THE ROBOTREPORT

EXPLORING THE BUSINESS AND APPLICATIONS OF ROBOTICS

A Supplement to Design World - June 2020
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2020 ROBOTICS BUSINESS REVIEW RBR 50 INNOVATION AWARDS

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The 2020 RBR50 robotics innovation awards

The annual RBR50 list, a leading indicator of robotics leadership, *has been broadened in 2020 to celebrate a wider range of technology and business innovation.*

DAN KARA
VP, Robotics

STEVE CROWE
Editor, Robotics

EUGENE DEMAITRE
Senior Editor, Robotics

The 2020 RBR50 Innovation Awards Judges

For nearly a decade, *Robotics Business Review* has produced the RBR50 robotics innovation awards, which recognize and celebrate forward-thinking companies and the original, impactful solutions they have created. Widely recognized throughout the world as a leading indicator of robotics innovation leadership, the RBR50 is also a critical measure of robotics sector growth.

For the robotics industry, the role, importance, and impact of innovation has never been greater. Moreover, multiple types of innovation -- technological, business, and market -- have converged to accelerate robotics sector growth overall. Accordingly, for 2020, the criteria for the RBR50 awards has been reworked and extended to celebrate robotics innovation over a wider range of forms, including the following:

- **Business and management innovation** -- Business and management initiatives or practices that enhance a company's commercial standing, foster robotics sector growth, or improve society.
- **Technology, products, and services innovation** -- New commercial solutions that that have the potential to benefit markets or the whole robotics and automation industry.
- **Application and market Innovation** -- Industry-specific, newly developed applications that deliver value, provide entry to new markets, or improve performance over existing approaches (i.e., improve productivity, increase quality, or reduce cost).

Methodology

Applications for the 2020 RBR50 robotics innovation awards came from multiple sources. WTWH Media's Robotics Group sought submissions from companies, business-development entities, research and investment groups, and others for innovations that were released, initiated, or executed since January 2019.

In addition, the RBR50 judges communicated with the leaders of major robotics clusters and other groups for submissions. The judges also reviewed announcements from investment groups, corporate briefings, and association and industry publications, as well as sessions at conferences and seminars.

Private interviews with industry representatives, investors, and other analysts also played a part in the submission and verification process.

Many factors were used as a basis judging RBR50 entries, including the originality and significance of the innovations and their business or technical merits.

Entries were also judged on their impact, or potential impact, on markets and the global robotics ecosystem. RR

Spotting trends among the RBR50 innovation award winners

This year's honorees were not only innovators, *but also leaders in robotics trends.*

Eugene Demaitre • Senior Editor • The Robot Report

Cruise raised $1.1 billion *last year.*

Each year, the RBR50 innovation awards receive many more nominations than can fit in the annual list. This year, the final selection reflects more rigorous judging criteria, current technological and business trends in robotics, and reactions to the COVID-19 pandemic.

Since companies of different sizes build robots for widely differing applications, it is difficult to compare them directly. Add to that regional clusters, universities and research institutions, and new business models, and it becomes clear that the best way to analyze robotics leadership is to see what categories and industries they fit into.

Innovation classes

A renewed emphasis on innovation in the 2020 RBR50 criteria led to half of this year's winners being recognized for the introduction of new products and technologies. This included both hardware and software for autonomous systems.

Fourteen companies were recognized for novel business management, with six in leadership, six in market engagement, and one organization, MassRobotics, for business model.

While several companies serve the healthcare industry, only one company was recognized for social good. AutoGuide Mobile Robots earned honors for participating in a program to retrain and hire former coal miners as robotics technicians.

Eleven companies were recognized for innovation in applications and markets, reflecting seven industries ranging from healthcare and manufacturing to forestry, logistics, and retail. AMP Robotics made the list for its development of a dual-robot recycling system.

***AutoGuide helped coal miners** become robotics technicians.* | *Source: AutoGuide Mobile Robots*

By innovation class:	
11	Application & Markets
14	Business & Management
25	Product, Technology & Services

Technologies and industries

Nearly half of this year's RBR50 innovation award winners, 21, were involved in industrial automation and manufacturing. This included nine companies making industrial or collaborative robot arms or end effectors, as well as Sarcos, which has developed an industrial exoskeleton.

Some of the biggest and best-known robotics makers in the world are in the industrial space, including ABB Robotics and Yaskawa Motoman, as well as cobot leader Universal Robots. Gripper makers OnRobot and Soft Robotics also came out with new products this past year.

Ten component suppliers made this year's RBR50 list, including drive makers FAULHABER MICROMO and Harmonic Drive, as well as processor makers Intel and NVIDIA.

While it may come as no surprise that Formant and Microsoft are among the six listees for robot software, Vecna Robotics also made the list for its Pivotal "orchestration engine" rather than its autonomous mobile robots (AMRs). Many submissions claimed to apply artificial intelligence to robotics and automation, but relatively few could demonstrate true innovation in the past year.

AMRs were well-represented, with nine organizations supporting supply chain and logistics operations, such as 6 River Systems, Geek+, Locus Robotics, and Waypoint Robotics.

Six companies in autonomous vehicles and transportation also made the 2020 RBR50, including Cruise, Nuro, and Waymo. Even with testing paused in the past few months, these companies have advanced the state of driverless technology.

The novel coronavirus crisis has increased interest in robotics for healthcare, which is the focus of September's Healthcare Robotics Engineering Forum. Three organizations -- Blue Ocean Robotics, Diligent Robotics, and Worcester Polytechnic Institute -- were winners this year.

Where the innovators are

Four robotics clusters and organizations won 2020 RBR50 awards: the Advanced Robotics for Manufacturing (ARM) Institute in Pennsylvania, MassRobotics in Massachusetts, Silicon Valley Robotics in California, and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia. The ARM Institute and CSIRO are national rather than regional groups.

All have both nurtured startups and led robotics development, which is the focus of the annual Robotics Summit & Expo in Boston.

While the majority of RBR50 winners this year happened to be based in the U.S., other countries represented included Canada, China, Denmark, Germany, the Netherlands, New Zealand, and Switzerland. Japan and South Korea, both leaders in the use of robotics and automation, were under-represented in nominations.

Within the U.S., organizations in 12 states qualified for this year's list, with Massachusetts and California leading with 15 and 14, respectively.

Nearly half (21) of this year's RBR50 winners have been on the list before, with ABB and Universal Robots each being

Some of the biggest and best-known robotics makers in the world are in the industrial space, including ABB Robotics and Yaskawa Motoman, as well as cobot leader Universal Robots. Gripper makers OnRobot and Soft Robotics also came out with new products this past year.

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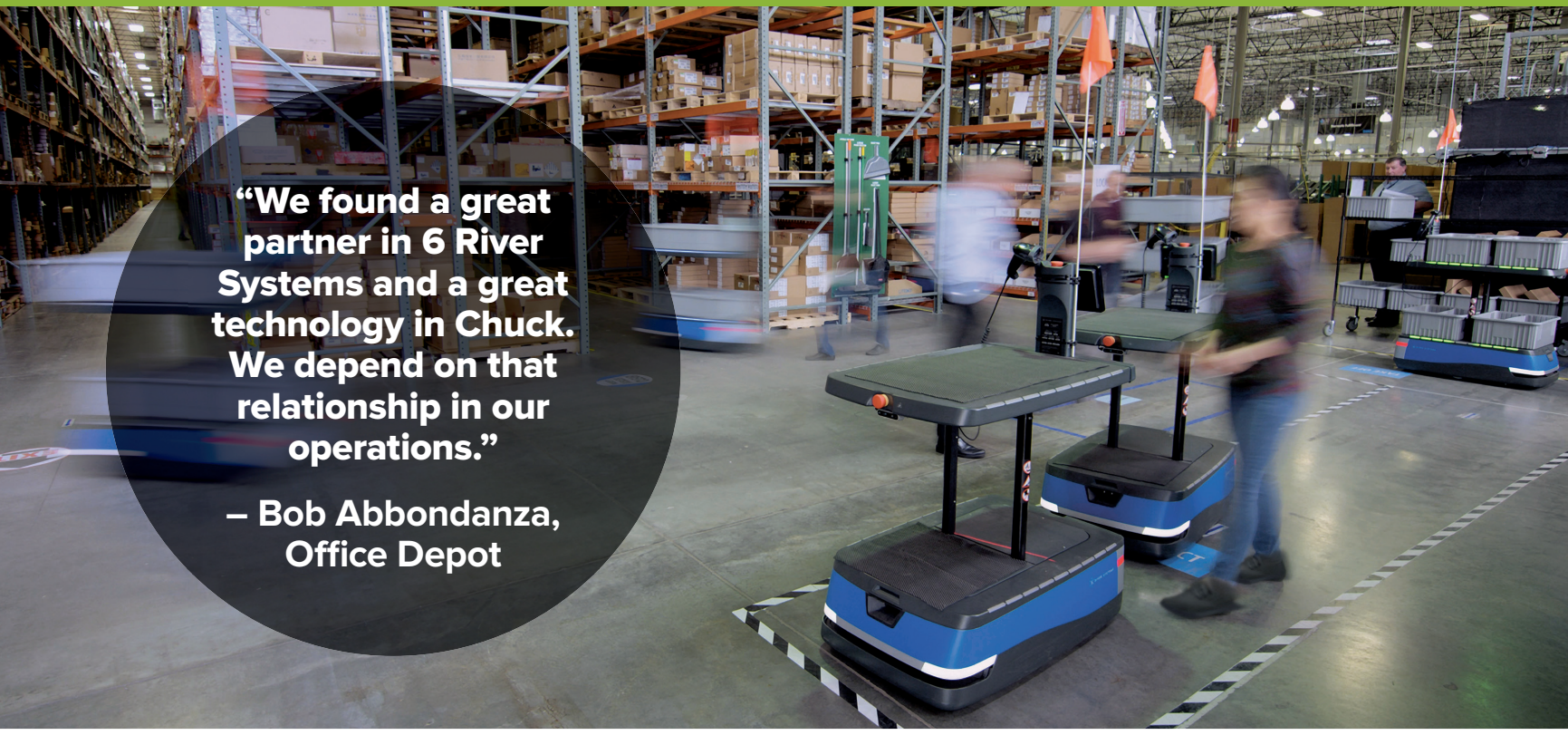

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"We will continue to operate, build and sell the 6 River Systems solution." – **Tobi Lütke, CEO, Shopify**

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honored nine times in the past decade. On the other hand, more than half of this year's innovators are new to the list, so organizations should not miss the annual call for submissions.

By the numbers:	
21	Repeat honorees
21	Industrial automation/manufacturing leaders
12	U.S. states represented
11	Organizations from outside the U.S.
9	Supply chain/logistics companies
8	Countries of origin

Investment in innovators

Investors, partners, and acquirers also recognized the 2020 RBR50 organizations, investing about $3.2 billion in them over the past year.

Innovative companies received money to develop and deploy autonomous mobile robots, self-driving cars, end-of-arm tooling, sensors, and industrial automation.

Top 12 transactions among 2020 RBR50 winners

Organization	Amt. ($M)	Type	Date
Cruise	1,150	Funding	5/7/2019
Nuro	940	Series B	2/11/2019
6 River Systems	450	Acquisition	9/10/2019
AutoGuide Mobile Robots	165	Acquisition	10/21/2019
Geek+	150	Series C1	6/13/2019
Vecna Robotics	50	Series B	1/7/2020
Fetch Robotics	46	Series C	7/23/2019
Boston Dynamics	37	Venture funding	2/6/2019
Built Robotics	33	Series B	9/19/2019
OnRobot	27.4	Early stage VC	12/19/2019
Locus Robotics	26.2	Series C	4/22/2019
Sense Photonics	26	Series A	6/11/2019

In addition, autonomous vehicle company Waymo raised $3 billion in funding last month, after the period covered by the 2020 RBR50 list.

