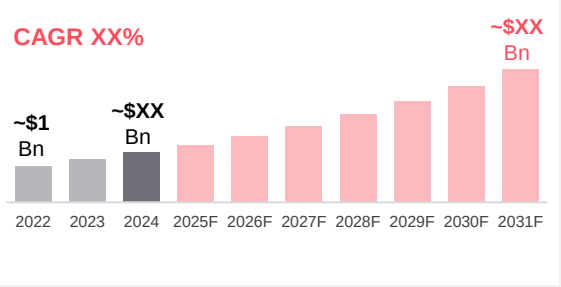
In recent years, robots have rapidly integrated into construction and industrial services, with automation now present at nearly every stage of the construction value chain.

What is fuelling growth of Construction Robots?

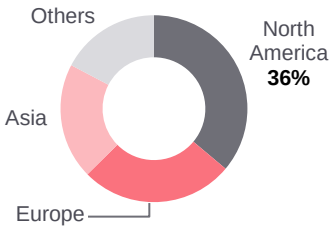
Precision
Operational Efficiency
Accuracy
Safety
Remote Control
High Quality
24*7 Monitoring
Ease of Adoption
Inspection Needs
Enhanced Capabilities
Hazardous environments
Inspection Needs
Labour Shortage
Low Maintenance
Worker Safety Regulations
AI/ ML capabilities
Customer demand
Fatality Rates
Technology Advancements
Waste Reduction
Operational Speed
Urbanization
Operational Speed
High Productivity
Sustainability
Competitive Edge
Smart Sensing
Co-working Capabilities
Edge Computation
Financial Incentives

Construction Robotics is a rapidly growing market, limited to certain applications and regions, but set for expansion with significant growth potential

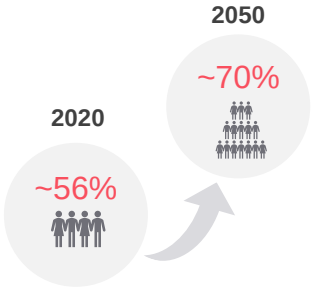
Market of Construction Robots
(Billion USD)

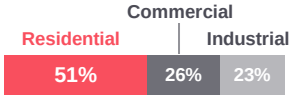


Construction Robot Market size across various Geographies



Projection of People Living in Cities





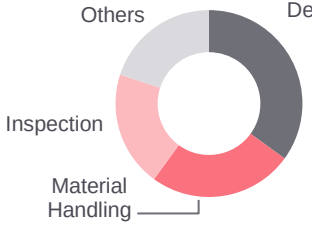
Residential Use segment within the construction robot market held a dominant market position, capturing more than **50% share**

- *Share of people living in urban areas globally will increase from 56% in 2020 to 70% in 2050*
- *Robots will be deployed full-fledged for major construction tasks going forward to meet the increasing housing demand in cities*

~14,000

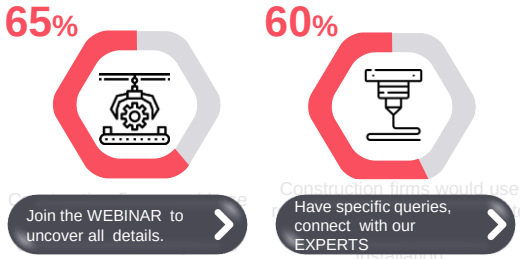
Buildings need to be constructed daily by 2051 to accommodate increasing population

Market by Segment



Demolition robots account for the **largest revenue share** of **~35%** and is expected to grow at a **CAGR** of **18%** over the forecast period

