


**FORi AUTOMATION**

Privately held, U.S. Owned  
and Operated Since 1984

# FORi AUTOMATION NEWSLETTER

13231 23 Mile Road  
Shelby Twp., MI USA 48315  
email: [sales@foriauto.com](mailto:sales@foriauto.com)  
586-247-2336  
[www.foriauto.com](http://www.foriauto.com)

## Issue 10

### NEW FORI MEXICO FACILITY

## Fori Mexico Opens New Facility



In order to meet the demand of Fori's welding division a new facility was required. The new facility includes:

- Manufacturing area: 70,000 square ft. / 6,500 sq m.
- Office area: 20,500 sq ft. / 1,900 sq m.
- 130 total employees

The new facility allows all the business units to be housed under one roof. The business units include welding, assembly, end of line testing and material handling. Having all of the business units in one facility will streamline design, production and project management.

The larger facility will allow entire welding and assembly systems to be setup and tested on Fori's floor prior to shipment to the end user. An additional expansion area of 20,000 sq ft. / 1,858 sq m. has already been allocated for future needs.

### IN THIS ISSUE

## Fori China

Fori China just received an FAW VW supplier award for a chassis marriage system upgrade to include the of the addition of the BSMV model in Plant #2. The launch was flawless. The manager said he never experienced so much work done in such a short time without delays or start up problems. The total Project price 18M rmb



# New Products

## Flex Floor Product Line



The Fori Flex Floor is a flexible assembly and material handling system designed to fit around the end users process and product. Whereas many of the other material handling products on the market require the end user process and product to fit around the material handling system. The Flex Floor platform includes a variety of vehicles based a on single mechanical & electrical architecture. The Flex Floor vehicles have varying levels of capability depending on the end users specific requirements. The platform is based on a reconfigurable chassis that utilizes standard building blocks, making dimensional modifications simple.

Flex Floor - RGC: Flex Floor Rail Guided Carts (RGCs) are a direct replacement for traditional, monument based conveyor systems. The RGCs utilize a low profile, floor mounted rail for guidance.



Flex Floor - 1.0 & 1.0T: Flex Floor 1.0 & 1.0T is a scalable unit load or tunnel AGC for assembly and material handling. The vehicle includes a single drive wheel, perfect for loop style assembly & material handling systems.



Flex Floor - 2.0 & 2.0T: Flex Floor 2.0 & 2.0T offer additional capability by utilizing dual drive wheels. The result is a vehicle with double the capacity of the 1.0 and omni-directional capability. Vehicles can be configured as a unit load assembly AGC or as a Tunnel AGC for material handling.



Flex Floor - 2.0 & 2.0T - HD: Flex Floor 2.0 & 2.0T - HD offer the same capability as the standard 2.0 & 2.0T, but the HD series provides nearly double the total unit load and towing capacity. The maximum load capacity for the HD series is 14,000 lbs.



The Fori Flex Floor utilizes a heavy duty extrusion frame that allow the footprint of each vehicle to be easily modified to fit the product being assembled or transported. The Flex Floor platform utilizes commercially available drive wheels, casters, batteries and control components. The Flex Floor platform is based on a Siemens Safety PLC control architecture, providing an open architecture to the end user. A Vehicle Management System (VMS) is supplied with each vehicle system enabling the system to be fully autonomous, only requiring input for scheduling of moves from the end user or plant production system.



### Automated Guided Vehicles (AGVs) for Aluminum Ingot Handling

#### Fori recently supplied (3) high capacity AGVs for the automated transport of aluminum ingots.

The three (3) high capacity AGVs will be the primary method of transporting the aluminum ingots through the finishing process. Traditional handling systems rely heavily on overhead crane utilization, the AGV based solution reduces reliance on cranes.

The AGVs were designed to fit within the existing plant and process. One of the biggest challenges on the project was packaging (8) drive wheels and (2) 100 Ton capacity lifters within the existing footprint. Each drive wheel was outfitted with a suspension system to ensure proper radial loading and equal load distribution between the (8) drive wheels.

Another improvement on the Fori system was integrated load cells for measuring forward to back and side to side loading of the ingots. If the aluminum ingot was loaded outside of an acceptable range the AGV stops immediately and sets down the ingot to ensure the safety of the operators and equipment in the plant.

The AGV utilizes a 72VDC sealed lead acid battery as a power supply for the Siemens Control Architecture. The vehicles utilize PMAC motors that provide improved control and efficiency over the previous system which utilized brushed motors. Each vehicle had a safety bumper front and rear, as well as (6) safety scanners around the perimeter of the vehicle to provided added safety.



### Tuggers - Automated Guided Vehicles (AGVs) for Composite Tooling Cart Transport

#### Fori recently supplied (2) automated Tugger AGVs for Aerospace composite tooling cart transport.

The Fori Tugger AGVs were supplied to transport a variety of composite tooling carts with total transfer weights up to 30,000 lbs. The Tugger AGV system included auto docking to the tooling carts. The purpose of the auto docking is to eliminate the need for operator intervention to couple to the carts and transfer them through the assembly plant.

The Fori Tugger AGV is utilized in two configurations, first as a Tugger pulling tooling carts in a single direction. The Tugger AGV is also used as a Dock N' Lock. In the Dock N' Lock configuration, the AGV automatically connects

to the tooling cart and pulls it against the bumpers (shown in bottom picture). The attachment allows the tooling cart to rotate with the Tugger AGV and back it into work stations as required by the process.

Previously the transfer of tooling carts was completed with fork lifts or manned tow vehicles. The Tugger AGVs were commissioned to ensure safe and reliable product transfer.

The AGVs eliminated non-value added material handling operations and provided a hands off production system for transporting product through the assembly process.



## Automated Guided Vehicles (AGVs) - Tunnel AGVs



**Fori recently designed and built a Tunnel AGV to support its global customers for transport of product and dunnage.**

The Fori Tunnel AGVs are capable of automated docking and transport of loads up to 5,000 lbs. The design intent was to build a vehicle that was modular and interchangeable. The Tunnel AGVs are capable of docking to various companion carts each serving a different purpose.



