Mini Flextrack (MFT) System
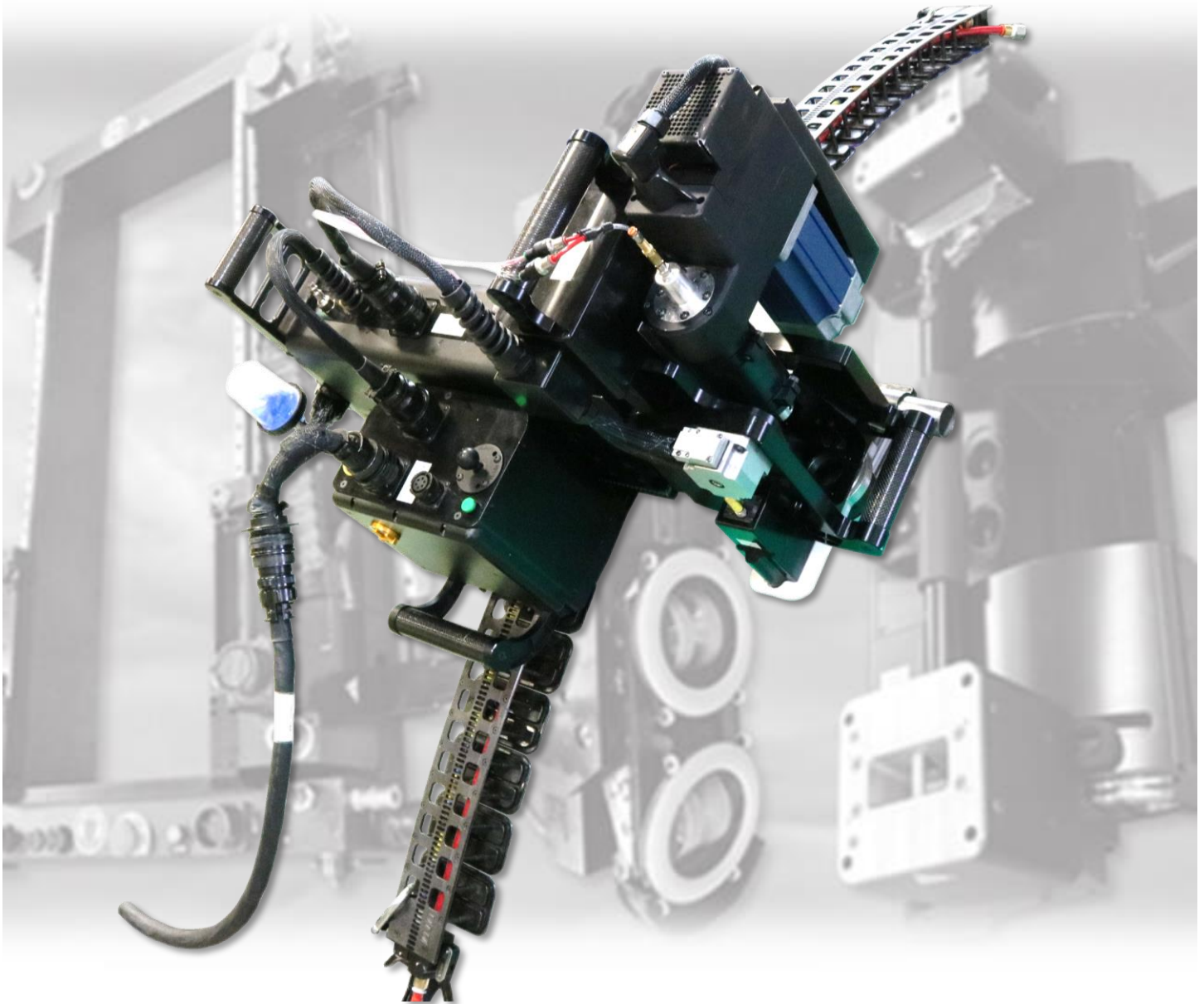
Delivering New Technology to the Factory Floor

Mini Flextrack (MFT)

Product Overview

The Mini Flextrack (MFT) is a modular 5-Axis robotic system that is used to drill precisely aligned holes on aircraft surfaces. The MFT system is supported and mounted to the aircraft surface by a single Flextrack rail and uses a load reacting rear foot on the opposite side of the drill head to stabilize the driller during drilling and clamping operations. Due to the light modular design, the MFT and Flextrack can be assembled by one person in less than five minutes. Microprocessors located in each of the robot modules provide control over the entire machine. Only one small diameter umbilical cord is required to power and command the robot. The software interface is intuitive and user friendly to operate.
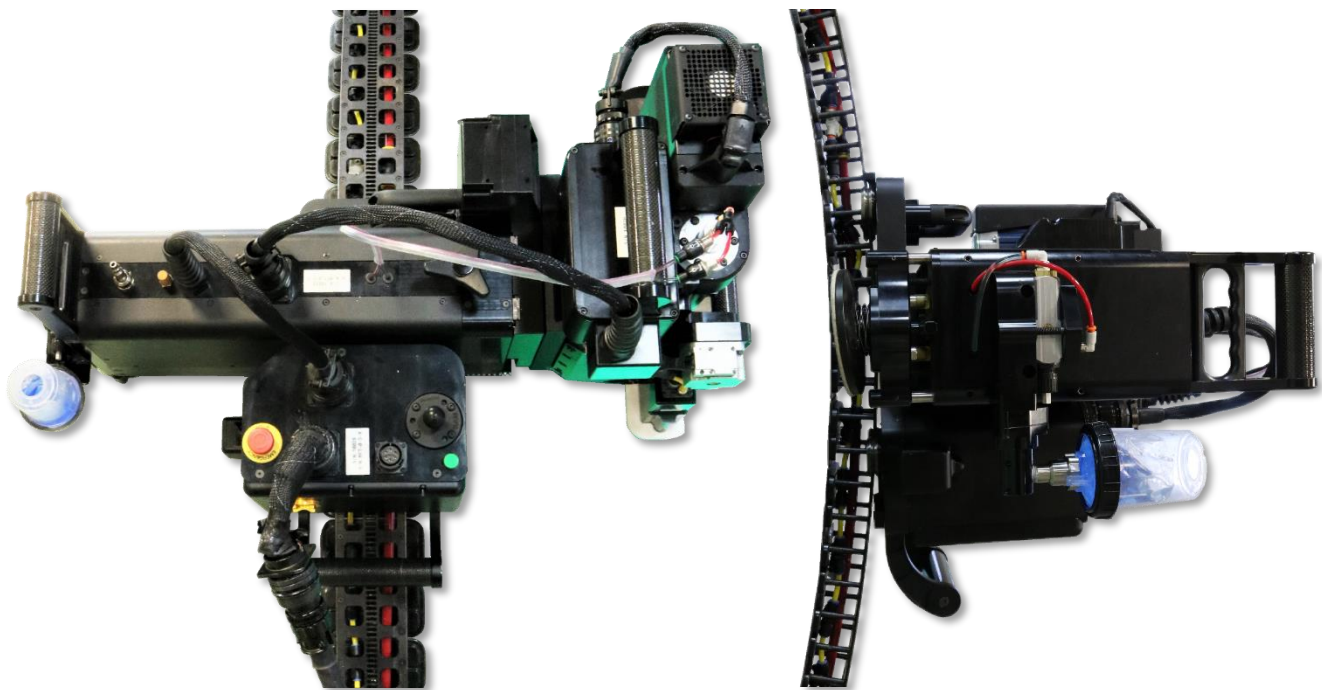