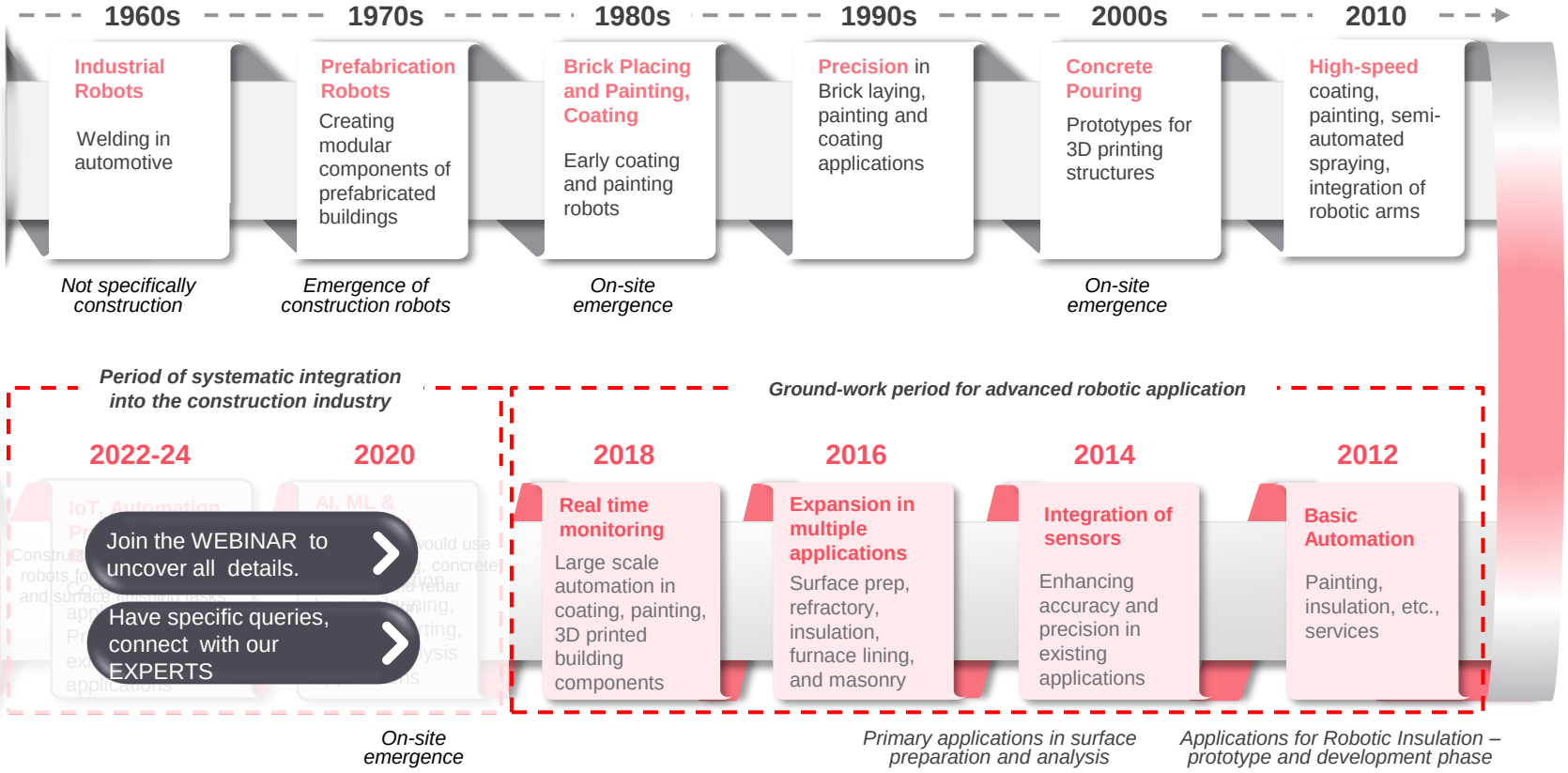
Expected Robot Adoption in Various Services/ business segments



Source: 1, 2, 3, 4, 5, 6, 7, 8, 9

02 Construction Robots: Evolution Types, and Prominent Applications

After 50 years in basic construction, robotics have quickly expanded into new applications over the past decade.