For more detailed discussions of why each organization is in the 2020 RBR50, please see the individual descriptions of their innovations. RR

6 River Systems Inc.	6 River Systems helps fulfillment operations scale with Chuck mobile robots, scales quickly to serve market	Business & Management Innovation	Leadership
ABB Robotics	ABB opens global research hub for robotics at the Texas Medical Center	Business & Management Innovation	Leadership
ACEINNA Inc.	ACIENNA releases OpenRTK33L guidance module for robots, drones, and autonomous vehicles	Product, Technology & Services Innovation	Product Introduction
Advanced Motion Controls	Advanced Motion Controls adds 15 new models of FlexPro high-performance servo drives	Product, Technology & Services Innovation	Product Introduction
Agility Robotics	Agility Robotics announces the commercial availability of Digit humanoid robot	Product, Technology & Services Innovation	Product Introduction
AMP Robotics	AMP Robotics launches AMP Cortex Dual-Robot System for rapid recycling	Applications & Markets Innovation	Waste management
Apex.AI Inc.	Apex AI releases Apex.OS, a software framework based on ROS 2 designed to ease and speed software development for autonomous vehicles	Product, Technology & Services Innovation	Product Introduction
ARM Institute	The ARM Institute relocates to offer expanded offices and labs optimized for robotics development, co-locates with Carnegie Mellon University's Manufacturing Futures Initiative	Business & Management Innovation	Market Engagement
AutoGuide Mobile Robots	AutoGuide Mobile Robots hires retrained coal miners as robotics technicians	Business & Management Innovation	Social Good
Blue Ocean Robotics ApS	Blue Ocean Robotics produces a UV-D disinfection robot, aiding in COVID-19 response worldwide	Applications & Markets Innovation	Healthcare / Rehabilitation
Bossa Nova Robotics	Bossa Nova Robotics announces deployment of self-scanning inventory robots in 1,000 Walmart stores in the U.S.	Business & Management Innovation	Market Engagement
Boston Dynamics Inc.	Boston Dynamics commercializes its Spot quadruped robot	Product, Technology & Services Innovation	Product Introduction
Built Robotics Inc.	Built Robotics partners with International Union of Operating Engineers for robotics training	Business & Management Innovation	Leadership
Commonwealth Scientific and Industrial Research Organisation	CSIRO opens new Robotics Innovation Centre in Australia	Business & Management Innovation	Leadership
Cruise LLC	GM unit Cruise unveils Origin, a driverless ride-sharing vehicle challenging transportation paradigms	Product, Technology & Services Innovation	Product Introduction
Diligent Robotics Inc.	Diligent Robotics introduces the Moxi mobile manipulation assistance robot in hospitals	Applications & Markets Innovation	Healthcare / Rehabilitation
Energy Robotics & ExRobotics BV	Energy Robotics and ExRobotics launch mobile robots for remote oil and gas site inspection	Applications & Markets Innovation	Energy
Exyn Technologies Inc.	Exyn Technologies offers aerial imaging and mapping system for surveying mines in GPS-deprived environments	Applications & Markets Innovation	Mining / Quarrying
FAULHABER MICROMO LLC	FAULHABER MICROMO releases compact BXT flat brushless DC motors	Product, Technology & Services Innovation	Product Introduction
Fetch Robotics Inc.	Fetch Robotics releases Workflow Builder to facilitate the design and implemention of workflows for robotic fleets	Applications & Markets Innovation	Product Introduction
Formant Inc.	Formant includes ease of use, remote control, and analytics in cloud-based robot management platform	Product, Technology & Services Innovation	Product Introduction

Gatik	Gatik provides software stack for autonomous vehicles for middle-mile delivery applications and partners with Walmart	Applications & Markets Innovation	Logistics
Geekplus Technology Co.	Geek+ deploys more than 10,000 mobile robots as a service around the world, expands into the U.S.	Business & Management Innovation	Leadership
Harmonic Drive LLC	Drive leader Harmonic Drive opens a new manufacturing and R&D facility	Business & Managemen Innovation	Leadership
Intel Corp.	Intel RealSense L515 lidar camera brings high resolution and depth perception indooors	Product, Technology & Services Innovation	Product Introduction
iRobot Corp.	iRobot diversifies its manufacturing supply chain, reducing exposure to ongoing trade issues	Business & Management Innovation	Leadership
Kinova Inc.	Kinova's Gen3 robotic arm family supports research and spurs commercial development	Product, Technology & Services Innovation	Product Introduction
Locus Robotics Inc.	Locus Robotics launches software and hard-ware suite optimized for omnichannel fulfill-ment and expands its partnership with DHL	Applications & Markets Innovation	Logistics
MassRobotics	MassRobotics expands its robotics innovation center to nurture innovations in industrial automation, human-machine interaction	Business & Management Innovation	Business Models
maxon motors	maxon motors opens a new engineering and manufacturing facility, expanding its North American footprint beyond sales and distri-bution to better serve customers and partners	Business & Management Innovation	Market Engagement
Microsoft Corp.	Microsoft releases Robot Operating System (ROS) for Windows 10.	Product, Technology & Services Innovation	Product Introduction
New Scale Robotics	New Scale Robotics' Q-Span Automated Small-Part Measurement System enables robotic inspection in manufacturing environments	Applications & Markets Innovation	Manufacturing
Nuro	Nuro upgrades R2 autonomous vehicle development platform, obtains dual exemptions for on-road testing	Applications & Markets Innovation	Transportation
NVIDIA Corp.	NVIDIA launches the Jetson Xavier NX, a small, high-performance compute platform that supports all popular AI frameworks	Product, Technology & Services Innovation	Product Introduction
OnRobot A/S	OnRobot's One System Solution allows its end-of-arm tools to work with a range of collaborative and light industrial robots	Product, Technology & Services Innovation	Product Introduction
Robotics Plus Ltd.	Robotics Plus introduces automated log-scaling system designed to increase productivity and reduce injuries	Applications & Markets Innovation	Forestry
Sarcos Corp.	Sarcos Robotics commercializes Guardian XO full-body exoskeleton for industrial use	Product, Technology & Services Innovation	Product Introduction
SCHUNK GmbH	Schunk EGL-C enables robots to handle up to 8 kg while collaborating with humans and conforming to international safety standards	Product, Technology & Services Innovation	Product Introduction
Sense Photonics Inc.	Sense Photonics launches Osprey, a 3D Flash LiDAR solution for automotive applications	Product, Technology & Services Innovation	Product Introduction
Sevensense Robotics AG	Sevensense Robotics provides a 360-degree view with newly released Alphasense Core system	Product, Technology & Services Innovation	Product Introduction

SICK Inc.	SICK's nanoScan3 laser scanner combines compact design, environmental resistance, and high performance	Product, Technology & Services Innovation	Product Introduction
Silicon Valley Robotics	Silicon Valley Robotics celebrates 10 years of community building and leadership	Business & Management Innovation	Market Engagement
Soft Robotics Inc.	Soft Robotics' SuperPick Polybag Picking System addresses complexity, variability in the unstructured environment of reverse logistics	Product, Technology & Services Innovation	Product Introduction
Universal Robots A/S	Universal Robots launches UR+ Application Kits to remove barriers to integration of UR collaborative robots	Product, Technology & Services Innovation	Product Introduction
Vecna Robotics Inc.	Vecna Robotics introduces Pivotal, a "multi-agent orchestration engine" that integrates into WMS / ERP systems and optimizes workflows among automated systems and manual activities	Product, Technology & Services Innovation	Product Introduction
Veo Robotics Inc.	Veo Robotics launchs FreeMove, a safety-rated vision system that allows standard industrial robots to operate more collaboratively with humans	Product, Technology & Services Innovation	Product Introduction
Waymo LLC	Waymo pulls ahead in autonomous vehicle race	Business & Management Innovation	Market Engagement
Waypoint Robotics	Waypoint Robotics builds MAV3K, an omnidirectional, heavy-duty autonomous mobile robot	Product, Technology & Services Innovation	Product Introduction
Worcester Polytechnic Institute	WPI opens the PracticePoint facility to foster innovation and commercialization of medical robotics	Business & Management Innovation	Market Engagement
Yaskawa Motoman	Yaskawa Motoman releases the HC20XP, the first food-grade collaborative robot	Product, Technology & Services Innovation	Product Introduction

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2020 ROBOTICS BUSINESS REVIEW RBR 50 INNOVATOR

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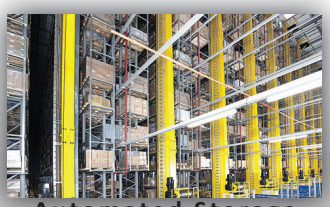
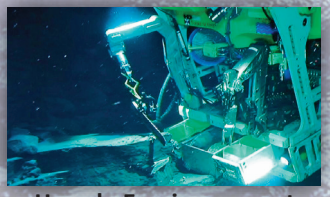


Automated Storage

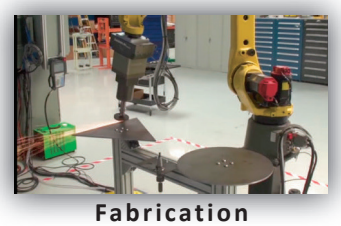
Order Fulfillment

Material Handling

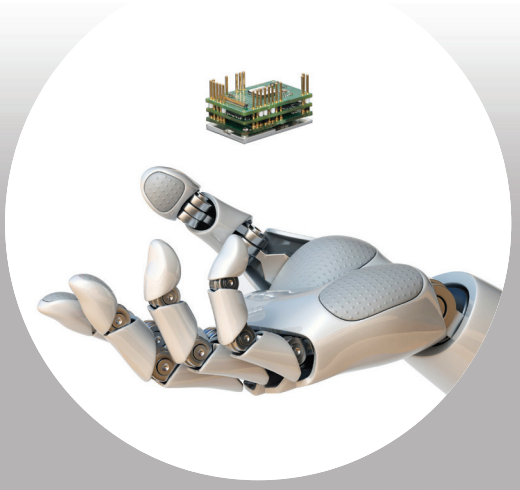


Harsh Environments

Defense



Fabrication



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6 RIVER SYSTEMS

6 River Systems helps fulfillment operations scale with Chuck mobile robots

Organization Name:	6 River Systems Inc.
Country:	U.S.
Website:	www.6river.com
Year Founded:	2015
Number of Employees:	140+
Innovation Class:	Business & Management Innovation
Innovation Subclass:	Leadership

RBR 50 INNOVATION AWARDS

Description:

6 River Systems' (6RS) Chuck is an autonomous mobile robot (AMR) that is designed to work with human pickers for e-commerce order fulfillment.

In March 2020, Waltham, Mass.-based 6RS unveiled enhancements to Chuck including increased capacity, expanded compliance with international safety standards, and features such as globally recognized lighting for improved usability and faster training of associates. The robot won two Red Dot Awards for product design in April.

Not only is Chuck able to continuously improve, thanks to cloud-based software updates, but it is also able to operate without extensive physical infrastructure. 6RS said its AMRs can deliver a return on investment in as little as nine months and increase productivity by 10% year over year.

Analysis:

6 River Systems' leadership has deep experience in the competitive market for AMRs. Co-founders Jerome Dubois and Rylan Hamilton had been executives at Kiva Systems, which was acquired by Amazon.com Inc. in 2012. They were joined by Chris Cacioppo, who designed electrical and mechanical systems.

In September 2019, Shopify Inc. validated 6RS's innovative approach by acquiring it for $450 million. The multi-channel e-commerce provider said Chuck will help it and its customers scale to meet demands for reliability and speed.

Unlike Kiva, which was later renamed Amazon Robotics, 6RS will continue providing Chuck to other companies, including DHL, Lockheed Martin, Office Depot, and XPO Logistics.

In just four years, 6RS has gone from being a startup to a major player in AMRs for e-commerce. RR -- *Eugene Demaitre*

ABB opens global research hub for robotics at Texas Medical Center

Organization Name:	ABB
Country:	Switzerland
Website:	www.new.abb.com
Year Founded:	1988
Number of Employees:	144,000
Innovation Class:	Business & Management Innovation
Innovation Subclass:	Leadership

RBR 50 INNOVATION AWARDS

Description:

ABB's healthcare research center opened in October 2019 at the Texas Medical Center in Houston. The facility is using ABB's collaborative robots to explore the development of non-surgical medical robotics systems, including logistics and next-generation automated laboratory technologies. This is ABB's first dedicated healthcare research center. A 20-strong team from ABB Robotics will work in the research facility, which includes an automation laboratory and robot training facilities, as well as meeting spaces for co-developing solutions with innovation partners.

Analysis:

A key element of ABB's long-term growth strategy is to continue to invest and innovate in underserved robotics sectors. ABB's healthcare research center could fuel its collaborative robotics business by bringing its automation expertise to new areas such as healthcare.

Throughout the world, the healthcare sector is struggling from the combined pressures of skyrocketing costs, the need to improve the quality of services and results, rapidly aging populations, and a shortage of qualified workers.

Many highly skilled medical workers also spend a large part of their days doing repetitive and low-value tasks.

ABB said its analysis showed that repetitive tasks could be completed up to 50% faster with automation in comparison wth current manual processes. ABB estimated that by 2025, more than 60,000 non-surgical medical robots are expected to be working in hospitals. RR -- *Steve Crowe*

ACEINNA ships cost-effective, high-precision navigation system for robotics and autonomous vehicles

Organization Name:	ACEINNA
Country:	U.S.
Website:	www.aceinna.com
Year Founded:	2017
Number of Employees:	20+
Innovation Class:	Product, Technology & Services Innovation
Innovation Subclass:	Product Introduction

RBR 50 INNOVATION AWARDS

Description:

In March 2020, **ACEINNA** launched the OpenRTK330L, a high-performance, multi-band RTK/GNSS receiver and triple-redundant inertial sensor designed for autonomous vehicles, Level 3 autonomous driving and driver-assistance systems, drones, mobile robots, and industrial/agricultural machinery. The OpenRTK330L is compatible with multiple satellite systems, including GPS, GALILEO, GLONASS, QZSS, and BeiDou.

