



AIT DRILLING & FASTENING TECHNOLOGY

Flex Track - Numerically Controlled Drill Jig - Fixed Drilling

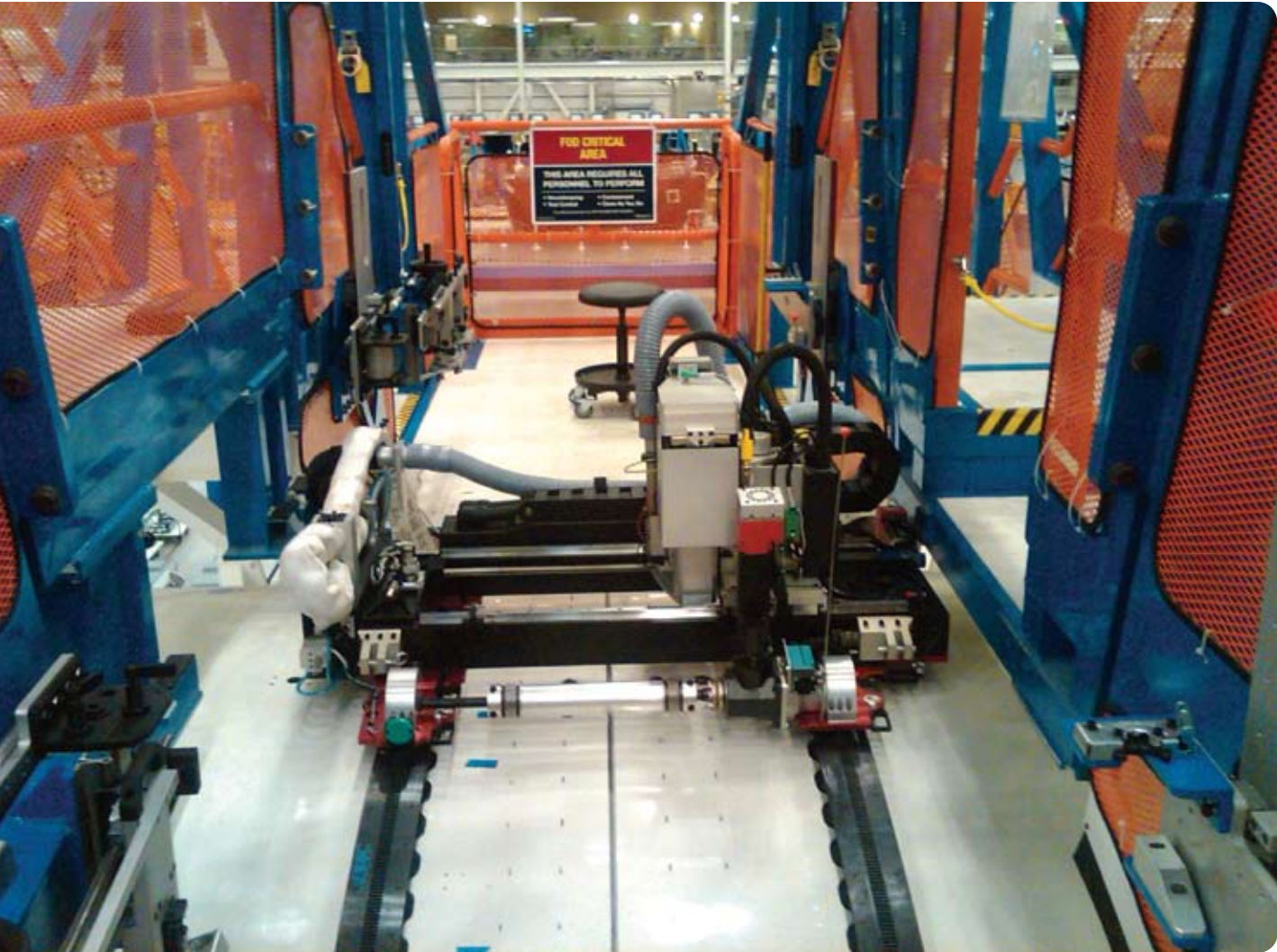


FIGURE 1 ⚙️ Flex Track drilling machine, drilling 787 fuselage

FIGURE 2 ⚙️ NCDJ machine



FROM THE CIRCUMFERENTIAL FLEX TRACK DRILLING AND FASTENING MACHINE TO THE NUMERICALLY CONTROLLED DRILLING JIG (NCDJ), AIT drilling machines offer robust, scalable, and flexible systems for any size aircraft. They are designed and developed specifically to speed the intensive process of drilling thousands of holes – all with incredible accuracy.



FLEX TRACK DRILLING MACHINE

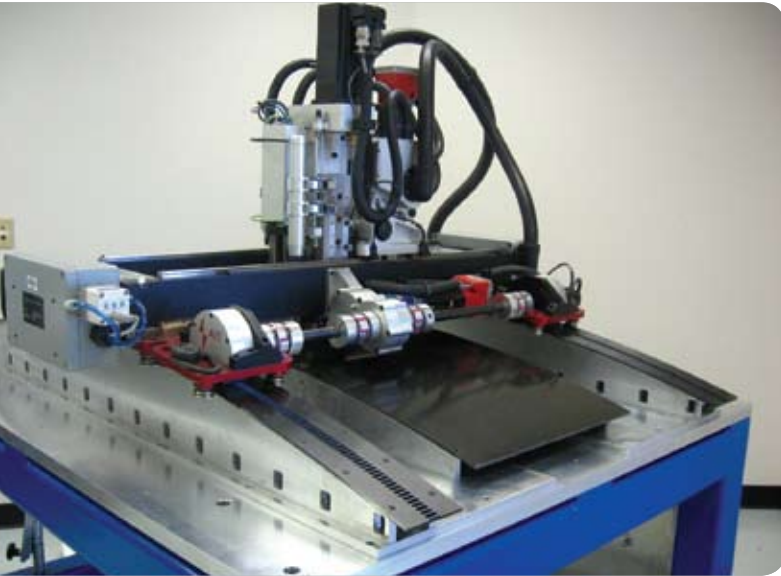


FIGURE 3 📌 Flex Track drill unit with onboard controls

The Drilling Unit

The lightweight drilling unit (Figure 1) sits on a dual set of flexible vacuum tracks affixed directly to the plane's fuselage (Figure 2) and conforms to the shape of the airplane. During the drilling, the unit rides along the track system, which also stabilizes the drilling unit and ensures accurate positioning throughout the drilling process. This engineered precision means substantially better quality and reduced

FIGURE 4 📌 Boeing 787, Flex Track drill at Everett, WA, facility



rework for our customers – all equating to less time and money spent overall.

The carriage assembly accurately positions the drilling head in X and Y axes, using servo control closed loop feedback. The drilling head consists of a spindle with an HSK-32C tool holder interface and an integrated machine vision system, which performs machine-to-part referencing and AIT's scan and correct vision algorithms. It also offers optional through the bit coolant delivery, and a pressure foot that provides part clamp up, and skin position feedback for precise countersink control.

Throughout the drilling process, a single vacuum hose continuously picks up drilling swarf and coolant, maintaining a cleaner and safer work environment.

Onboard Control System

The onboard control system functions as the brains of the machine. The NC part program is fed to the integrated onboard control system, which interprets the program and directs the servo motors where to position the carriage assembly and drilling head. It also provides critical information about the part being drilled, such as RPM, feed rate, clamp force, tool geometry, and part thickness.