Tunnel AGV and companion cart applications include pallet transfer, lift tables and powered trunnions. Docking to the companion carts is completed with (2) automated docking pins. The docking pins ensure alignment to the companion cart for repeatable pick and drop.

The Tunnel AGV is designed to minimize the total footprint, while providing suitable capacity for a wide range of applications. With a height of 15", the vehicle provides a high capacity material handling solution in a small footprint. The vehicle design allows for bi-directional travel and zero turn capability.

If required a Fori Vehicle Management System (VMS) can be utilized for scheduling of vehicles and traffic management for the system. The vehicle controls are based on an open architecture utilizing a Siemens safety PLC, eliminating the black box used by many of AGV companies. The Tunnel AGV has proven to be a reliable material handling system for a variety of applications.

## Automated Guided Vehicles (AGVs) for Battery Pack Decking



**Fori has further improved on its standard Tugger AGV design by incorporating a Fori chain lift and pallet tooling for battery pack installation.**

Fori AGVs have been used for a variety of material handling applications within the automotive industry. Most recently Fori was enlisted to supply a derivative of the standard Tugger product line that has a built in electric lift and pallet tooling to be used for decking the electric vehicle battery to the chassis.

The AGV was required to synchronize with the vehicle chassis transported by the overhead carrier. The synchronization was a challenge in itself as there was no physical tracking arm.

All of the vehicle synchronization for battery decking was completed utilizing tracking cameras and encoder positioning. The most important process consideration was the safe and reliable positioning of the product for the operators.

Further improvement was the integration of a Fori Vehicle Management System (VMS). The Fori VMS allows for vehicle scheduling, charging, vehicle status information and traffic control.

The Fori battery decking AGV platform partnered with the Fori VMS is a proven and robust product that can be applied to a variety of material handling applications.



## Automotive Assembly System

### Tuggers - Automated Guided Vehicles (AGVs) for Product Transport



**Fori has further improved on its standard Tugger AGV design by doubling the overall towing capacity.**

Fori Tugger AGVs have been used for a variety of material handling applications within the automotive industry. Most recently Fori was enlisted to supply a derivative of the standard Tugger product line that is capable of nearly double the capacity of the original Tugger vehicle. The purpose for increasing the capacity was to transport up to (3) carts.

The Fori Tugger capacity allowed more product to be transferred during each move, further increasing the return on investment to the end user and decreasing the number of vehicles required.

The Tugger AGVs were commissioned to replace non-value added material handling tasks within the assembly process. The most important process consideration was safety of operators in the plant and reliable delivery of product.

Further improvement of the safety and reliability of the material handling system was the integration of a Fori Vehicle Management System (VMS). Vehicle scheduling of moves, system reporting, tracking and traffic control is coordinated through the Fori VMS.

The Fori Tugger is a proven and robust product that can be applied to a variety of material handling applications.



## Aerospace Assembly System

### Automated Guided Vehicles (AGVs) for Composite Wing Assembly



**Fori recently provided (9) high capacity Aerospace AGVs for the automated transport of tooling for stringer assembly for composite wing production.**

The (9) high capacity AGVs, capable of auto-leveling and synchronized transport of stringer tooling up to 40,000 lbs. have been designed to accommodate projected wing production.

The Fori AGVs will be the primary method of transporting the tooling and product through the assembly process. Traditional assembly systems rely heavily on overhead crane utilization, the AGV based solution eliminates the reliance on cranes. The AGVs will also be utilized for the loading of the autoclaves used for curing the composite components.

The loading of the autoclave is completed utilizing a natural feature guidance system, the AGV uses the walls of the autoclave for the guidance in and out, while still maintaining +/- 5mm positional accuracy.

The design intent was to build a vehicle that was modular and interchangeable. The AGV system is required to transport many tools of different lengths and weights. The AGV system needs to be able to accommodate synchronization of up to (3) AGVs during the lift and transport from assembly stations.

A Fori Vehicle Management System (VMS) was also supplied to coordinate the (20) vehicles that are currently in the production at the end users facility.





## Automotive Module Assembly System

### Axle Assembly Line with Automated Guided Carts (AGCs)

**The Axle Assembly System sequences and processes multiple product variants utilizing Fori Automated Guided Cart (AGC) assembly solution.**

Fori's integration of manufacturing execution systems (MES) with the AGC system allows the value added assembler the means to create multiple variants of axle assemblies.

The single loop style conveyor system consists of (12) AGCs to transport axle assemblies from incoming material dunnage through the various assembly processes and (2) off-line turntables including:

- Automatic positioning of Axle housings for various fill and drain plugs, using (2) trunnions on a turntable.

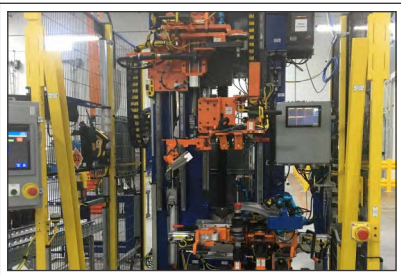
- Robotic transfer from plug turntable to dowel weld turntable to AGC load.
- Semi-auto dowel welding
- Robotic sealant apply to a variety of Axle housing carrier shapes.
- Leak test while manual start of carrier bolts.
- Manual final torque of carrier bolts.
- Manual loading with assist of various Axle shafts.

Utilizing experienced resources, Fori developed a viable process, engineered the system, manufactured the equipment and integrated the assembly line at the end user.



## Automotive Module Assembly System

### Assembly Line for Front / Rear Corner & Front Coil Over Shock Modules



**Low JPH rating requirements mean high cycle times. Increased cycle time requires taking a step back & looking how to develop a process that does not over complicate a station for an operator, but fulfills their time effectively.**

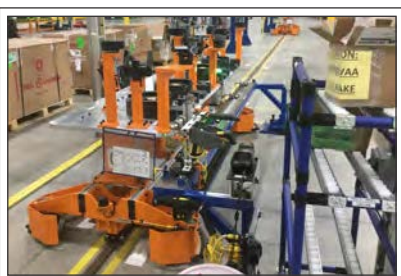
The end user requested the build of four corner modules on a single pallet. Rail guided carts (RGCs) were utilized for conveyance for the assembly of the corner modules.

