Light Modular Gantry (LMG) System

## Delivering New Technology to the Factory Floor

Light Modular Gantry (LMG)

Product Overview

Our Light Modular Gantry (LMG) is a 5-Axis robotic system used to drill precise holes on aircraft structures and sub-assemblies. The LMG systems is a light-weight mobile platform with a modular design that allows the end effector to be quickly removed and installed.

Microprocessors are located on-board in each of module and only a small diameter umbilical cord is required to power and command the entire robot. The machine is simple to use with a software interface that is intuitive and user friendly.
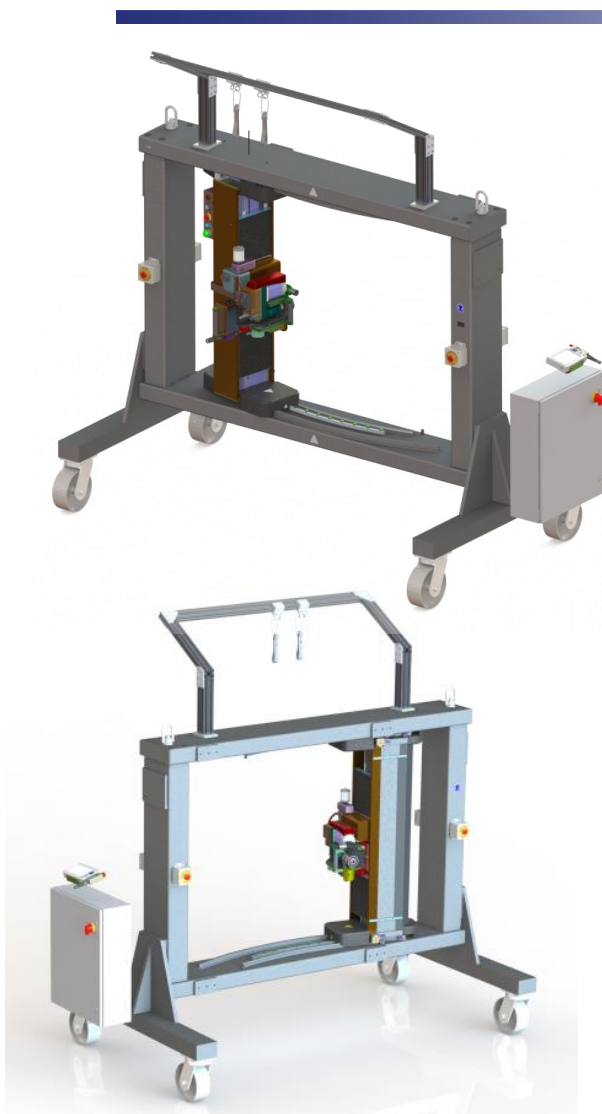

LMG currently in production

Light Modular Gantry (LMG)

Module Design Overview

The LMG is light-weight mobile system. This allows then entire machine to be easily moved around the factory and utilized on a verity of applications. The dovetail interface and on-board controllers allows the End Effector to be quickly removed and inserted in minutes.

The LMG system comes with two modules.
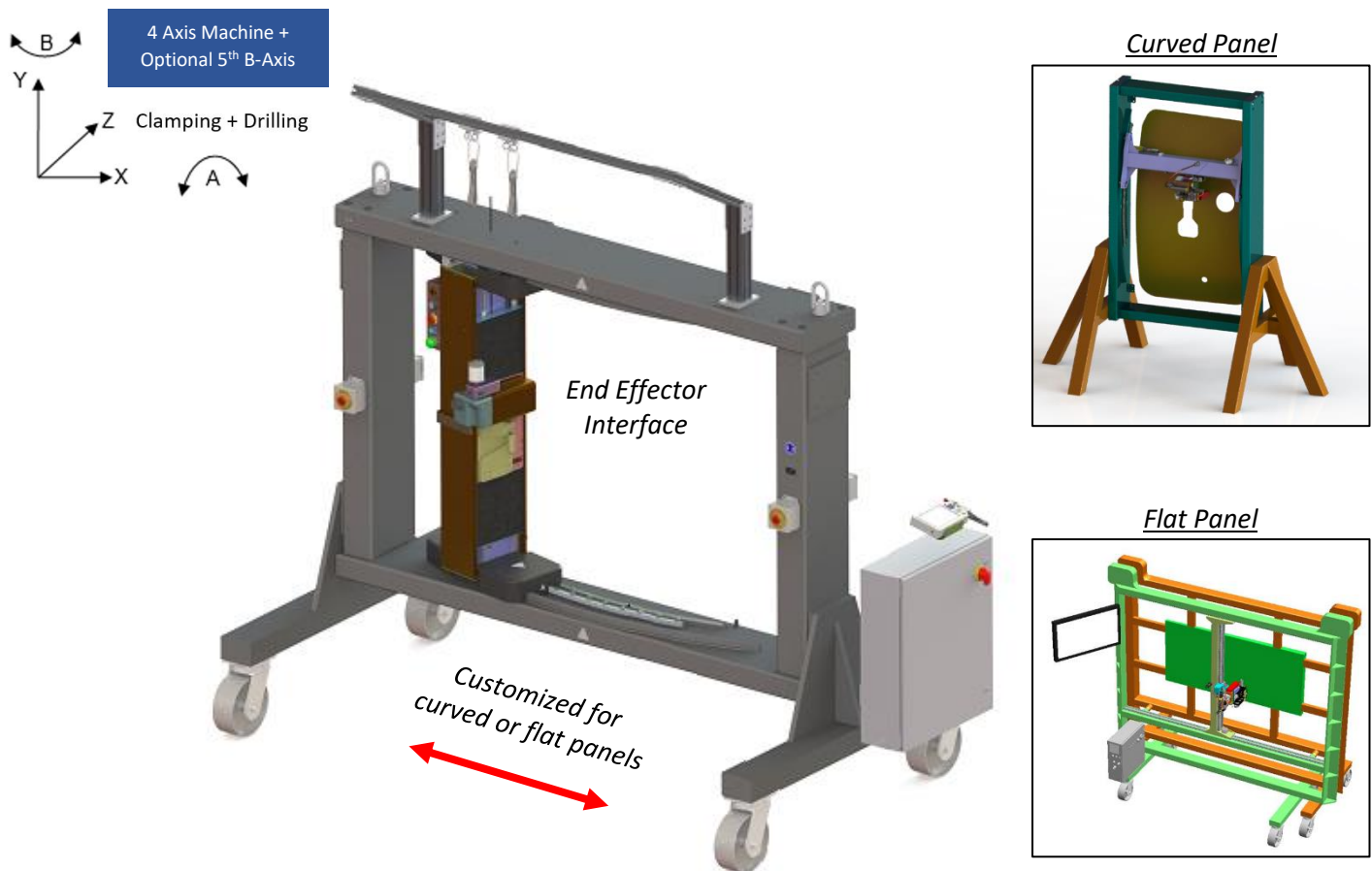   A. Gantry Module
   B. End Effector Module