User Interface

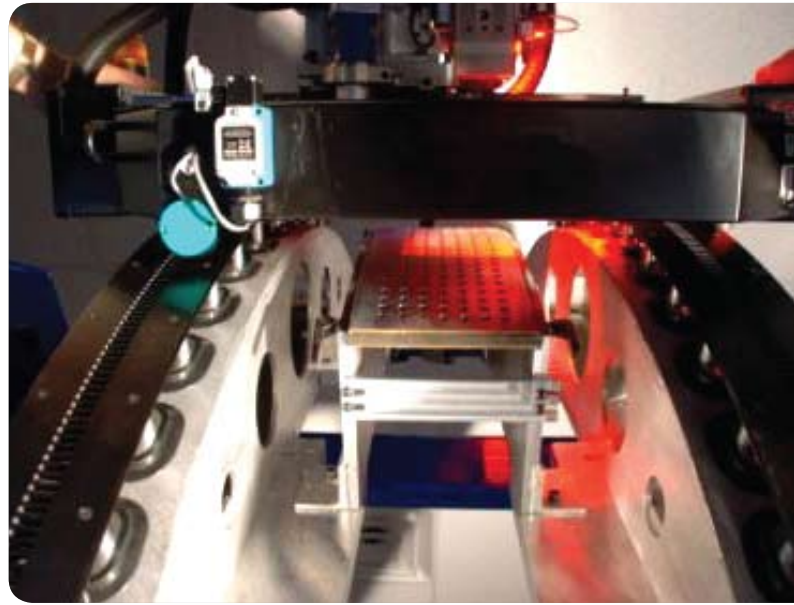
The user interface of the control system is AIT's graphical user interface – or GUI, which is delivered to the operator via a pendant touchscreen computer. The intuitive touchscreen computer is inherently easy to use and simplifies the drilling process. By organizing similar control functions onto similar screens, this grouping feature reduces human error and speeds the overall drilling process. Plus, it makes the ramp-up to train others in its use a much shorter process. Operators don't even need to be familiar with CNC programs or machines to operate our drilling machine. They are able to get to work sooner with the AIT drilling system – usually within hours.

FLEX TRACK ADVANTAGES

- Lightweight unit for portability, smaller "footprint," and cleaner factory environment
- Scalable for any size aircraft
- Intuitive GUI for ease of use, fewer human errors, and faster ramp-up

FLEX TRACK FEATURES

- Machine vision system for scan-and-correct algorithm
- Drillers use standard CNC code with AIT-developed controls
- Multi-material stacks up to 1.125"
- Linear encoder for precision countersink control (0.003" depth)
- Drill spindle load cell to detect broken or dull bits
- Onboard control system
- Dual track drive system
- Titanium drilling capability (peck cycles, stack drilling)
- HSK-32C spindle interface
- Hole diameter capacity – 1/8" to 7/16" for composite, aluminum, and titanium stacks
- Simple, easy-to-use graphical user interface – with pendant controls
- Circumferential drilling stand that houses auto-drilling system and allows access to 100% plane circumference
- Vacuum system collects chips and coolant
- End of track sensors
- Onboard RFID Tool Management System

**FIGURE 5**  Hawker 4000 Flex Track Drilling Machine**FLEX TRACK DRILLING PROJECTS****Boeing 787 Dreamliner Flex Track Driller**

- Four drillers per stand with 19 total supplied (Charleston, SC, and Everett, WA)

Hawker Beechcraft Hawker 4000 Flex Track Driller

- Two drillers with a calibration stand

Embraer 170/190

- Two drilling machines with a calibration stand

Spirit AeroSystems A350 Section 15

- Longitudinal Flex Track with Fastener Insertion
- 2 units provided with calibration stand

FIGURE 6  Boeing 787 flexible tracks at Charleston, SC, facility

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FLEX TRACK SYSTEM WITH FASTENING TECHNOLOGY

The automated AIT Flex Track system with fastener insertion is able to precisely drill, countersink, feed the fastener, apply sealant, and install the fastener at the point of use, reducing the manual labor involved in previous generations while also improving hole quality. These drilling machines are the logical next step for Flex Track technology implementation.