Ecosystem of Construction and Industrial Service Robots

Masonry and Concrete Finishing

CONSTRUCTION ROBOTICS, FBR, fastbrick, Nanjing Mason Automation Technology Co., Ltd, HYUNDAI, DAFANG AI, okibo, DERUTU, ctapa, ChangeMaker 3D, Kappa

Painting and Coating

okibo, FANUC, ROBOSURF, KUKA, Hapag-Lloyd, CANVAS, JAKA, ABB, YASKAWA, STÄUBLI, ADAPTEC SOLUTIONS, BOTA, qlayers, TAIKUBO, UNIVERSAL ROBOTS, DAFANG AI, Daido Engineering, Kawasaki Robotics

3D Planning, Layout Scanning and Mapping

Boston Dynamics, RUGGED ROBOTICS, Robotnik, AMVbotics, CIVROBOTICS, hp, DUSTY ROBOTICS, roboception, CATERPILLAR, Forsight, GeoShack

Material Handling

ABB, Boston Dynamics, Built robotics, JHRobotics, Inc., MiR, cross, KUKA, YASKAWA, SOLUTIONS, Kawasaki Robotics, CATERPILLAR, MIRAI-LAB Inc., TERADYNE, ASUKA CORPORATION, World System Inc., UNIVERSAL ROBOTS, Continental, SHMZ, KOBOT, MITSUBISHI ELECTRIC, FUJITA

Abrasive and Demolition Applications

UNIVERSAL ROBOTS, YASKAWA, UMEÅ INSTITUTE OF DESIGN, vertidrive, ARE, Kawasaki Robotics, Henan Boy Machinery Co., Ltd., MES, Husqvarna, Augmentus, EMPIRE, BROKK, JHRobotics, Inc., Blastman, CONJET

Hostile Environment Applications

Welding & Bonding Applications

Specialized Applications

NDT, Inspection, etc.,

Join the WEBINAR to uncover all details.

Have specific queries, connect with our EXPERTS

03 Different Kinds of Robot, Technical Features and Interesting Developments

What Defines a Construction Robot?

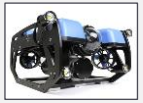
A Comprehensive Look at Its Physical Framework and Intelligent Control Algorithms

Mobility

Tracked Robots
- Crawlers
- Guided Vehicles

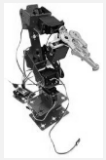
Wheeled Robots

Legged Robots
- Humanoid
- Bipedal
- Quadrupedal
- Hexapedal



Marine & Aerial
- ROVs | AUVs
- UAVs | Drones

Manipulators/ Robotic Arms



Industrial Arms

Specialized Arms

COBOT Arms

SCARA
(Selective Compliance Assembly Robot Arm)

Parallel-kinematic Arms
(Delta Robots)

End Effectors

Grippers
Vacuum, magnetic, and multi-fingers

Service Tools
Welding torches, Spray nozzles, painting & coating nozzles

Machine Tools
Sorting, breaking, excavating tools, trenching, grappling, etc.,

Custom Effectors
Cameras, sensor mount, needles, shotcrete, Blowers, Vacuum suction, flame-throwers, etc.,

End-use Applications

GENERAL CONSTRUCTION APPLICATIONS

Site Preparation
Autonomous excavators, demolition, laying and planning

Structural Construction
Brick-Laying, concrete pouring, Rebar-Tying

Finishing Work
Tile-Laying, painting, Drywall Installation

Inspection & Monitoring
Surveying Drones, health and safety robots

Maintenance & Repairs
Facade Cleaning, Roof Inspection, Concrete Repair

Logistics & Material Handling
Autonomous Material Transporters, Load-Lifting, cranes etc.

INDUSTRIAL CONSTRUCTION APPLICATIONS

- **Precision Assembly:** Welding, prefab assembly,
- **Specialized Tasks:** Pipeline & tanks Inspection and maintenance etc.
- **Monitoring and Analytics:** Drone Surveys, Digital Twin Robots, Thermal Inspection Robots

Software & Controls

Integration and Connectivity

Join the WEBINAR to uncover all details.