The module assembly project consisted of two complex front coil over shock (FCOS) machines. Each machine is equipped with a (5) camera vision system to inspect various items based on the product variations.

The lateral run out (LRO) area sequenced six or more variations of rotors to the main assembly line. Careful means of transport and handling were considered within the design process to ensure the rotors were sufficiently fixtured during assembly.

The corner assembly line was composed of (9) RGCs, (7) operators, a semi-automatic lateral run-out cell, (2) complex mechanical gravity flow racks and (2) front coil over shock machines (FCOS).

The new RGC assembly line was installed and production ready during the first quarter of 2019.



## Automotive Module Assembly System

### Suspension Assembly System with Rail Guided Carts (RGCs)

**The Fori module assembly system sequences and processes multiple product variants utilizing the Fori Flex Rail assembly solution.**

Integration of manufacturing execution systems (MES) with the Flex Rail System allows the value added assembler the means to create multiple variants of suspension modules. Flexible configurations allow for the most cost effective utilization of the plant floor and personnel while handling large volumes and variables of product.

The loop style conveyance system consists of (57) rail guided carts (RGCs) to transport suspension module components from incoming material dunnage thru the various assembly processes including:

Front & rear brake corner assembly system:

- Automatic hub bearing & rotor lateral runout test and assembly.
- Robotic assembly of knuckle to hub bearing and caliper to knuckle with vision inspection.



Front vertical assembly system:

- Automatic Front Coil over Shock assembly.

Rear suspension module assembly system:

- Automatic setting of camber and toe.
- Simultaneous auto-torque of all links in (5) link suspension with vision inspection.
- Robotic unload of completed module to shipping container.



## Automotive Module Assembly System

### Assembly Line for Front & Rear Corner, Front & Rear Suspension & FCOS Modules



**Complex assemblies matched with high production requirements mean reduced ability to provide repeatable operator output. In an industry with constant pressure to boost efficiency and improve quality, automation becomes the solution most look for.**

The suspension module assembly consisted of a heavily automated system. The equipment included a rear suspension module line, front suspension module line, front and rear combo module line and a front coil over shock assembly (FCOS).

Rail guided carts (RGCs) were provided for conveyance of the product down through the entire production line.

The front and rear corner assembly consisted of (13) RGCs, robotic hub assembly & caliper torque cell.

The front suspension assembly line consisted of (16) RGCs, a semi-automatic ride height and trending set machine that positioned the links within a slot. The equipment could be adjusted based on the tolerances provided by the OEM.

The rear suspension assembly line consisted of (37) RGCs, (2) automatic module alignment systems, ride height set automatic torque cell and a robotic flip station.

The new RGC assembly line was installed during the first quarter of 2019.



## Automotive Assembly Systems

### Assembly & Alignment Line for Rear Suspension Modules

**Fori recently provided a module assembly and alignment line with limited floor space available. The system is between an existing assembly line & plant wall. The inability to get material to all parts of the assembly line required a unique process.**

The minimal footprint available for assembly provided challenges for common unload areas within an existing assembly line. The Fori RGCs were utilized to accommodate our customer's need for a flexible material handling system.

The assembly system included a consolidated kit area. The kit area was specific to loading and hand starting parts followed by an area for torqueing. Due to the foot print constraints the process had to be strategic on how to best utilize the available space.

The project also included a fully automatic suspension module aligner & backup semi-automatic aligner.

The utilization of Siemens controls matched the controls architecture for the end user and provided a seamless integration into Martinrea's assembly plant.

The rear main assembly line was composed of (17) RGCs, (16) operators, (1) automatic drive through suspension module alignment machine & one semi-automatic backup alignment system.

The new RGC assembly line was installed early June of 2018 & was production capable in Fall of 2018.



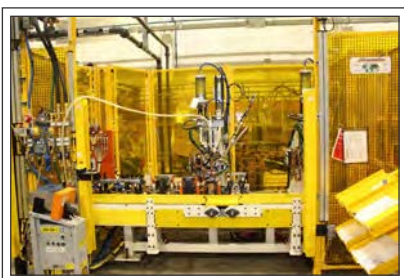
## Robotic Welding Systems

### Automotive Door Ring Robotic Welding System



**Fori recently design and built a low volume nut welding & spot welding cell for hot stamped materials. Maximum utilization of floor space and capital equipment was accomplished by batch running right or left hand door rings.**

The lower volume assembly cells can actually be more of a challenge than a high volume system. By a simple HMI input, the cell transforms from a RH to a LH assembly system. The two GEO weld fixtures are each mounted on a Fori, heavy duty precision trunnion with opposing handed fixtures. The trunnions also allow for setting an ergonomic position of the fixture for operator load heights that is usually difficult with a full vehicle panel such as a door ring.



In addition to the (4) spot welding robots that are almost 100% utilized, (3) material handling robots, two of which are on Fori's 7th axis slide, manipulate the part throughout the entire assembly cell. Internal and external to the cell are a variety of nut welding pedestal that utilize Fanuc IR vision allowing the robot to accurately position the large stamping over the small nut electrode every cycle.

By the use of two small conveyors, Fori was able to reduce the re-handling or re-packaging of parts coming out of the off-line nut welders. The multiple part nests being processed through the nut weld guns is controlled with a servo driven slide unit with ejectors sending the part on the correct conveyor and placing the part for load almost directly in the hands of the next operator.



## Robotic Welding Systems

### Robotic MIG Welding Assembly Cells

**Highly flexible, automated robotic MIG welding assembly cells, consist of (3) similar lines that accommodate (12) different model variations.**

Front sub frame and final full frame lines with 120+ robots each line (3 production lines).

The production lines include a front module rail line, cross member and all front end brackets.

