



**Total Solution
for Aircraft
Automatic
Assembly Jigs**



The World's Most Comprehensive Range of Solutions for Aircraft Automatic Assembly Jigs

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Total Solution for Aircraft Automatic Assembly Jigs

MTORRES has developed over the years the widest range of systems to automate, with the highest flexibility and productivity, the Assembly of aircraft components.

Ranging from Wings and Wing Box forming systems, Wing integration systems, Fuselage Barrel forming solutions, Fuselages Sections Joining systems, to Moving Lines, Crawling Drilling and Riveting Systems, Moulds and Special Tooling, MTorres provides the most comprehensive, productive and well proven range of solutions.

MTORRES extremely powerful Engineering and Project Management capabilities fully ensures the capacity to define, manage and successfully implement complex integrated projects and to provide Turn Key Solutions to our customers.

This powerful engineering capacities has allowed the development of a number of operative solutions, to form fuselage barrels, VTP and HTP as well as wing assembly systems, moving lines, crawling robots, etc, customized to match customer requirements and needs.

Every unit built includes customized Human Machine Interface (HMI) software for easy operation of the jig. A step by step workflow based software approach allows an error free operation, even in the highly automated and advanced solutions in production.



Fuselage

The MTORRES positioning system, MTPS, is an in house developed system to accurately locate in space the aircraft components to allow the best fit among themselves.

MTPS positioning software is an MTORRES proprietary software package, that defines and controls all the system parameters related to the parts positioning process.

It is a new generation of reconfigurable assembly jigs equipped with integrated "On line" measurement systems and using NC controlled reconfiguration axes for parts motion/repositioning.

It reduces the assembly time required in the jig and it is capable of producing highly consistent and traceable assemblies substantially rising the overall quality standards.

MTORRES Positioning System as an integrated system designed to support, measure and reposition the different parts involved at the final assembly position.



A400M POSITIONING SYSTEM FOR FORWARD CENTRAL FUSELAGE SECTION

- Positioning system to assemble the complete A400M FCF Section
- 12 MTPS Positioners in the system with a total of 18 CNC Axes.

A340 500/600 FUSELAGE SECTION 16 ASSEMBLY JIG

- Positioning system for A340 panels to assemble the fuselage barrel section 16.
- 2 units for four A340 configurations: A340 500 plus A340 600 (Section 16), both cargo and passenger versions.

A380 SECTION 13/18/18.3 ASSEMBLY LINE

- **Mega Shell Assembly Jig**
- 14 MTPS positioners, locate panels at their theoretical position using a total of 28 NC interpolated controlled axes (2 XYZ units, 10 YZ units, 2 Y units), plus 4 additional auxiliary axis (non interpolated).

Fuselage Section 13/18.1 Assembly jig

- MTPS Positioning system to assemble the complete A380 Fuselage Sections 13 or 18.1.
- 2 Units in operation
- 28 MTPS Positioners in the system with a total of 48 CNC Axes.

Fuselage Section 13/18.3 Assembly jig

- MTPS Positioning system to assemble the Complete A-380 fuselage Section 18.3.
- 15 MTPS Positioners in the system with a total of 24 CNC Axes are set up on the jig.



Wing and Box Tooling



EF2000 RIGHT WING ASSEMBLY LINE

- Flexible layout design approach for a step by step assembly line implementation.
- It integrates 10 stations as well as auxiliary machinery tools.
- Additionally a Manipulation and Transport System (MTS) is installed at the assembly hall to handle the components from station to station.

A380 STABILIZERS ASSEMBLY

- The jig is automatically reconfigured in order to allow for the potential skin over-thickness, reducing the final stress at the stabilizer.
- 6 Automated Assembly Jigs: 2 Elevator Inboard (Left & Right); 2 Elevator Outboard (Left & Right); Rudder Upper; Rudder Lower.

FALCON 7X HTP BOX ASSEMBLY JIG

- Horizontal Stabilizers Assembly jig.

FALCON 7X HTP INTEGRATION

- MTPS system to integrate the HTP.
- Control Software corrects HTP Roll, Pitch and Yaw based on Laser Tracker measurement of predefined HTP reference points.
- Best aerodynamical position approach is implemented in this jig.