Have specific queries, connect with our EXPERTS

Crawler Robots

General Features

- Coordinate, marking and travel accuracy within a few millimetres
- Wheels and tracks – custom developed
- **8-10 hours** of battery life; 20Ah-60Ah batteries (LioN)
- **Custom designed chassis**; supporting battery, Modular structure

- Custom Built software; Each robot has different OS
- **Sensor Package:** LIDAR, Wi-fi, Bluetooth, 3D Scanning, Photo, Ultrasonic & IR sensors, Proximity sensing, etc.,
- **Customizable:** Alerting, communication , data package frequency

Software & OS

Layout Printing systems
- 4W drive system
- Top mount – visual alert and control unit
- Front/ Back – proximity sensors

Exterior Inspection
- Track Based
- Vacuum/ magnet grip additional
- Robotic arm with Sensors

Interior Inspection
- Multi-Track
- Sensor in between
- Robotic arm can be added

Surface Finishing
- Mounted nozzle for spraying
- Robotic arm
- Wheel or track based

Motors - Servo motors for propulsion (light duty)

Robotic Arms

- **Fixed arms** (customizable while manufacturing)
- Usually created by the manufacturer and often designed for specific functions
- Retrofitting possibilities attachments are not available

R&D Focus/ Upcoming Features

Join the WEBINAR to uncover all details.

Got questions? Our EXPERTS are ready to answer!

Source 1, 2, 3, 4

Material Handling Robots: Guided Vehicles, Heavy Machinery, and Similar Systems

General Features

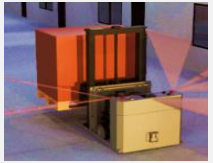
- Autonomous driving (utilizing GPS, route planning, environment sensing, etc.,)
- IoT based; cameras, sensors, and wearable data utilized for machine control
- **24 hrs** data sharing (cloud); past data and performance review available
- **Specialized Machines**; IoT integration, automation are part of additional packages

Software & OS

- Standardized material handling and site material transport
- **Customized:** Vehicle operations; site control, performance data, edge computation capabilities, etc.,
- **Sensors:** Image, proximity, capacitance, resistance, pressure, load, forces, etc.,

Dump Trucks

- Highly Autonomous: Use GPS, route, and surrounding data for autonomous driving
- Data shared with remote operators



On Site Material Handling

- Automatic loading, unloading, material transfer
- Proximity and obstacle sensing

Mining & Construction ops

- Multi-sensor approach
- Detect operator and ensure human safety
- Planning tool speed, motion, and operation

Crane Systems

- Highly autonomous for braking, loading, and unloading
- Remotely operated
- Multi-sensor approach

Developments done both by manufacturers and system integrators who create software for existing machines

Automation Status

Highly Automated (Level 4)

Machines can work in fixed environments for certain criteria; Data shared with remote operator for any unseen events

Uses IoT, wearables, machine status, etc., to create output

R&D Focus/ Upcoming Features

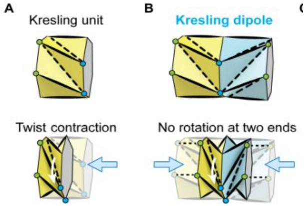
Join the WEBINAR to uncover all details.

Got questions? Our EXPERTS are ready to answer!

Source 1, 2, 3, 4, 5, 6, 7, 8

Interesting Developments in Crawler, Articulated Arms, Articulated Arms, and Guide Vehicles

Crawler Robots

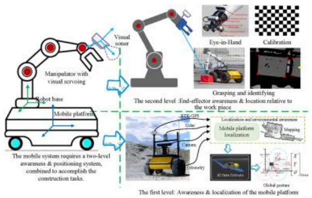


Biomimetic soft crawlers

Earthworm-like crawlers achieve locomotion through in-plane contraction, driven by a four-unit Kresling origami assembly with two Kresling dipoles and two-level symmetry. (**magnetic actuation**) [1]

Impact: Can travel on almost all kinds of surfaces (multiple applications)

Articulated Arms



Environment perception

Articulated arms on mobile platforms are transforming construction. Advances in this field now integrate sensors that enhance environmental perception, enabling precise operation control. A key innovation is the addition of image sensors at the arm's end for improved accuracy.