Surface Finish	Typical aircraft skin finishes including smooth, painted, raw metal, high gloss and carbon fiber finishes.
Materials	Aluminum, Carbon Fiber and Titanium. Other materials may be used upon review by MTM.
Surface Geometry	Flat to 1.8m (72in) radius, laps up to 5mm (0.2in) in thickness, flush fasteners

Mini Flextrack (MFT)

Module Design Overview

The MFT 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.
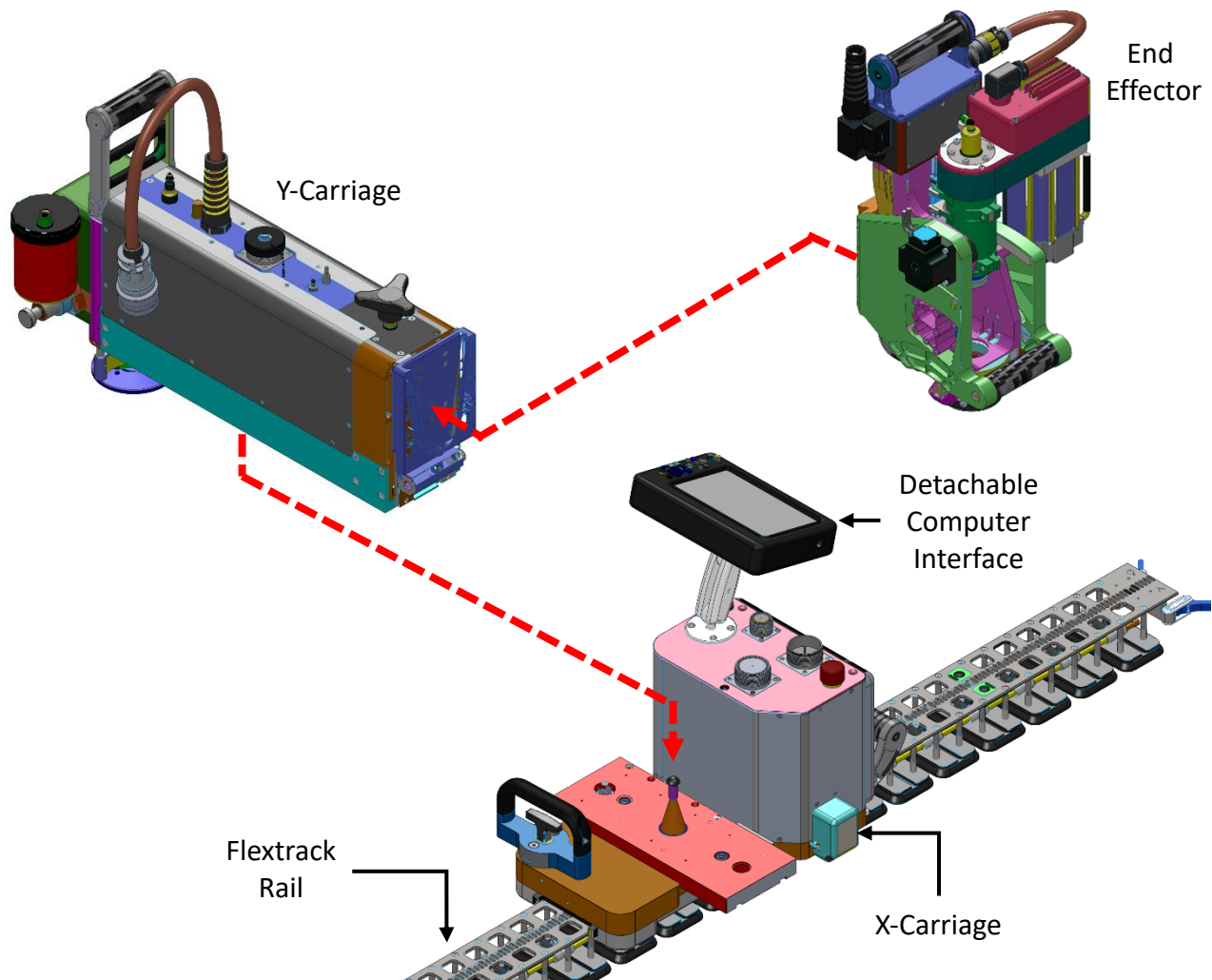
MFT system comes with four modules.

- A. Flextrack Rail
- B. X-Carriage
- C. Y-Carriage
- D. End Effector Module

Mini Flextrack (MFT)

Flextrack Rail

The Flextrack system is a flexible rack and pinon rail system that a robotic carriage uses to travel on to perform drilling operations. Specialty suction cups designed by MTM Robotics are integrated under the Flextrack rail and hold robotic carriages securely to the fuselage skin. Flextrack rails can conform to flat or curved surfaces in convex or concave positions.