Analysis:

Commercial class mobile robots, drones, and other vehicles face conflicting mandates for autonomous navigation and mapping. It is critical that they locate themselves as precisely and reliably as possible, but the technology must not be cost-prohibitive. Solutions must be robust in the extreme, but the devices themselves must be as compact as possible.

The OpenRTK330L is the only positioning solution that can boast of a triple-band RTK/GNSS receiver and a triple-redundant inertial in a single device.

With the OpenRTK330L receiver/sensor, ACEINNA has delivered a cost-effective (a $150 price point), highly accurate (3cm), and dependable positioning solution. For developers creating mobile robots, drones and autonomous vehicles, the cost/performance tradeoffs for guidance and navigation systems are now much less stark. RR – *Dan Kara*

Advanced Motion Controls adds 15 models of FlexPro high-performance servo drives

Organization Name:	Advanced Motion Controls Inc.
Country:	U.S.
Website:	www.a-m-c.com
Year Founded:	1987
Number of Employees:	140+
Innovation Class:	Product, Technology & Services Innovation
Innovation Subclass:	Product Introduction

RBR50 INNOVATION AWARDS

Description:

Camarillo, Calif.-based **Advanced Motion Controls** designs and manufactures compact servo drives for the robotics industry. In 2019, it added six models to its FlexPro product line, and it added nine more in the first quarter of 2020.

Advanced Motion Controls said its drives are designed for high performance, easy connectivity, and functionality in challenging environments, which is important for mobile robots.

The FlexPro line includes a variety of designs because they are used in numerous applications, from industrial automation and collaborative robot arms to autonomous vehicles and automated storage and retrieval systems.

Analysis:

Advanced Motion Controls has developed drives that can be used in increasingly specialized robotics applications. They can tolerate vibration and high temperature, use a wide range of voltages for different types of batteries, and be placed nearly anywhere in a device.

The new FlexPro models enable robotics developers and vendors to select precisely the servo drives they need for power and endurance.

The company's servo drives can be found in surgical robots, order-fulfillment systems, and unmanned military vehicles. RR -- *Eugene Demaitre*

Agility Robotics commercializes Digit humanoid robot

Organization Name:	Agility Robotics
Country:	U.S.
Website:	www.agilityrobotics.com
Year Founded:	2015
Number of Employees:	11–50
Innovation Class:	Product, Technology & Services Innovation
Innovation Subclass:	Product Introduction

RBR 50 INNOVATION AWARDS

Description:

Agility Robotics in January 2020 launched the commercial version of Digit, a humanoid robot that costs in the low-mid six figures. Digit's upper torso includes integrated sensing, computing, and two 4-DOF (degrees-of-freedom) arms that can carry up to 40 lb. Digit also has two 2-DOF feet, sealed joints for outdoor operation, a UN 38.3-certified battery for cargo air shipment, and an API so it can be used as a development platform. Digit navigates semi-autonomously, thanks to lidar and other sensors. Digit is designed for classic dull, dirty, and dangerous manual labor jobs, including basic tasks in warehouse logistics that can have high rates of dissatisfaction, injury, and turnover.

Analysis:

Digit is the first humanoid with walking and manipulation capabilities to be sold commercially rather than just to academic institutions. While the utility of humanoid robots has and will still be questioned, perhaps Digit will start changing that tune. Commercializing Digit is an important milestone for humanoid robots and Agility Robotics, which spun out of Oregon State University in 2015 to specifically commercialize bipedal locomotion research.

Ford, which purchased the first two Digits, is exploring how the robot could be placed in self-driving delivery vans to carry packages from vans to customers' front doors. This is what Ford is calling "last-50-feet delivery."

The automaker is also focusing on how Digit can be used indoors for first-mile logistics. RR -- *Steve Crowe*

AMP Robotics launches Cortex Dual-Robot System for recycling

Organization Name:	AMP Robotics
Country:	U.S.
Website:	www.amprobotics.com
Year Founded:	2015
Number of Employees:	52
Innovation Class:	Applications & Markets Innovation
Innovation Subclass:	Construction/Demolition, Other

RBR 50 INNOVATION AWARDS

Description:

Louisville, Colo.-based **AMP Robotics** launched its Cortex Dual-Robot System (DRS) in May 2019. It is an expansion of its high-speed recycling robots guided by the Neuron platform, which uses computer vision and machine learning to recognize items of different shapes, as well as materials such as metal, paper, and plastic.

The AMP Cortex DRS uses two robots to pick and place materials for recycling around the clock at up to 160 pieces per minute -- twice as fast as human workers. The system can be easily added to existing recycling facilities, and its precision results in a purer stream of post-consumer materials and construction waste.

In September 2019, Single Stream Recyclers LLC (SSR) in Sarasota, Fla., added eight AMP systems to its existing six for sorting fiber in the largest deployment of its kind to date. SSR was able to increase its productivity while moving people to higher value-added roles.

Analysis:

The U.S. recycling industry has faced serious difficulties in the past few years, with fewer countries accepting mixed waste for sorting, chronic staff shortages, and the need to keep workers safe. The AMP Cortex DRS allows recyclers to extract materials for better commodity prices and protect people from handling dangerous items.

The ultimate benefit of AMP's Cortex system is that it reduces the amount of waste going into overstuffed landfills and directs more materials toward recycling and less resource consumption. This could help U.S. industry achieve the economies of scale for profit-driven environmental protection. RR -- *Eugene Demaitre*

Apex.AI

Apex.AI adapts ROS 2 to autonomous vehicles with Apex.OS software framework

Organization Name:	Apex.AI Inc.
Country:	U.S.
Website:	www.apex.ai
Year Founded:	2017
Number of Employees:	38
Innovation Class:	Product, Technology & Services Innovation
Innovation Subclass:	Product Introduction

RBR 50 INNOVATION AWARDS

Description:

Among the technical hurdles for developers of autonomous vehicles (AVs) is the need for standardized and reliable software to build upon. The open-source Robot Operating System (ROS) offers such a code base for robotics developers, and Palo Alto, Calif.-based **Apex.AI** has worked to extend it to the AV software stack with Apex.OS.

Apex.OS v1.0 is based on ROS 2 and uses more modern programming techniques than those used in electronic control units. This is necessary for the many simultaneous functions of AVs, including sensor fusion, machine learning, and controls.

Apex.AI is working with automakers and Open Robotics, the organization supporting open software and hardware, to incorporate the latest features that are relevant to self-driving cars.

Analysis:

One of the benefits of an open-source code base is that anyone can contribute to it and help improve its security and reliability. The assurance that Apex.OS provdes can help advance the acceptance and adoption of autonomous vehicles.

The system is the first of its kind to be certified to ASIL-D, the highest level of functional safety for road vehicles, according to the company.

By adapting ROS 2, which has already gone through an extensive development process for industrial automation, Apex.AI is helping the entire autonomous vehicle space. RR

-- *Eugene Demaitre*

ARM Institute relocates to new, state-of-the-art facility, further distinguishing Pittsburgh as a robotics powerhouse

Organization Name:	Advanced Robotics for Manufacturing (ARM) Institute
Country:	U.S.
Website:	www.arminstitute.org
Year Founded:	2017
Number of Employees:	22
Innovation Class:	Business & Management Innovation
Innovation Subclass:	Market Engagement

RBR50 INNOVATION AWARDS

Description:

In July 2019, the Pittsburgh-based **ARM Institute** (Advanced Robotics for Manufacturing) relocated its headquarters to Mill 19, a redeveloped facility that was part of the former Jones & Laughlin Steel Co. The site had shuttered completely in 1997. The new ARM Institute headquarters is co-located with Carnegie Mellon University's Manufacturing Futures Initiative in a 90,000-sq.-ft., state-of-the-art facility that offers labs and office space optimized for robotics development.

Analysis:

The ARM Institute is one of 14 Manufacturing U.S. Institutes in a national network of linked manufacturing institutions funded by the U.S. Department of Defense with the goal of accelerating advanced manufacturing. Each Manufacturing U.S. Institute has a unique technological concentration. In the case of the ARM Institute, it is collaborative robotics, sensors, and other technologies for advanced manufacturing.

Constructing the Mill 19 building within the steel frame of one of the largest steel mills in Pittsburgh showcases ARM's dedication to driving the future of manufacturing while honoring the past.

The sheer size and modern amenities at the Mill 19 facility are sure to spur robotics and automation innovation. Not only could it benefit manufacturing, a well-funded vertical market sector, but it could also act as a catalyst of all manner of non-manufacturing robotics applications. The new headquarters also makes it easier for ARM to partner with other regional and national stakeholders.

The fact that the ARM Institute is co-located with Carnegie Mellon University's Manufacturing Futures Initiative makes it easier for ARM's robotics and workforce projects to take advantage of manufacturing research incorporating artificial intelligence and other digital technologies.

Finally, ARM's new facility bolsters Pittsburgh's regional robotics capabilities, and by extension, the global reputation of the Pittsburgh robotics cluster. RR – *Dan Kara*

AutoGuide Mobile Robots hires re-trained coal miners as robotics technicians

Organization Name:	AutoGuide Mobile Robots
Country:	U.S.
Website:	www.agmobilerobots.com
Year Founded:	2018
Number of Employees:	60+
Innovation Class:	Business & Management Innovation
Innovation Subclass:	Social Good

RBR 50 INNOVATION AWARDS

Description:

AutoGuide Mobile Robots, a Massachusetts-based developer of autonomous mobile robots, and its premier integrator, Heartland Automation, have hired 25 former coal miners to fill labor shortages. The displaced miners were retrained and graduated from the Haas eKentucky Advanced Manufacturing Institute (eKAMI) in Paintsville, Ky. Students train on state-of-the-art CNC equipment and are taught soft skills for professional development. AutoGuide was acquired by Teradyne in October 2019 for potentially $165 million.

Analysis:

eKAMI was started in 2017 by Kathy Walker, who spent many years in the coal business herself, including 15-plus as a member of the National Coal Council, a federal advisory committee that helps shape policies about matters relating to coal. Many coal miners are born into the business, and those living in Appalachia often live below or straddle the poverty line. In 2008, regulatory pressure from President Obama forced many coal mines to close. The industry coined this the "War on Coal."

Robots are often viewed as a threat to human jobs, but not in this case. This is a great example of how re-skilling helped AutoGuide fill labor shortages and positioned dislocated coal miners for future career success. It also provides a potential blueprint on how to re-skill more displaced coal miners and diversify the local economy by creating additional advanced manufacturing opportunities. RR -- *Steve Crowe*

Blue Ocean Robotics builds UV-D disinfection robot

Organization Name:	Blue Ocean Robotics ApS
Country:	Denmark
Website:	www.blue-ocean-robotics.com
Year Founded:	2013
Number of Employees:	95
Innovation Class:	Applications & Markets Innovation
Innovation Subclass:	Healthcare/Rehabilitation

Description:

Even before the COVID-19 pandemic, hospitals needed a way to disinfect rooms without exposing personnel or patients to harmful pathogens or radiation. The novel coronavirus crisis has rapidly escalated demand for disinfection robots worldwide, but only a few companies were ready to satisfy that demand.

Blue Ocean Robotics began as a robotics integrator and became a full-service robotics company, designing and developing service robots for the agriculture, construction, healthcare, and hospitality markets. As a "venture factory," it has created divisions to commercialize its technologies. Its UVD Robots unit first sold the UV-Disinfection robot last year after six years of development.

The UVD robot is an autonomous mobile robot that uses UV-C light to kill up to 99.999% of viruses and bacteria in a patient room in 15 minutes. A Taiwan hospital study conducted over four to six months found that the UVD robot can reduce the number of infections by more than 25%.

Analysis:

In the U.S. alone, more than 1.7 million people develop hospital-related infections each year, and 75,000 die from them, according to the Centers for Disease Control. Blue Ocean Robotics has rapidly scaled up production and distribution of the UVD robot, providing it to more than 50 countries in 2020.

In addition to hospitals, the UVD robots can be used in other public spaces, such as hotels, schools, and airports.

Since the novel coronavirus outbreak, Blue Ocean Robotics' UVD robot has experienced a quadrupling of sales (and spawned a host of imitators). With thousands of robots expected to be in the field in the next few years, this disinfection robot will continue to be on the front lines of the fight against pandemics. RR -- *Eugene Demaitre*

Bossa Nova Robotics expands Walmart deployment to 1,000 stores

Organization Name:	Bossa Nova Robotics
Country:	U.S.
Website:	www.bossanova.com
Year Founded:	2005
Number of Employees:	185
Innovation Class:	Business & Management Innovation
Innovation Subclass:	Market Engagement

RBR 50 INNOVATION AWARDS

Description:

In January 2020, mobile retail robotics supplier **Bossa Nova Robotics** announced that the company will deploy its shelf-scanning inventory robot to 1,000 Walmart stores in the U.S., up from 350. The deployment should be completed by early fall 2020. Boss Nova initially partnered with Walmart in 2017 with a 50-robot evaluation program.