B787 HORIZONTAL STABILIZER INTEGRATION

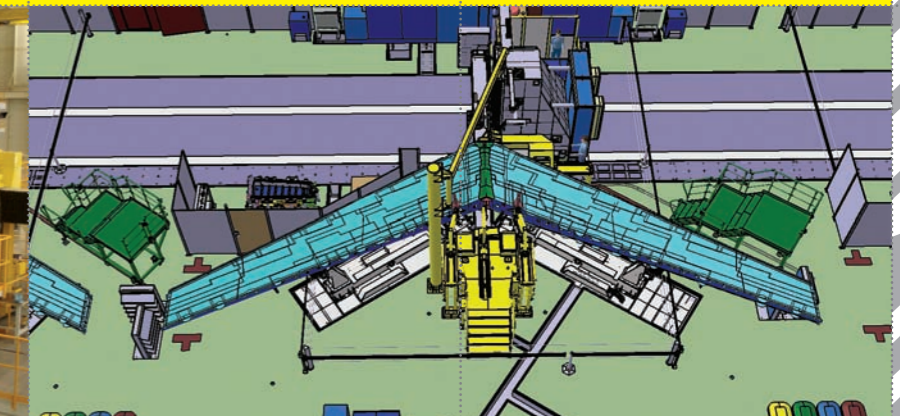
- Automated assembly system to integrate B787 Horizontal Stabilizer to the fuselage, at the FAL.
- Additionally the Tail Cone is integrated as well to the HS.
- Special Transport System holds the Tail Cone during the integration with the HS.
- 6 MTPS positioners in the system with a total of 12 CNC Controlled Axes are used on the jig implementation.

A400M WING INTEGRATION FINAL ASSEMBLY LINE

- Flexible Assembly Line to integrate the A400M Wings to the central wingbox.
- Two stations assembly line supplied for wing integration/equipment and wing test.
- Station 72 Wing integration and equipment.
- Fully Automatic alignment system, using laser tracker as measuring feedback system, for best fit approach implementation.
- 10 MTPS positioners for wing parts integration with a total of 18 NC controlled axes.
- Two TORRESDRILL units 5 axis NC drilling columns integrated in the assembly cell.

A350 XWB HTP INTEGRATION AND AUTOMATIC DRILLING

- Five automatic positioning stations with on line measuring system, for HTP side boxes integration plus two automatic drilling system Torresdrill, that are able to work at all five integration stations, for TI-ALU-CFRP stacks drilling process.
- One fixed Laser Tracker unit at each station provides data to the MTORRES MTPS Software which calculates the best fit trajectory.
- All process and jig functionality are controlled from an operator control desk, that ensures safety, ergonomics and product quality.



Assembly Lines



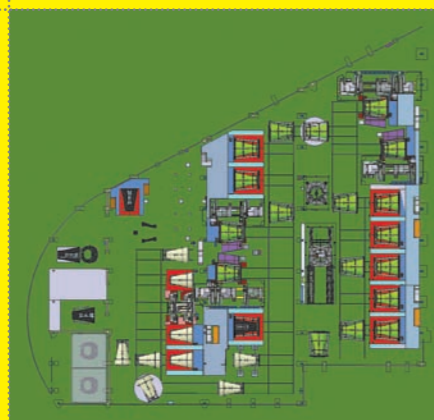
MTORRES has developed and successfully implemented at the Aerospace Industry worldwide, a number of turnkey assembly lines, using state of the art technology and equipment that assures the required degree of flexibility and productivity that the industry demands, after carefully listening the customer requirement.

MTORRES provides a complete solution covering every project phase, from the concept development to the Assembly Line Final Acceptance and production support.

MTORRES integrates at its jigs a wide range of technical solutions that goes, from the most simple assembly tooling to the highest and most sophisticated technology of reconfigurable assembly jigs, equipped with integrated "On Line" measurement systems and a top performance range of automatic machines, controlled by powerful control & production software packages.

Every MTORRES developed concept is designed to fulfill the most demanding customer requirements focusing on easy working procedures to maximize production rates, using the latest technology to boost flexibility via automation implementation, minimizing manufacturing process time, footprint minimization, flexibility on the steps to be implemented according to the production ratios increases, etc.

MTORRES powerful engineering and project management capabilities ensures a satisfactory project implementation from the early project steps, through a concurrent engineering phase, till the end with the customer operators training and full production support.



A350 PROGRAM S19

Turn key assembly line installation for the A350 XWB fuselage Section 19 project. A total of 28 assembly stations are involved in an automatic pulse moving line concept regulated under Lean directives and prepared for a maximum Rate of 13 Aircraft per Month.

The project has been conceived to allow progressive and flexible implementation of some of the systems involved on the complete solution, according to aircraft program rate requirements, split on 3 different stages, Rate 4, Rate 7 and Rate 13.

A wide range of technologies has been applied at this assembly line. They cover from the most traditional geometrical assembly jigs on a perfect match with the most advanced automated assembly technologies and automatic drilling and riveting process, managed from a customized control and production software.