Gantry Module

Removable End Effector

End Effector Module
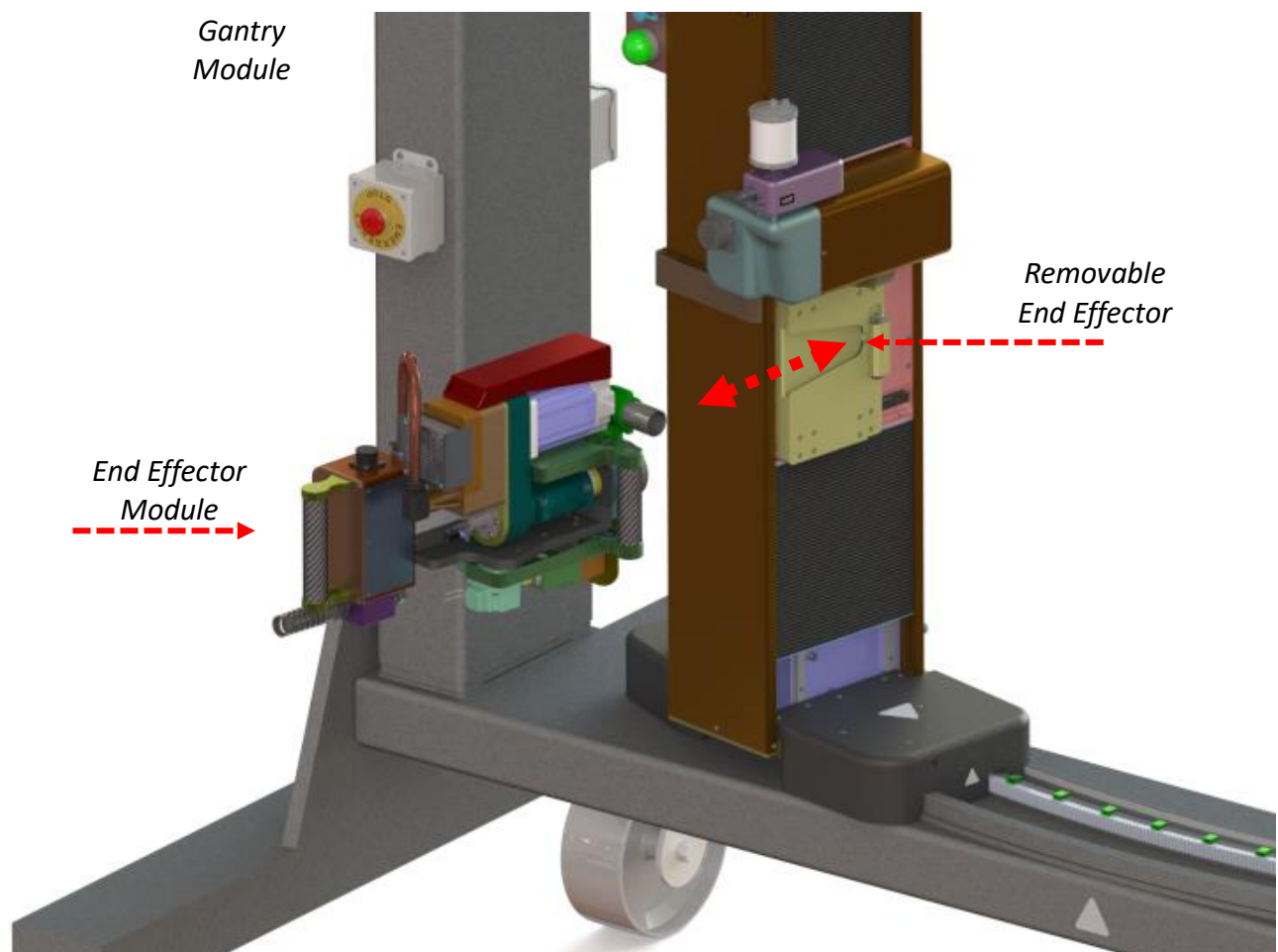
Light Modular Gantry (LMG)

LMG Frame Module (X and Y Axis)

The LMG Frame Module is a customizable vertical gantry that can be designed to accommodate curved panels, like doors, or straight panels like smaller empennage panels or smaller aircraft wing structures.   The power supply is typically attached to the LMG Frame Module so that the entire system remains mobile. The power supply does not need to be hard wired and typically runs off a standard outlet with 110 VAC (20A) or 220 VAC (10A).

4 Axis Machine + Optional 5th B-Axis

Clamping + Drilling

End Effector Interface

Customized for curved or flat panels

Curved Panel

Flat Panel

Rev: V6

Light Modular Gantry (LMG)

Drilling End Effector Module

The End Effector performs all drilling, clamping, normalizing and datuming operations. To perform these, the End Effector consists of key components. These are: Male Dovetail Plate, Camera System, Normality Sensors, A-Axis, Load Cell, Spindle Assembly, and Feed (Z) Axis. The Dovetail Plate precisely aligns the End Effector to the Y-Carriage. The vision system allows the end effector to locate off existing datums such as final fasteners, open holes, panel edges and temporary fasteners.

A-Axis
Linear Rail

Spindle Motor

Clamp Pressure Load Cell

Vacuum Port
(FOD Removal)