Key Features

- ✓ Quick and easy single operator setup
- ✓ Simple addition of rails using rail splices
- ✓ Works on flat to 1.8m (71in) radius
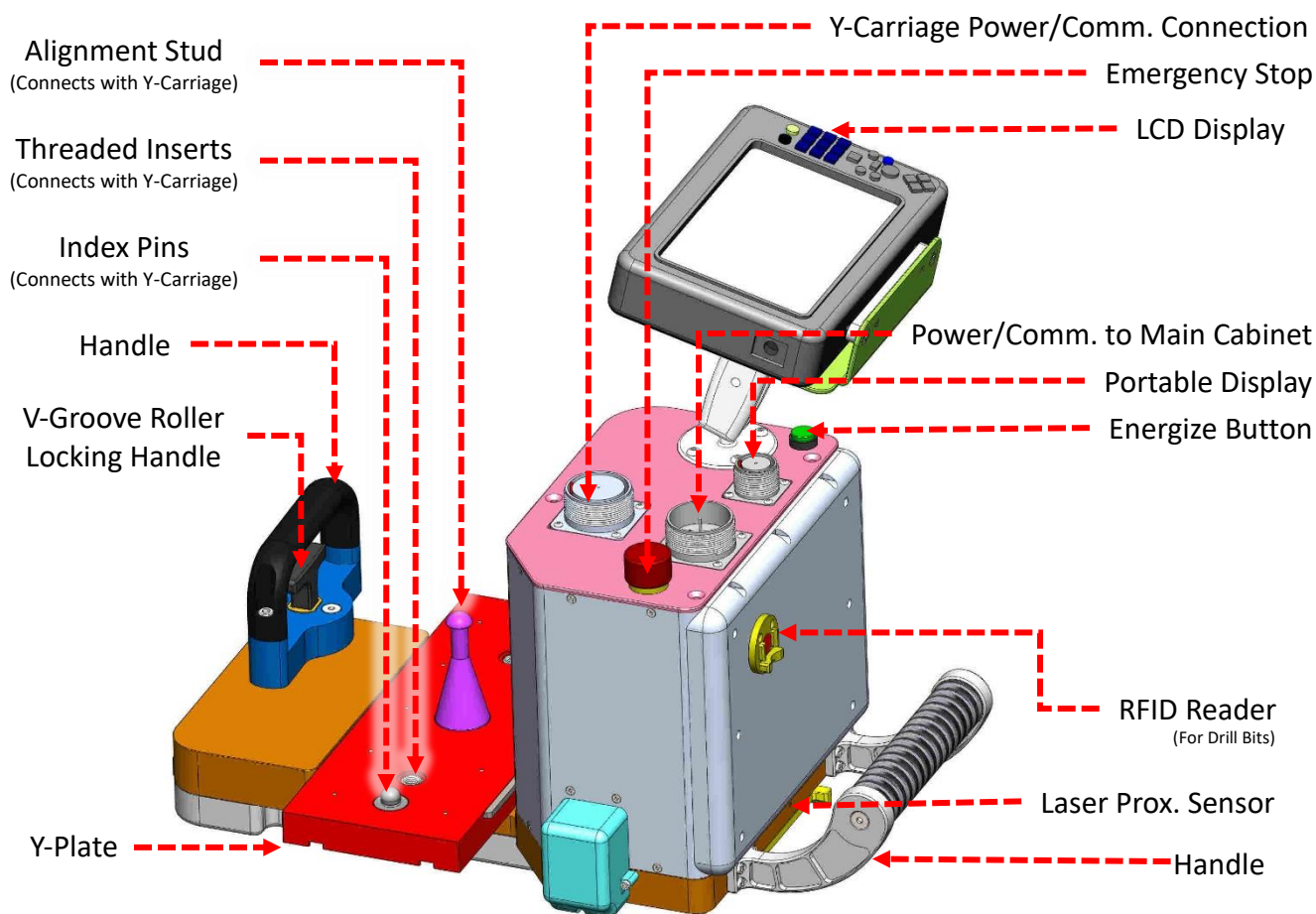- ✓ Non-marking vacuum cup for use on easily marred surfaces such as Alclad aluminum
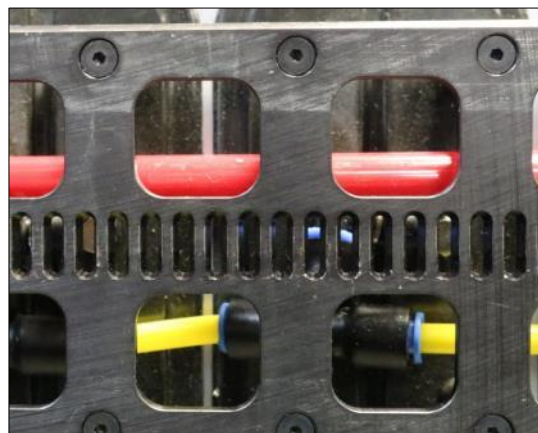
Standard rail length (Custom sizes upon request)	72 in (1.82m)
Typical rail weight	19.8 lbs. (9kg) for standard length rail
Vacuum cup size	5 in x 3 in (127mm x 76mm)
Air supply (Based on standard 1.8m (72in) rail)	170 lpm (6 cfm) per rail segment @ 6 bar (87psi)
Air supply range	80psi to 110psi (5.5 bar to 7.6 bar)

Mini Flextrack (MFT)

X-Carriage Module

This module contains the drive components that are used to precisely position the MFT in X (parallel to the Flextrack rails) and in Y (perpendicular to the rails). The X-Carriage also contains X-Axis and Y-axis brakes which are activated when no power is supplied to the module.