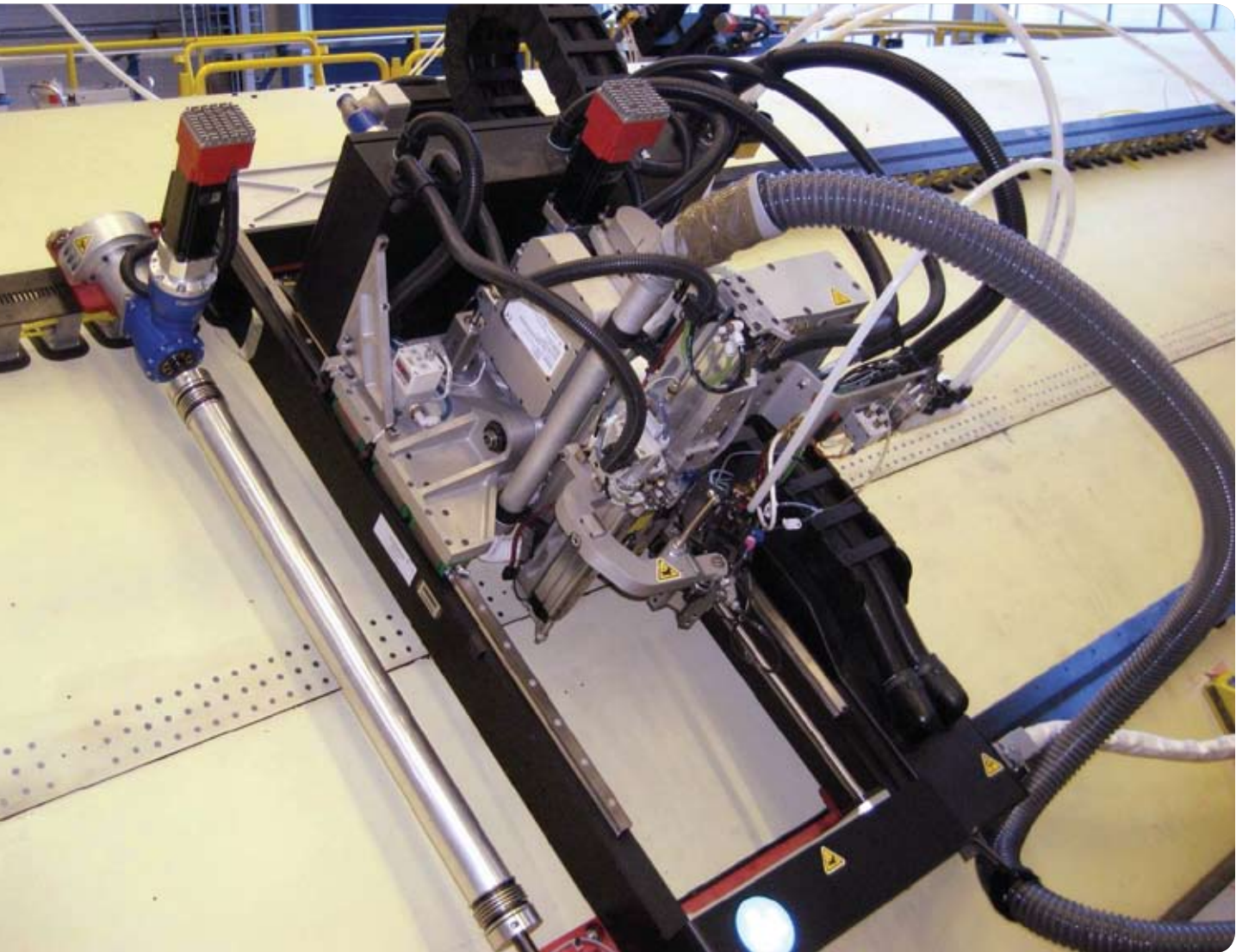


FIGURE 7 ⚡ Flex Track driller with fastening technology

