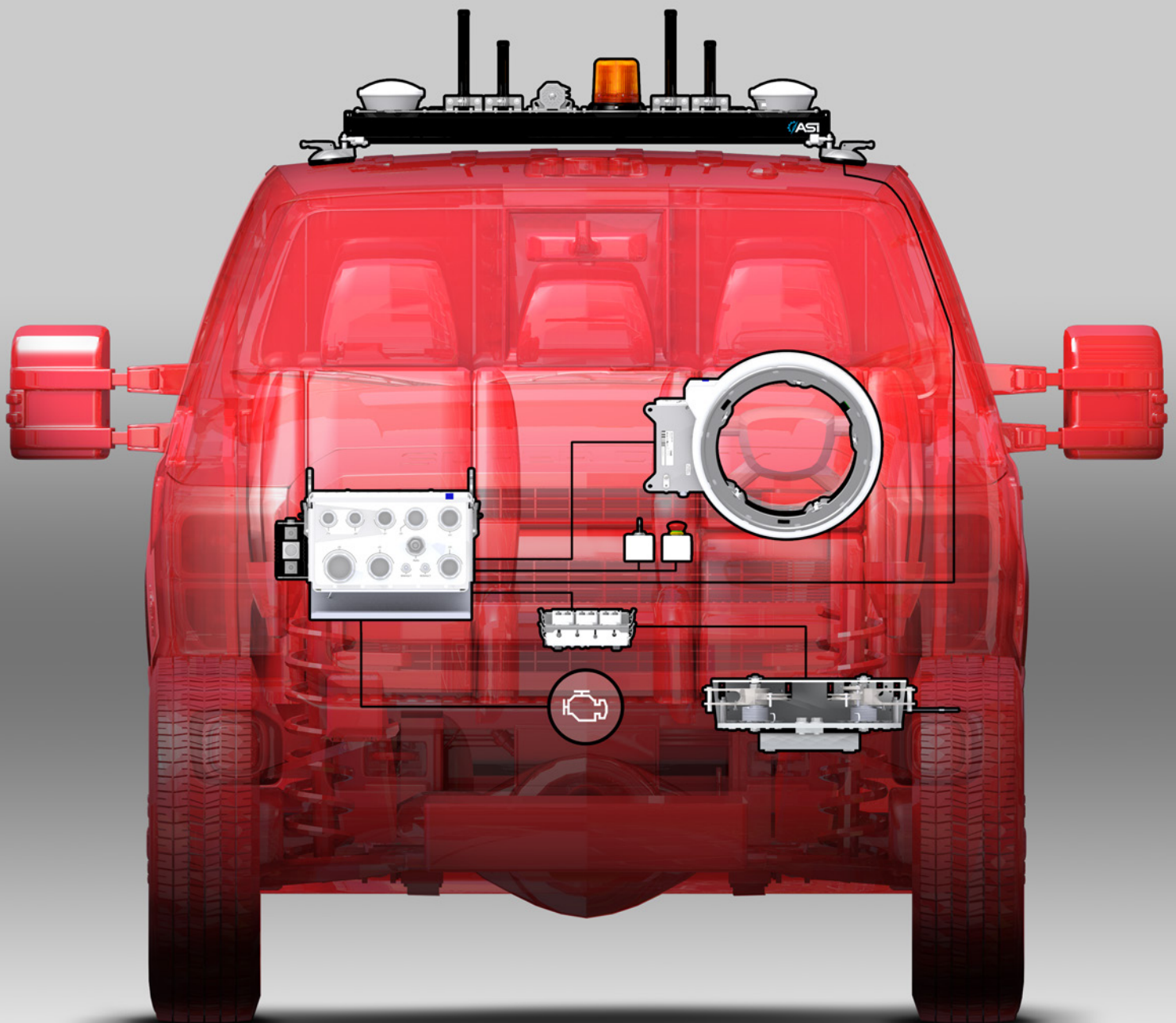


ROBOTIC DURABILITY & MISUSE TESTING



Universal Vehicle Automation Kit



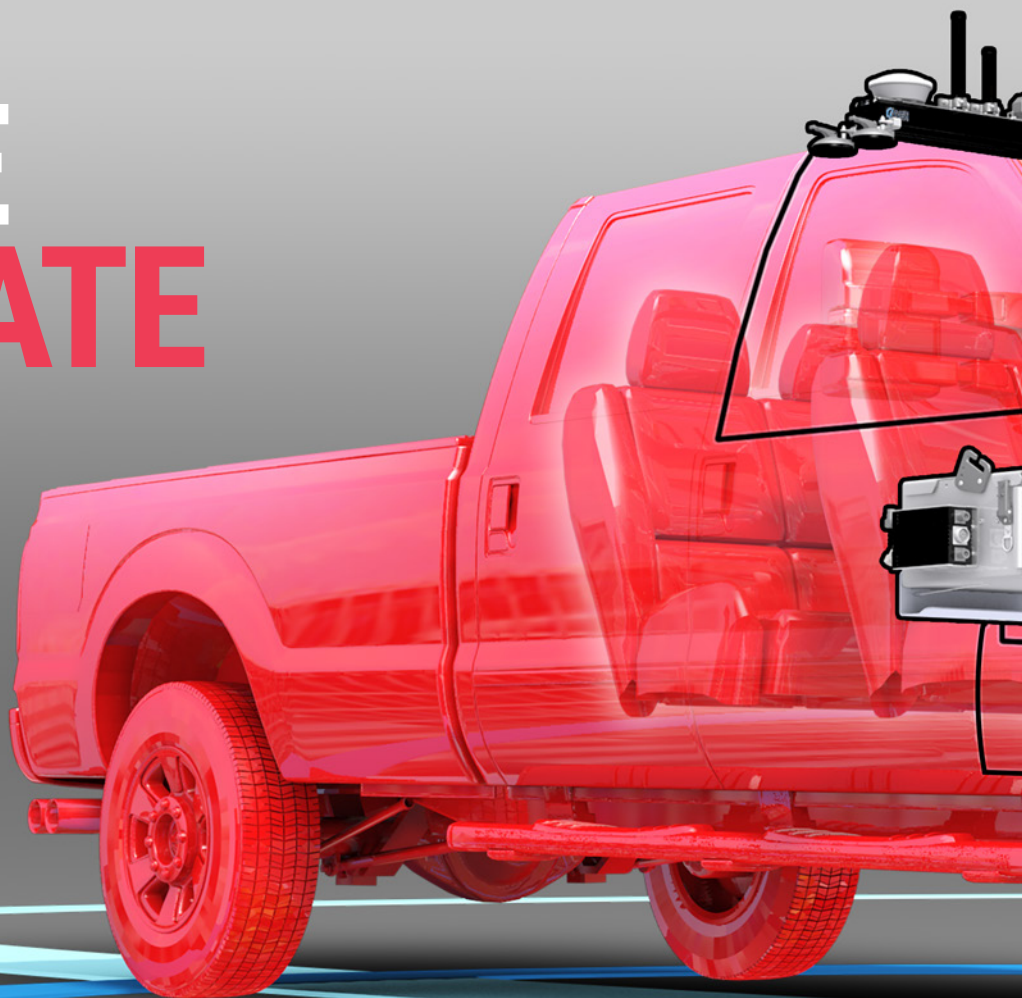
AUTONOMOUS SOLUTIONS

HOW WE AUTOMATE

“...Our only objective was to create a solution that allows for this type of intense off-road testing that could take our vehicles to the most extreme limits of their engineering while ensuring the safety of all involved.”

Dave Payne

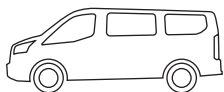
MANAGER OF VEHICLE DEVELOPMENT OPERATIONS
FORD MOTOR COMPANY



Automate Any Vehicle Type, Including:



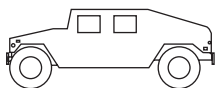
CARS



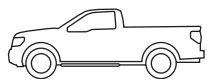
VANS



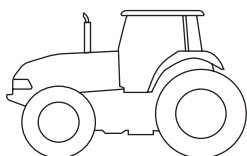
SUVS



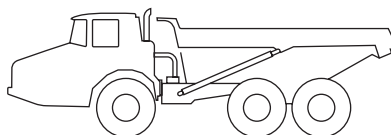
MILITARY VEHICLES



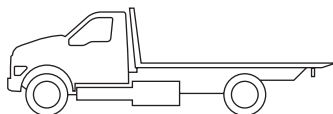
PICKUP TRUCKS



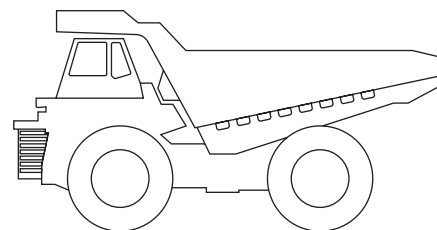
AGRICULTURAL VEHICLES



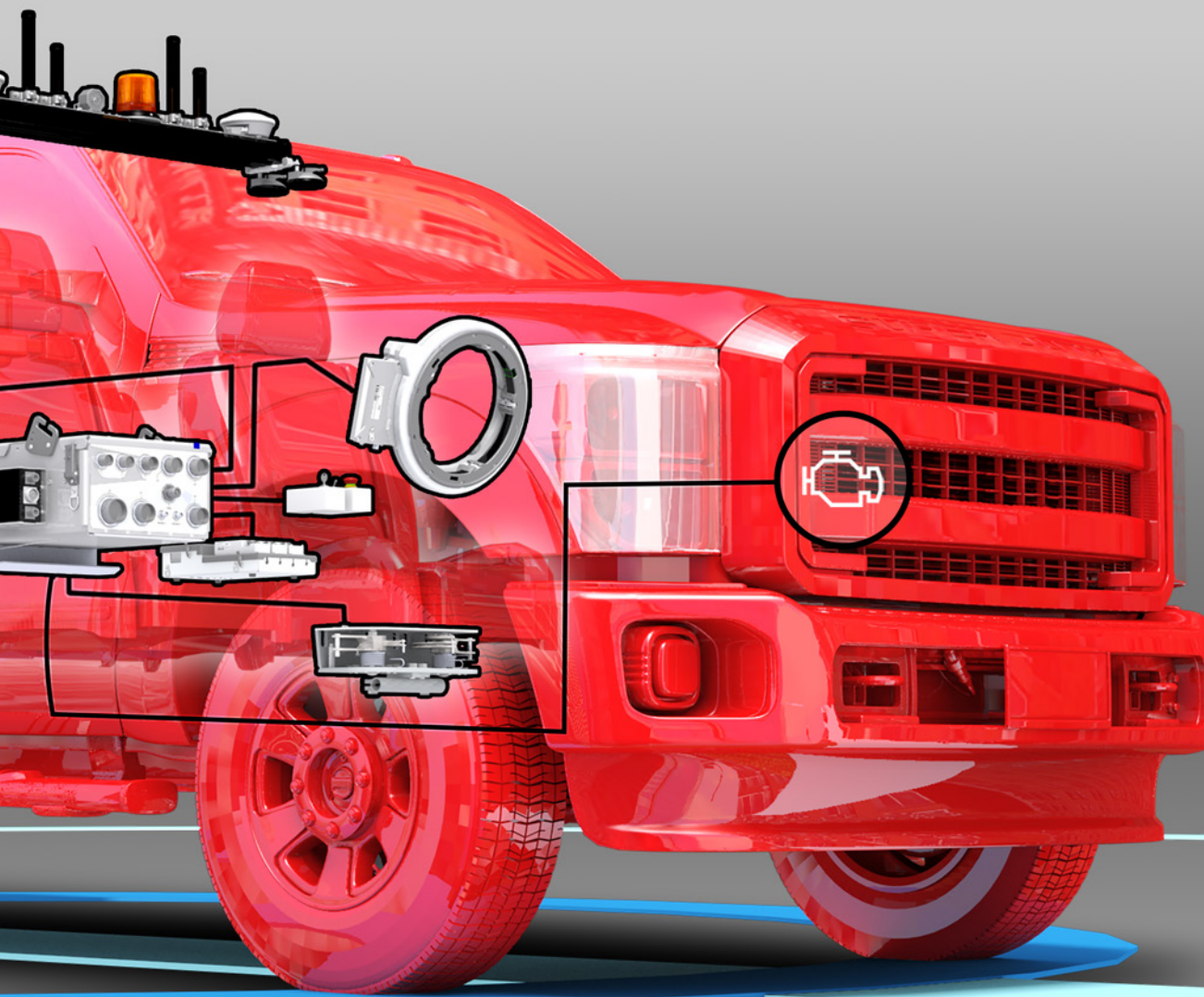
CONSTRUCTION VEHICLES



LARGE TRUCKS



MINING VEHICLES



Sensors

Sensors collect environmental info and relay it to the on-board VCU to give awareness to the automation system. Compatible with the Mobileye® camera system.



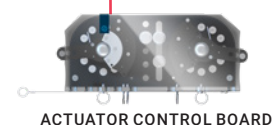
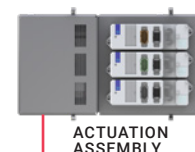
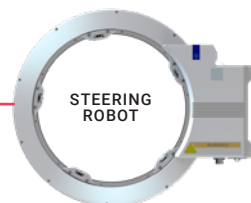
Control Unit