Impact: Arms have their own intelligence and can work in tandem with the platform

Guided vehicles and Arms mounted on Moving platforms

BIM Integration

Existing BIM integration with robots is at task level. Robots engage in tasks and once the task is completed, they engage in further tasks

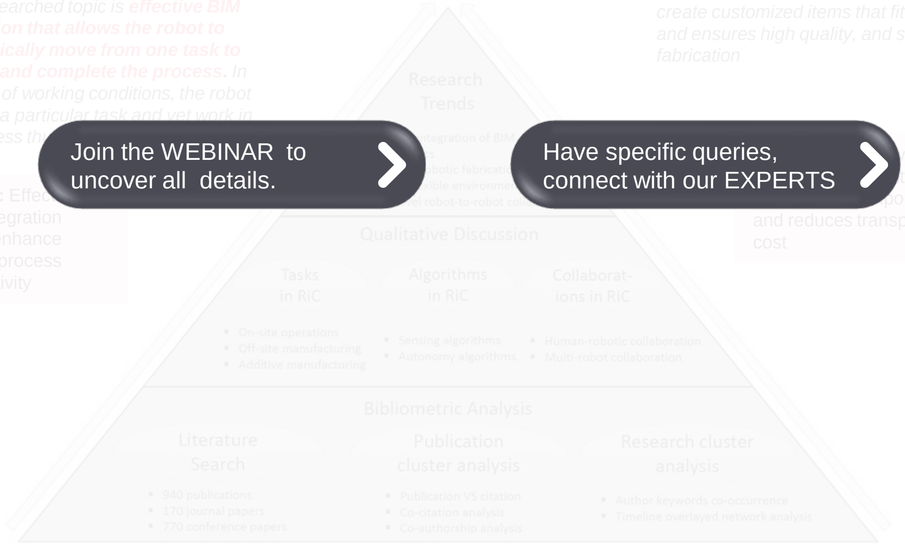
*Most researched topic is **effective BIM integration that allows the robot to automatically move from one task to another and complete the process**. In absence of working conditions, the robot can skip a particular task and yet work in the process th*

Impact: Effe... BIM integration would enhance overall process productivity

Near-site robotic fabrication

*High focus on creating modular robot platforms with multiple attachments. These platforms can **bring in quality fabrication at construction sites**. Reduced off-site fabrication allows engineers and workers to create customized items that fit to site needs and ensures high quality, and safe fabrication*

...aste ...ty, ...ponents, and reduces transportation cost



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Have specific queries, connect with our EXPERTS

Source 1, 2, 3

04 Robot Impact on Processes: Comparing Automation vs. Manual Efforts

Demolition Robots: Global Availability, Customization, High Productivity, and Ease of Adoption has made Demolition Robots a Preferred Choice at Construction sites (30% Market Share)

Brook's Demolition Robot

Definition

Structures that have reached the end of their useful lives are demolished by robots and are also further cleaned up using robots

Prominent Applications

- Building Demolition
- Structure Demolition
- Demolish areas that cannot be accessed with breaker-equipped excavators
- Selected Area Demolition
- Demolish structure where adjacent structures need to be protected

Adoption Benefits

- **22x** A single robot performs work of 22+ workers (handheld hydraulic breakers
- **90%** Remote-controlled and distant operations improve labor safety by reducing accidents.
- **50%** Time reduction in demolishing certain complex parts
- **10x** Efficiency - Robots outperform 20-25 workers with jackhammers

Current Capabilities Vs. Research Focus

Programmed for cutting geometric shapes at 40000 psi pressure

AI & ML enabled - Reactive for unforeseen situation

Forced draf… & breaker

…bots

Compact ro… through doo…

…bots

Can perform precise demolition of selected areas

Hand Guiding: Direct human control of robots

Join the WEBINAR to uncover all details.