The system includes a final front module suspension pierce, alignment pin staking, testing and final assembly vision measurement quality verification for the parts.

Overhead transfer conveyor (250 ft) transfers the front module frame to the main line.

Vision inspection of all incoming parts is completed for quality control. Final frame line assembles the front module frame, rear module frame, mid frame and all final cab and box mounts and crash impact braces.

Final frame pierce and vision measurement is utilized for quality control and to provide alignment data for OEM end user. Full frames are delivered robotically to a wax coating line.

Final Frame bolt on assembly and robotic stacking on shipping pallets for shipment by railcar to OEM plants.



## Robotic Welding Systems

### Automated Adhesive Apply & Drawn Arc Welding



**Fori recently supplied a high volume, flexible automated adhesive apply, robotic drawn arc stud welding and robotic spot welding system consisting of two identical lines and a state of the art, RGC (rail guided cart) system for part transfer.**

The supplied system is not your typical robotic spot welding cell. The rail guided cart (RGC) style system allows for easy adaptation of the line to accommodate future models, additional assembly stations, and production volume changes by avoiding the typical rigid, non-flexible material handling robot or automation part transfer.

In addition to the (17) mig weld, spot weld and material handling robots in the sub-assembly area, each line possesses (26) spot welding robots, (22) material handling robots and a (20) cart RGC system.

The current assembly system runs consistently under 75.8 seconds per line netting 37.9 seconds per assembly.

After fully assembled and welded, a precision inspection vision station accurately checks and documents critical features and attributes of the Rear Floor Assembly.

Upon demand, the customer may also opt to inspect the RGC fixture during off shifts with the same measuring station allowing for quality control of the transfer tooling on a regular basis.

One of many advantages of the RGC style of part transfer, is the virtually free buffering of parts in between station throughout the assembly line.



## Automotive End of Line Testing Systems

### Wheel Alignment System with Headlamp Aiming (HLA) & Wheel Base Adjust

**Fori USA recently designed, built, and integrated a wheel alignment system with headlamp aiming (HLA) and wheelbase adjust for a large automotive OEM.**

The End of Line system included: non-contact wheel alignment and automatic headlamp aiming (HLA). Wheel base adjust was also included in order to handle a variety of vehicle wheel bases.

The wheel alignment machine is designed for automatic measuring of toe and camber. Feedback is supplied to the operator, who completes a manual suspension adjustment of the vehicle parameters.

The wheel alignment equipment is designed for a wide range of wheel bases and tire tread width sizes.

An integrated headlamp aimer measures the vehicle headlight intensity and positions the aimer automatically to guide the operator to the correct adjustment necessary. The "Fori Vision" aiming unit utilizes a 2.3 megapixel camera system to measure the intensity and position of the headlight.

The latest high resolution camera box was also included for improving the headlamp aiming resolution and accuracy required by the latest IIHS standards.



## Automotive End of Line Testing Systems

### Adaptive Driver Assist Safety Cell (ADAS)

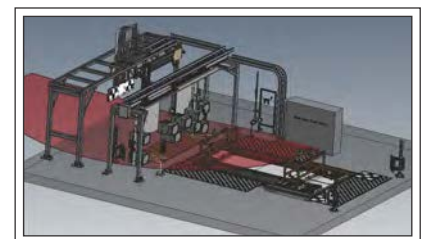
**Adaptive Driver Assist Safety (ADAS) centering cells are stand alone and can be placed in any audit or production facility.**

The stand-alone ADAS cell was developed for an electric vehicle manufacturer with plans to move to a total autonomous vehicle level 5 stage.

The project required the calibration of the vehicles long range radar sensor, corner radar sensors, front camera, (stereo vision) and surround view camera. Headlamp aiming (HLA) was integrated into this platform to best utilize the operator's process time.

The ADAS system was developed using lower cost solutions for:

- HLA with the high resolution Fori camera box and manual positioning gantry.
- Pneumatic "auto" positioning of the LRR aluminum target for Gen 5 radar sensors.
- Pneumatic drop down positioning of the LDW target.
- Fixed stanchions with corner reflectors for the corner radar calibration.
- Pneumatic centering platform for a wheelbase range of 500mm.
- A self-contained control system with Siemens based s7-1200 series PLC for conducting all positioning and the adjust sequence.
- PC and software to interface with other plant provided systems that communicated to the vehicle OBDII.





## Automotive End of Line Testing Systems

### Heavy Duty Wheel Alignment System with Headlamp Aiming (HLA)

**Fixed audit Headlamp Aiming (HLA) systems stand alone and can be integrated within existing wheel alignment machine, pneumatic centering platform or other centering system.**

The heavy duty 3D wheel alignment system was developed for the FCA Saltillo Mexico facility to accommodate the heavy truck loads and 110" wheelbase ranges of various RAM truck models.

The equipment was developed to improve the wear capability of machine load components such as the floating plates and sliding access plates for accommodating the high throughput of the heavy duty truck

models. Additionally telescoping machine covers were provided to accommodate the long wheelbase adjustment range of 120-210".

The machine included other special features for measuring and tracking underbody points with laser displacement modules during the truck's suspension adjustment cycle. The machine also performed audit checks for caster measurement using the caster sweep audit process.

For HLA an above floor gantry system was provided with Y and Z servo motor positioning and the latest high resolution camera box for improving the HLA resolution and accuracy required by the latest IIHS standards.



## Automotive Assembly System

### Chassis Marriage Line and Super Pallets for Vehicle Final Assembly

**Fori China recently designed, built and integrated a super pallet and associated modifications for a final assembly line for SVW at their Ningbo, China plant.**

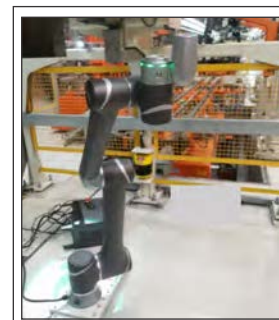
Fori China was responsible for designing, building and integrating (4) different final assembly line retrofits to accommodate an additional (3) vehicle platforms on an existing assembly line.