Labels (left side):
- Alignment Stud (Connects with Y-Carriage)
- Threaded Inserts (Connects with Y-Carriage)
- Index Pins (Connects with Y-Carriage)
- Handle
- V-Groove Roller Locking Handle
- Y-Plate

Labels (right side):
- Y-Carriage Power/Comm. Connection
- Emergency Stop
- LCD Display
- Power/Comm. to Main Cabinet
- Portable Display
- Energize Button
- RFID Reader (For Drill Bits)
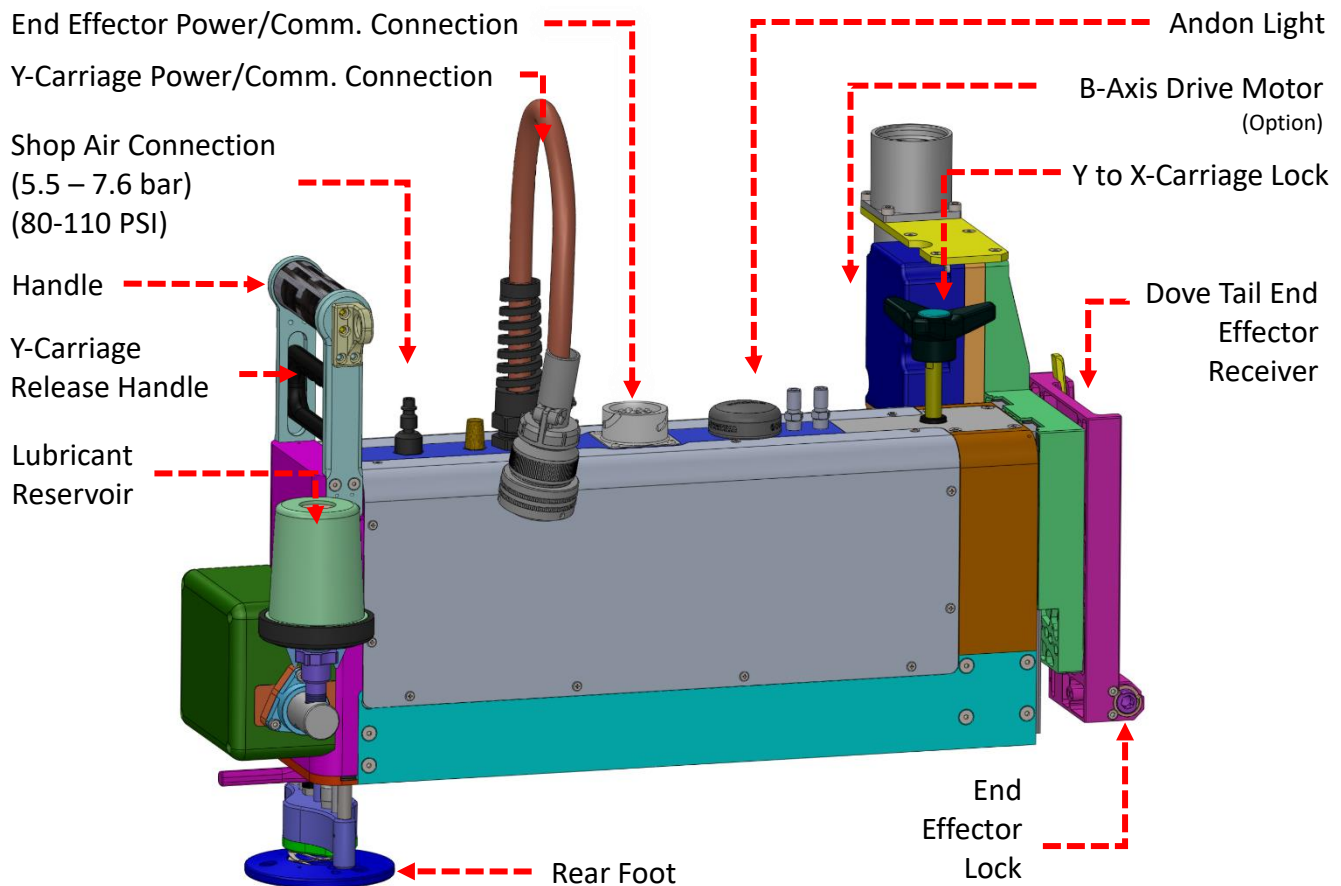- Laser Prox. Sensor
- Handle

Key Features:

- ✓ Carriage Rack & Pinon drive motors provide precise Flextrack movement.
- ✓ Emergency Stop (E-Stop) instantly cuts power to all high voltage circuits.
- ✓ RFID Reader scans and verifies drill bits for ease of setup.
- ✓ Incorporated X and Y axis brake system that applies the brake to the Flextrack even when no power is applied to the system or it is in E-STOP.
- ✓ Laser Proximity Sensors provide collision detection along the rails.

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Y-Carriage Module

The Y-Carriage module has four key features which are the Rear Foot, Dove Tail End Effector Receiver, Clamp Axis and Lubricant System. The Rear Foot stabilizes the End Effector during drilling and clamping operations. The Dove Tail End Effector Receiver precisely locates and provides the mount for the End Effector. The Clamp Axis provides linear travel perpendicular to the aircraft surface. The Lubricant System has a reservoir and a pump that can be connected to the End Effector when drilling lubrication is required.

- End Effector Power/Comm. Connection
- Y-Carriage Power/Comm. Connection
- Shop Air Connection (5.5 – 7.6 bar) (80-110 PSI)
- Handle
- Y-Carriage Release Handle
- Lubricant Reservoir
- Rear Foot
- Andon Light
- B-Axis Drive Motor (Option)
- Y to X-Carriage Lock
- Dove Tail End Effector Receiver
- End Effector Lock

Key Features:

✓ Pneumatic actuated Rear Foot stabilizes assembly during drilling and clamping operations.
✓ Ball screw drive assembly provide precise clamp up of the End Effector.
✓ Optional B-Axis can be added for complex curvature applications.