Analysis:

Bossa Nova Robotics was founded in 2005, a spinout from Carnegie Mellon University's Robotics Institute. The company initially focused on robotic toys. Bossa Nova pivoted to become a data service provider for the retail industry using highly sensored, autonomous mobile robots to detect out-of-stock items, identify mispriced and misplaced items, and more.

Bossa Nova faces competition from a number of other companies that employ robotics as autonomous mobile sensors. The 2017 partnership announcement with Walmart was rightly seen as a huge win for Bossa Nova. At one stroke, it legitimized the company, along with its business model and value proposition.

But it is Bossa Nova's follow-up expansion of Walmart deployments following initial assessment phase that is most critical.

Walmart is the world's largest brick-and-mortar retailer, with over 1,500 stores and 2 million employees worldwide. It is in the midst of a massive innovation program centered on robots, AI, and data. Bossa Nova Robotics is a key piece of that initiative. RR — *Dan Kara*

Boston Dynamics commercializes Spot quadruped robot

Organization Name: Boston Dynamics
Country: U.S.
Website: www.bostondynamics.com
Year Founded: 1992
Number of Employees: 101-500
Innovation Class: Product, Technology & Services
Innovation Subclass: Product Introduction

RBR 50 INNOVATION AWARDS

Description:

Boston Dynamics' Spot quadruped launched in September 2019 through the company's Early Adopter Program. With mounting rails, payload ports, and an open-source software development kit, developers can create custom methods of controlling the robot, design payloads that expand the capabilities of the base robot platform, and integrate sensor information into data analysis tools.

Spot autonomously accomplishes industrial sensing and remote operation needs, while carrying payloads with endurance far beyond aerial drones. Early adopters are in a range of industries, from construction to energy utility, public safety, mining, and entertainment.

Analysis:

Quadruped robots have historically been relegated to research labs. The high prices, combined with challenges in agility, control, power consumption and stability, often make them less reliable and desirable than wheeled mobile robots. Boston Dynamics is hoping to change that and kick-start the commercial quadruped market with the limited release of Spot. This is not only an important measuring stick for quadruped robots as a technology, but it is also a crucial test for Boston Dynamics' goals of solving the hard problems in robotics. These efforts have led to major new functionality, as the company focuses on developing robots for real-world applications. RR -- *Steve Crowe*

BUILT ROBOTICS

Built Robotics partners with 400k strong International Union of Operating Engineers

Organization Name:	Built Robotics
Country:	U.S.
Website:	www.builtrobotics.com
Year Founded:	2016
Number of Employees:	11–50
Innovation Class:	Business & Management Innovation
Innovation Subclass:	Leadership

RBR 50 INNOVATION AWARDS

Description:

Built Robotics, a San Francisco–based startup that transforms heavy equipment into autonomous robots with its AI guidance system, partnered with the International Union of Operating Engineers (IUOE). Founded in 1896, the IUOE represents 400,000–plus members, primarily construction workers who work as heavy equipment operators, mechanics, surveyors, and stationary engineers.

The multi–year partnership will train IUOE members to oversee and manage robotic equipment, as well as work alongside autonomous machines. Built Robotics will provide its guidance systems to the IUOE's International Training & Education Center near Houston. IUOE members will be trained to install, operate, and repair robots in realistic job–site conditions.

Analysis:

The construction industry has not been known to embrace cutting–edge technologies with open arms. By partnering with the IUOE, one of the largest and most historic construction institutions in North America, Built Robotics is getting its technology into the hands of more skilled operators. This will help construction workers familiarize themselves with and accept robotic technology, which is often a barrier to adoption in many industries.

Built Robotics' technology can help fill an impending labor shortage facing the construction industry. According to the nonprofit National Center for Construction Education and Research, many current heavy equipment operators are close to retirement age. The Bureau of Labor Statistics estimates such jobs will grow 10% between 2018 and 2028, twice the rate for all occupations.

Finally, this partnership is noteworthy, as other unions have not embraced automation. In 2017, for example, the International Brotherhood of Teamsters, a union representing truck drivers across North America, helped convince the U.S. Senate to exclude autonomous trucks from draft legislation on self–driving vehicles, which has been a major setback for the technology. RR –– *Steve Crowe*

Cruise Origin autonomous vehicle challenges transportation paradigm

Organization Name:	Cruise LLC
Country:	U.S.
Website:	www.getcruise.com
Year Founded:	2013
Number of Employees:	1,400
Innovation Class:	Product, Technology & Services Innovation
Innovation Subclass:	Product Introduction

Description:

Electric and self-driving cars are often envisioned as more efficient replacements for conventional gasoline-powered, human-driven automobiles. Delivery and ride-sharing services are among the applications, but what if a vehicle was designed from the ground up for a different model of personal transportation?

Cruise, which General Motors Co. acquired in 2016, has been working on autonomous vehicles to improve safety, reduce the environmental impact of transportation, and mitigate urban traffic congestion. In January 2020, Cruise unveiled Origin, a new approach to transportation combining elements of rides on demand with an electrical and fully autonomous vehicle.

The Origin has a modular design with fewer moving parts for a longer lifespan. It is also intended to be comfortable for up to six passengers facing one another. The shuttlebus-like Origin has no steering wheel and was developed in cooperation with GM and Honda Motor Co.

Analysis:

Cruise executives said they expect Origin to surpass human performance levels.

Other technology companies and automakers are pursuing self-driving vehicles, but none has so directly challenged the traditional model of individual ownership. GM said it is investing $2.2 billion in its Detroit-Hamtramck plant in Michigan to manufacture Cruise Origin.

While it's too soon to say which autonomous vehicles will be technologically viable or commercially successful, Cruise's Origin is a bold step toward a new mode of transport. RR -- *Eugene Demaitre*

CSIRO'S Data61 opens a new robotics innovation center

Organization Name:	Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Country:	Australia
Website:	www.csiro.au
Year Founded:	1949
Number of Employees:	5,500
Innovation Class:	Business & Management Innovation
Innovation Subclass:	Leadership

RBR 50 INNOVATION AWARDS

Description:

In March 2019, Data61, a business unit within Australia's **Commonwealth Scientific and Industrial Research Organisation** (CSIRO), opened a new purpose-built research center for robotics and autonomous systems — the Robotics Innovation Centre. The 48,000-sq.-ft. facility, which is located at CSIRO's Queensland Centre of Advanced Technologies, features the biggest motion-capture system in the Southern Hemisphere, which used to validate data collected by robotics systems. It also boasts of a 13x5 m pool, which is used for testing aquatic robots, along with a number of unmanned ground vehicles, legged systems, aerial drones, and industrial robots. Data61 representatives indicated that the Robotics Innovation Centre is open for both research and industry use, along with collaborative projects.

Analysis:

Australia has a well-deserved reputation as a robotics innovation leader, known for groundbreaking research and commercialization efforts. In particular, the country has expertise in "field robotics" systems for agriculture and mining, along with advanced manufacturing, machine learning, and various autonomous systems. The new CSIRO Robotics Innovation Centre solidifies Australia's international robotics standing. More importantly, the center will directly support ongoing research and help speed robotics commercialization efforts. RR – *Dan Kara*

Diligent Robotics introduces Moxi mobile manipulator in hospitals

Organization Name:	Diligent Robotics Inc.
Country:	U.S.
Website:	www.diligentrobots.com
Year Founded:	2017
Number of Employees:	31
Innovation Class:	Applications & Markets Innovation
Innovation Subclass:	Healthcare/Rehabilitation

RBR 50 INNOVATION AWARDS

Description:

Healthcare facilities were already understaffed before the COVID-19 pandemic, which has brought new attention to how robots can help improve care by freeing human staffers to attend to patients. A prime example is the Moxi mobile manipulator, which **Diligent Robotics** began testing in hospitals last year.

Healthcare industry analysts estimate there will be a shortage of 1.1 million registered nurses in the U.S. in 2022, and 9 million in 2030. Moxi is designed to retrieve medical supplies and integrate with hospital systems so that human staffers spend less time running around.

The robot uses machine learning for object recognition and grasping, as well as navigation software based on the Robot Operating System (ROS). Moxi also includes components from Fetch Robotics, Velodyne Lidar, Intel, Kinova, and Robotiq.

Moxi is available through a robotics-as-a-service (RaaS) model from Diligent Robotics, and the Austin, Texas-based company raised $10 million in Series A funding in March 2020.

Analysis:

Rather than try to perfect a humanoid general-purpose robot or create a system for both patient interaction and materials handling, Diligent Robotics has built an autonomous service robot that can be deployed now to help nurses and other clinicians.

In addition, Moxi can help reduce the need for contact among personnel and patients, thereby reducing the risk of infection.

Mobile manipulation has taken a while to arrive in supply chain operations and e-commerce order fulfillment, but the urgency of hospital demand makes Moxi's arrival especially timely. RR -- *Eugene Demaitre*

Energy Robotics and ExRobotics launch mobile robots for remote inspection of oil and gas sites

Organization Names:	Energy Robotics and ExRobotics
Country:	Germany / Netherlands
Website:	www.energy-robotics.com / www. exrobotics.global
Year Founded:	2018 (Energy Robotics), 2015 (ExoRobotics)
Number of Employees:	5 (ER) / 7 (EX)
Innovation Class:	Application & Market Innovation
Innovation Subclass:	Transportation

RBR 50 INNOVATION AWARDS

Description:

In 2019, Germany-based **Energy Robotics** and Netherlands-based **ExRobotics** launched the ExR-1, the world's first commercially available IECEx/ATEX certified (Ex certified), explosion-proof, mobile ground robotics system for remote inspection for oil and gas (O&G) operations. ExR-1 systems, which can operate in potentially explosive environments, are in daily operation on four continents serving multiple first customers.

Analysis:

The O&G industry operates about 100,000 onshore and 9,000 offshore sites. The sector is under intense pressure to improve cost efficiencies, enhance safety, ensure environmental compliance, and increase the digitalization of operations at their sites. Continuous inspection can support these initiatives.

The remotely operated ExR-1, which unlike inspection drones is explosion-proof and robust enough to operate in adverse weather and environmental conditions, can provide continuous and detailed multi-sensorial inspection data of O&G facilities. This delivers a more accurate overview of the maintenance state of expensive industrial installations, as well as ensures compliance with environmental regulations, while eliminating any risks of operators being exposed to hazardous materials. RR – *Dan Kara*

Exyn Technologies offers aerial mapping systems for surveying mines

Organization Name:	Exyn Technologies
Country:	U.S.
Website:	www.exyn.com
Year Founded:	2014
Number of Employees:	About 50
Innovation Class:	Application & Market Innovation
Innovation Subclass:	Mining / Quarrying

RBR50 INNOVATION AWARDS

Description:

In February 2019, **Exyn Technologies** announced the commercial availability of its Advanced Autonomous Aerial Robot (A3R). It is a fully autonomous aerial system for data collection in GPS-denied environments, including for mapping and inspection of underground mines. Exyn's exynAI software stack allows robots to navigate autonomously and reliably without the need for prior information, persistent communication, or infrastructure of any kind. They can generate detailed maps using 3D lidar and work together as a collaborative swarm. Last year, Exyn deployed its A3Rs as a service for customers in the U.S., Latin America, and Europe.

Analysis:

For mining operations, underground cavities must be continually analyzed to determine the success of drill and blast exercises. These areas are often over a kilometer underground, extremely dangerous, and constantly changing. Current technology requires workers to be dangerously close to the edge of an open slope, takes over an hour to use, and can only gather data visible at the base of the cavity. By flying pilotless robots that do not require GPS or consistent communications into these cavities, Exyn is able to produce information-rich 3D maps that can dramatically improve a mine's day-to-day operations and safety. The maps also help mine operators better understand their own project needs to improve resource planning. RR – *Dan Kara*

FAULHABER MICROMO releases compact BXT flat brushless DC motors

Organization Name: FAULHABER MICROMO LLC
Country: U.S.
Website: www.faulhaberusa.com
Year Founded: 1961
Number of Employees: 81
Innovation Class: Product, Technology & Services Innovation
Innovation Subclass: Product Introduction

RBR 50 INNOVATION AWARDS

Description:

FAULHABER MICROMO recently became part of the FAULHABER Drive Systems division. Among the products that FAULHABER MICROMO has launched in the past year or so is the BTX flat brushless DC motor series.

The BXT's compact design makes it suitable for medical devices and robotics, and FAULHABER can customize its electrical and mechanical interfaces for different industrial applications.

The external rotor BXT can provide continuous output of 100 W and up to 134 mNm of torque. The motors also come in a variety of gearhead, encoder, and diameter options, as well as with digital Hall sensors that are designed for up to 10,000 rpm. It can come with or without housing.

Analysis:

FAULHABER is already known for its high-precision components for medical, manufacturing, telecommunications, aerospace, and robotics applications. With the BXT line, Clearwater, Fla.-based FAULHABER MICROMO supplies a full range of miniature and micro motion systems.