In order to support the super pallet modifications and the additional vehicle platforms, there were (4) different line modifications required for the equipment.

The final assembly line retrofits included:

- Super pallet modifications for new vehicle powertrain
- Addition of new load bar for different powertrain
- Updated tooling for hub tightening
- Robotic auto-tightening for battery package

The most unique portion of the modification project was the integration of an auto-tightening station for the battery electric vehicle (BEV) battery. The auto-tightening was completed with (4) fastening robots. plement them into the equipment.



**FORI CHINA**

Beijing, China

## Automotive End of Line Systems

### Wheel Aligner with Headlamp Aimer & Roll & Brake System

**Fori China recently supplied a 3-D wheel aligner, digital headlamp aimer and a roll & brake DVT system for BAIC ChangHe.**

In 2017, Fori China undertook the End of Line testing line project for the ChangHe Jiujiang Factory of BAIC and continued its long-term cooperative relationship with BAIC.

The automotive end of line project includes (1) 3-D non-contact wheel aligner, (1) digital headlamp aimer (HLA) and (1) roll & brake / DVT system. Among them, the wheel base adjustment of the DVT adopts plate-chain design, which is the

new design of wheel base adjustment for Fori DVT equipment. The DVT system can adapt larger wheel base changes.

The plate-chain structure for wheelbase adjust provides a wheelbase adjustment range of 950 mm. The wheelbase adjustment was implemented in order to also satisfy smaller wheelbase vehicle type testing.

The wheel aligners are not the "typical" systems supplied in the past. Fori's strong engineering group and past experience enabled us to take on these requirements and successfully implement them into the equipment.

**FORI CHINA**

Beijing, China

## Automotive End of Line Systems

### Wheel Aligner with Headlamp Aimer & Roll & Brake System

**Fori China recently supplied a 3-D wheel aligner, digital headlamp aimer, roll & brake DVT and ADAS system for NIO, Inc.**

In 2018, Fori China undertook the End of Line testing line project for the Hefei factory of NIO Inc., an electrical vehicle manufacturer. The project was the second line Fori provided for the NIO factory. The cooperation with NIO marks a new chapter for Fori China end of line systems with the emergence of electrical vehicles.

The automotive end of line project includes (1) 3-D non-contact wheel aligner, (1) digital headlamp aimer (HLA), (1) roll & brake / DVT system and (1) ADAS system.

The ADAS equipment included an automatic heads up display (HUD) calibration device, which is the first automatic calibration device in the end of line testing field. The ADAS equipment also included calibration of adaptive cruise control (ACC) and lane departure warning (LDW).

The NIO end of line testing equipment included the full suite of automotive EOL equipment offered from Fori China. The system started running production vehicles during the 3rd quarter of 2018.





**FORI CHINA**

Beijing, China

**Automotive End of Line Systems****Wheel Aligner with Headlamp Aimer & Roll & Brake System**

**Fori China recently designed, built and integrated a Chassis Marriage system for Ford at their Saar Louis, Germany Plant.**

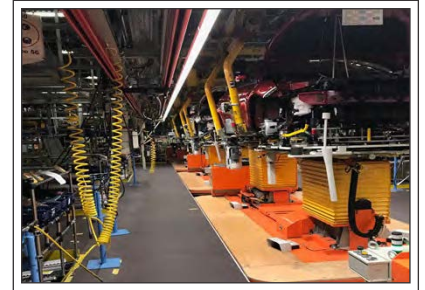
Fori China was responsible for supplying the Rail Guided Vehicles (RGVs), associated track, overhead loader and PLC control system that controls the loop.

The Chassis Marriage RGVs are based on Fori's long standing mechanical design and controls architecture. Each RGV includes (2) Fori patented servo controlled chain lifts for the synchronized lift and locate of the front and rear pallet.

Each Fori chain lift includes a floating table for alignment to the vehicle chassis that is transferred via overhead rail system.

The RGV is focused on maintainability and simplicity for the end user. The system utilizes a variety of off the shelf components and Fori standard product. The RGVs have been a robust solution for many years, pushing Fori to become a global leader in Chassis Marriage systems.

Fori also offers induction based rail guided vehicles and automated guided vehicles (AGVs) for chassis marriage that utilize a combination of induction and battery power.

**FORI INDIA**

Pune, India

**Automotive Assembly System****Front Corner Automotive Module Assembly System**

**Fori India recently designed, built and integrated an automotive module assembly system for Ford India at their Chennai plant.**

In 2018, Fori India undertook an automotive module assembly project for the Chennai plant of Ford India. Ford India is the sixth largest supplier of vehicles in India, supplying nearly 100,000 units domestically.

The assembly system supplied included (2) presses, an overhead lift assist and a half-shaft assembly fixture. The servo press supplied for the front corner module assembly is capable of 200kN.

The system was capable of pressing the dust shield, knuckle bearing and hub. The force versus distance graphs for each hub & knuckle were computed for each pressing action and sent to the end users manufacturing system.

An overhead lift assist was supplied to load the cap press and front corner module assembly fixture. The cap press fixture comprises of a pneumatic press for hub cap press. The OH lift assist also loads the half-shaft pulling fixture, which is utilized for assembling the hub & knuckle assembly with the lower control arm, brake disk, caliper arm & drive-shaft. Both the cap press fixture and half-shaft pulling fixture are controlled by a common control panel.



**FORI INDIA**

Pune, India

## Automotive Welding System

### Welding Cell, Fixtures & Cradle Assembly

**Fori India recently supplied assembly and welding fixtures and a welding cell to Tenneco Automotive India.**

In 2018, Fori India designed, built and integrated an automotive assembly & welding system for the Pune plant of Tenneco Automotive India.

The project consisted of two installations one for the TML 3.3L engine and another for the dual end drive assembly.

For the TML 3.3L engine, Fori India was contracted to design and manufacture (27) welding fixtures. The welding fixtures included one for the inlet assembly, outlet assembly, diesel oxidation catalyst, diesel particulate filter and heat shield.