Vision System
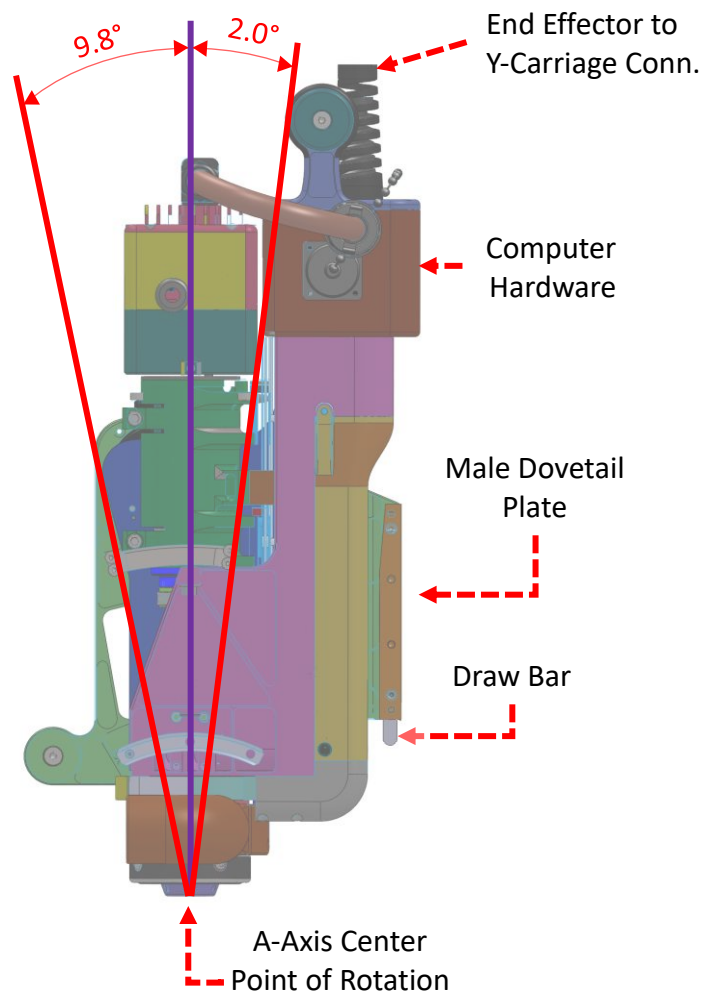
Normality Sensors
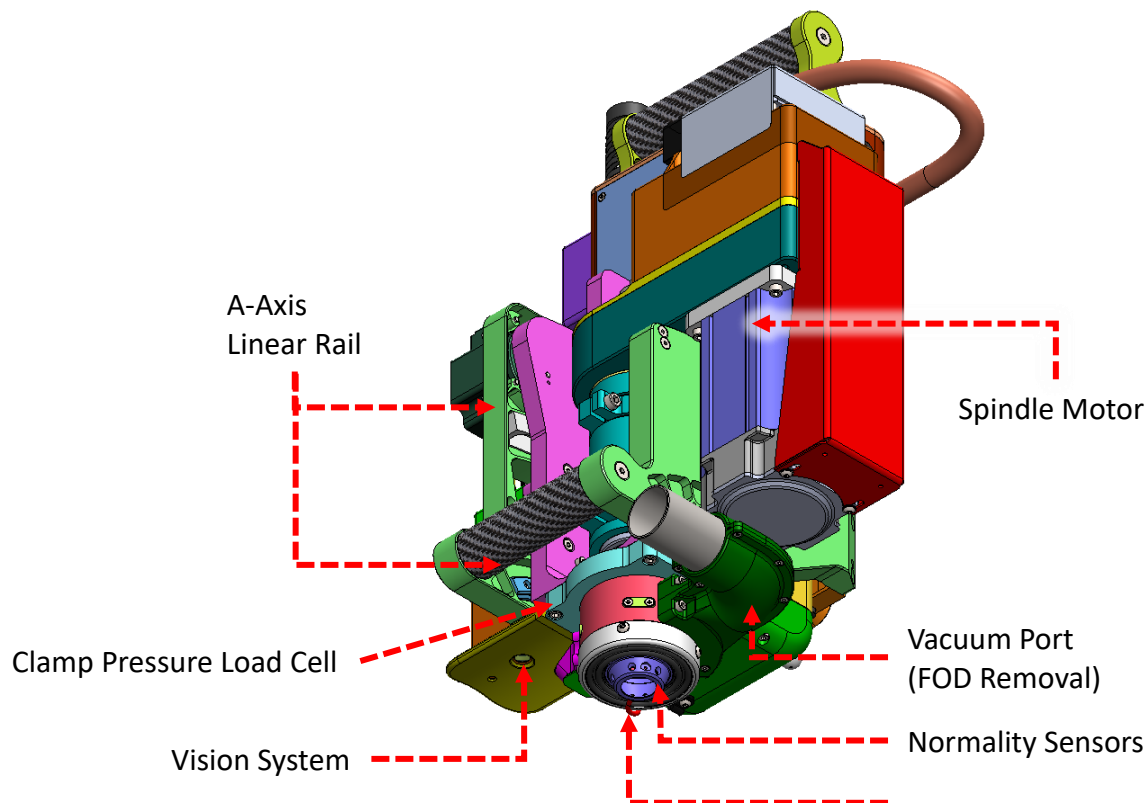
Key Features:

- Through bit coolant.
- Precision ball screw and rack & pinon components driven by industrial servo motors provide precise movement of the End Effector.
- Contact normalization and clamp force monitoring.
- Diameters up to 7/16in (11mm) in aluminum with repeatable countersinks.