The main technical project highlights are:

- Automatic pulse moving line.
- Three stations with fully automated NC alignment system using laser tracker for section positioning.
- Two TORRESDRILL, 5 axis NC drilling column machines integrated in the assembly line.
- Three TORRESRIVETER 5 axis NC riveting column machines integrated in the assembly line.
- Two Flexible Drilling Heads FDH type are also part of the scope of work.
- One Flexible Drilling & Riveting Head FDRH is also included in the scope.
- One TORRESMILL NC Surface Milling Machine for final tail connection.
- Special MTP Software and HMI for machines and automatic stations control
- Manufacturing control software.

A380 MOVABLES

Large project involving the Design, manufacture, installation and integration of the Vertical and Horizontal Stabilizers for the A380 assembly line .

The Manufacturing, Process Flow and the Installation Lay Out definition were made at the concurrent engineering phase. Additional companies were sub-contracted by MTORRES to work at certain project phases.

The main technical features are:

- Customized & Integrated automatic Cell for drill and assembly Ribs & Fittings, with automatic work piece exchanging system.
- Flexible Spars, Ribs (leading edge) & Fittings drilling and assembly cell. Four working areas plus a customized double spindle machine are included at this area.
- Six automated jigs for movable final assembly. (Skins, Spars, Web Ribs & Skins Assembly, drilling and final fastening).
- TORRESTOOL and C frame TORRESRIVETER system for trailing edge drilling, countersinking and final riveting. It is a very flexible assembly cell capable of working on all Airbus family of aircraft movables.

Moving lines

A380

Transfer car system for section 13 & 18-19 (10 units)

- Moving line to transport A380 Sections 13 (5 units) and Sections 18-19 (5 units).
- Transfer cars automatic operation.
- Used for Sections hydraulic and electrical equipping operations.

A320 FAMILY

Moving line for A320 family fuselage final assembly (10 units)

- Moving line including transfer cars for fuselage.
- 14 Working Stations -10 Transfer Cars.
- 2 Transfer Stations.
- Non-Stop moving line at 1m/h operational speed.



Special tooling

A380

Stabilizers ribs and spars assembly and drilling cell.

- The cell is part of the complete Moveables (Elevators and Rudders) assembly solution Integrated Cell to drill and assembly Ribs & Fittings.
- 3 Axis Gantry CNC Drilling Machine.
 - Automated parts storage.
 - Lift platform included a independent 3 axis CNC.
 - 12 Manual Transport cars to storage of final pieces.
 - 4 Working tables.

A320/A340/ A380

Stabilizers flexible drilling and riveting system.

- The riveter is designed and built to perform the riveting operation of the elevators trailing edges only. Feed, Torque and Speed controlled, depending on the material being drilled at any given time. Built-in metal chips and carbon fiber dust removal system. Dual spindle system, drilling and countersinking from both, top and bottom of the component trailing edge. Measuring of the different materials thickness. Rivet length classification and insertion depending on the material thickness.

C17

Shuttle car for fuselage panels assembly line.

- Shuttle car tools for riveting/splicing moving line of large fuselage components.



Moulds

LAYUP MOLDS

Layup moulds design and fabrication, in invar and other materials.



Flexible Drilling Head [FDH]

5 Axis Crawling Drilling and Riveting Machine

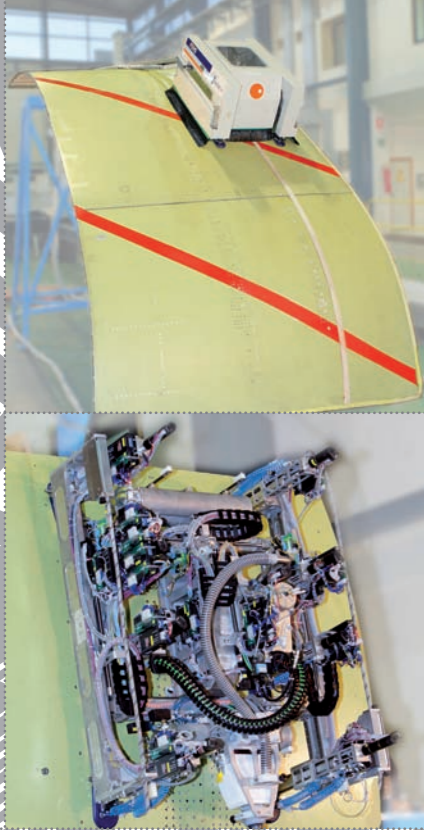
The FDH is a 5 interpolated axis drilling machine with modular design for easy system customization. Its principle is to 'walk' over the aircraft fuselage, holding on place by means of a set of vacuum cups. Once the FDH walks to position, gets locked with the vacuum cups and is ready to perform the drilling/riveting operation. After drilling/riveting at the current area, the FDH walks one more step, by releasing the vacuum at half of the cups and moving them one step ahead, where it will lock them on place again getting ready for the next drilling/riveting operation.