Mini Flextrack (MFT)

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
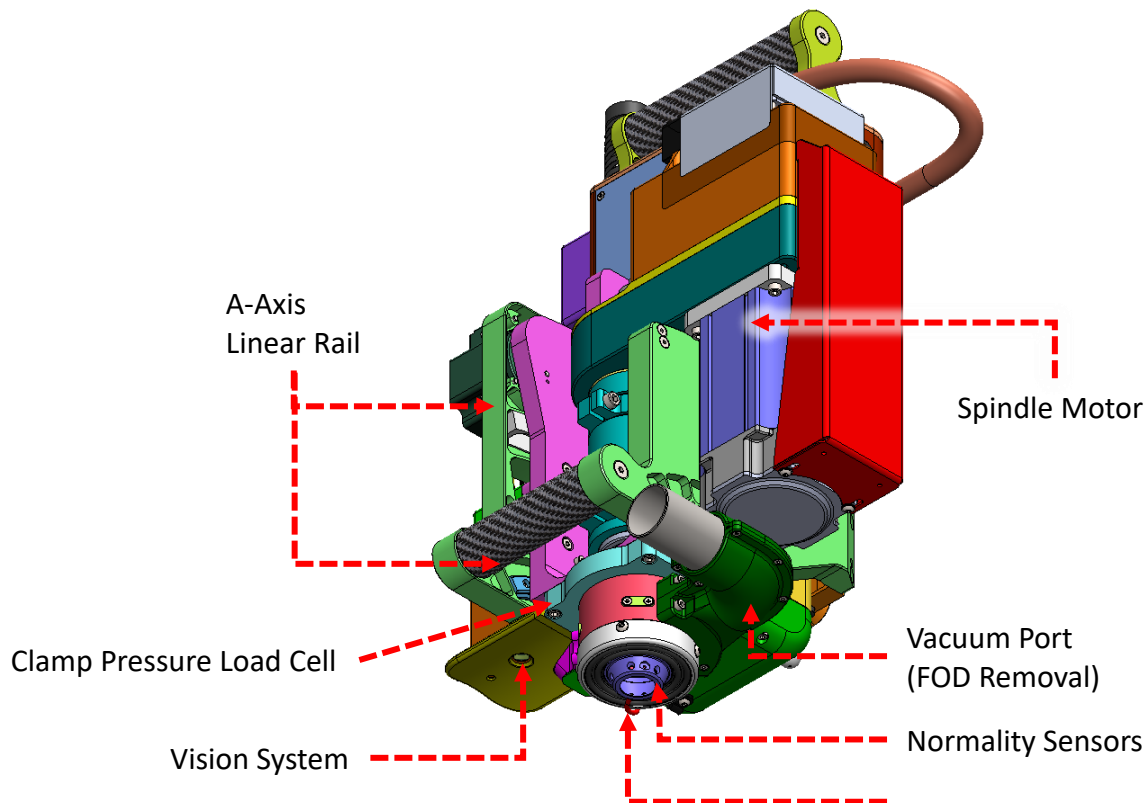
Key Features:

- 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.
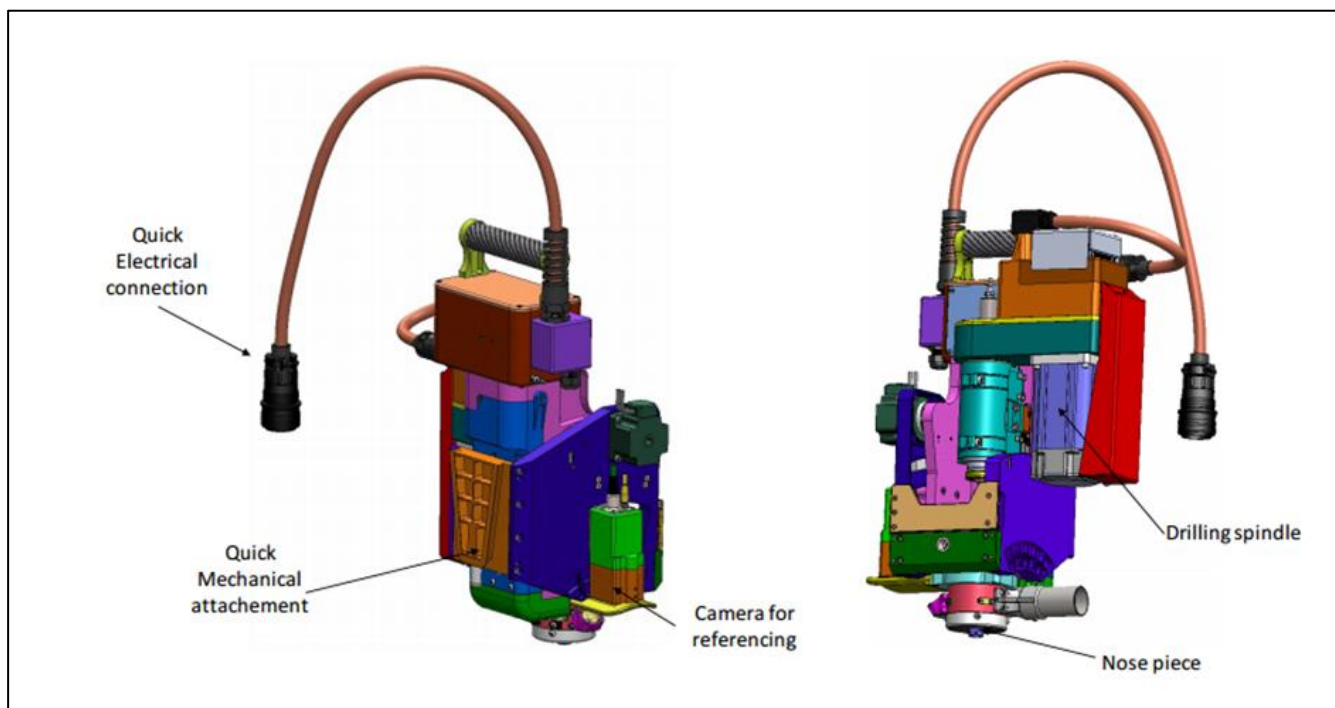- Diameters up to 7/16in (11mm) in aluminum with repeatable countersinks.