The BXT series uses high-performance, rare-earth magnets to delivery high torque with a short drive, putting power where it is needed for robotics developers. RR -- *Eugene Demaitre*

Fetch Robotics WorkFlow Builder simplifies deployment of mobile robot fleets

Organization Name:	Fetch Robotics
Country:	U.S.
Website:	www.fetchrobotics.com
Year Founded:	2014
Number of Employees:	51–200
Innovation Class:	Application & Market Innovation
Innovation Subclass:	Product Introduction

RBR50 INNOVATION AWARDS

Description:

Fetch Robotics launched in March 2020 its Workflow Builder toolkit, which allows customers to design, implement, and redesign their own workflows for Fetch's autonomous mobile robots (AMRs). Based on Blockly programming, Workflow Builder features a drag-and-drop interface that non-programmers can learn. WorkFlow Builder allows customers to deploy AMRs in days, doing all the work in-house without the need to rely on third-party integrators.

Although Workflow Builder is used for device, warehouse management system (WMS), and warehouse execution system (WES) integration, it is not dependent on the use of a WMS or WES. It can be deployed with WMS-related workflows such as picking and putaway, or workflows completely outside the WMS such as pack station replenishment, empty tote return, or recycling removal.

Analysis:

Designing for ease of use is a growing mantra of the robotics industry. In fact, Fetch Robotics CEO Melonee Wise at RoboBusiness Europe 2017 called ease of use the next big challenge for robotics. Fetch's WorkFlow Builder is certainly a major step in the right direction.

It is now easier than ever for Fetch's customers to design, install, and maintain their fleets of AMRs.

Many other types of robots still require the expertise of third-party integrators for initial setup and reprogramming when workflows change. This work is costly, disruptive, and does not guarantee that automation workflows will meet ROI expectations.

WorkFlow Builder helps lower several barriers to adoption by simplifying integration and re-programming efforts, lowering overall system cost, enabling system flexibility, and shortening the return on investment. RR -- *Steve Crowe*

Formant

Formant puts data collection, analysis, and robot management in the cloud

Organization Name:	Formant Inc.
Country:	U.S.
Website:	www.formant.io
Year Founded:	2017
Number of Employees:	18
Innovation Class:	Product, Technology & Services
Innovation Subclass:	Product Introduction

RBR 50 INNOVATION AWARDS

Description:

An emerging challenge for enterprise robotics users is analyzing the data gathered and generated by fleets of robots. **Formant.io** provides the analytics platform, which presents application data in a single Web-based user interface.

Formant's cloud software enables organizations to monitor robot fleets in real time, look deeply into their operations, and take remote control of individual robots if needed.

The San Francisco-based company said its monitoring, analytics, and intuitive interface can help healthcare, maintenance, construction companies and more.

Analysis:

As mobile robots and other hardware gradually commoditize, the value of automation lies in analyzing and acting upon business data. Formant has created a platform that is ready to handle increasingly complex tasks and robot configurations while focusing on delivering actionable information to end users.

Even as systems gain more autonomy, humans will still need to be "in the loop" for higher-level decisions, particularly those affecting mission-critical enterprise functions.

With automated analytics and annotated data, Formant's platform allows humans to work with robots in real time while also having instant access to relevant historical data. RR -- *Eugene Demaitre*

Gatik Level 4 autonomous vehicles tackling middle-mile logistics for retailers

Organization Name:	Gatik
Country:	U.S.
Website:	www.gatik.ai
Year Founded:	2017
Number of Employees:	11–50
Innovation Class:	Applications & Markets Innovation
Innovation Subclass:	Logistics

RBR 50 INNOVATION AWARDS

Description:

Palo Alto, Calif.–based startup **Gatik** came out of stealth mode in July 2019 to address the pain point of middle-mile logistics for businesses. Middle-mile delivery is the most expensive part of the whole supply chain for businesses. With the rise of e-commerce and a short supply of drivers, businesses are struggling to meet the consumer expectations of an increasingly on-demand economy.

Gatik's Level 4 autonomous vehicles, which include light trucks and vans, operate on fixed, repeatable routes about 15 times per day. The autonomous vehicles are restricted to the right-most lane as often as possible to eliminate technical challenges such as unprotected left turns. However, if needed, its vehicles will operate in left lanes and are capable of making lane changes and unprotected left turns. The vehicles also avoid routes with fire stations, hospitals, and schools to avoid unpredictability.

Analysis:

Gatik is implementing its solution with major retailers in North America, including Walmart, the world's largest retailer. Gatik's vehicles are responsible for shuttling groceries from a Walmart Supercenter to Neighborhood Stores in Bentonville, Ark. The company is helping retailers like Walmart reduce the high cost of middle-mile logistics, while improving safety, increasing efficiency, and reducing congestion and emissions. Gatik claims it makes "millions" per year in revenue.

The partnership and approach to autonomy are unique in the autonomous vehicle industry. They are also proof that commercialization and scalability of autonomous vehicles could happen first in B2B short-haul logistics and that viable business models do not require SAE Level 5 full autonomy. RR –– *Steve Crowe*

Geek+
Moving the world intelligently

Geek+ expands globally, provides 10,000 mobile robots as a service

Organization Name:	Geekplus Technology Co.
Country:	Beijing
Website:	www.geekplus.com
Year Founded:	2015
Number of Employees:	438
Innovation Class:	Business Management
Innovation Subclass:	Leadership

RBR 50 INNOVATION AWARDS

Description:

The global market for autonomous mobile robots (AMRs) is growing quickly, with many players and plenty of room for growth, thanks to accelerating e-commerce demand. **Geekplus Technology Co.** marked several milestones in the past year, including deploying more than 10,000 AMRs worldwide, working with major brands, and opening new offices in San Diego and Dusseldorf, Germany.

Geek+ also launched its RoboShuttle system for multi-level, goods-to-person automation and opened a factory that uses its own robots to build more robots. The Beijing-based company offers its AMRs through a robotics-as-a-service (RaaS) model. It raised $150 million in Series C1 funding last July.

According to Interact Analysis, Geek+ has become the No. 1 supplier of AMRs in the world, with 10% market share. Its customers include Decathlon, Dell, Nike, and Walmart.

Analysis:

Geek+ said its mobile robots can replace traditional conveyor belts and provide scalable and flexible production. On Nov. 11, 2018, or "Singles Day" in China, Geek+ helped deliver 8.11 million orders within 72 hours at a rate nearly double that of manual 3PL (third-party logistics) warehouses.

The company has carefully cultivated major customers and partners, applying its understanding of their capabilities to new applications. By using this know-how in its own production lines, Geek+ promises to scale to satisfy global demand for fast, accurate deliveries. RR -- *Eugene Demaitre*

Harmonic Drive opens a new manufacturing and R&D facility

Organization Name:	Harmonic Drive LLC
Country:	U.S.
Website:	www.harmonicdrive.net
Year Founded:	1960
Number of Employees:	5,500
Innovation Class:	Business Management Innovation
Innovation Subclass:	Leadership

RBR50 INNOVATION AWARDS

Description:

Harmonic Drive, a leading producer of servo actuators, gearheads and gear components, opened a newly constructed, purpose-built headquarters and manufacturing facility in Beverly, Mass., in March 2019. Approximately two-thirds of the 97,000-sq.-ft. facility is dedicated to manufacturing. The space is also optimized for gear production and parts flow. This includes flooring specifically engineered for the heavy equipment and specialized machinery used to manufacture high-precision gears. The site also includes clean rooms, test labs, assembly rooms, a painting chamber, and more.

Analysis:

The new Harmonic Drive facility more than doubles the square footage of the location it replaced. Company representatives have stated that the new plant will allow it to increase its manufacturing capacity by several hundred percent, partially in anticipation of strong robotics sector growth. They also noted that the state-of-the-art site will allow Harmonic Drive to manufacture more efficiently, and thereby increase production capacity and lower overall costs. The state-of-the-art facilities will also enable the company's R&D engineering team to design, test, and deliver prototypes and products faster for both standard and custom-engineered systems. RR -- Dan Kara

Intel announces low-cost, high-resolution RealSense LiDAR Camera L515

Organization Name: Intel
Country: U.S.
Website: www.intelrealsense.com
Year Founded: 1968
Number of Employees: 110,000
Innovation Class: Product, Technology & Services Innovation
Innovation Subclass: Production Introduction

RBR 50 INNOVATION AWARDS

Description:

The **Intel RealSense LiDAR Camera L515**, which is optimized for indoor applications such as warehouse robotics, features a proprietary micro-electro-mechanical system (MEMS) for enhanced precision and resistance to shock, temperature fluctuations, and vibration. The L515 captures 9.2 million depth points per second in 640 x 480 resolution, with a 95% reflectivity range of 0.25 to 9 m. It also captures 23.6 million depth points per second in 1024 x 768 resolution, with a 95% reflectivity range of 0.25 to 6.5 m.

An included RGB camera with a rolling shutter, the OV2740 CMOS image sensor from OmniVision, provides up to 1920 x 1080 resolution at up to 30 fps. An inertial measurement unit with accelerometer and gyroscope is included, and processing is achieved via an Intel RealSense Vision ASIC.

Analysis:

At just 61 x 26 mm in size and 100 g in weight, the L515 packs a power technological punch into a small form factor. Intel claims this is the world's smallest, most power-efficient high-resolution lidar. It is also one of the most cost-efficient lidar sensors, starting at $349.

While Intel's RealSense cameras are popular among robotics developers, the L515 marks its first product that incorporates solid-state lidar technology, which is a sensor without moving parts, into a depth-sensing camera. But the combination of low cost and high resolution make it an ideal lidar option for indoor robotics applications. RR -- *Steve Crowe*

iRobot diversifies its manufacturing supply chain

Company / Group Name:	iRobot Corp.
Country:	U.S.
Website:	www.irobot.com
Year Founded:	1990
Number of Employees:	1,000+
Innovation Class:	Business & Management Innovation
Innovation Subclass:	Leadership

RBR50 INNOVATION AWARDS

Description:

iRobot, the market leading producer of robotics vacuum cleaners and other consumer robotics products, announced in November 2019 that manufacturing operations in Malaysia had commenced. iRobot representatives indicated that the Malaysia manufacturing expansion was the result of the company's strategic supply chain diversification initiative.

Analysis:

Many U.S. manufacturers are actively diversifying their supply chain and manufacturing locations as they seek alternatives outside of China to reduce exposure to continuing trade issues. For example, the 25% levies against Chinese imports raise the cost of manufactured goods, iRobot's vacuums among them, which results in reduced unit sales.

In the announcement describing the Malaysia move, iRobot noted that project was completed from start to finish in less than a year and ahead of schedule, a huge undertaking and accomplishment. iRobot also highlighted the assistance it had received from manufacturing solutions provider Jabil.

Jabil has been an iRobot partner since 2006, when it first began supplying parts for iRobot's mobile robots for defense applications.

The corporate partnership was key to the iRobot expansion. In addition to providing manufacturing outsourcing competency, Jabil's large size, global reach, and massive buying power ensures a vast, diversified supplier base. RR -- Dan Kara

KINOVA

KINOVA's Gen3 family of robotic arms supports research efforts and spurs commercial development

Organization Name: KINOVA
Country: Canada
Website: www.kinovarobotics.com
Year Founded: 2006
Number of Employees: 160+
Innovation Class: Product, Technology & Services
Innovation Subclass: Production Introduction

RBR 50 INNOVATION AWARDS

Description:

Following several years of research and development work, and in close collaboration with research centers worldwide, in January 2019, **KINOVA** announced the commercial launch of the KINOVA Gen3 robotic arm. It is a 7-DoF (degrees-of-freedom), lightweight (carbon-fiber) collaborative robotic arm specifically engineered for research and commercial labs. The Gen3 system boasts of embedded 2D (RBG) and 3D (Intel RealSense) vision, and an interface module offering a variety of options for connectivity and end effector development. In March 2020, the company extended the Gen3 line with the Gen3 Lite, an ultralight arm designed for light manipulation tasks.

Analysis:

Academic and commercial R&D efforts are the wellspring of most robotics innovation, including early experimentation and development for commercial-class robotics systems. Collaborative robotics arms are commonly employed as research tools, but the suppliers of most cobots consider research to be a secondary or tertiary target market after the manufacturing, logistics, and other commercial sectors.

Since its founding, KINOVA focused on supplying highly versatile, off-the-shelf robotics technologies for academic and commercial R&D -- initially, personal assistance systems. The company has been working with partners to provide robotics solutions for challenging, typically low-volume applications.

This approach has resulted in KINOVA arms acting as adaptable research tools for many commercial solutions, or as the platform on which a wide range of commercial systems and applications are built. Examples include bomb disposal and hazmat robots, surgical systems, field robotics technologies and more.