The FDH does not need any additional guiding system mechanically engaged to the Aircraft to walk on its fuselage, irrespective of its position, even upside down.

FDH is a 5 axes autonomous platform that carries the necessary end-effectors for drilling and countersinking. A 5 minutes set up on place by 2 operators is enough. The robot optimal design ensures the best drilling and countersinking positioning accuracy and a high speed performance at the lowest weight. A vision and laser system ensures that the FDH follows the desired path and correct CNC program from theoretical to real path. The FDH may work and walk on most of the current aircraft models from smaller aircraft to the largest jetliners. Applications are drilling and riveting circumferential, longitudinal and conical joints. A portable electric cabinet is provided, connected to the FDH by means of a minimum hosing/wiring harness.

A MTORRES developed control system allows the FDH to work without needing a conventional CNC system.

FLEXIBLE DRILLING HEAD (FDH) 5 Axis Drilling Crawler Robot is a portable and autonomous drilling and riveting stand alone robot.



Software

HMI

HMI applications are developed to create user friendly interfaces that allow the machine operator to execute complex manufacturing processes.

MTORRES HMI'S are specifically designed for each application providing the maximum flexibility and quick learning curve for operators. The range of HMI solutions include Process and Machine User Interfaces, in which all the station processes are sequenced and displayed graphically in the form of a workflow.

These are the main features:

- Process workflow.
- Integrated management of data and tools: part programs, part measurements, tool measurements, tool life, tool wear.
- Integrated management of measuring devices: laser trackers, laser radar, indoor GPS, artificial vision cameras, NDI or contact probes.
- Full system monitoring, including maintenance / diagnosis visualizations: alarms, operational statuses of electrical circuit breakers, operational tests.
- Process reports generation.

The tasks in MTORRES HMI'S can be linked to MTORRES MES/PMS solution, in order to provide fully automatic real-time production management.

TORRES POSITIONING SYSTEM

MTORRES has developed a software package for the completely automatic assembly of aerospace components.

The Torres Positioning System, TPS, kernel integrates a measuring system module, a path calculation module and a positioning control module. The main objective is to allow the positioning of parts of any size and shape in the space by means of the automatic calculation of trajectories for the elements that support the parts, avoiding any deformation during their movement.

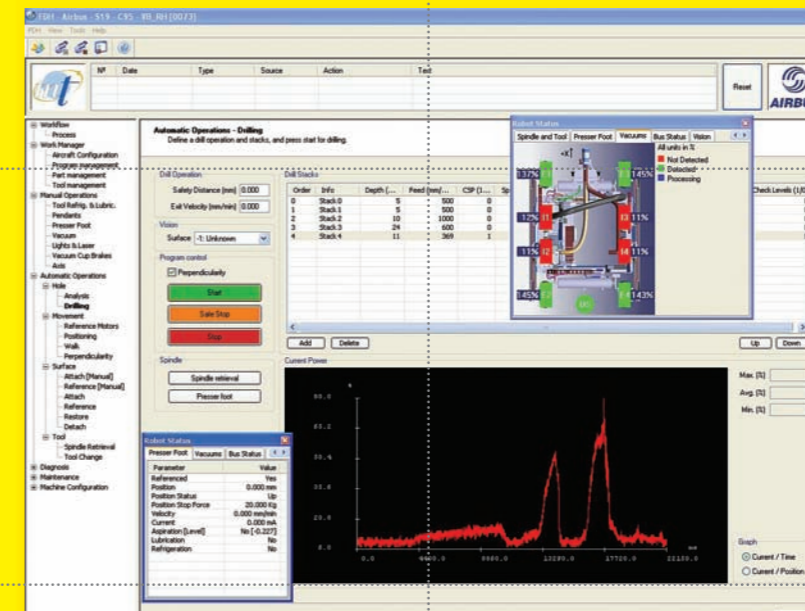
Since 2000, TPS has been used successfully in several projects, and it has proved to achieve optimal results in the assembly of different aircraft structures: fuselage parts, wings and stabilizers. As a result of this experience, current versions include tens of positioning algorithms that can be applied out of the box to most of the positioning problems in the aerospace industry: best-fit assembly, wing/stabilizer integration matching both mechanical and aerodynamical criteria, etc.