ASI's patented VCU computer is the brain in the vehicle. It communicates with the sensors and controls the vehicle. It also relays info between the vehicle, server, and Mobius.

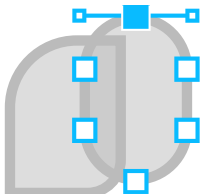
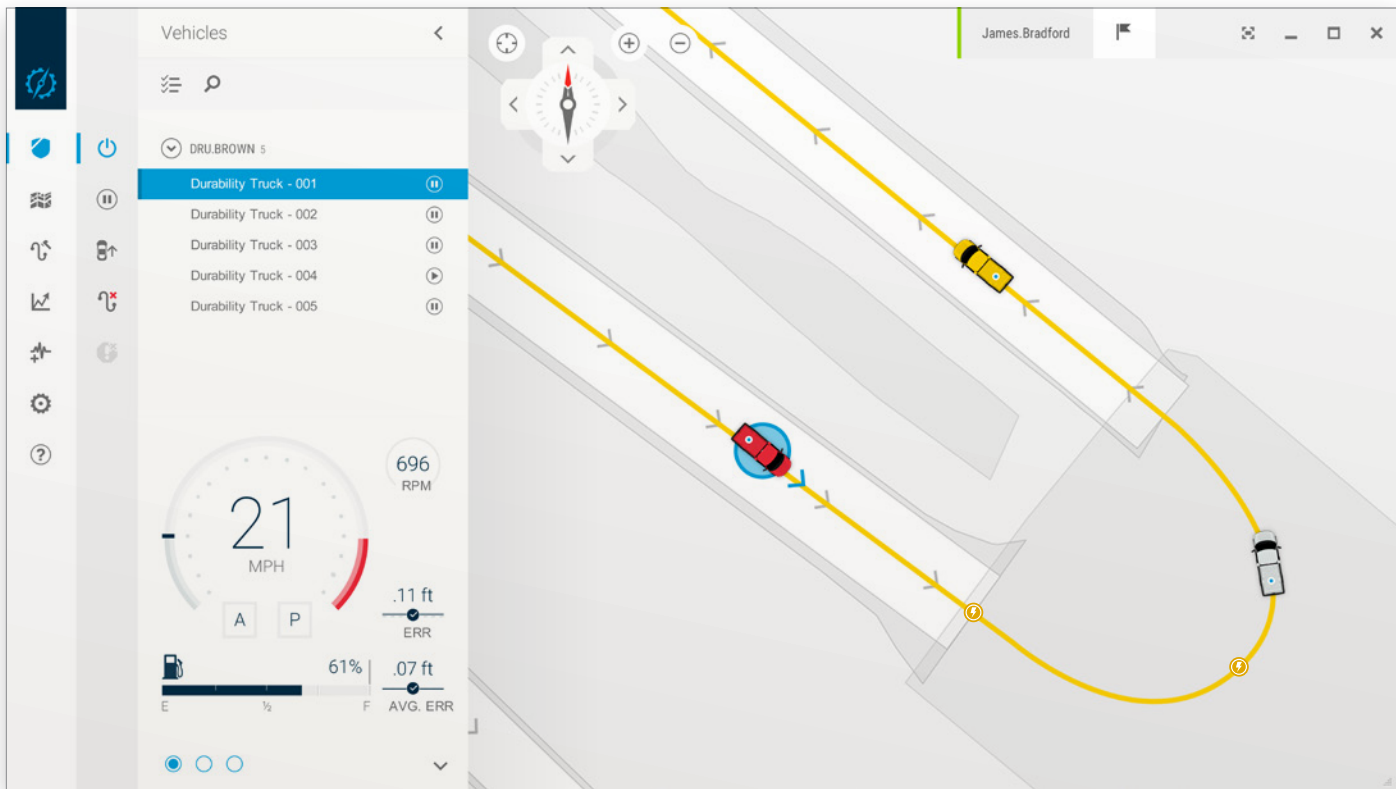


Actuators

Universal actuators are placed in the vehicle to communicate with the VCU so that vehicle operations can be controlled safely and accurately. In by-wire vehicles no actuators are needed, as the VCU integrates with vehicle controls directly.



Mobius Command & Control

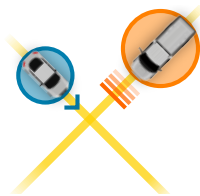


Map Builder

SIMPLE SITE SETUP

Quickly generate custom maps, designate lanes and roadways, set safety perimeters, and create drivable areas with Map Builder.