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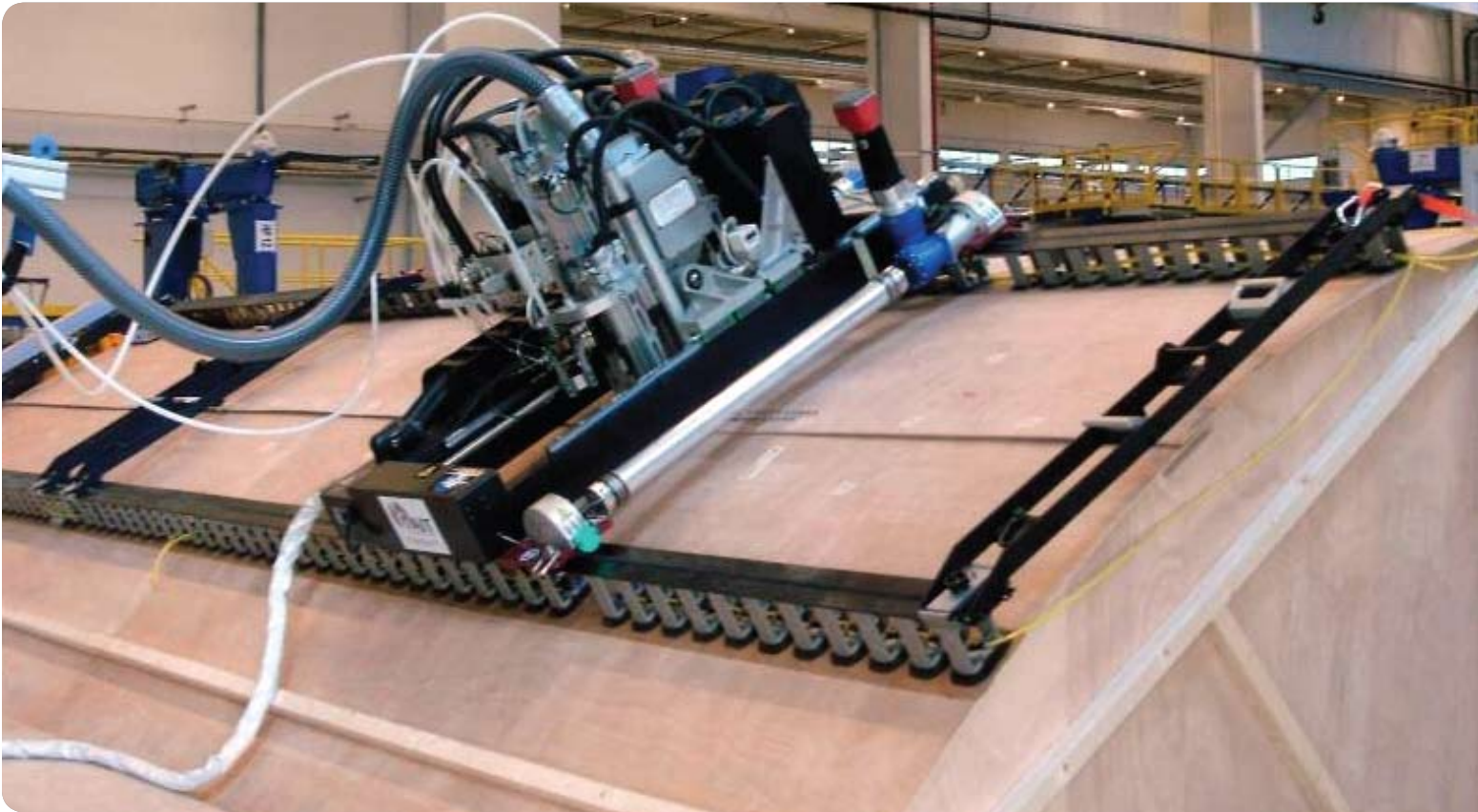