These are the main features:

- Automatic positioning: TPS functionality can be controlled from customized screens that perform complex positioning tasks without additional operation from the user.
- TPS software also optimizes manual operation with its Teach-In & Manual-movement modes. Teach-in functions can

generate trajectories to go back to previously stored positions through well known paths. Other functions calculate rotations around programmable virtual axes through virtual or measured aircraft points. All these features can be controlled from a radio control or similar customized device, for ease of in-place visual alignment of aircraft parts.

- Powerful: TPS includes an array of powerful algorithms to solve almost any positioning problem.
- Flexible & Scalable: TPS can be integrated with different systems for data acquisition: gapman readers, laser trackers (Leica, FARO), vision cameras, indoor GPS, etc., it also supports the use of different configurable axis combinations.
- Extensible: TPS provides a general framework that makes easy to incorporate new functionality that matches our customer's manufacturing requirements, thus reducing development costs and innovation risks. Furthermore, the reuse of underlying functionality allows providing fast response to the changing aerospace industry requirements.
- Interoperable: TPS has been designed to interoperate with other systems. TPS can manage and exchange data in different standard formats, including relational databases (SQL Server, Oracle) and CSV/Excel/Html/XML reports.
- Tested: TPS is a mature product that has been successfully proven in different major projects for years.



PRODUCTION MANAGEMENT/MES

MTORRES has developed an easy to deploy MES solution (Manufacturing Execution System). MTORRES MES provides a complete tool to implement Lean Manufacturing strategies.

The main systems are:

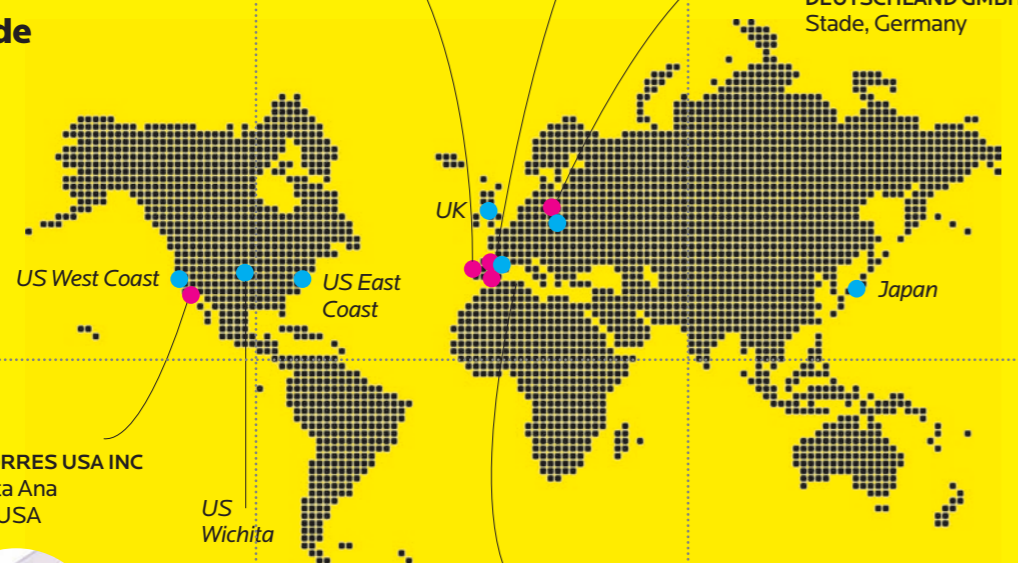
- Production Management System.
- Machine Data Analysis.
- Quality Data Management.

MTORRES PMS (Production Management System) is based on job templates which assign station processes to each section to be produced. These processes are entered as tasks. Production management is based on task planning and execution control. MTORRES PMS allows real time visualization of manufacturing progress and reporting of execution times.

MTORRES MDA (Machine Data Analysis) provides continuous information about the production output, quality and availability of manufacturing and assembly system. All relevant information is acquired in real time, collected through OPC, and stored in relational databases. Real time acquisition allows displaying graphically an overview of the production line with current machine operating statuses coloured. Maintenance operators can navigate into the detail of machines statuses and alarms.

MTORRES QDM (Quality Data Management) provides quality data of the different machines and stations. All relevant information is acquired in real time and stored in relational databases. Fully customizable reports can be generated with MTORRES Reporting solution, which supports Excel, HTML, CSV. Additionally, quality data and master measurements are also available through standardized XML formats, which can be also easily transformed using XSLT technology.

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