Experience the simple, clean Mobius interface that leverages advanced design and development techniques and incorporates user testing results from industry professionals.



Choreographer

PROXIMITY MONITOR

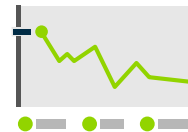
When multiple vehicles are on a track at the same time, Proximity Choreographer monitors their location, direction and speed. If paths may cross, it directs vehicles to react appropriately to avoid collisions.

SAFE AREA LOCKOUT

These areas exist around autonomous vehicles and can be designated around human controlled vehicles on a track. Unmanned vehicles will stop if they approach any designated safe areas.

E-STOP

If unmanned vehicles leave the safety area or lose signal, the e-stop override immediately applies the brake.



Productivity

MULTI VEHICLE OPERATION

Enjoy greater productivity and economies of scale as a single operator controls multiple unmanned vehicles interacting in the same area or at dispersed locations.

A.I.

Improve productivity with embedded artificial intelligence modules that automatically task vehicles, generate maps and paths, and more.



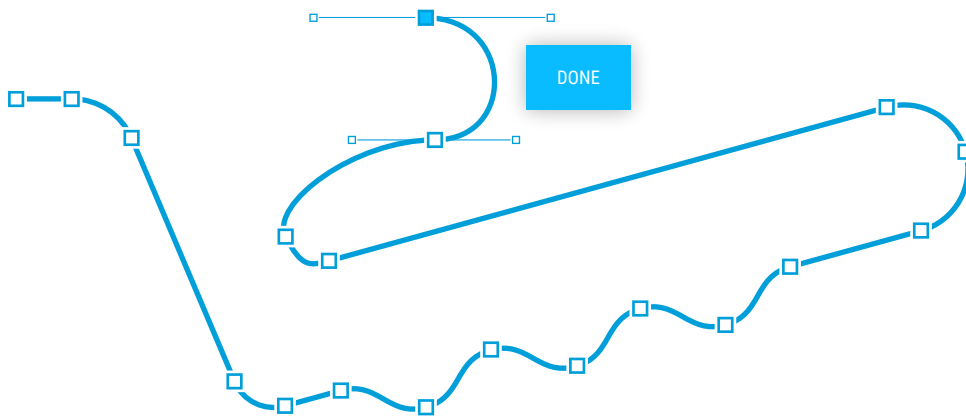
Feedback & Control

LIVE TELEMETRY

View real-time gauges and meters that display a vehicle's current speed, gear, RPM, fuel level, & more...

MANUAL MODE

Easily switch between autonomous mode and manual mode to control the vehicle manually when needed.

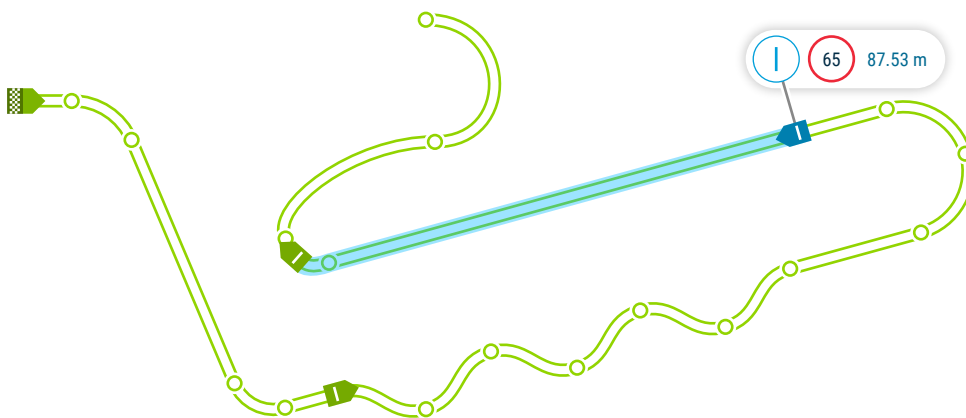


STEP ONE

01

Path Builder

Creates a drivable path that can be customized to match testing needs and course routes.



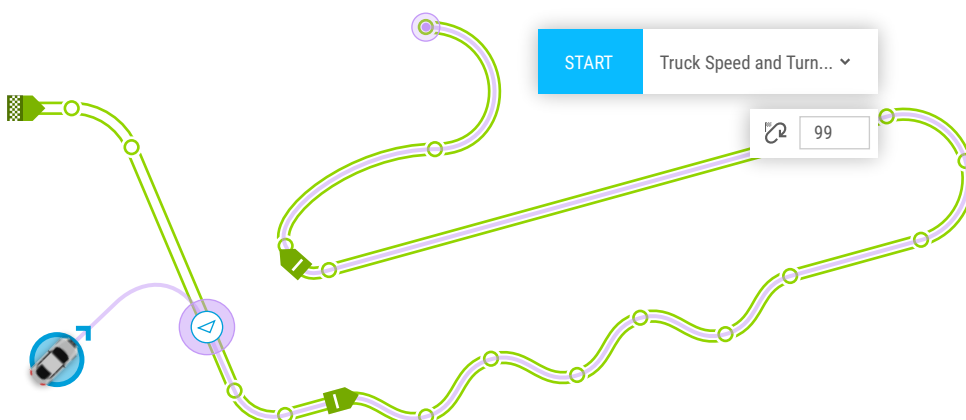
STEP TWO

02

Event Planning

Execute actions at a specific point in a path. Functions include: acceleration, deceleration, stop, wait, lane change, variable force braking, roll over, and more...