Have specific queries, connect with our EXPERTS

Technology Readiness and Commercialization Status

AUTOMATION ★★★☆

Programmed automation, remote control and autonomous demolition & route planning functionalities

AVAILABILITY ★★★★

Available worldwide; major focus on EU & US; Available both on rent & for sales

EASE OF ADOPTION ★★★☆

Easy to adopt; 200k and above pricing for single unit; robots are programmed for basic tasks, external software's are available for specific tasks

CUSTOMIZABLE ★★★☆

Robots available in various sizes and capacity, compact robots can enter though door hole; various attachments available for different tasks during demolition

Source: 1, 2, 3, 4, 5,

Sample Details: Demolition Robot (Brokk & Husqvarna)

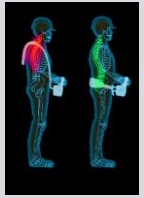
Structure and Mobility

- Power/ Weight Ratio: up to 0.17 kW/kg
- Power Range: up to 63 kW
- Transport Speed: 1.5 Km/hr to 3 Km/hr
- Climbing Inclination: up to 30 degrees
- Most robots have both: a traction belt and support legs for stability and mobility

Can even fit in an ordinary van

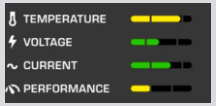
Power System

- Diesel Powered - 25hp engines
- Tool Input power - via Motors (10kW to 41kW)
- 32A – 63A fuse
- Continuous operation: up to 8 hours
- *Dust & water resistance components – IP6*
- *ABB is prominent motor supplier for demoli… robots*



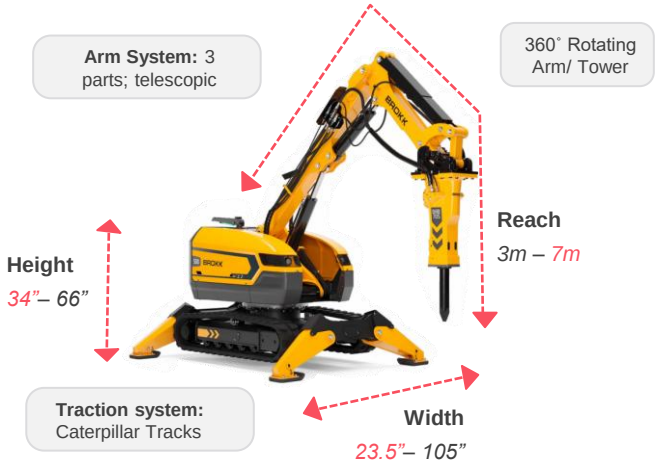
Control System

- **Wireless Smart Controller – 300m range; 3kg weight;** Joystick based controls



Visual alerts for machine performance & state

- **OTA upgrades for new functionalities**
- Dedicated online portal (multi-functionality)
- Trainers available; Training videos and … available
- … certification
- … regulatory compliance



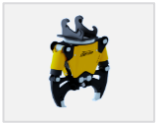
Aftersales, Spare and Services

- … with companies (3rd party attachments are supported)
- … with major companies (guaranteed uptime)
- … via phones, tab and web browsers
- ***Service need to happen with the companies in order to avail uptime agreements*

Join us in the WEBINAR to get all the details–and so much more!

Got questions? Our EXPERTS are here to help you out!


Breaker


Concrete Crusher


Vacuum Excavator


Metal and Combi Shear Attachments


Shotcrete for confined space


Grapple Attachments


Sorting & Grappling


Cut-off saw


Tap Hole Device


Bucket

Multiple Attachments supported…
~9 attachments for demolition process

Source: 1, 2

Underfloor Insulation Spraying, Scaffold Transportation in High-rise Buildings, Wind-turbine Cleaning, and Precision Coating, etc., are few niche Applications that are Seeing the Entry of Robots

Q-bot has tapped in the segment of property management, insulation, and assessing energy-efficiency of buildings. It is a unique product that can assess hard to reach places, spray insulation foam, and assess the energy efficiency for building

Adoption Benefits

Join the WEBINAR to uncover all details.