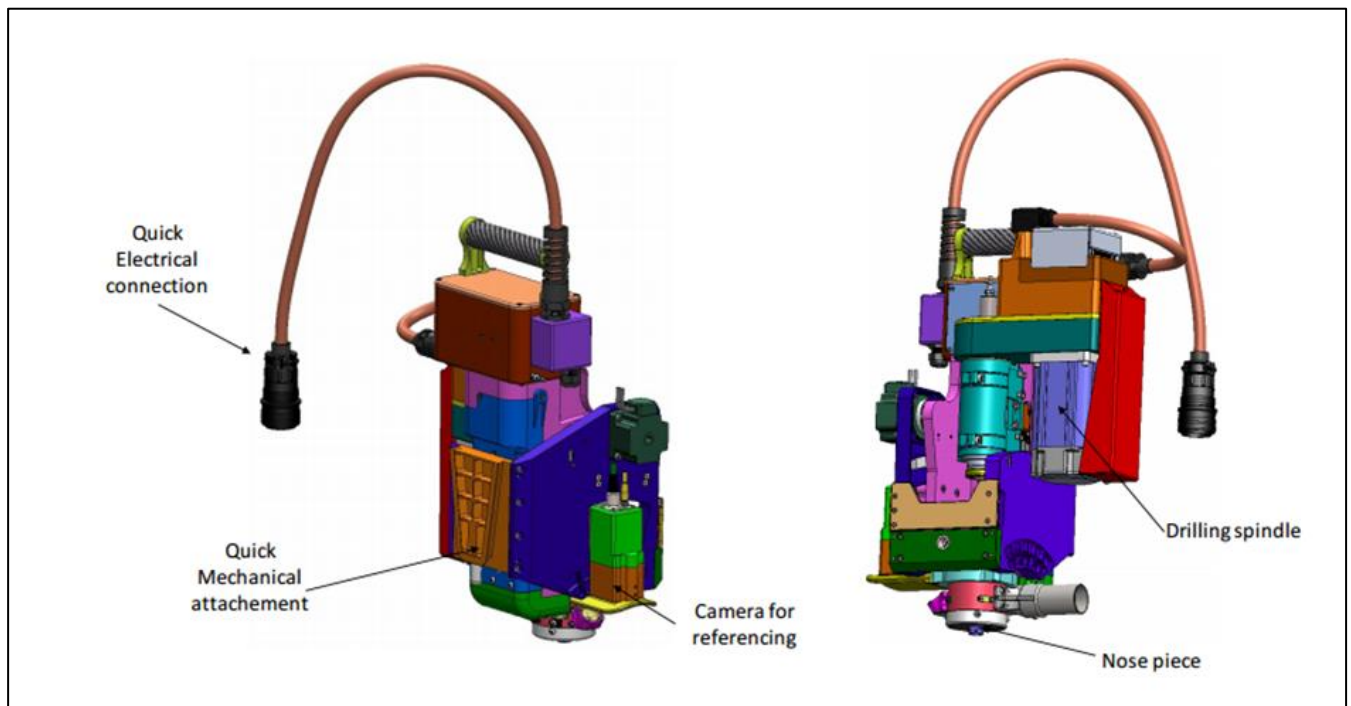# *Light Modular Gantry (LMG)*

Drilling End Effector Module

The Normality Sensors, A-Axis and B-Axis (Add-On) allow the system to touch the skin and adjust the normality of the feed axis to the panel at each drilling location so that the system drills holes perpendicular to that exact location on the aircraft surface. The Load Cell provides constant feedback to the MFT so that it can clamp up on the surface to a specified pressure to compensate for the drill thrust. The Load Cell also allows the system to monitor drill thrust during drilling operations. The Spindle Assembly and the Feed (Z) Axis are the components that perform the actual drilling and countersinking operations.
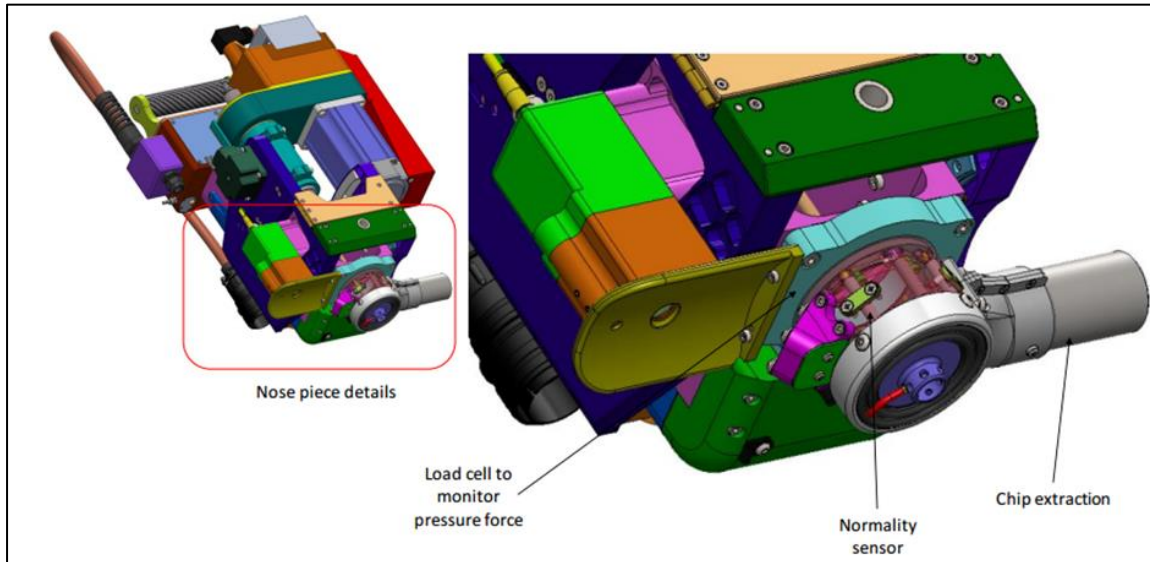

End Effector to Y-Carriage Conn.

Computer Hardware

Male Dovetail Plate

Draw Bar

A-Axis Center Point of Rotation

9.8° 2.0°

Rev: V6

Light Modular Gantry (LMG)

Drilling End Effector Module

Drilling Modes	Peck, Micro Peck, Plunge, Stacks with Different Materials, Constant IPR Drilling
Vision System	Cognex Camera
Spindle Motor Type	DC Servo
Spindle Drive	Configurable Belt Drive
Spindle Speed	Programable up to 12,000rpm (configurable pulley options)
Spindle Collet Type	HSK-32A
`Recommended Max Drill Diam	7/16 inch (11mm)
Recommended Max Drill Depth	3 inches (76mm)
Countersink Repeatability	+/- 0.002 inches (+/- .05mm)
A-Axis Travel	+9.8deg to – 2.0deg
A-Axis Normality Accuracy	+/- 0.5 deg
Weight	41lbs (18.6kg) Spindle is removable from End Effector: EE 24lbs (10.kg), Spindle 17 lbs (7.7kg)

Quick Electrical connection

Quick Mechanical attachement

Camera for referencing
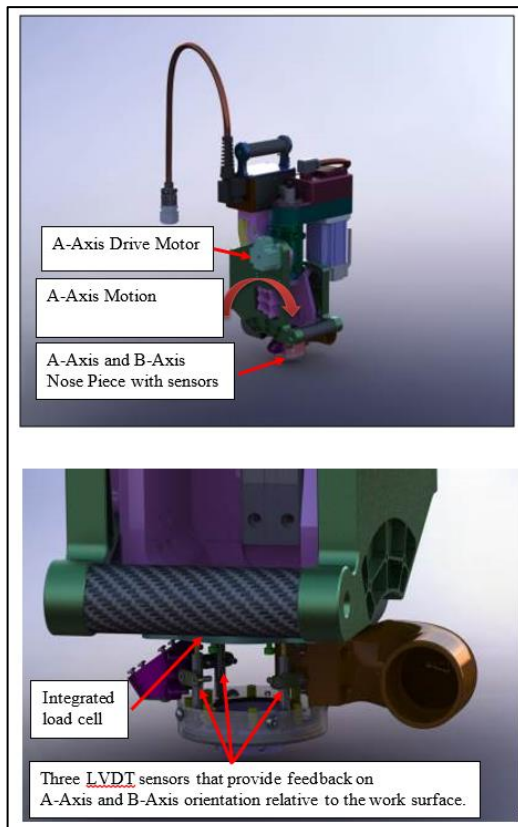
Drilling spindle

Nose piece

Light Modular Gantry (LMG)

Drilling End Effector Module

Main Components/Functionality of the End Effector

A-Axis, B-Axis Normalization System

Light Modular Gantry (LMG)

Drilling End Effector Module

Hole size range

The MFT end effector currently supports drilling and countersinking up to 7/16in diameter holes in a 3in stack of aluminum. This is typically done with an IPR of 0.006in per revolution at 6000rpm. The spindle is belt driven so it can be optimized for spindle torque/speed.