Truck Speed and Turning Test - 00C7				141.62m	
▼	Speed then Brake	65	87.53 m	While Running	⊗
Accelerate		▼	63	%	⊗
UNTIL	Velocity Feedback	▼	>=	20.0	m/s
Brake		▼	100	%	
⊕ Set Action		⊕ Until			



STEP THREE

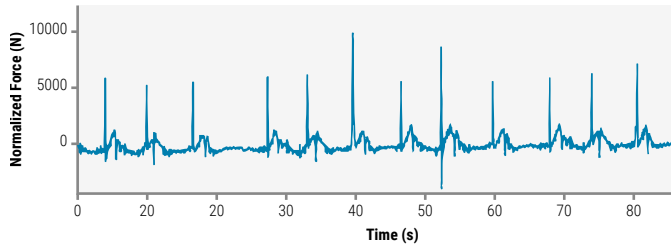
03

Vehicle Tasking

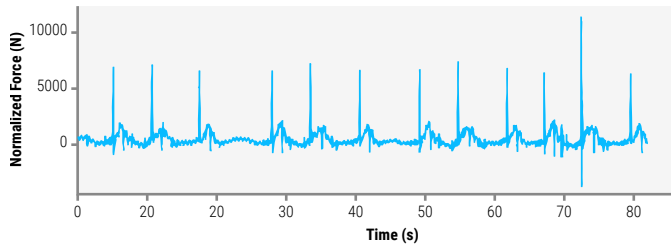
Vehicles can be tasked to run routes as many times as needed. No need to switch drivers out due to hazardous road conditions, fatigue, and driver breaks.

Robotic Automation Benefits

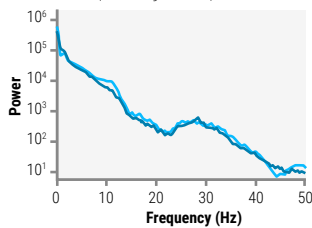
Robotic Driver 1



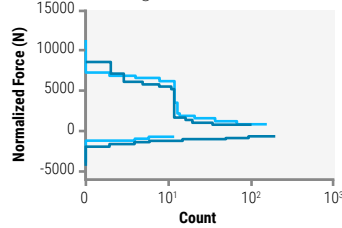
Robotic Driver 2



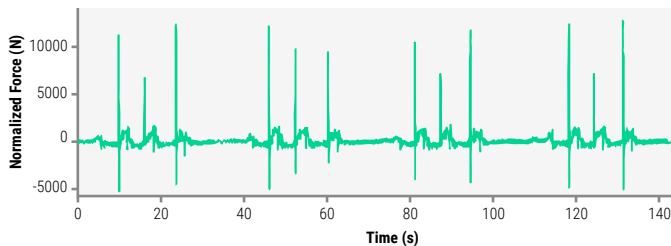
Frequency Response



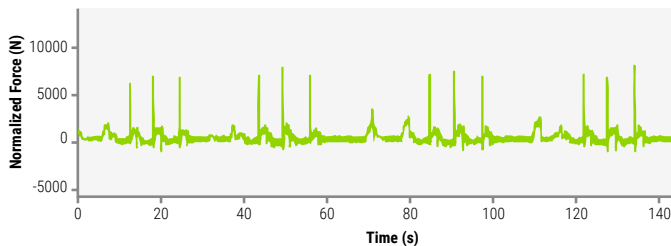
Histogram



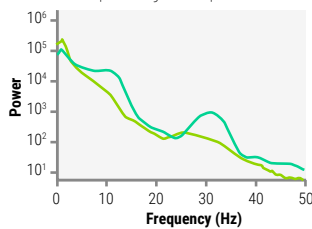
Human Driver 1



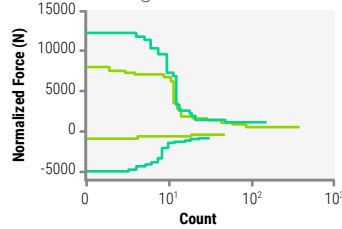
Human Driver 2



Frequency Response



Histogram



Variability Between Human Drivers vs. ASI's High Precision Robotic Kit

This data was taken from real proving ground durability tests and highlight the variability between human drivers and the variability between ASI robot drivers.

Four vehicles of the same model were subject to a standard durability test cycle. Two of the vehicles were driven by two different drivers. The other two vehicles were driven by two different ASI robot drivers. Each vehicle was fitted with an accelerometer measuring force in a single axis. The charts to the left plot the measurements made on the four trials at that same point.

Accuracy

The Frequency Response and Histogram charts at left highlight the reduced variability between robot drivers when compared to similar data from human drivers. Robot drivers allow for much more consistent application of your drive cycles to your prototype vehicles.

Repeatability

Tests being repeated more consistently by robotic drivers mean the integrity of that data increases due less variability in the results.

Productivity

In results from proving grounds that were conducting tests performed by ASI robotic kits, they were able to complete a series of tests in about half the time that it would take human drivers to complete that same series of tests. With robotic drivers, there is no need for regulated brakes or switching drivers out.

Safety & Stamina

The ASI automation kit is rugged enough to withstand any harsh durability test, and repeat it over and over again without any need to stop. A robotic automated durability test vehicle can run for as long as its fuel tank will allow.

Robotic drivers can be used in tests that are not suitable for humans.

Value

Enjoy greater productivity and economies of scale as single operators can control multiple unmanned vehicles.

A robotic automation kit costs much less than trained durability drivers operating the same vehicle.

Automate Any Durability Test



Supported Test Feature Types:

HARD SURFACES



Chuck holes



Jounce holes



Drop slabs
of varying heights



Acceleration bumps for
drive line shock



Twist ditch



Pavé



Cobblestone



Belgian block



Resonance road



Corrugations



Potholes



Water splash and
wading troughs

OFF ROAD SURFACES



Compacted Rubble



Loose rubble



Potholes and ruts



Mud



Wading pool and trough



Rough grassy field

Most other severe misuse surfaces

Supported Testing Types:



Durability / Mileage
accumulation



Chassis
development



Severe
maneuvers



Stability
roll over tests



Braking systems
(ABS/Regenerative)
– on wet surfaces



General
durability



Repeated
brake test



Lane
changes



Pothole
braking



Any other standard
durability test

Robotic Accelerated Structural Durability



Suspension



Damping



Mountings



Components



Bodies and
structures



Accessories



Vehicle Control Unit

Function

The VCU manages vehicle network connections. POE switch for cameras that powers and networks a camera system. OEM Signal Interface connects to vehicle via CAN Bus and OBD Port (sends OEM data such as speed, RPM, engine temp., etc. back to Mobius command & control base station).