The Normality Sensors, A-Axis and B-Axis (Optional) 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.
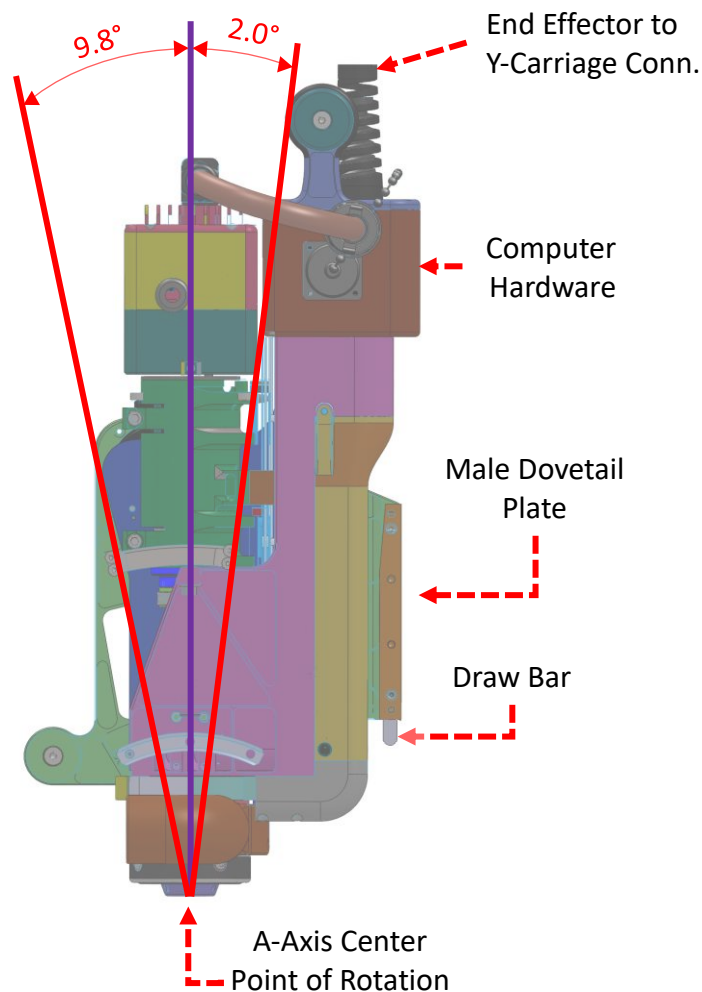
Mini Flextrack (MFT)
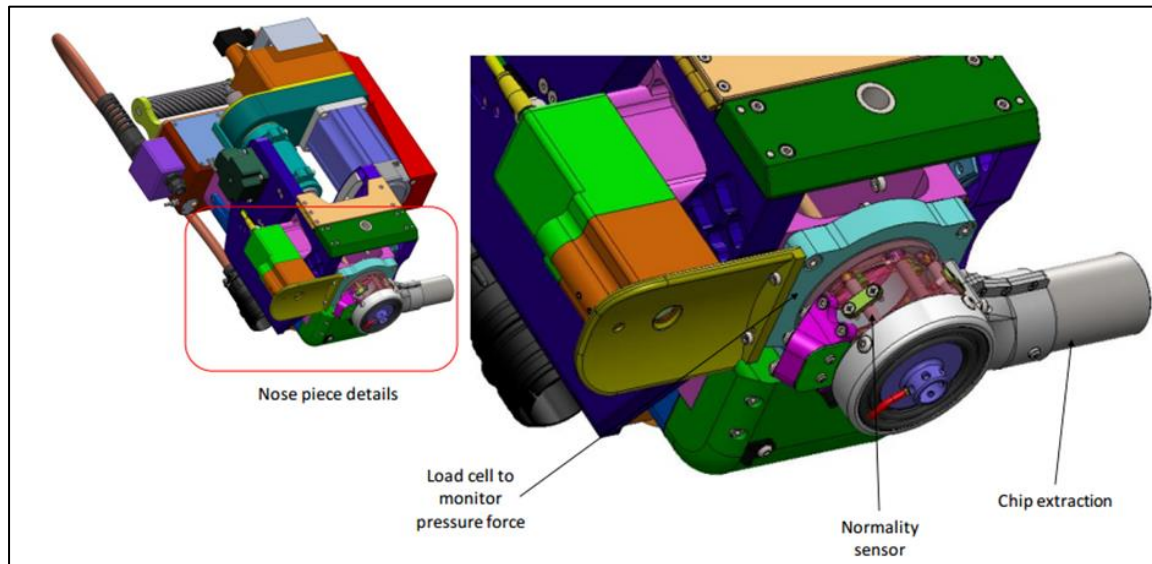
Drilling End Effector Module

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

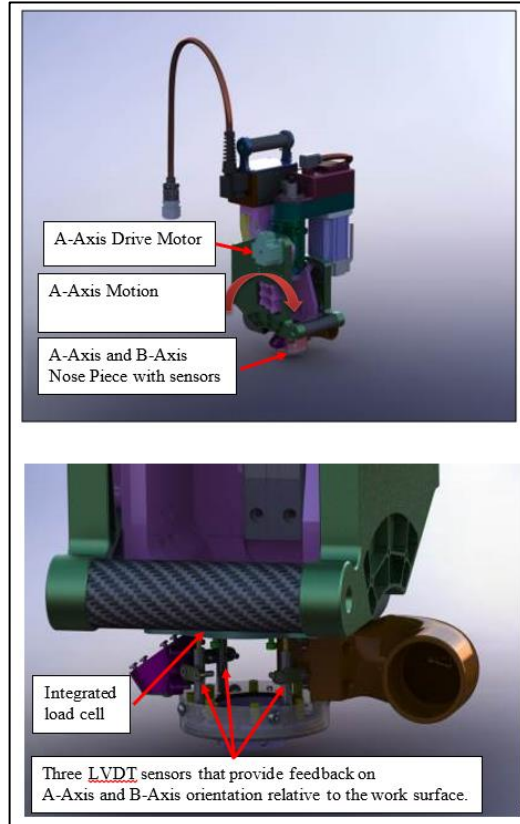Drilling spindle

Nose piece

Mini Flextrack (MFT)

Drilling End Effector Module

Main Components/Functionality of the End Effector

A-Axis, B-Axis Normalization System

Mini Flextrack (MFT)

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 depending on pully configuration. The spindle is belt driven so it can be optimized for spindle torque/speed per application.

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: V23

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.

Mini Flextrack (MFT)

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

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

Auto-datuming is possible with the addition of laser homing tags installed on the rails. The system can use these, in conjunction with the part program X/Y coordinates, to automatically move to commanded K-hole locations.