The dual end drive welding SPM was provided to reduce the space requirements compared to traditional robotic welding cells. The dual end drive welding cell also reduces the cycle time of the robotic cells. The supplied system is capable of production cycle time of 106 seconds, up to 75,000 units per year.

The assembly and welding system was installed and running production during the third quarter of 2018.

**FORI INDIA**

Pune, India

## Automotive Assembly System

### Front Corner Automotive Module Assembly System

**Fori India recently supplied a production line for trim, chassis and final assembly for Mahindra & Mahindra.**

In 2018, Fori India designed, built and integrated an automotive assembly system for the Chakan, Pune plant of Mahindra & Mahindra. The Chakan, Pune plant originally built in 2010, recently supplied its 1,000,000th vehicle during the 2nd quarter of 2019.

The scope of work for the project is a trim line conveyor with trolleys, chassis line conveyor with trolleys and a final line slat conveyor.

The marriage line supplied is a sub-set of the trim & chassis and final assembly system. The line delivers completed front and rear modules after being assembled to the marriage loop. The initial line speed for the installed system is 4 JPH, system design accommodates future production increases up to 8 JPH.

The trim line Towveyor includes a 1 ton capacity, 6,300mm station pitch and (12) trolleys for assembly. The chassis line is of similar design, but includes a 1.5 ton capacity and a 6,000mm station pitch, quantity of trolleys is (11).

The production system was installed and running production during the second quarter of 2017.





**FORI GERMANY**

Merzig, Germany

## Automotive Chassis Marriage System

### Chassis Marriage Station with AGCs for Product Delivery



**Fori Germany recently designed, manufactured and integrated a chassis marriage system with automated guided carts (AGC) for the VW Osnabruck, Germany plant.**

The system consists of (9) AGCs with are utilized for pre-assembly and the conveyance of the front and rear suspension to the main line for chassis marriage.

The chassis marriage system was a stand-alone cell which included an integrated lift to raise the front and rear suspension for installation. Once the suspensions are raised into position the fastening and torque of the fasteners is completed via robots and electric nut-runners.

Torque values are tracked to ensure process consistency.

The AGCs are based on Fori Germany's standard vehicle platform. Safety scanners were mounted on the front of the vehicle to ensure collision avoidance. Guidance for the AGCs was completed through the utilization of a camera system, which follows colored tape and/or paint on the floor. The AGC power supply is an induction loop, which does not require batteries or charging. The system can run 24/7/365.

The supplied equipment leveraged Fori Germany's automated material handling and chassis marriage experience to supply a turnkey final assembly line. The results were a flexible conveyance system and robust chassis marriage station.

**FORI GERMANY**

Merzig, Germany

## Automotive Assembly Systems

### Rear Axle Adjustment System

**Fori Germany recently designed, manufactured and supplied a new rear suspension adjustment stand for the Audi Ingolstadt, Germany plant.**

At the Ingolstadt location, a rear suspension alignment stand is installed to set the camber for the AU37x, 38x Front and Quattro.

The system is set up next to a second "HAEST" in hall GVZ B. The Fori provided equipment is surrounded by a corresponding protective fence and is a fully automatically cell. The rear suspension module is delivered by an existing conveyor system and automatically raised to the setting position.

Once located, the suspension is clamped and the measurement of the camber takes place without contact. Once the measurement is complete, the required adjustment is completed automatically by appropriate torque units. After completing the adjustment process, the suspension is placed back on the tool carrier and extended out of the protected area of the adjustment cell.

Consists of the following components:

- Protective safety fencing
- Rear suspension adjustment system
- Contactless measurement device
- Auto-torque for adjustment
- Device to simulate actual vehicle weight during adjustment



**FORI GERMANY**

Merzig, Germany

## Automotive Assembly System

### Rear Axle Adjustment System



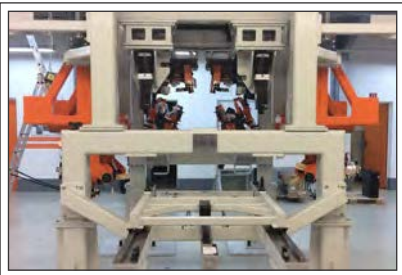
**Fori Germany recently designed, manufactured and supplied a new rear suspension adjustment stand for the Audi Brussels plant.**

The rear axle is delivered by an existing conveyor system and automatically raised to the setting position. Once located, the suspension is clamped and the measurement of the camber takes place without contact. After the suspension is located the installed vehicle force is applied to the module, force displacement is included within the equipment to simulate vehicle loading.

Once the measurement is complete, the required adjustment is completed automatically by appropriate torque units. After completing the adjustment process, the rear axle is placed back on the tool carrier and extended out of the protected area of the adjustment cell.

Consists of the following components:

- Protective safety fencing
- Rear suspension adjustment system
- Non-contact measurement device
- Auto-torque for adjustment
- Device to simulate actual vehicle weight during adjustment

**FORI GERMANY**

Merzig, Germany

## Chassis Marriage Assembly

### Chassis Marriage Station with Frame Storage

**Fori specializes in design, build and integration of customized vehicles / equipment for a variety of different industries. Flexibility and capabilities enable Fori to meet its customers ever changing demands.**

The units pre-assembly on AGV vehicles and units Installation (wedding) for the vehicle PO 526 has been realized as a floor-level oval course of about 25 x 15 m. The system consists of several electromechanical, pneumatic and hydraulic units, a main control panel and several control panels in the work areas of the workers; and automated guided vehicles (AGV).

#### Wedding Station

In this station chassis and body are connected and bolted. There is one (1) lifting device that lifts and positions the loaded frame.

The lifting device is driven by servomotors. The entire system is controlled by a PLC.

#### AGV vehicle

The oval contains FTF (Automated Guided Vehicles). These are provided with components in various cycles and pre-assembled.