Have specific queries, our EXPERTS are here to answer

Available in Europe & North-America

Kewazo's Liftbot targets major problems of scaffold lifting and transport on high rise buildings. It has high potential for constructors, general contractors and field labour in reducing the scaffold transport and assembly timings

Adoption Benefits

20% *Man-hour reduction*

50% *Time reduction*

Built robotics specializes in solar farm construction. Their robots are fully automated and remote controlled. They can pick, place, assemble, and install solar panels in most challenging soil conditions

Built robotics also has a software platform to monitor the progress and control these robots

Adoption Benefits

100% *Real-time process visibility*

100% *Operator & Worker safety*

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❖ *Automated trenching and solar piling capabilities*

Aerones provides robots for wind turbine maintenance services. These robots can inspect, clean, coat, and perform maintenance activities on turbine blades, tower, internal and external parts

Adoption Benefits

4X *Faster operations*

90% *Reduction in Idle hours*

75% *Reduction in downtime*

99% *Safe & Accurate*

glayers is targeting coating for tanks, wind turbines, and industrial infrastructure. These are highly specialized applications that require precise spray for difficult to reach spots, and work under windy conditions

Adoption Benefits

Join the WEBINAR to uncover all details.

Have specific queries, our EXPERTS are here to answer

05 Trends, Challenges, and Recent Developments

The Demand for Automation, Competitive Needs, and Emerging Business Models have Opened Doors for Collaboration and Investments

10+ Partnerships and Fundings

Since 2022

Partnerships

LIEBHERR · Fortescue · SafeAI · maca · CATERPILLAR · FMI

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5+ Niche Applications

Players with RaaS offerings

PAINTJET — Painting services

KEWAZO — Scaffold Transport

AERONES — Wind-Turbine Maintenance

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OEMs Focus on AI/ML

RaaS

Capability Expansion

Entry of PE/VCs

Automating Core Operations

Undisclosed amounts

TRL 6 & Above

Automating Painting

AkzoNobel · glayers

Automating Abrasive Blasting

BLASTONE · vertidrive

$1Bn+

PE/ VC Funding
Since 2022

MONUMENTAL $25Mn · MATERIAL VENTURES · NORTHZONE · FOUNDAMENTAL · NP-Hard Ventures

Join the WEBINAR to uncover all details.

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The hype around construction robots is building, fueled by government initiatives, investments from major players, rising adoption, and bullish views from industry leaders.

Initiative

Dubai 3D Printing Strategy

UAE

By 2030, **25% buildings would be based on 3D printing technology**

Ongoing Plan

14th Five-Year Construction Industry Development Plan

China

Vigorously promotes prefabricated buildings and **accelerates application of construction robots**

Current Adoption

NEOM Investment Fund

UAE

NIF signed agreements with GMT robotics to fast-track capital projects through construction robotics.

The current focus is on bringing the technology to the ground.

Opinion

Rising Automation

CYNGN

By 2030, 30% of manual mining tasks would be automated and require robots

Investments

Rising Investments in Automation

SHIMZ

Labor shortage, rising infrastructure demands has pushed giants like Shimizu to inve[illegible]~$30 Mn invested in past 5

Join the WEBINAR to uncover all details.

Investments

Stepping into pra[illegible]

Construction RX

Construction RX Consortium in Japan focusses on construction automation. Material handling, BIM integration would be focus areas

Have specific queries, connect with our EXPERTS

Source 1, 2, 3, 4, 5, 6

Rising Labor Cost, Declining Margins, And Increased Safety Requirements Are Pushing Automation To Forefront And Business Leaders Face Challenges More Than Ever To Craft Their Automation Strategies

Here's How FutureBridge Can Help?

Robot Manufacturers

- Innovation scouting
- Market assessment
- Demand prediction
- Identifying right customers
- Vendor/ Supplier Benchmarking
- Competitive benchmarking for products
- Whitespots for product development

Equipment Vendors and Rental Players

- Market assessment and demand prediction
- Voice of customers analysis
- Competitive benchmarking for products
- Inventory and Product Management
- Identifying new markets and customer scouting

Construction & Industrial Services

- Automation Decisions: short- and long-term Needs, right products, expected impact and right suppliers
- Competitive evaluation of Services
- Understanding returns for investment planning
- Customer surveys, needs and service optimization strategies

Private Equity & Project Finance Players

- Identifying right investment options
- Competitive benchmarking exercises
- Due diligence reports
- Market analysis and demand pattern recognition exercises

Thank you

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