Countersink Depth Control

The MFT is capable for controlling countersink with an accuracy of +/- 0.002in (0.05mm). Our feed mechanism uses a high precision ball screw coupled to a brushless DC Servo motor. The spindle also utilizes a linear encoder to monitor the exact position of the spindle. In addition, thermal compensation can be added to further improve accuracy to meet the most demanding requirements.

Lubricant Delivery

Our Lubrication system is integrated into the MFT. It can accept various other types of lubricants/coolants. The lubrication parameters are controlled through the part program. Therefore, lubricants can be tuned on and off within the part program. In addition, the pulse rate is programable per hole so the amount of cutter fluid can be adjusted as needed.

Speed and Feed Control

The MFT supports variable feed and speed drilling by stack layer including air, transit, and countersink layers. The MFT spindle utilizes an industrial brushless DC servo motor. It is belt driven and can be
configures for various applications. Typical drilling RPM is 6,000 RPM but can be configured and programmed to range from 500 RPM to 12,000 RPM. Pulley options allow for higher torque with lower maximum RPMs

MTM: Clamping Force

The MFT End Effector is programable and monitored by a load cell integrated into the nose piece. The end effector can clamp up to 300 lbs. Typically, the clamp force is set between 100lbs and 200lbs.

Rev: V6

Light Modular Gantry (LMG)

Drilling End Effector Module

Perpendicularity

The MFT End Effectors uses active normalization when contacting the surface. Normality is held to less than 0.5 deg in the A-Axis. B-Axis is monitored but not normalized to. B-Axis is fixed unless equipped with an optional B-Axis normalization motion.
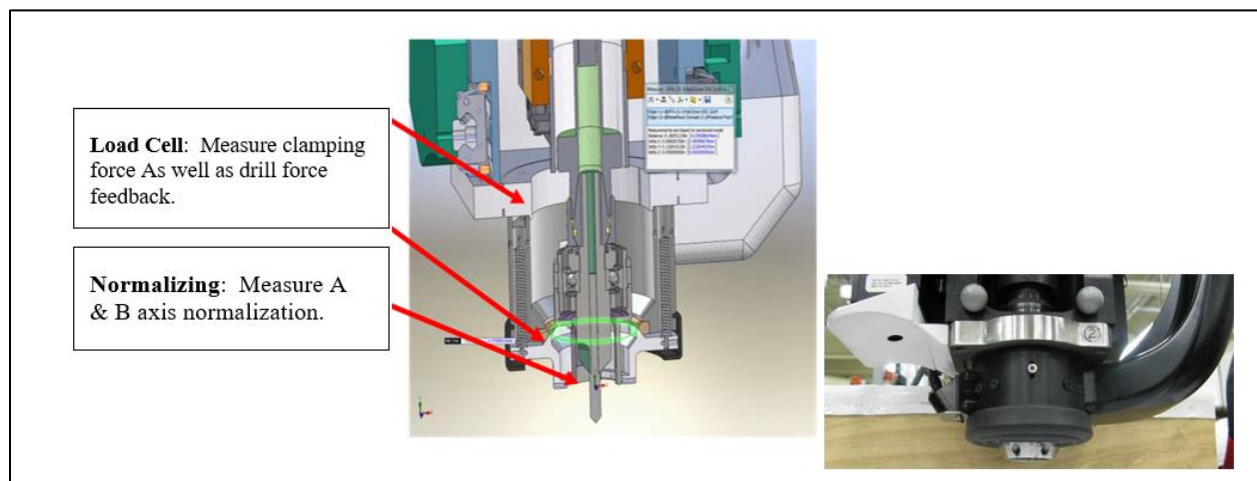
Chip Evacuation

Our Standard End Effector come with a built-in vacuum port for chip extraction. Typically, customers use factory vacuum. MTM can quote or recommend an industrial vacuum if needed. We also prove a chip blast feature that helps remove chips from the cutter and directs them towards the vacuum port.

Thrust and torque sensing

The end effector supports cutter break detection based on thrust measurement, and cutter stall detection based on torque measurement. Measurement is performed using motor current draw. Both thresholds are configurable.

There are two ways the system detects broken drill bits. One, the drill spindle motor provides torque feedback so when there is a change in the drilling process that the system does not expect, the drilling operation is aborted. The system also has a Load Cell built into the nosepiece for monitoring drill thrust. When there is a change in the thrust due to the broken drill then the system will abort the drill cycle.

Load Cell: Measure clamping force As well as drill force feedback.

Normalizing: Measure A & B axis normalization.

Light Modular Gantry (LMG)

Drilling End Effector Module

Camera Referencing:
Our machines come with a vision system that is used to identify reference locations found on the panel or structure. The system works in flat coordinate (X;Y). Two or more references called K-holes are used to set the local coordinate system.

K-Holes Options:
  - Empty hole
  - Temporary fastener head
  - Final fastener head

Reference System Options:
  - Camera
  - Laser
  - Through Skin Sensor (Blind hole detection)

The system checks if K-hole are within the expected tolerance during probing operation

Auto-datuming system is possible with the addition of RFI tags in the rail devices.

Light Modular Gantry (LMG)

Power Supply (Typical Configuration)

Key Features:

- ✓ Only 29.5 kg (65 lbs)
- ✓ Interchangeable with other LMG (and MTM) systems (not matched to a specific drilling system)
- ✓ Includes Ethernet router for stand-alone command and control, or within a factory/enterprise network environment
- ✓ Small and flexible low-voltage DC umbilical cable that can be up to 24m (80ft) long
- ✓ Options include backup battery to maintain system state and vacuum control system
- ✓ Industrial control PC can be incorporated into supply (may affect external dimensions)
- ✓ (ETL) and (CE) health, safety, and environmental certified

Local Area Network (LAN)
Wide Area Network (WAN)
Vacuum Auto Turn On
External Emergency Stop Port
LMG Connection
Cooling Fan