Mini Flextrack (MFT)

Power Supply (Typical Configuration)

Key Features:

- ✓ Only 29.5 kg (65 lbs.)
- ✓ Interchangeable with other MFT systems (not matched to a specific serial numbered 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
MFT Connection
Cooling Fan

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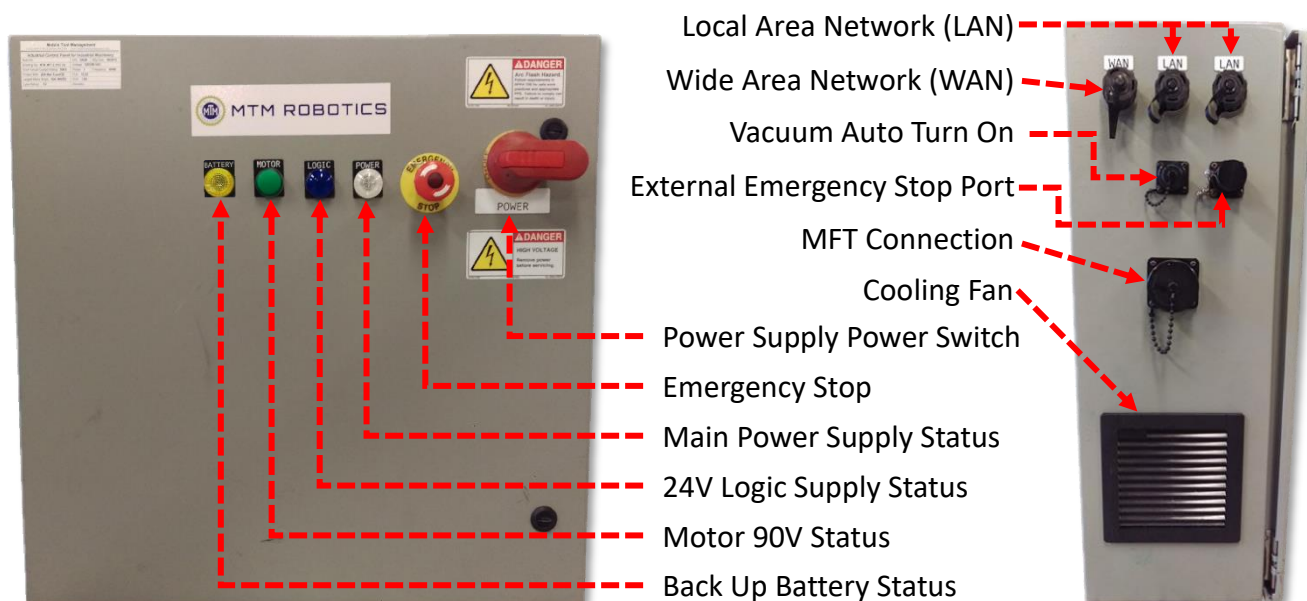
Power Supply Specifications

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)

Mini Flextrack (MFT)

MFT System Features

The MFT 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 MFT 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

Mini Flextrack (MFT)

MFT 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 stall detection
- Micro-pecking (servo driven feed axis)
- 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

Mini Flextrack (MFT)

MFT HMI (User Interface)

The MFT HMI allows access to all features and is compatible with PCs running Windows 7 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.

Mini Flextrack (MFT)

MFT 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 MFT has similar functionality.)
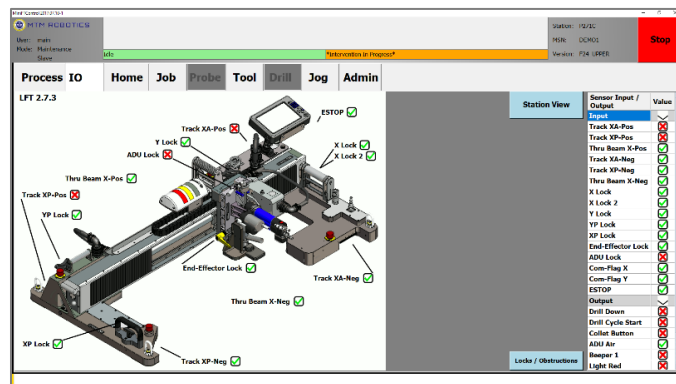
Home – Displays the home state of the machine and allows homing to be performed
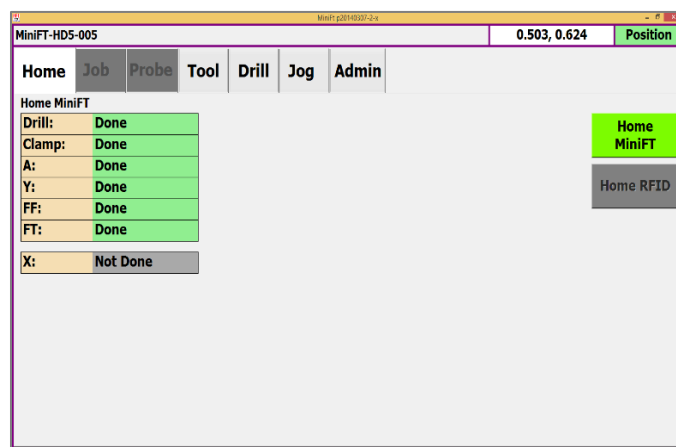
Job – Allows loading of a new job from the file system, if this is permitted by access level
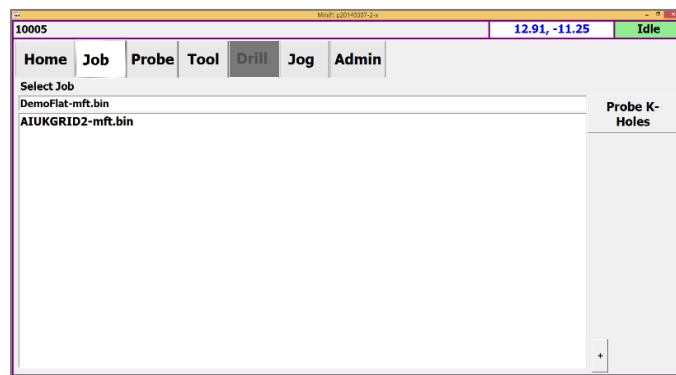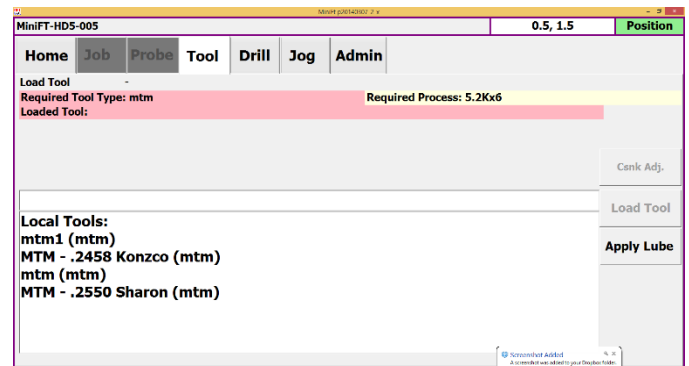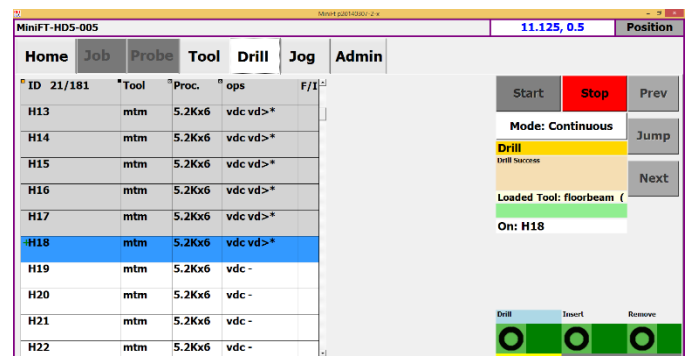
Mini Flextrack (MFT)