FIGURE 8 📌 Flex Track with fastening technology on wooden training fixture

4-AXIS LONGITUDINAL FLEX TRACK SYSTEM – KEY FEATURES

- 1st production Flex Track with full-size fastening machine to be developed and implemented in the world
- Programmable 4th axis
- Programmed in "World/Airplane" coordinates (not a flat pattern as was typical with previous flextrack systems)
- Collar installed by an operator on the opposite side of the skin
- Used on CFRP/Alum structures
 - Easily adaptable to CFRP/Alum/Ti structures
- Single-Pass Drill, Countersink, Seal and Install 3/16", 7/32" & 1/4" Diameter Hi-Loks & Lockbolts with grips up to 9/16" long.
- Utilizes standard, production proven GEMCOR Fastener Installation Tooling
 - (Anvils, Injectors)
 - Manual Drop Station
- Integrated F2C2 Cassette Feeding and Loading System
- Balluf RFID Tool Management system
 - Read and Write capability
- Machine Weight: 180 kg
- Programmable speeds 0-6000 RPM
 - Also available in 10,000 RPM option
- Programmable clamp force up to 1400 N
- HSK32C Tribos Tool Holder
- Integrated Machine Vision system

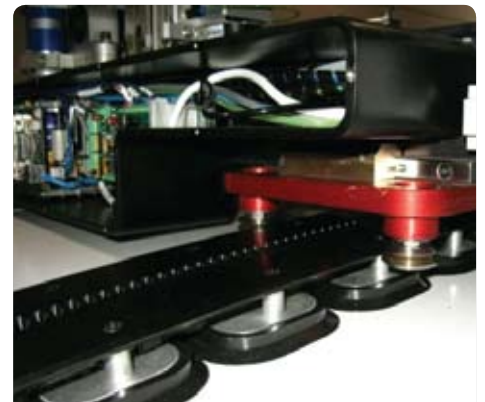
FIGURE 9 📌 Vacuum Cups



FIGURE 10 📌 Flex Track Umbilical that delivers high/low voltage, compressed air, and data to machine



FIGURE 11 📌 Flex Track with drill carriage interface





NUMERICALLY CONTROLLED DRILLING JIGS

To overcome many of the disadvantages associated with conventional drilling machines, AIT developed and implemented its mobile numerically controlled, multi-axis drilling machines. In fact, a new wing design for the Boeing 767 in late '90s drove need for AIT to develop its Numerically Controlled Drill Jig (NCDJ).

The small, mobile NCDJ possesses extensive computing power to download positions of hole sites and to control end effector positioning. The NCDJ conforms to various jig configurations regardless of the program model or position on the aircraft.

Frame Assembly

The primary support structure for the NCDJ and its components – the axis carriages, the spindle, and the control system cabinet. Compact and portable so the entire machine may be stowed when not in use.

Control System Cabinet

The primary power distribution unit for the system, housing the servo motion controller or real-time controller (RTC), fuses and terminal blocks, master control relays, and digital I/O rack and servo amplifiers.

Spindle Assembly

Positioned by X,Y, Z, A and B motors. The spindle drive directly turns the drill bit at commanded speed and direction. The spindle assembly feed drive (Z-axis) controls the rate at which the drill enters the spar. A lubrication system provides coolant to the drill bit during drilling. A vacuum system removes chips generated during drilling.

Pendant

A mobile touchscreen computer that serves as the operator interface for the system. It is mounted in a carrying case to allow mobility near drill location and portability with the driller. Plugging the pendant into the system connects the pendant to the Ethernet network to interface with the RTC.



FIGURE 12 Airbus A350 Keel Beam Curved NC Drilling Machine



FIGURE 13 NCDJ 5-axis drilling machine used to drill F/A-18 forward fuselage.