There are 10 workstations (ST01 to ST11) each about 8 m long. These are located in the pre-assembly area. The pre-assembled frames are transported via a lift to the wedding. With a lifting device and NC axes, the pre-assembled trolleys are connected to the chassis and bolted. The system consists of several electromechanical and hydraulic units, a main control panel, several control panels in the work areas of the workers; a PLC from Siemens and Automated Guided Vehicle Handling (AGV) vehicles.



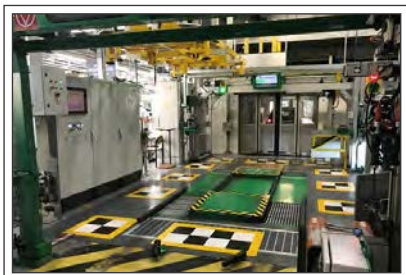
**FORI KOREA**

LTD

Sihung-Si, Korea

## End of Line Testing Systems

### ADAS Calibration System for Front Camera, Front/Rear Radar & AVM



**Fori Korea recently supplied a fully integrated end of line testing system for Renault in Revoz, Slovenia.**

In 2018, Fori Korea undertook an end of line testing project for the Revoz plant of Renault. The Revoz plant is the only vehicle manufacturing plant in Slovenia.

The EOL testing equipment installation included Advanced Drive Assistance Systems (ADAS) calibration equipment.

The equipment calibrated the front camera, front radar, rear radar and the around view monitor (AVM). The supplied equipment included a new ADAS system, as well as upgrades on a previously supplied ADAS system for the Revoz plant.

The ADAS system was designed to for the Renault Twingo. Total annual production for the Twingo was over 130,000 units during 2018.

The end of line testing equipment began running production vehicles during the 4th quarter of 2018.

**FORI KOREA**

LTD

Sihung-Si, Korea

## End of Line Testing Systems

### Non-Contact Wheel Alignment & HLA, Side Slip Test, Roll & Brake Test

**Fori Korea recently supplied a 3-D wheel aligner & HLA, roll & brake system & side slip testing equipment.**

In 2017, Fori Korea undertook the end of line testing project for the Cangzhou factory of Beijing Hyundai Motor Company (BHMC), a joint venture by BAIC Motor Investment & Korea Hyundai Motor Company.

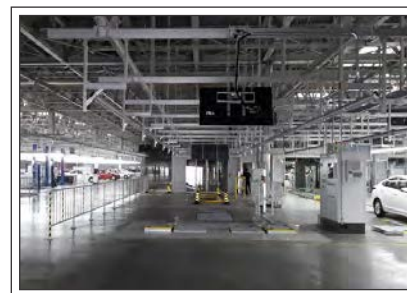
The project consisted of (3) sets of end of line (EOL) testing equipment.

The first (2) sets were installed during 2016, with the third and final set being installed during 2017. With the (3) sets of EOL equipment, the plant has the production capability of 300,000 units.

The latest installation of automotive EOL equipment includes (1) 3-D non-contact wheel aligner, (1) digital headlamp aimer (HLA), (1) roll & brake / DVT system and (1) side slip station.

The BHMC end of line testing equipment included many of the automotive EOL testing equipment offerings from Fori Korea.

The system started running production vehicles during the 3rd quarter of 2017.





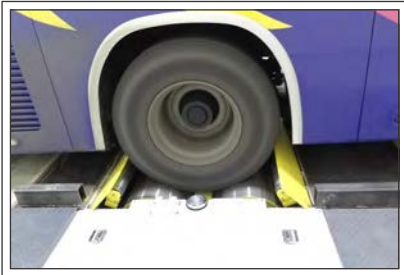
**FORI KOREA**

LTD

Sihung-Si, Korea

## End of Line Testing Systems

### Free Roll Tester & Brake Tester



**Fori Korea recently supplied (2) sets of free roll and brake test equipment for a large vehicle & bus assembly plant.**

In 2018, Fori Korea undertook an end of line testing project for the Jeonju Plant of Hyundai Motors Company, the largest automotive manufacturer in South Korea.

The project consisted of (2) free roll and brake test systems.

The systems were designed to accommodate (3) different vehicle models, which included the Universe, County & Solati.

The brake tester is driven by the integrated servo motors, allowing a maximum drive speed of 20 km/h. The equipment was designed to support up to 10,000 kg. which supports the three Hyundai Motors buses. The production rate required for the equipment is 12 jobs per hour.

The Hyundai Motors brake test system is the highest capacity brake test system supplied by Fori Korea. The system started running production vehicles during the 4th quarter of 2018.

**FORI KOREA**

LTD

Sihung-Si, Korea

## End of Line Testing Systems

### Non-Contact Wheel Alignment with HLA, Roll & Brake Testing & Side Slip Test

**Fori Korea recently supplied a fully integrated end of line testing system for Kia Lucky Motors in Karachi, Pakistan.**

In 2019, Fori Korea undertook an End of Line testing project for the Karachi plant of Kia Lucky Motors in Pakistan. The Karachi plant is Kia Motors reentry into the Pakistan automotive market.

The EOL testing equipment installation included (1) non-contact wheel aligner, (1) gantry style head lamp aimer with centering device, (1) roll and brake tester and (1) side slip tester.

The supplied equipment was designed for (2) vehicle models the Kia Sportage and Picanto. The Sportage is a compact SUV and the Picanto is a city compact car.

The Fori Korea end of line testing equipment began running production vehicles for Kia Lucky Motors during the 4th quarter of 2019.



**FORI MÉXICO**

Saltillo, Mexico

**Automotive Assembly System****Truck Cab Transfer System**

**Fori Mexico recently provided a truck cab delivery system for an FCA production plant in Saltillo, Mexico.**

The cab transfer system was designed and built for the delivery of truck cabs from the paint area to the vehicle assembly area. The cab transfer system was designed to transfer three models of truck cabin, including crew cabs, mega cabs and standard cabs. (2) free roll and brake test systems.

The system was provided to replace existing cab transfer equipment. The Fori equipment was supplied to provide a more robust and safe delivery system.

The cab transfer system body and frame carrier utilize a servo driven and controlled ball screw assembly to ensure consistent position of the truck cab.