MFT 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
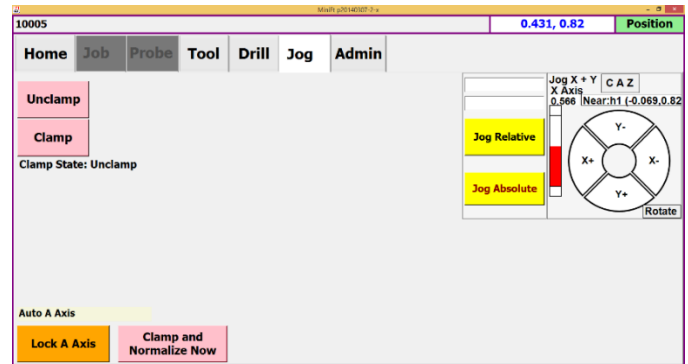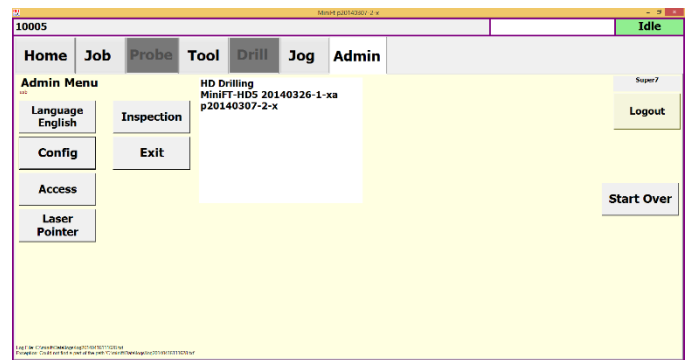
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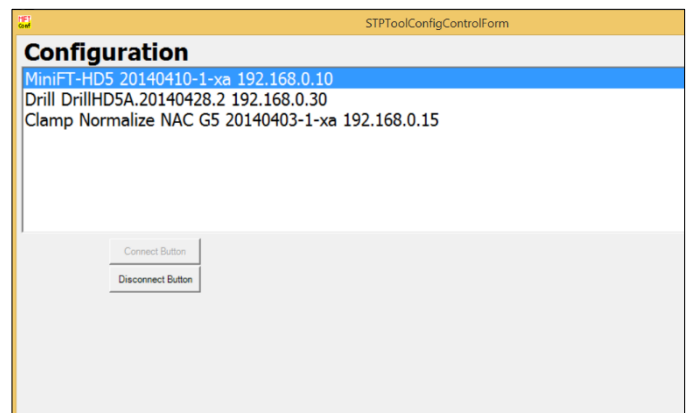## MFT HMI (User Interface)

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

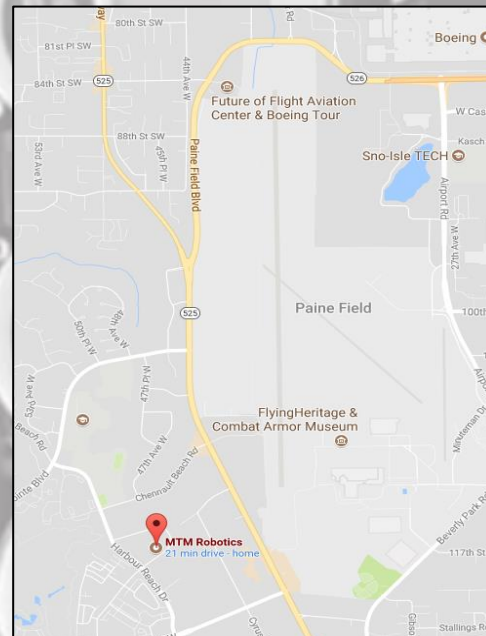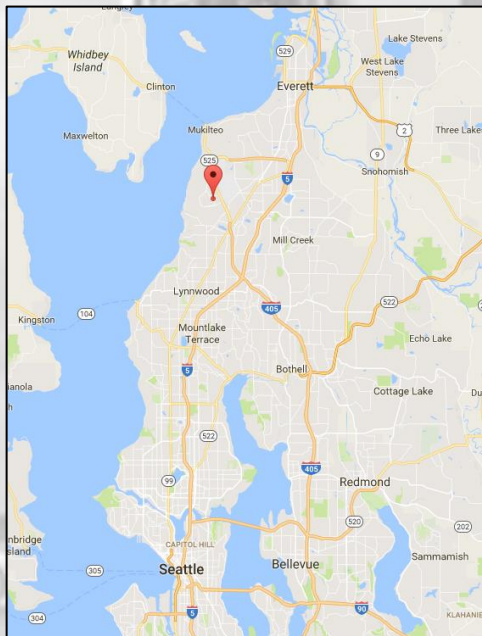Admin (Config Access) – Allows controlled levels of login/logout.

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

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