Power Supply Power Switch
Emergency Stop
Main Power Supply Status
24V Logic Supply Status
Motor 90V Status
Back Up Battery Status
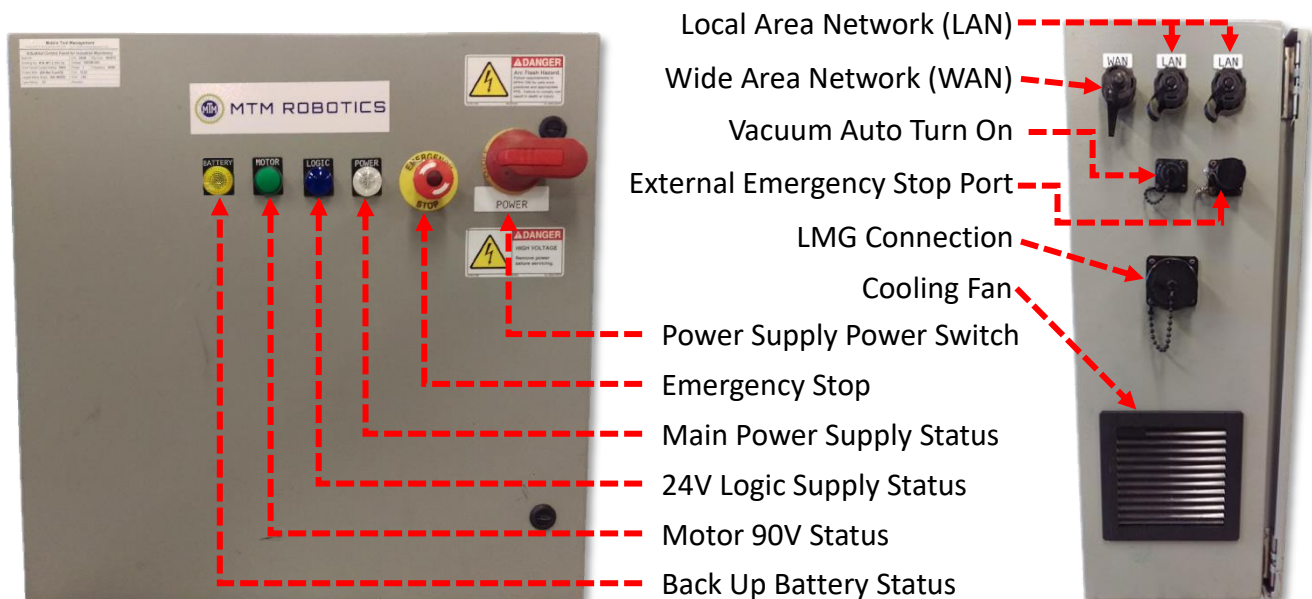
Power Supply Specifications

Input Power	Universal AC: 85-264VAC,1-phase 50/60Hz,15A-30A
Output Power	24VDC, 48VDC, 90VDC
Communication Interface	Ethernet
Emergency Stop	Daisy-chain feature allows E-Stop for single machines or for multiple machines on a master Emergency Stop circuit in the factory.
FOD Vacuum	Can be fully automated and under control of machine
Umbilical Length	Up to 24m (80ft)
Weight	29.5 kg (65lbs)
Positioning Carriage Size(LxWxH)	610mm x 508mm x 229mm (24in x 20in x 9in) (Size Varies Depending on Configuration)

Rev: V6

Light Modular Gantry (LMG)

LMG System Features

The LMG is mobile and easy to use and provides a simple and intuitive user interface.

Typical operation steps are as follows:

- Validate cutter countersink depths on test bench and store to RFID tags
- Install equipment on station, connect energy/air supplies
- Deliver NC file from UTAS to system control PC
- Power on machine (main cabinet switch)
- Clear E-Stop / Energize motors (acknowledge button)
- Home machine
- Load NC file to machine
- Probe reference locations – operator approves reference results
- Operator installs cutter with RFID read
- Drill holes
- Install fasteners/other operations
- Return machine to park position
- Power down and disassemble

If the optional Serenity packages are purchased, all the above steps are broken down in detail on the Serenity screen, with machine-based actions automatically moving the operator to the correct HMI view. Automated NC file retrieval from the UTAS servers is also supported.

The LMG system supports many validation, safeguarding, and advanced features to help ensure hole quality and positioning accuracy.

Movement/Referencing features:

- Automatic movement to reference features after homing
- Reference<->Reference tolerance check for positioning accuracy
- Automatic reference validation after lost locks, lost air, or customizable idle time
- Overcurrent, position, velocity, and obstruction detection
- Jog, relative, and absolute move features with adjustable access level
- Edge probe adjustment

Light Modular Gantry (LMG)

LMG System Features

Clamping/Normalizing features:

- Clamp learning to reducing clamping/normalizing times
- Surface contact normalization
- Nosepiece liftoff/low pressure detection during drilling

Drilling features:

- RFID cutter validation
- Cutter break detection
- Automatic layer shift detection
- Cutter stall detection/prevention
- Micropecking
- Lubrication-by-layer
- Vacuum presence detection
- Vacuum on/off control (optional addon)

Other features
- Built-in service and maintenance counters
- Sensor view showing status of all Boolean machine sensors/detectors on a graphical machine display
- Access control/lockout features
- Direct access to and control of system parameters through administration panel

Light Modular Gantry (LMG)

LMG HMI (User Interface)

The LMG HMI allows access to all features and is compatible with PCs running Windows 8 and 10.

After loading of the part program, the system will guide the operator through the process steps, including redirecting the operator to the correct tab of the HMI for the next task to be performed. The below images show example screens of the HMI. Note that all screens are example only and may change in this implementation. The contents of the tabs are as follows:

Process – Displays the Serenity process screen (step by step assembly instructions), if applicable.   Requires Serenity to access this type of screen.

Light Modular Gantry (LMG)

LMG HMI (User Interface)