Specs

OPERATIONAL TEMP. RANGE
-40°C to +55°C
(-40°F to +130°F)

WEATHER PROOFING
Weather sealed to IP67;
usable in moderate rain,
snow and light dust

DIGITAL I/O
Quadrature x1 (5 V)
Digital In x8 (5-30 V)
Analog In x3 (0-5 V)

COMMS INTERFACE
Ethernet 1x (10/100)
CAN x3
Serial x3 (RS-232)

PROCESSOR
iMx6 QuadCore
1GHz ARM 9

RAM
2 GB DDR3

STORAGE
micro SD x2

BOOT FLASH
128 Mbit

NAND FLASH
2 GB

WEIGHT
2.3 kg
(5 lb)

Mounting

INSTALL FEATURES

The VCU is placed within a steal carrier box that is secured via the seat belt. This allows the user to easily transfer kit components from one vehicle to another.





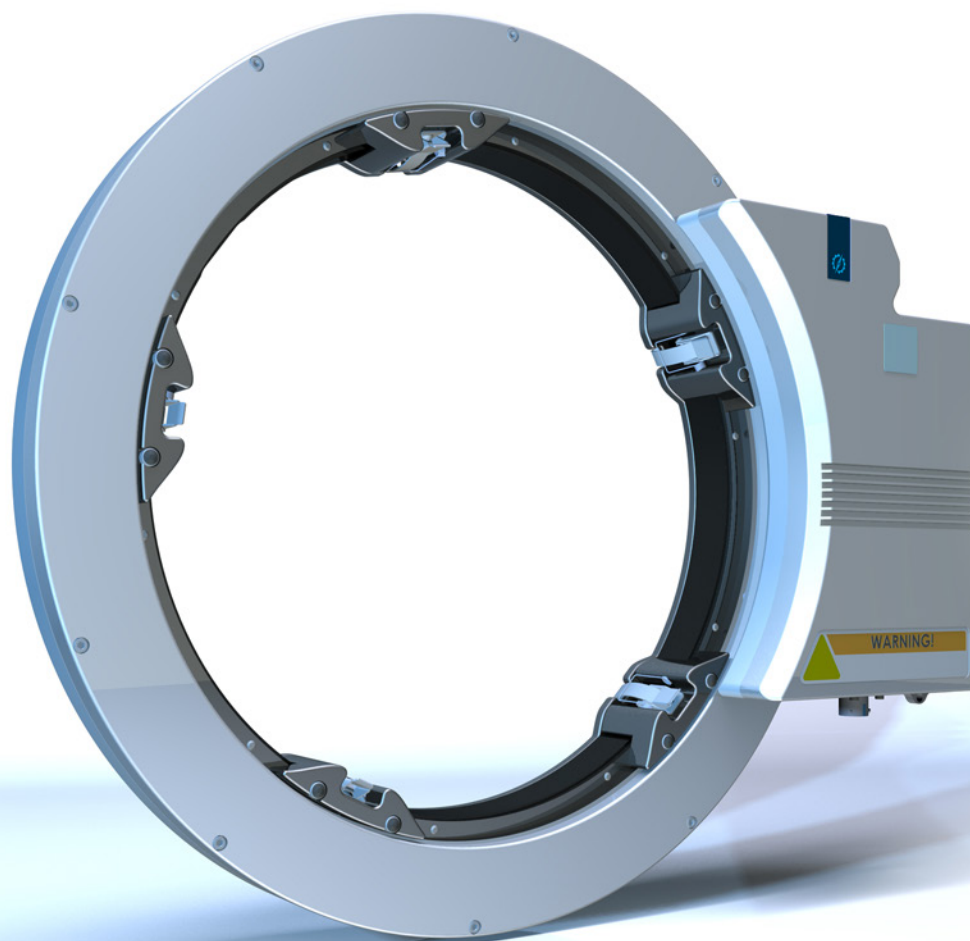
Ignition By-Pass & E-Stop

Function

Ignition By-Pass allows the Vehicle Automation Kit to be powered independent of the vehicle. It also provides a layer of safety and security. Turning the key to the "off" position powers off the kit and cannot be powered on without the key in the "on" position.

E-stop immediately halts all vehicle operations as an emergency safety override. Available in both on-board and remote switches.

Auto/Manual Switch provides the ability to toggle the vehicle between automated and manual control. Autonomous-capable vehicles may be driven in manual mode even with kit installed.



Steering Robot Assembly

Function

The Steering Robot actuator provides more accurate and repeatable steering than a human driver by applying powerful and precise speed and torque.

Specs

MAX SPEED
1000°/sec @ 12 V
2000°/sec @ 24 V

TORQUE
60 N.m. max @ 500°/sec
15 N.m. continuous 1000°/sec

CURRENT DRAW
10 Amp mean
60 Amp peak

SUPPLY VOLTAGE
9–36 V

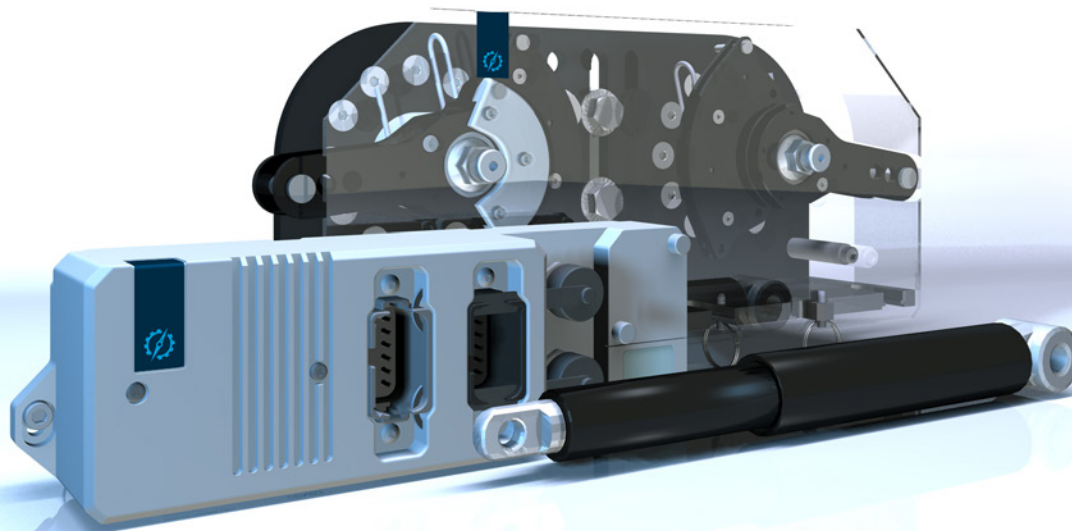
WEIGHT
8.6 kg
(19 lb)

Mounting

Easily unmounted from the vehicle steering wheel without losing calibration.