With the release of the Gen3 and Gen3 Lite systems, robotics innovation will be better supported in just this way. RR -- *Dan Kara*

Locus Robotics expands partnership with DHL Supply Chain

Organization Name:	Locus Robotics Inc.
Country:	U.S.
Website:	www.locusrobotics.com
Year Founded:	2014
Number of Employees:	51–200
Innovation Class:	Applications & Markets Innovation
Innovation Subclass:	Logistics

RBR50 INNOVATION AWARDS

Description:

Locus Robotics and DHL Supply Chain expanded their partnership to include 10 new deployments of the LocusBots autonomous mobile robots (AMRs) across U.S. locations throughout the rest of 2020. With the agreement, DHL Supply Chain, part of the Deutsche Post DHL Group, will have 1,000 LocusBots supporting 12 DHL sites in North America. The two companies initially partnered in 2017 to pilot the LocusBots to support associates in piece-picking order fulfillment in warehouses.

The AMRs navigate autonomously within a warehouse to quickly locate and transport pick items to associates. The robots can support a range of picking strategies, helping to reduce time spent on routine or physically demanding tasks, reducing manual errors and increasing productivity for customers.

Analysis:

Out of all of its customers, which include Boots, GEODIS, Port Logistics, Radial, Verst Logistics and many others, the DHL Supply Chain partnership has proven Locus' approach to logistics robotics the most. DHL has piloted many of Locus' competitors. In fact, the entrance to DHL's Innovation Center in Chicago prominently displays the logos of the many logistics automation companies it has worked with over the years.

DHL Supply Chain announced in 2018 a multi-year plan to invest $300 million in emerging technologies in its North American operations. Locus has capitalized on this opportunity.

DHL's initial implementation of the LocusBots within the life sciences and retail sectors saw increases in fulfillment productivity of up to 80%. This new expansion is a direct result of proven customer success.

Earlier in 2020, Locus surpassed its 100 millionth pick with its LocusBots. And the pick happened at a DHL Supply Chain fulfillment facility in Hanover, Pa. RR -- *Steve Crowe*

massrobotics

MassRobotics expands robotics innovation center to nurture innovations in industrial automation, human-machine interaction

Organization Name:	MassRobotics
Country:	U.S.
Website:	www.massrobotics.org
Year Founded:	2017
Number of Employees:	7
Innovation Class:	Business Management Innovation
Innovation Subclass:	Business Models

RBR 50 INNOVATION AWARDS

Description:

In November 2019, **MassRobotics**, an independent, non-profit organization serving as an innovation hub for robotics and smart connected devices, formally opened a 25,000-sq.-ft. addition to the existing MassRobotics facility in Boston's Seaport District. The expansion was funded by a $2.5 million grant from the state of Massachusetts, with equivalent funding coming from MassRobotics' corporate partners.

Analysis:

After two years of concept planning and development, in early 2017, MassRobotics officially opened an initial 15,000-sq.-ft. robotics innovation center. Within the first six months, the facility attracted 18 startups from around the US, which grew to 34 companies by mid-2019.

The MassRobotics expansion nearly doubles the size of the original workspace. The most critical driver for the success of MassRobotics initiative is the organization's business model, in which resident start-ups are provided with much more than space to work.

Under the MassRobotics program, tenant companies have access to state-of-the-art electronic and mechanical prototyping labs, including a variety of 3D printers, soldering stations, oscilloscopes, laser cutter, mini-CNC, and other machine tools.

The expanded space also includes industrial automation labs equipped with conveyor belts, a variety of robotic arms and other manufacturing technologies.

In addition, the center has common robotics platforms, from collaborative robot arms to autonomous mobile robots and even humanoids, that residents can borrow and experiment with.

MassRobotics offers its tenants CAD and other design and development tools from vendors such as AutoDesk, SolidWorks, MathWorks, Amazon AWS and Google.

Finally, MassRobotics' expert staff can provide personal Introductions to investors, corporate partners, potential customers, manufacturers, and technical and business talent. RR -- Dan Kara

maxon

maxon precision motors opens new manufacturing facility, expands capabilities

Organization Name:	maxon precision motors
Country:	U.S.
Website:	www.maxongroup.com
Year Founded:	1961
Number of Employees:	3,000+
Innovation Class:	Business Management Innovation
Innovation Subclass:	Market Engagement

RBR 50 INNOVATION AWARDS

Description:

In March 2019, maxon precision motors, a subsidiary of Switzerland based **maxon motors**, opened a new 59,000-sq.-ft. engineering and manufacturing facility in Fall River, Mass. The site also includes conference areas, design spaces, and offices. Company representatives indicated that maxon planned to add employees at the site.

Analysis:

maxon motors has a well-earned reputation as a producer of high-quality, precision motors, gearheads, encoders, and controllers. They are used in a variety of commercial robotics systems, some of them the most recognizable in the world including NASA's Mars rovers and Robonaut humanoid. maxon drive systems are also used in medical devices, industrial systems, tools, and other products.

North America, particularly the U.S., is maxon's largest market. The previous maxon motors facility, also located in Massachusetts, provided sales, distribution, and assembly operations for maxon's North American customers.

With the new building, maxon will increase its North American capabilities to include not only manufacturing, but also design and engineering. The new building includes an electronics and machine shop, and prototyping and modeling space

maxon also said that it intends to work with domestic suppliers for their engineering projects and that local customers will be able to work with maxon engineers developing new solutions, including dedicated, customer-specific products. RR -- *Dan Kara*

Microsoft

Microsoft Windows 10 supports Robot Operating System

Organization Name:	Microsoft Corp.
Country:	U.S.
Website:	www.microsoft.com
Year Founded:	1975
Number of Employees:	150,000+
Innovation Class:	Product, Technology & Services Innovation
Innovation Subclass:	Product Introduction

RBR 50 INNOVATION AWARDS

Description:

At its 2019 Build Conference, **Microsoft** announced that Windows IoT Enterprise now supported Robot Operating System (ROS), the widely used open-source platform that provides robotics developers with a variety of powerful libraries and tools for developing and deploying robotics solutions. Prior to this, the ROS developer community had built kludgy workarounds for Windows. ROS had mainly been running on operating systems such as Linux and an experimental version of MacOS.

Analysis:

The partnership between Microsoft and Open Robotics, the company behind ROS, is mutually beneficial. For Microsoft, ROS for Windows 10 is an opportunity to expose its Azure cloud platform, and associated products, to ROS developers around the world. This will help Microsoft bring innovations in edge computing to robots.

ROS for Windows 10 also creates a more familiar, user-friendly development environment. For example, ABB recently released ROS nodes for Windows. ABB roboticists can bring up ROS and RobotStudio, the company's simulation and offline programming software, on the same Windows machine to commission the robot and run simulations. This means the simulation tests are now more realistic because the virtual controller running on RobotStudio truly mimics the capabilities of the robot controller. It is also easier for business developers to work on one computer rather than switch among multiple machines.

There also was a time when Microsoft was anti-open source. In 2001, Microsoft's then-CEO Steve Ballmer said, "Linux is a cancer that attaches itself in an intellectual property sense to everything it touches."

Many robots run on Linux, and Microsoft has had a change of heart over the years. RR -- *Steve Crowe*

New Scale Robotics

New Scale Robotics introduces Q-Span Automated Small-Part Measurement Systems

Organization Name:	New Scale Robotics
Country:	U.S.
Website:	www.newscalerobotics.com
Year Founded:	2002
Number of Employees:	11-50
Innovation Class:	Applications & Markets Innovation
Innovation Subclass:	Manufacturing

RBR 50 INNOVATION AWARDS

Description:

New Scale Robotics in March 2020 introduced its Q-Span Automated Small-Part Measurement Systems for quality control (QC) teams in high-mix, small-batch manufacturing environments. Q-Span combines robotic pick-and-place with automated measurement of small parts. Q-Span can pick small parts weighing up to 3.5 oz. (70.8 g) and measuring up to 3.94 in. (10 cm). Measurement resolution is 0.0001 in. (0.0024 mm), with better than 0.0002 in. (0.005 mm) repeatability and 0.0006 in. (0.015 mm) accuracy.

Each Q-Span workstation includes up to three New Scale Robotics gripper/calipers with part-specific metrology fingertips, modular trays for parts-in and parts-out, a measurement fixture and zero-reference fixture with gauge block, and a worktable. New Scale integrates a six-axis UR3e e-Series cobot arm from Universal Robots (purchased separately) into the workstation and creates the scripts for each customer's first part.

Analysis:

Q-Span helps accelerate robotics sector growth by introducing affordable automation to a new audience in manufacturing -- the QC department of high-mix, small-batch manufacturing companies. Until now, the use of cobots in these companies has been concentrated on materials handling and assembly. Customers will see improvements in measurement consistency and the ability to maintain or increase throughput without adding headcount.

Q-Span also helps accelerate cobot adoption by offering a complete, application-specific solution. The QC team does not need to have an automation specialist, learn about cobots, or identify the right combination of cobot, end-of-arm-tooling, and accessories.

Q-Span is also the first application kit for quality inspection to be certified by cobot leader Universal Robots and featured on the UR+ platform. RR -- *Steve Crowe*

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Nuro upgrades R2 autonomous vehicle development platform, obtains dual exemptions for on-road testing

Organization Name:	Nuro AI
Country:	U.S.
Website:	www.nuro.ai
Year Founded:	2016
Number of Employees:	200+
Innovation Class:	Applications & Markets Innovation
Innovation Subclass:	Transportation

RBR50 INNOVATION AWARDS

Description:

In February 2020, **Nuro AI** became the first American autonomous vehicle developer to be given exemptions by the U.S. National Highway Traffic Safety Administration (NHTSA) for testing on public roads without the need to have controls for human operators. In April, Nuro received a second permit, this time granted by the state of California, allowing the company to test its second-generation test platform, the Nuro R2, on certain public roads in sections of nine cities within Santa Clara and San Mateo counties.

Analysis:

The NHTSA and California exemptions are a step in the right direction and an important milestone in the development of SAE Level 4 automation on the road. The Nuro R2 itself is a significant upgrade on the earlier R1 vehicle, weighing nearly twice as much at 1,150 kg to the R1's 680 kg. It is designed for a payload of up to 190 Kg (418 lb.). The R2, which is described as an SAE Level 4 vehicle, began testing at the end of February, joining the fleet of Toyota Priuses that Nuro uses for autonomous vehicle testing. RR – *Dan Kara*

NVIDIA debuts the Jetson Xavier NX, a credit card-sized supercomputer for AI at the edge

Organization Name:	NVIDIA
Country:	U.S.
Website:	www.nvidia.com
Year Founded:	1993
Number of Employees:	13,200+
Innovation Class:	Product, Technology & Services Innovation
Innovation Subclass:	Product Introduction

RBR 50 INNOVATION AWARDS

Description:

In November 2019, **NVIDIA** launched the latest entry into the company's Jetson portfolio of embedded processors, the Jetson Xavier NX, a powerful, low-power edge-computing platform for machine learning inferencing. With a form factor smaller than the size of a credit card, the Jetson Xavier NX delivers up to 21 terra operations per second (TOPS) for running artificial intelligence workloads. It consumes as little as 10 watts of power. The NX can also run multiple neural networks in parallel and process data from multiple sensors simultaneously.

Analysis:

The Jetson Xavier NX, like all Jetson family members, is enabled and supported by NVIDIA's programming model and solution stack. For example, all Jetson developers can use NVIDIA's CUDA-X GPU acceleration libraries for data science and machine learning. The same holds for NVIDIA's JetPack (including CUDA, cuDNN, and TensorRT) and DeepStream software development kits.

The Jetson family is also agnostic regarding machine learning, supporting the most widely used frameworks, such as TensorFlow, PyTorch, Caffe, and MXNet and their "lite" equivalents, as well as less-common libraries and tools.

For developers of commercial robots, drones, and other edge computing devices that demand high performance, but are constrained by power and size considerations, the Jetson Xavier NX checks all boxes and at a very affordable price ($399).

While it is ideally suited as an Internet of Things edge device, the NX is primarily engineered to support AI on the edge — really machine learning/deep learning on the edge. RR -- *Dan Kara*

OnRobot's One System Solution provides a unified interface for end-of-arm tooling

Organization Name:	OnRobot
Country:	Denmark
Website:	www.onrobot.com
Year Founded:	2015
Number of Employees:	101-500
Innovation Class:	Product, Technology & Services Innovation
Innovation Subclass:	Product Introduction

RBR50 INNOVATION AWARDS

Description:

OnRobot's One-System Solution provides a unified interface for end-of-arm tooling (EOAT). It allows OnRobot's cameras, grippers, and sensors to work with leading robot brands, including ABB, Doosan, FANUC, Hanwha, Kawasaki, KUKA, Nachi, Techman, Universal Robots, and Yaskawa.

All OnRobot products now have an integrated mechanical and communications interface based on the OnRobot Quick Changer. An additional Dual Quick Changer incorporates these same capabilities while allowing the use of two tools in one cycle, mixing and matching to suit application needs and maximizing robot utilization.

Analysis:

OnRobot's goal is to become the one-stop shop for collaborative EOAT. Its approach to doing so is transforming the market by moving the focus from the robot to the customer's applications. OnRobot said its EOAT technologies reduce engineering time and get customers' collaborative applications up and running almost immediately.