IO – Displays the state of the machine IO. Second tab for station IO is available with Serenity.
(This is an example of our Light Flextrack system. Our LMG has similar functionality.)
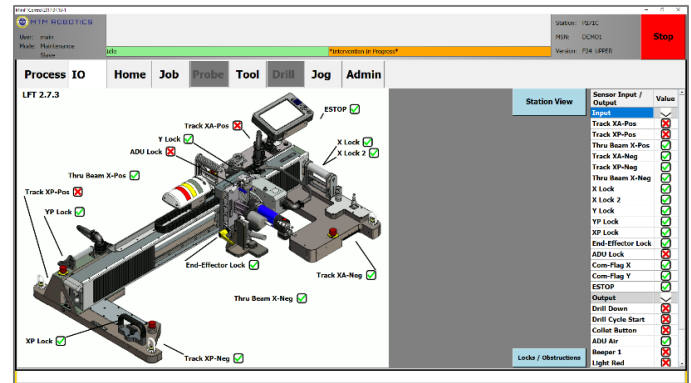
Home – Displays the home state of the machine and allows homing to be performed
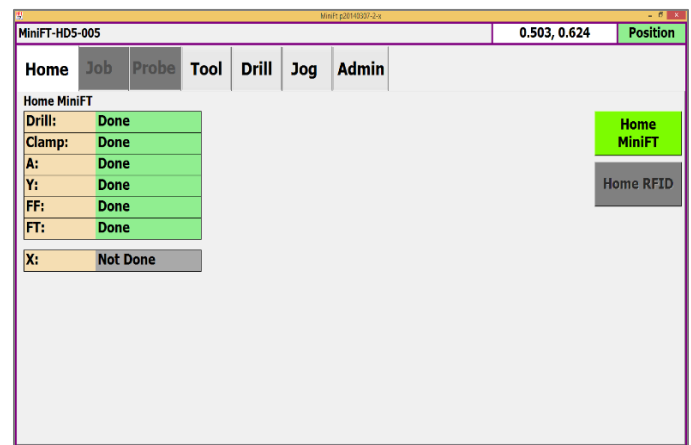
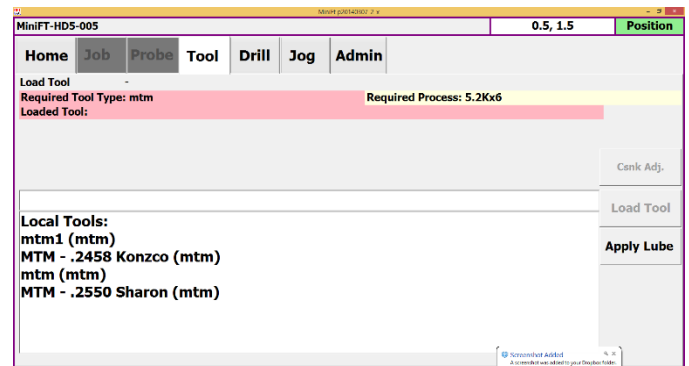Job – Allows loading of a new job from the file system, if this is permitted by access level
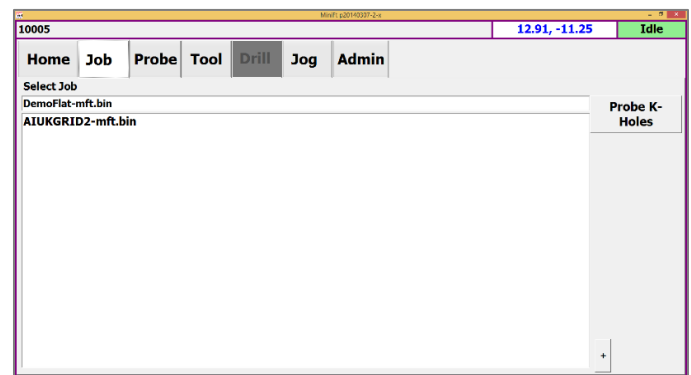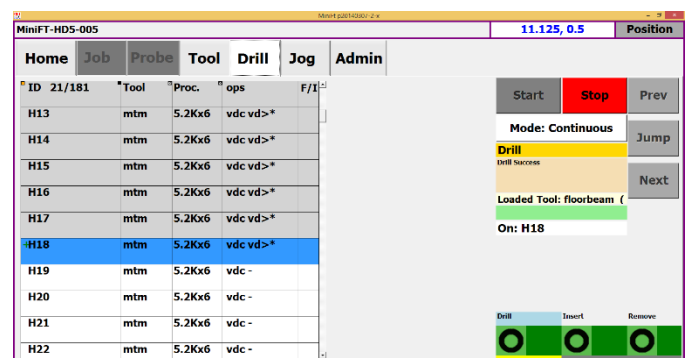
Light Modular Gantry (LMG)

LMG HMI (User Interface)

Probe – Shows the current reference results and allows operator to accept/reject results

Tool – Allows unloading/loading/reading/writing of tool, as well as countersink adjustment

Drill – Allows starting of operations, including fastening, and to move forward and backwards in program, if this is permitted by access level
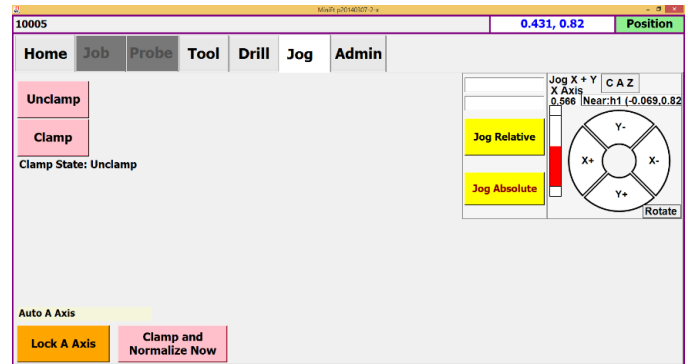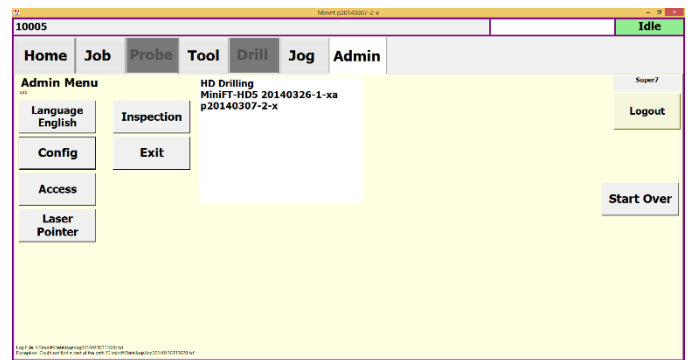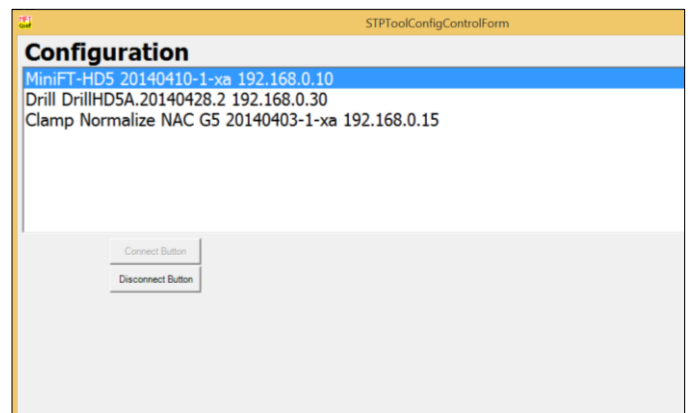
Rev: V6

Light Modular Gantry (LMG)

LMG HMI (User Interface)

Jog – Allows jogs and relative moves as well as clamp/unclamp, if this is permitted by access level

Admin (Config Access) – Allows controlled levels of login/logout.

Admin (Config Mods) –After admin authentication, modification of machine configurations is permitted.