Start of production for the equipment was during the 1st quarters of 2018. The system provided improved safety and overall robustness versus the previous transfer system.

**FORI MÉXICO**

Saltillo, Mexico

**Automotive Assembly System****Robotic Bushing Press System**

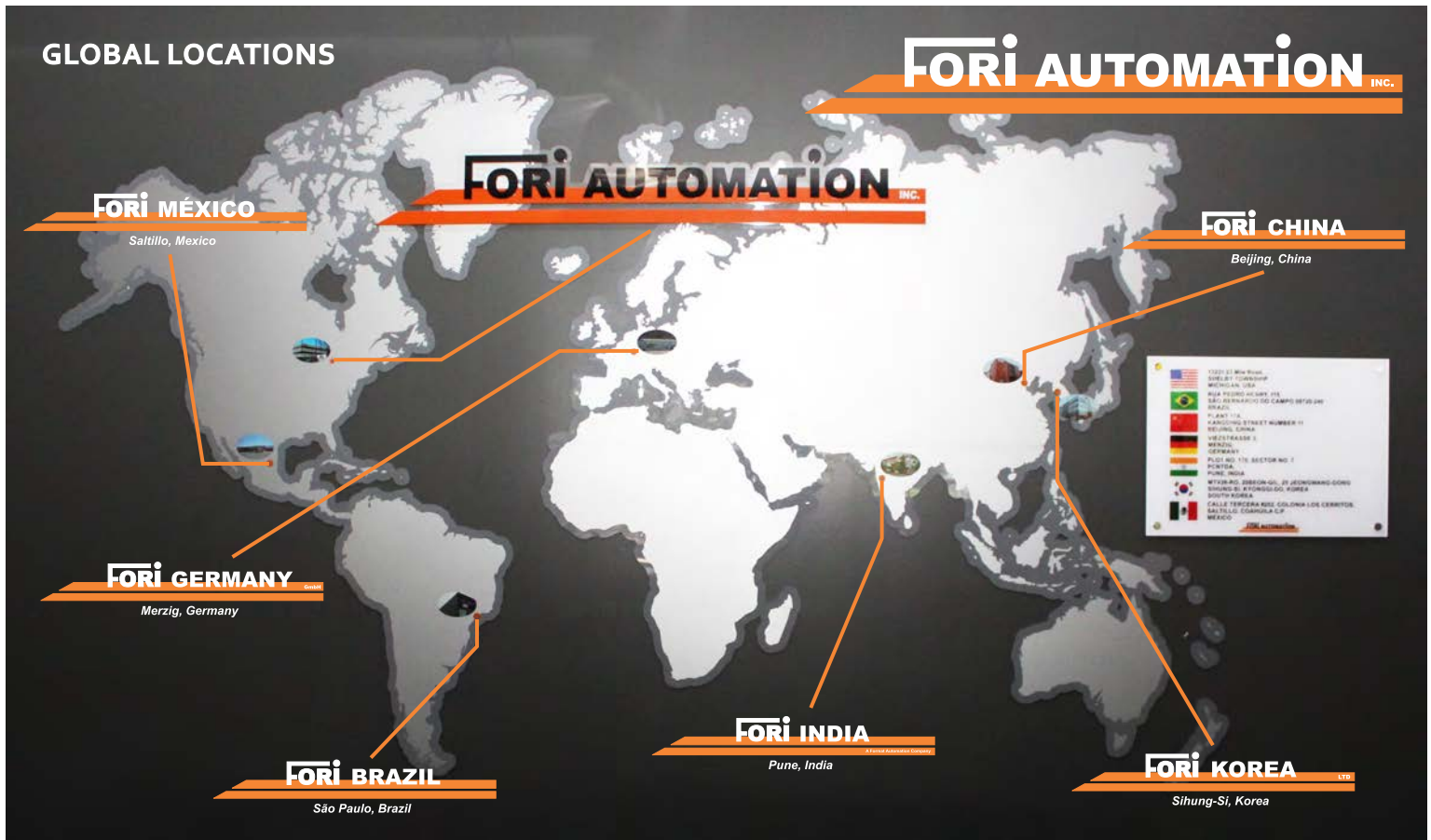
**Fori Mexico recently provided an automated bushing press system for a Magna production plant in Ramos, Mexico.**

The bushing press system includes two robots for the automated load and unload of the end users product. The press system supplied utilizes a Fori servo controlled press system that is capable of 50 kN of force.

An operator loads the bushing into a gripper that is mounted on an overhead robot, the robot places the bushing into the press system. The press moves to the work position via servo controlled slide and performs the insertion of the bushings. The chassis is positioned via z-axis lifters, there are additional lifters provided that receive the chassis and reduce the overall cycle time.

Start of production for the equipment was during the 1st quarters of 2019. The system provided improved production rate versus more manual methods of bushing insertion.



**Fori Automation Inc.**

Global Headquarters  
Shelby Twp., MI, USA 48315  
Phone: 586-247-2336  
Fax: 586-266-6773

**Fori Automation China**

Beijing, BDA, 100176 China  
Phone: 86-10-6780-2940  
Fax: 86-10-6780-2945  
email: sales@foriauto.com

**Fori Korea Ltd.**

Sihung-Si, Korea  
Phone: 82-31-496-3400  
Fax: 82-31-431-528

**Fori Automation India**

Pune, India  
Phone: +91-20-30792679/80  
Fax: +91-20-30792681

**Fori Automation do Brasil**

São Paulo, Brazil  
Phone: 55-11-4124-7624  
Fax: 55-11-4337-3172

**Fori Automation GmbH**

Merzig Germany  
Phone: + 49 (0) 6861-7009-0  
Fax: + 49 (0) 6861-7009-310

**Fori Automation de México**

Saltillo, Coahuila, Mexico  
Phone: 52-844-416-8918



Privately held, U.S. Owned  
and Operated Since 1984



[www.foriauto.com](http://www.foriauto.com)



ISO 9001:2008 ISO 14001:2008 Certified / ITAR Certified / Cage Code M20746