WHEEL DIAMETER
365–415mm
(14.4–16.3 in)
*Adapters available to fit any size wheel





Actuation Assembly

Function

Actuator Boards each control an individual actuator: throttle, brake, automatic transmission, redundant brake. Typically sits on the floor in front passenger or back seat.

Bell Crank Assembly allows remote location actuation and simple variable length calibration. Easily adapts to different vehicle types.

Shifting Assembly can be configured for rotary shifter, steering column shifter, or console shifter. Each is adjustable based on software and hardware configurations.

Specs

	WEIGHT	STROKE	SPEED	FORCE	CURRENT DRAW (AT FULL LOCK)
THROTTLE ACTUATOR	1.1 kg (2.5 lb)	7.6 cm (3 in)	7.6 cm/sec (3 in/sec)	13.6 kg (30 lb)	18 Amp (stall)
TRANSMISSION ACTUATOR	1.1 kg (2.5 lb)	7.6 cm (3 in)	7.6 cm/sec (3 in/sec)	13.6 kg (30 lb)	18 Amp (stall)
BRAKE ACTUATOR	1.8 kg (4 lb)	10.2 cm (4 in)	17 cm/sec (6.7 in/sec)	225 kg (500 lb)	26.8 Amp (stall)
REDUNDANT BRAKE ACTUATOR	1.4 kg (3 lb)	5.1 cm (2 in)	0.5cm/sec (0.2 in/sec)	275 kg (600 lb)	
CONTROL BOARD	1.4 kg (3 lb)				
BELL CRANK	9.1 kg (20 lb)				
SHIFTER	0.2–2.3 kg (0.5–5 lb)				



Roof Unit Components

Function

Universal roof unit can be applied to most vehicles through bracket clips or suction cup mounts. The roof rack can be customized to fit a variety of components such as radio, GPS, camera, beacon lights, sirens, and others.

Positioning

POSITIONING
GPS, GLONASS, & RTK
220 channels
1PPS (pulse per sec) output
L1/L2/L2C signal support
CAN 2.0B & RS-232 support.

Comms

HIGH FREQUENCY RADIO
Fixed Outdoor Wireless
2.4GHz Frequency
100Mbps Bandwidth
Point to Multi-point

Various frequencies available depending on your network needs.

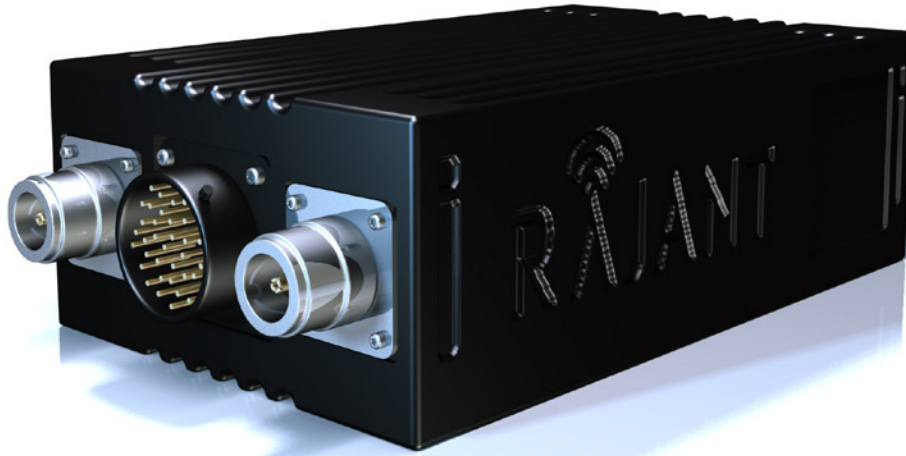
Camera

Network Camera
105° degree view



3rd Party Integration

Recommended Radio



Rajant®
BreadCrumb® ME4
rajant.com

The Rajant BreadCrumb ME4 node is a rugged, wireless device that forms a mesh network when used with other BreadCrumb systems and is reliable in extreme weather conditions. The BreadCrumb ME4 also exceeds both wireless data-transfer and security standards.

Model: ME4—2450R; ME4 with (1) **2.4GHz**, 2x2 MIMO, 300 Mbps and (1) **5GHz**, 2x2 MIMO, 300 Mbps transceivers.

Wireless Specs

2.4GHz

Throughput: 54Mbps

Frequency²: 2.4 GHz

Max Physical Layer Data Rate: 300Mbps

Max RF Transmit Power³: 29 dBm $\pm$ 2 dB

5GHz

Throughput: N/A

Frequency²: 5GHz

Max Physical Layer Data Rate: 300Mbps

Max RF Transmit Power³: 28 dBm $\pm$ 2 dB

Security Specs

Multiple cryptographic options, including NSA Suite algorithms (implementation not certified).

Separately configurable data and MAC address encryption via AES256-GCM, AES192-GCM, AES128-GCM, AES256-CTR, AES192-CTR, AES128-CTR, XSalsa20, XSalsa20/12, and XSalsa20/8.

Configurable per-hop, per-packet authentication between BreadCrumbs via AES256-GMAC, AES192-GMAC, AES128-GMAC, HMAC-SHA512, HMAC-SHA384, HMAC-SHA256, HMAC-SHA224, and HMAC-SHA1.