The One System Solution frees up manual labor from many "dull, dirty, and dangerous" tasks, allowing workers to put their skills to better use with more value-added tasks, according to the company.

With the One System Solution, all of OnRobot's products are multi-purpose solutions that can be attached, programmed, and changed in minutes, supporting faster production line changes.

The One System Solution is another example of OnRobot's continued innovation and disruption of the EOAT market since it was founded in 2015. RR -- *Steve Crowe*

Robotics Plus automates log scaling; increased productivity and reduced injuries result

Organization: Robotics Plus
Country: New Zealand
Website: www.roboticsplus.co.nz
Year Founded: 2008
Number of Employees: 40+
Innovation Class: Applications & Markets Innovation
Innovation Subclass: Forestry

RBR 50 INNOVATION AWARDS

Description:

In June 2019, New Zealand–based **Robotics Plus**, an agricultural robotics and automation supplier, launched its Automatic Log Scaler (ALS), the world's first automated logging truck scaler. The ALS uses a robotic arm to scan truck loads. Using machine learning techniques, the system quickly provides an accurate volumetric measurement of logs on trucks and trailers, along with generating an audit trail. By the end of 2019, the company had finished seven installations in several locations in New Zealand, with another six planned for 2020.

Analysis:

The logging industry is under intense pressure to improve efficiency, productivity and safety. The critical forestry supply chain process of measuring log volumes on trucks is normally a manual operation that is slow and repetitive. It can also be dangerous -- people are often required to climb at risky heights over muddy and wet vehicles. These challenges are exacerbated by chronic labor shortages and other inefficiencies.

According to Robotics Plus, the ALS can process a logging truck between 3.5 to 4.5 minutes with an accuracy that exceeds manual methods. This compares favorably with the manual process, which takes an average of 18 minutes, and sometimes up to 40 minutes. Productivity benefits are amplified when fleet utilization is accounted for (trucks waiting to be measured).

The ALS solution demonstrates how robotics and automation can positively impact society by transforming traditional industries facing increasing labor shortages, higher costs, supply chain inefficiencies and growing demand. Automating dirty, dull, and dangerous manual tasks also creates opportunities for higher value roles and labor upskilling. RR -- *Dan Kara*

Sarcos Robotics commercializes Guardian XO full-body exoskeleton for industrial use

Organization Name:	Sarcos Robotics
Country:	U.S.
Website:	www.sarcos.com
Year Founded:	2015
Number of Employees:	98
Innovation Class:	Product, Technology & Services
Innovation Subclass:	Product Introduction

RBR50 INNOVATION AWARDS

Description:

While researchers have been developing wearable robotics for therapeutic uses for years, industrial exoskeletons have emerged only recently. Such technologies promise to relieve fatigue and augment human capabilities. **Sarcos Robotics** began delivering its Guardian XO last year and demonstrated the exoskeleton with partner Delta Air Lines at CES 2020.

Salt Lake City–based Sarcos has been developing its exoskeleton for more than 20 years with initial funding from the Defense Advanced Projects Agency (DARPA). The Guardian XO can help humans lift 35 to 200 pounds and reduce the risk of injury. It is also designed to be worn for an entire shift and can run for up to eight hours on a single charge.

Sarcos said Guardian XO is the first full-body commercial exoskeleton in the U.S. It is designed to address labor shortages and occupational safety hazards in industries including aerospace, construction, defense, logistics, and manufacturing. The exoskeleton is currently in alpha testing, and the company expects to deliver it via a robotics-as-a-service (RaaS) model later this year.

Analysis:

Labor shortages and worker safety have posed challenges for a variety of industries, but powered exosuits remained science fiction until Sarcos developed comfortable and compact systems. The Guardian XO bears its own weight and is designed to be adjustable according to the size of the wearer.

Sarcos has worked with its Exoskeleton Technical Advisory Group (X-TAG), which includes executives from companies such as Bechtel, BMW, Caterpillar, and Delta to ensure that its exoskeletons meet their needs.

Among the benefits of Sarcos' Guardian XO is that it could enable a wider and more diverse talent pool to engage in heavy lifting without risk of injury. The commercial exoskeleton is a milestone in technologies to assist human strength and endurance. RR -- *Eugene Demaitre*

SCHUNK EGL-C provides high gripping forces while complying with global safety standards

Organization Name:	SCHUNK GmbH
Country:	Germany
Website:	www.schunk.com
Year Founded:	1945
Number of Employees:	500+
Innovation Class:	Product, Technology & Services
Innovation Subclass:	Product Introduction

RBR 50 INNOVATION AWARDS

Description:

Introduced in March 2019, the EGL-C gripper surpasses the typical force-limited 140 N used by most collaborative grippers in accordance with safety standard ISO/TS 15066. It achieves high gripping forces up to 450 N, offers a long stroke of 42.5 mm per finger, and handles workpiece weights up to 2.25 kg. The gripper force is limited to <140 N while the fingers are in motion. Only when the gripper fingers are within 4 mm of gripping the workpiece can the force be increased up to 450N.

The EGL-C combines six safety functions -- an integrated, safe path-measuring, a safe position detection of the gripper fingers, a safe switch-off, a safe brake control, a safe operating system architecture, and a safe movement and speed control.

Analysis:

SCHUNK has time and again introduced innovative grippers for the global market, and the EGL-C is no exception. SCHUNK's EGL-C is one of the world's first long-stroke grippers designed for human-robot collaboration (HRC). The gripper helps open up HRC to applications that involve weights beyond small parts assembly. The EGL-C will prove beneficial for the automotive, automotive related-supply industry and other industrial applications. RR -- *Steve Crowe*

Sense Photonics launches Osprey, a novel 3D flash lidar system for automotive applications

Organization Name:	Sense Photonics
Country:	U.S.
Website:	www.sensephotonics.com
Year Founded:	2016
Number of Employees:	1000+
Innovation Class:	Product, Technology & Services
Innovation Subclass:	Product Introduction

RBR50 INNOVATION AWARDS

Description:

Fast on the on the heels of its $26 million Series A round in June 2019, **Sense Photonics** in January 2020 formally launched Osprey, a "modular," high-resolution 3D flash lidar system for automotive applications that provides for a 80 degree x 75 degree field of view and has a range of 15 m. The units consist of two components, a laser emitter, and a separate sensing unit (the 3D receiver) which simplifies installation and allows for positioning flexibility.

Analysis:

Sense Photonics' proprietary laser and sensing solution provides advantages over both standard lidar solutions and other 3D flash lidar providers. The company's laser array and 3D receiver provides for an ultra-wide field of view, and the images themselves do not suffer from motion distortion. It is also possible to combine Osprey with 2D cameras to create a 2D textural image overlaid with 3D depth imagery.

Sense Photonics also produces its own advanced laser emitters that overcome earlier drawbacks to flash lidar sensors — namely, high cost, along with limited range and resolution. These attributes map to Sense Photonics' primary value proposition — namely, high-performance delivery of quality data at low cost — which is especially well suited to automotive safety systems such as collision avoidance and lane-departure warning systems, as well as with autonomous driving in general. RR -- *Dan Kara*

sevensense

Sevensense Robotics' Alphasense Core visual sensing solution born out of necessity

Organization Name:	Sevensense Robotics
Country:	Switzerland
Website:	www.sevensense.ch
Year Founded:	2018
Number of Employees:	30+
Innovation Class:	Product, Technology & Services
Innovation Subclass:	Product Introduction

RBR 50 INNOVATION AWARDS

Description:

In the fall of 2019, **Sevensense Robotics**, a spin-off from the Swiss Federal Institute of Technology, ETH Zurich, released Alphasense Core, an advanced multi-camera sensor designed specifically for robotics applications. The Alphasense Core consists of up to eight high-resolution cameras that can be flexibly mounted around a robot to ensure the best positioning on the system, depending on the target application. The cameras are all precisely mid-frame, synchronized together with a motion sensor to provide high quality, 360-degree spatial awareness, even in suboptimal lighting conditions.

Analysis:

The Alphasense Core had its genesis at ETH Zurich, and was the product of more than a decade of research and development. ETH researchers were dissatisfied with the sensing capabilities and reliability of the 2D lidars typically employed for sensing on mobile robots, as well as with vision-based navigation solutions that required complex and costly software and hardware.

Born out of necessity, Sevensense Robotics' Alphasense Core provides robotics developers with a powerful, configurable multi-camera sensing solution. It also provides another sensing option when developing advanced robotics systems. RR -- *Dan Kara*

SICK
Sensor Intelligence.

SICK launches extra-compact, 2D safety laser scanner

Organization Name:	SICK
Country:	Germany
Website:	www.sick.com
Year Founded:	1946
Number of Employees:	10,200
Innovation Class:	Product, Technology & Services
Innovation Subclass:	Product Introduction

RBR 50 INNOVATION AWARDS

Description:

In early 2020, **SICK** released its smallest 2D safety sensor to date – the SICK nanoScan3. The nanoScan3, which measures just 101 x 101 x 80 mm, and has a field range of three meters with a scanning angle of 275-degrees. The device offers a choice of eight (Core version) or up to 128 (Pro version) configurable fields, including navigation data and contour-detection fields.

Analysis:

SICK representatives describe the nanoScan3 as the world's smallest safety laser scanner. Be that as it may, at only 80 mm in height (8 cm or 3.1 in.), the small size of the nanoScan3 allows the sensor to be easily sited into locations other than open, fixed infrastructure.

In fact, the device is particularly well suited for integration into both fixed and mobile robotics systems, according to the company.

The nanoScan3 is based on SICK's proven safeHDDM (High Definition Distance Measurement) scanning and evaluation technology, which allows the sensors to operate under difficult conditions such as dust or variable lighting. This enables it to meet another requirement for use in robotics systems. RR -- *Dan Kara*

Silicon Valley Robotics celebrates a decade of robotics cluster stewardship and success

Orgaanization Name:	Silicon Valley Robotics
Country:	U.S.A.
Website:	www.svrobo.org
Year Founded:	2010
Number of Employees:	About 10, plus volunteers
Innovation Class:	Business & Management Innovation
Innovation Subclass:	Market Engagement

RBR 50 INNOVATION AWARDS

Description:

This year, non-profit organization **Silicon Valley Robotics** (SVR), is celebrating a decade of successfully accelerating robotics outreach, innovation, and commercialization. SVR, in cooperation with its member companies and partner universities, organizes networking, startup, and investment events on a regular basis. The group also produces industry reports and hosts job fairs. In addition, SVR supports affiliates including international business-development groups, other robotics clusters, robotics media and event producers (such as Robotics Business Review), and others.

Analysis:

California's Silicon Valley is the quintessential business cluster for software, hardware, and high-tech services innovation. The same holds true for robotics. The Santa Clara Valley contains a high concentration of universities and research institutions, autonomous systems startups, technology suppliers, investors, and other robotics ecosystem participants.

Although Silicon Valley is world-renowned for industry leadership, prior to the formation of Silicon Valley Robotics, the cluster was very loosely organized in comparison with the more formal robotics clusters found in Pittsburgh, Boston, and Odense, Denmark.

But a decade after the founding of SVR, it has become an integrated, self-reinforcing web of robotics innovation, reciprocity, and promotion -- a true robotics cluster. RR -- *Dan Kara*

SOFT ROBOTICS

Soft Robotics' SuperPick addresses complexity, variability in the unstructured environment of reverse logistics

Organization Name:	Soft Robotics Inc.
Country:	U.S.
Website:	www.softroboticsinc.com
Year Founded:	2013
Number of Employees:	75
Innovation Class:	Product, Technology & Services
Innovation Subclass:	Product Introduction

RBR 50 INNOVATION AWARDS

Description:

The ability to quickly pick a wide range of objects has proven to be elusive for robots. This has led to the development of vision-guided systems and complex machine-learning algorithms to handle different shapes, materials, and orientations. **Soft Robotics** has reduced some of that complexity with its compliant grippers, which take inspiration from octopus tentacles and are based on the work of Harvard University researcher George Whitesides.

Bedford, Mass.-based Soft Robotics' mGrip gripper kits enable companies to assemble the best configurations of soft fingers for their robotics applications. These include pickinig and packaging in e-commerce order fulfillment, consumer goods, medical and pharmaceuticals, and food handling.

Reverse logistics and product returns are particularly challenging for retailers, with up to 30% of online orders sent back. Soft Robotics' SuperPick system works with unstructured, heterogenous bins of products without requiring prior training of stock-keeping units (SKUs), and it integrates with existing warehouse management systems (WMS).

The SuperPick Polybag Picking System uses 3D vision in combination with soft grippers to singulate and scan polybags, which traditional automation has had difficulty handling.

Analysis:

Soft Robotics' innovative combination of compliant grippers, computer vision, and suction cups directly addresses a pain point for many retailers. With approximately $90 billion in product returns from the 2019 holiday season, companies need to maximize accuracy and throughput while minimizing waste and demands on scarce staffing.