NCDJ ADVANTAGES

- **Flexibility** – Conforms to various aircraft configurations regardless of program model or spar hand and can work along entire length of spar
- **Size** – Maximizes work area while minimizing tooling costs with reduced driller size
- **Ergonomics** – Eliminates the need for movement of heavy powered feed drills from hole to hole, streamlining the manufacturing process
- **Cost Savings** – Eliminates need for fixed drill templates saving money associated with their design, fabrication, and maintenance
- **Safety** – Allows the operator to safely work adjacent to the machine without risk of being injured



FIGURE 14 📍 NCDJ machine in AIT's Vancouver, BC, facility



FIGURE 15 📍 Boeing F/A-18E/F outer wing NCDJ machine concept

NUMERICALLY CONTROLLED DRILLING JIG PROJECTS

Airbus A350 Keel Beam NC Drilling Machines

- Prime contractor/integrator
- Provided 2 mobile machines to drill pilot and full-sized holes
- Multiple flexible drilling machines share spar FAJ
- Machine vision system resyncs to aircraft features

Airbus UK A340 Leading Edge NC Drilling Machine

- Mobile 3-axis drilling machine
- Replaces approximately 200 Bushed Drill Templates
- Drill and ream up to 1" D holes in aluminum / titanium stack
- Drill in zones for multiple operations
- Drill 2 models and right- and left-hand spars

Boeing 767 Stage 2 Spar NC Drilling Machines

- Prime contractor/integrator
- Provided 8 mobile machines to drill pilot and full-sized holes
- Multiple flexible drilling machines share spar FAJ
- Automatically verifies drill bit before drill sequence

Boeing F/A-18E/F Outer Wing NC Drilling Machine

- Stationary 5-axis drilling machine
- Drill and countersink fastener holes in outer wing assembly

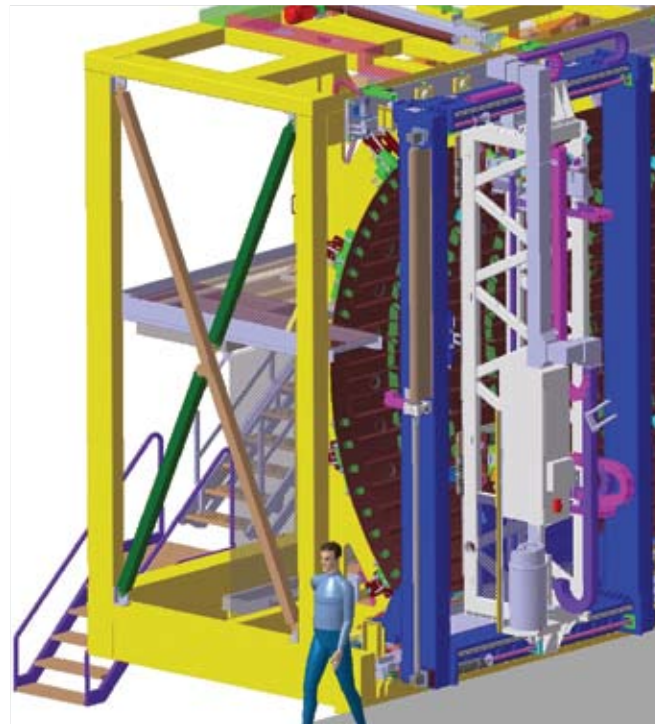
Boeing F/A-18E/F Forward Fuselage NC Drilling Machines

- Portable 3- and 5-axis drilling machines (Figure 5)
- Drill and countersink fastener holes in floors and panels
- Drill right- and left-hand fuselage panels in existing jigs
- Use scan-and-correct feature to index driller to subassembly

FIGURE 16 📍 A350 Keel Beam NC Drilling Machine



FIGURE 17 📍 A350 Keel Beam NC Drilling Machine drawing



ABOUT AIT

■ For 20 years, AIT automation and tooling solutions have assembled, moved, positioned, and drilled the most prominent aircraft in the world. From the 787 Dreamliner to the F-35 Joint Strike Fighter to the Learjet 85, AIT systems have helped put these planes – and many more – in the air.



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