Supports IEEE 802.11i: AES-CCMP and TKIP encryption, WPA-Personal/Enterprise, WPA2-Personal/Enterprise, 802.1x: 64/128-bit WEP: Access Control Lists; Compatible with Layer-2 and Layer-3 client/server and peer-to-peer security solutions; Compatible with Harris SecNet 54 encryption.

Physical Specs

Startup Temperature: 0° C to 80° C (32 F to 176 F)

Operating Temperature: -20° C to 80° C (-4 F to 176 F)

Storage Temperature: -40° C to 80° C (-40 F to 176 F)

Enclosure: Designed for IP67 (6: Dust-tight, 7: waterproof)

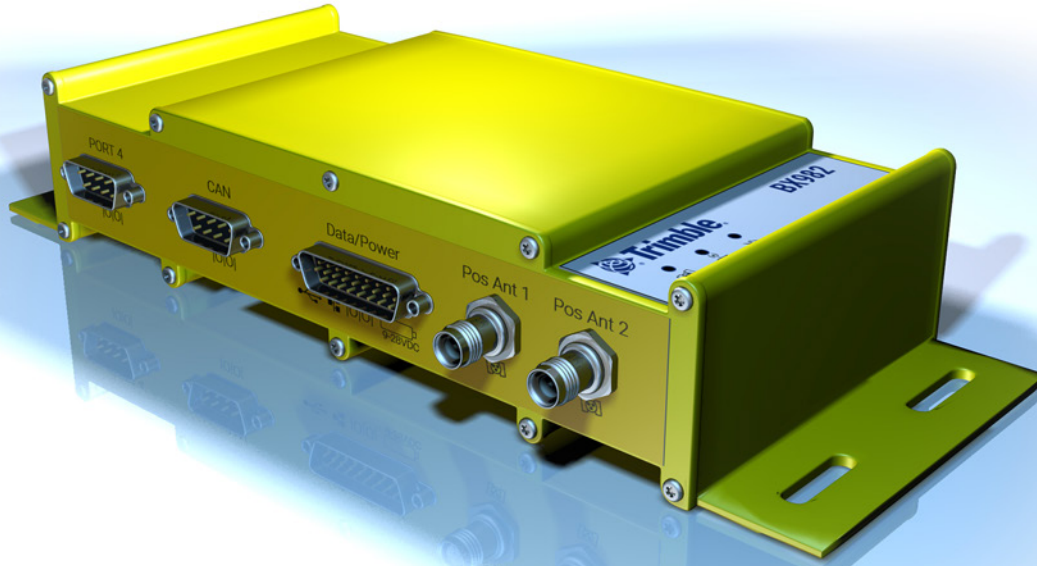
Certification: FCC Part 15 (USA)

ICES-003 and Rss-210 (Canada)

CE mark (European Economic Area, Switzerland and Turkey)

3rd Party Integration

Recommended GPS



Trimble® BX982 GPS

trimble.com

The Trimble BX982 is a sensible and durable GPS unit that meets ASI's utility and convenience standards and is the only GPS unit that ASI recommends. Key features include:

- Two 220 channel Maxwell 6 chips for multi-constellation GNSS support.
- Dual antenna inputs for precise heading calculation
- Centimeter level position accuracy
- Convenience of Ethernet connectivity

Technical Specs

Position antenna based on 220 Channel Maxwell 6 chip:

Navigation outputs – ASCII: NMEA-0183 GSV, AVR, HDT, GGA, GSA, VTG, GST

GPS: Simul. L1 C/A, L2E, L2C, L5

GLONASS: Simul. L1 C/A, L2 C/A, L2 P, L3 CDMA13

BeiDou: B1, B2

SBAS: Simul. L1 C/A, L5

RS232 ports (x3)

Environmental Specs

Operating Temp: -40° C to 70° C (-40° F to 158° F)

Storage Temp: -55° C to 85° C (-67° F to 185° F)

Vibration: MIL810F, tailored; Random 6.2 gRMS operating; Random 8 gRMS survival

Mechanical Shock: MEL810D; +/- 40 g operating; +/- 75 g survival

IP Rating: IP67 (6: Dust-tight, 7: waterproof)

Performance Specs

Velocity Accuracy, Horizontal: 0.007 m/sec

Acceleration: 11g

Positioning Specs

RTK (<50km): Accuracy – 0.015 m + 1 ppm Vertical

About ASI



Our Mission

“To help organizations reach their potential through innovative robotic solutions.”

Autonomous Solutions, Inc. is a world leader in vendor independent vehicle automation systems. From our headquarters and 100 acre proving ground in northern Utah (below), we serve clients in the mining, agriculture, automotive, government, and manufacturing industries with remote control, teleoperation, and fully automated solutions.

ASI's vehicle automation products can be found in companies and government agencies throughout the world, including: CNH Industrial, SHARP, Anglo American, Rio Tinto, Ford Motor Company, Fiat Chrysler Automobiles, Luke Air Force Base, and the Los Angeles Police Department.

Recent Awards

2015

Inc. 5000 list

An annual ranking of the fastest-growing private companies in America

2017, 2016, 2015, & 2014

Robotics Business Review 50

A list of the 50 most influential public and private companies in the global robotics industry.

2013

Automotive Testing Technology International

"Hardware Innovation of the Year" shared with FORD motor company for our robotic durability testing program.

15+ Patents

15+ patents have been awarded to ASI over nearly two decades of industry leadership including patents covering key features of our proving ground automation suite:

Robotic Path Planning

Robotic Command & Control





Sales & Support

Sales Staff

Contact our sales staff for quotes, to schedule a demo, or for any additional information.

SALES CONTACT

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sales@asirobots.com

ERIC BUDD

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M +1.435.512.5943
eric.budd@asirobots.com

Installation & Training

ASI offers initial installation and training to get your equipment up and running.

Support

Our dedicated and knowledgeable support staff are here to help.

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