The SuperPick Polybag Picking System continues Soft Robotics' development of flexible solutions for both reverse logistics and order fulfillment. RR -- *Eugene Demaitre*

UNIVERSAL ROBOTS

Universal Robots launches 20 UR+ Application Kits to remove barriers to integration for UR cobots

Organization Name:	Universal Robots A/S
Country:	Denmark
Website:	www.universal-robots.com
Year Founded:	2005
Number of Employees:	500+
Innovation Class:	Product, Technology & Services
Innovation Subclass:	Product Introduction

RBR 50 INNOVATION AWARDS

Description:

In March 2020, **Universal Robots** announced the release of 20 "UR+ Application Kits" for its UR family of collaborative robot arms. The kits fall into seven different classes, including Welding, Quality Inspection, Material Handling, Finishing, Machine Tending, Assembly, and Dispensing.

Analysis:

Since 2008, when Universal Robots sold its first six-axis UR5 system, the Odense, Denmark-based company has claimed that the key value proposition of its articulated arms as their ease of setup, integration, programming, and use. As a result, customers could benefit from fast deployment, greater flexibility, and reduced operational costs.

However, many small and midsize manufacturers still found cobots to be too difficult to deploy and program, even for common tasks.

Each UR+ Application Kit is designed to facilitate the automation of such manufacturing tasks. This benefits everyone in its collaborative robotics ecosystem, from full-stack integrators to small specialty firms and everyone in between, not to mention in-house robotics engineers at cobot end users.

In addition, Universal Robots' application-oriented solutions help the company with continuous product introductions, an expanding customer base, and new incremental revenue streams. RR -- *Dan Kara*

Vecna Robotics' Pivotal provides interoperability, enabling robots from different companies to work together and add value

Organization Name:	Vecna Robotics Inc.
Country:	U.S.
Website:	www.vecnarobotics.com
Year Founded:	2018
Number of Employees:	86
Innovation Class:	Product, Technology & Services
Innovation Subclass:	Product Introduction

RBR50 INNOVATION AWARDS

Description:

As demand rapidly evolves, warehouses and distribution centers must keep up, but mobile robots alone are not enough to maintain and grow efficiency. Last year, Vecna Robotics introduced Pivotal, an AI-based "orchestration engine" to help robots and human workers adapt workflows to shifting demand.

Waltham, Mass.-based **Vecna Robotics**, which spun out of Vecna Technologies, provides an "autonomy stack" of hardware, software, and support for safe and efficient materials handling. Its offerings include automated pallet jacks, conveyors, and tuggers, as well as Pivotal.

The Pivotal AI analyzes an organization's operations and dynamically adjusts them in real time, coordinating and distributing tasks to both people and robots. It is designed to integrate with legacy automation, warehouse management systems, and manufacturing execution systems

Analysis:

In the past few years, autonomous mobile robots have moved from trials to wide-scale deployments, and supply chain operations now need AI to effectively manage their fleets alongside other systems and staffers. Pivotal has helped one of the world's largest shipping companies double throughput and decrease non-value-added travel by 80%, according to Vecna.

Vecna Robotics has partnered with GEODIS, Humatics, and UniCarriers Americas, and it raised $50 million in Series B funding in January. Daniel Theobald, CEO of Vecna Robotics, is also a co-founder of MassRobotics and has led the company's community and humanitarian initiatives. These include the development of the Ventiv automated manual resuscitator to address the novel coronavirus crisis. RR -- *Eugene Demaitre*

Veo Robotics' FreeMove turns any industrial robot arm into a collaborative robot

Organization Name: Veo Robotics Inc.
Country: U.S.
Website: www.veobot.com
Year Founded: 2016
Number of Employees: 50
Innovation Class: Product, Technology & Services
Innovation Subclass: Product Introduction

RBR 50 INNOVATION AWARDS

Description:

Collaborative robot arms are typically smaller, less precise, and slower than industrial automation, but what if workcells could perform at peak speeds until they recognize a human entering the area? Veo Robotics' FreeMove system is designed to enable manufacturers to make industrial robots conform to international safety standards for speed and separation monitoring.

FreeMove uses custom 3D time-of-flight sensors and computer vision. It includes the FreeMove Engine for identifying objects in a workcell. It also includes the FreeMove Studio proprietary software for self-service setup, configuration, and real-time visualization of FreeMove Engine data.

Waltham, Mass.-based **Veo Robotics** announced the availability of FreeMove last November. It also released the FreeMove Application Development Kit so that customers could evaluate the system on non-safety-rated hardware.

Analysis:

Most manufacturers are not yet at the fully automated, "lights-out" stage of operations, but Veo's FreeMove can help them take advantage of the power, speed, and precision of industrial robots while also allowing for safer supervision by and interactions with human workers.

Veo Robotics has designed its systems with multiple redundant hardware elements and algorithms to expand the sphere of human-robot collaboration for flexible manufacturing. Note that robotics users should still conduct safety assessments for their systems, payloads, and workspaces.

By building its own sensors and software, Veo Robotics has started to change "collaborative" from a class of robots to a capability or characteristic, potentially transforming industrial automation. RR -- *Eugene Demaitre*

Waymo pulls ahead in the autonomous vehicle race

Organization Name:	Waymo
Country:	U.S.
Website:	www.waymo.com
Year Founded:	2009 (formerly known as the Google Self-Driving Car Project)
Number of Employees:	1,500+
Innovation Class:	Business & Management Innovation
Innovation Subclass:	Market Engagement

Description:

Waymo has made many announcements since Jan. 1, 2019, the oldest date of eligibility for this year's RBR50 list, including testing and mapping of new locations, new business applications such as delivery and trucking, selling its custom lidar to third-party customers, raising its first external funding round, and much more.

But the most significant announcement came late in 2019, when Waymo started to remove human safety drivers from some of its Chrysler Pacifica minivans taxiing members of its early rider program around the suburbs of Phoenix. Yes, the program is limited to a geofenced area that Waymo has been testing on since 2017, but it proves that autonomous vehicles are no longer a pipe dream. Fully driverless cars have arrived, albeit in a limited capacity.

Analysis:

Waymo experiences more competition in the autonomous vehicle industry with each passing day. But its continued innovation, both from a technical and business standpoint, continue to separate the wholly owned Alphabet subsidiary from the pack. In fact, Waymo has been the leader of the autonomous vehicle industry since it was founded in January 2009 as the Google Self-Driving Car Project.

But the flurry of activity over the past 18-plus months points to a shift from a technology project to a serious commercial business. Waymo's expansion into new locations, business models, acquisitions and partnerships, combined with its first external funding round of up to $3 billion, indicate that the company is closer than ever to scaling its autonomous vehicle technology. RR -- *Steve Crowe*

Waypoint Robotics releases MAV3K omnidirectional, heavy-duty mobile robot

Organization Name:	Waypoint Robotics Inc.
Country:	U.S.
Website:	www.waypointrobotics.com
Year Founded:	2016
Number of Employees:	10 to 20
Innovation Class:	Product, Technology & Services
Innovation Subclass:	Product Introduction

RBR 50 INNOVATION AWARDS

Description:

Unlike many autonomous mobile robot (AMR) companies, **Waypoint Robotics** has designed and built its systems with factory and warehouse workers in mind. The Nashua, N.H.-based company last year added the MAV3K robot, which has a 3,000-lb. payload capacity, to its line of omnidirectional AMRs.

As with Waypoint's 600-lb.-capacity Vector AMR, MAV3K uses advanced obstacle detection and avoidance systems including an optional 360-degree, 3D, 90-meter lidar similar to those used in self-driving cars. The heavy-duty AMR also works with the Dispatcher fleet management software, which enables users to set it up in only 15 minutes. Waypoint's systems are designed to be easily integrated with existing equipment and enterprise systems.

Despite its size, MAV3K can move safely around people, with dual safety-rated lidar sensors, a three-stage safety system, and continuous software upgrades. The Kingpin top module enables Vector or MAV3K to conduct multiple tasks, such as loading and unloading items while also towing carts.

Analysis:

The design of Waypoint's AMRs reflects its workforce-first approach to usability. MAV3K is engineered to be a ruggedized mobile robot with multiple redundancies for safety, as well as EnZone contactless charging, intuitive controls, and high capacity for automotive manufacturing, pallet moving, and other use cases.

By keeping its focus on workers on the floor, Waypoint Robotics has built an ecosystem of tools to help them deploy its robots as quickly and as smoothly as possible. This frees human workers for less stressful, more value-added tasks.. RR -- *Eugene Demaitre*

WPI opens PracticePoint medical technologies innovation and commercialization facility

Organization Name:	Worcester Polytechnic Institute
Country:	U.S.
Website:	www.wpi.edu
Year Founded:	1865
Number of Employees:	500+
Innovation Class:	Business & Management Innovation
Innovation Subclass:	Market Engagement

RBR 50 INNOVATION AWARDS

Description:

Following a two-year effort and a $5 million capital grant from Massachusetts Technology Collaborative (MTC), on Jan. 15, 2020, **Worcester Polytechnic Institute** (WPI) opened PracticePoint, a membership-based, medical technologies research and development center. WPI pledged matching funds for the facility, and founding partners included MITRE, University of Massachusetts Medical School, and Boston Scientific.

The PracticePoint facility boasts of several different suites for home health, patient care, fully functional operating room, as well as MRI, neurotechnology, motion-capture, and 3D printing laboratories. It also includes an electronics fabrication workshop and a machine shop.

PracticePoint alliance members — such as public and private universities, research institutions and industry — have access to these collocated resources, and they can collaborate with one another and members of the WPI research community.

Analysis:

The healthcare sector is struggling with skyrocketing costs, as well as the need to continuously improve the quality of services and results. Rapidly aging populations and a shortage of qualified workers, not to mention the COVID-19 pandemic, are also stressing healthcare systems.

Robotics technology can play a major role in addressing a wide range of pressing healthcare challenges. It can be a key means for providing better healthcare services while controlling costs. But despite the monumental potential of such technologies and the obvious need, commercial development of healthcare robotic products has been relatively slow.

PracticePoint was specifically designed to accelerate development of commercially viable medical technologies, including robotics systems. This unique facility is more than the sum of its parts. One way to describe PracticePoint is as a one-stop, prototype-to-product, innovation and commercialization ecosystem for medical — and robotics — technologies. RR -- *Dan Kara*

YASKAWA

Yaskawa Motoman releases the HC20XP, the first food-grade collaborative robot

Organization Name:	Yaskawa Motoman
Country:	U.S.
Website:	www.motoman.com/en-us
Year Founded:	1989
Number of Employees:	700+
Innovation Class:	Product, Technology & Services Innovation
Innovation Subclass:	Product Introduction

RBR 50 INNOVATION AWARDS

Description:

In March 2020, **Yaskawa Motoman** released the HC20XP, which it described as the robotics industry's first fully collaborative robot with an IP67-rating. The single-armed, cast-aluminum, 6 DoF (degrees-of-freedom) HC20XP is engineered to operate continuously in damp or splash-prone environments. The robot's easy-to-clean surface makes it suitable for use in sanitary environments. NSF H1 food-grade grease is included as standard, allowing the HC20XP to be used in settings where there is a possibility of incidental food contact.

Analysis:

Food manufacturing has not yet benefited from robotics automation to the same degree of other manufacturing sectors such as automotive, electronics, and consumer durable goods. Yet food producers are under the same competitive pressures to reduce labor costs and increase throughput.

At this time, most robotics systems for food production are used for end-of-line picking, packaging (primary and secondary packaging) or palletizing operations, mostly using standard articulated and delta robots. These applications are typically less complex than the food-processing steps further up the line, where objects are unwrapped, inconsistent in size, and often delicate, wet and slippery.

Currently, much interest and a good deal of effort is focused on developing "upstream" applications for the robotic handling of raw or fresh foodstuffs, such as inspection and processing, especially using vision-based systems.

Collaborative robots, which can operate in close approximation to human workers, are well suited to such tasks, but most cobots to date have not met the requirements for the hygienic handling of foodstuffs.

With Yaskawa Motoman's introduction of HC20XP, collaborative robots can now be employed for these upstream food processing tasks. Other producers of collaborative robotics systems will follow suit, but Yaskawa Motoman got there first. RR -- *Dan Kara*

Robotics

IDS Imaging Development Systems Inc.

3D camera with onboard data processing

When 3D image processing is used in compute-intensive applications, interfaces and CPU power quickly become a bottleneck. Wouldn't it be convenient if the 3D camera already did some of the computing? Ensenso XR is the first stereo vision camera offered by IDS that processes 3D data directly in the FPGA. The camera family initially consists of XR30 and XR36 models. They are very robust thanks to IP65/67 protection class, feature 1.6 MP Sony sensors and can detect objects at working distances of up to 5 m. Since the camera calculates 3D data itself, a high-performance industrial PC is no longer required. The transfer of result data instead of raw data also reduces the load on the network considerably.

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Robotics

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