Light Modular Gantry (LMG)

LMG Versatility and Customizability

MTM Robotics can accommodate a variety of applications with our LMG systems. It's important to recognize the versatility of this type of system. It can be used for drilling both sides of a tooling fixture and with the flexibility of an interchangeable End Effector the possibilities are endless.
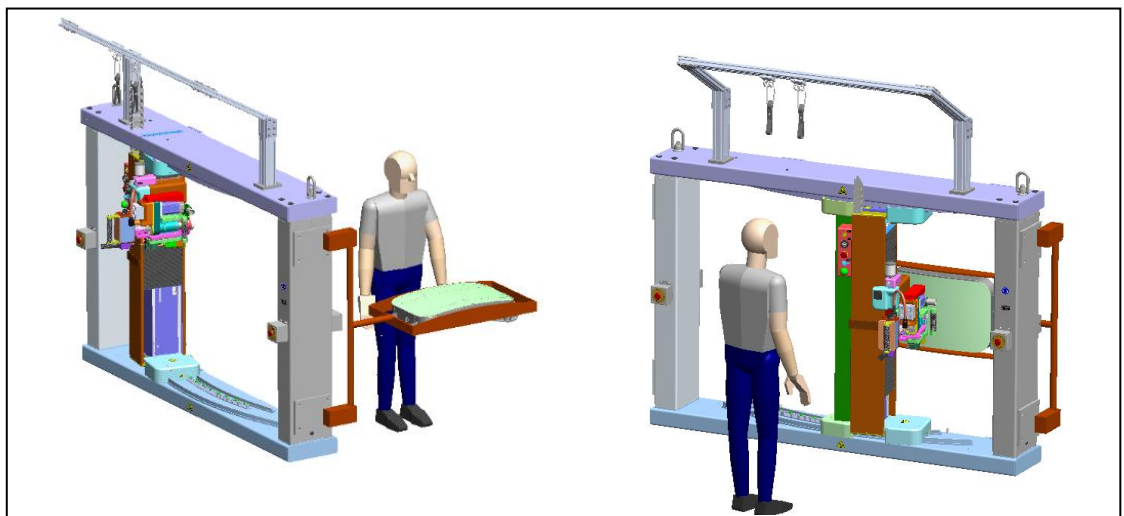
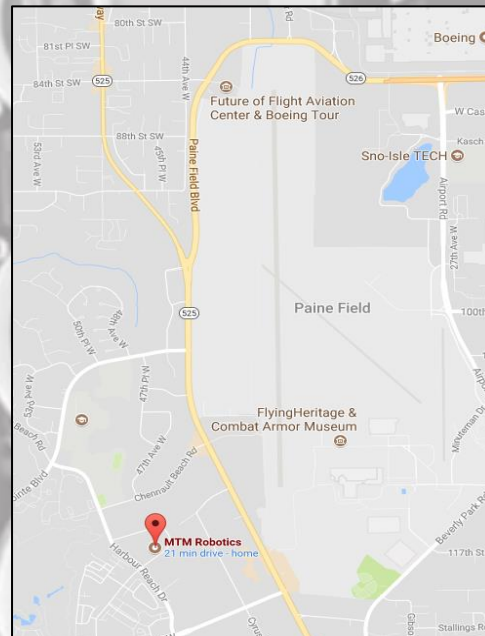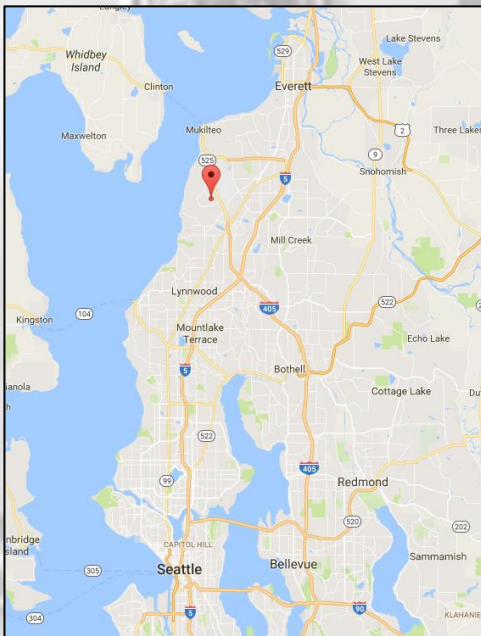Interchangeable End Effector
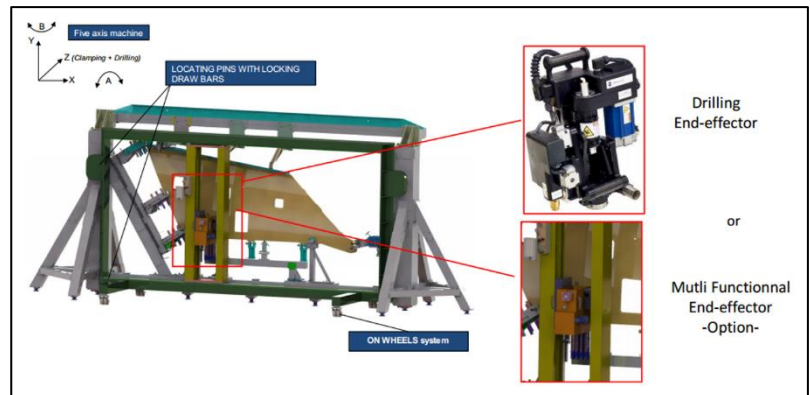
Mobile and Versatile

Customizable

Rev: V6
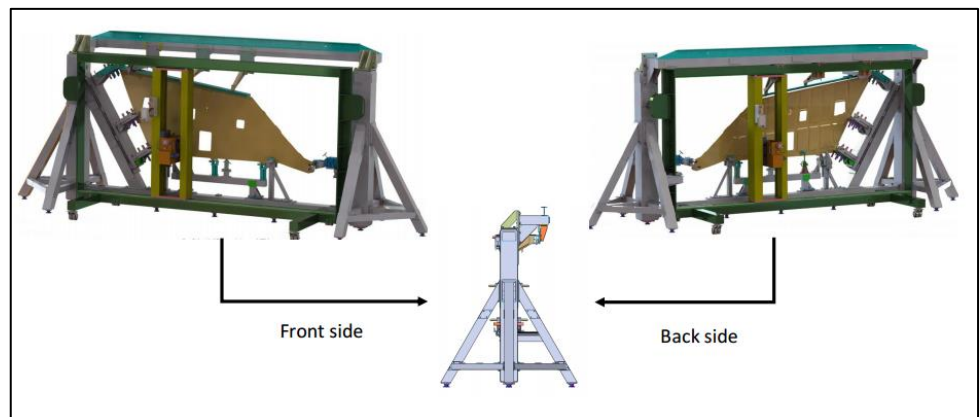
MTM Robotics

11620 49th Place W. Suite B
Mukilteo, WA 98275
Phone: 425-438-8127
Fax: 425-347-3235
www.MTMRobotics.com

Delivering New Technology to the Factory Floor