

Traveling Column Machines for Automated Drilling and Fastening Operations on Different Aircraft Structural Components

Christian Soehner
Airbus Deutschland GmbH

Holger Mayländer
Brötje Automation GmbH

Copyright © 2008 SAE International

ABSTRACT

The demand of fulfilling the increasing requirements to shorten development lead times force suppliers to enhance modularity and flexible applicability of their machinery component portfolio. The presented examples show how basically similar machinery components, i.e. traveling column systems, can be applied for significantly different types of applications in the aircraft industry. Application examples are shown for drilling and installation of two-piece and blind rivet fasteners on box-type and barrel-type aircraft structures at Airbus Deutschland. It is shown how the basic drilling/riveting system is integrated into assembly stations and assembly lines and how it adapts to the varying operational requirements of A380 and A400M.

INTRODUCTION

Within new aircraft programs, the need to reduce recurring cost during the series production lifetime usually results in an analysis, if, where and how automation systems for assembly operations can be implemented. The conception of automation systems, however, relies heavily on the knowledge and experience of the production planning personnel involved. When the concept of an automation system is frozen, it is easy to calculate economic benefits with respect to manual assembly tooling. But in the conception phase, a set of modules of automation components can strongly support the quick assessment of a feasibility or economic viability of an automated approach versus manual assembly.

Even for very different automation applications, a relatively small number of machinery modules or components can satisfy a majority of automation requirements when it comes to the assembly of large aircraft components (Ref. 1). The availability of these modules as building blocks to a complete automation system help the aircraft production planner as well as

the automation system supplier to reduce development cost in the concept phase and as well later on in the design and production phase of an automation system. The availability of these modules in the same data format as the aircraft component data, e.g. CATIA V5, strongly supports quick design integration, NC programming and even instruction and training of personnel.

A400M INTEGRATED FUSELAGE ASSEMBLY BREMEN

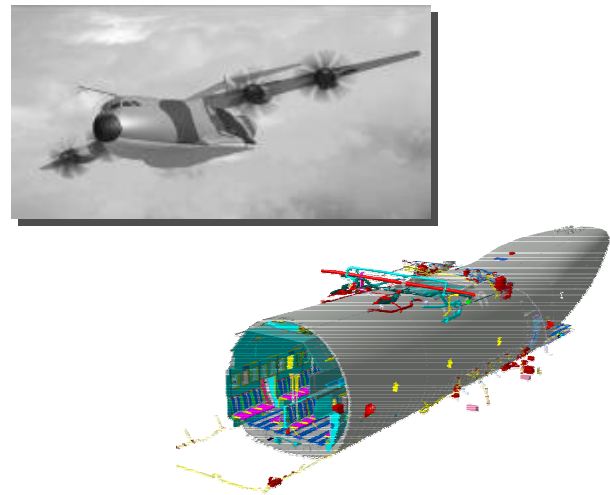


Figure 1: A400M military transport aircraft (top) and its main fuselage which is assembled, equipped and furnished at Airbus Deutschland in Bremen (bottom)

The general approach of the Integrated Fuselage Assembly (IFA) of the military airlifter A400M at the Airbus Site in Bremen is that of a synchronized flow line under one roof. It incorporates structural assembly,

surface protection, equipping and furnishing in one hangar in 10 stations. These stations work in 9 cycles, so 2 stations are usually operated in parallel. In series production, "pulling" a completed fuselage from the last station to the FAL delivery by Beluga in Seville will trigger a sequencing of all stations to the following station. All these transportations will be done during one extra shift by hangar crane. The stations are arranged in the hangar so that the transportation area between them is used by all stations. Material supply is done via extra supply lanes at the back of the assembly stations.

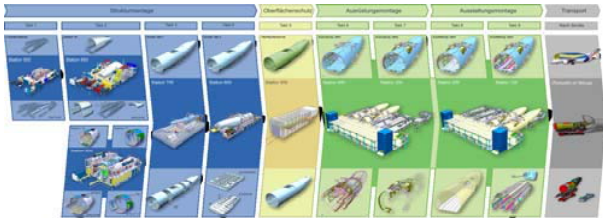


Figure 2: Schematic flow of operations for the A400M fuselage assembly. Bottom row: station input, middle row: station 3D view, top row: station output

A crucial assembly operation in the IFA is the structural integration of the all-metallic fuselage. This is done in the so-called station 700, which integrates section 13, delivered structurally complete by Beluga from TAI, Ankara, with the other sections 15, 17 and 18, which are assembled from large components in previous stations in the IFA. This operation involves the assembly of 3 circumferential joints between 4 sections and various longitudinal joints within the sections. For reasons of machine utilization, the longitudinal joints (e.g. 4 joints within section 15) have only been tack-riveted in the section assembly. To provide sufficient stiffness for component transportation, the frame couplings of the joints inside the sections have been completely riveted manually and the overlap joints of the panels have been tacked only.

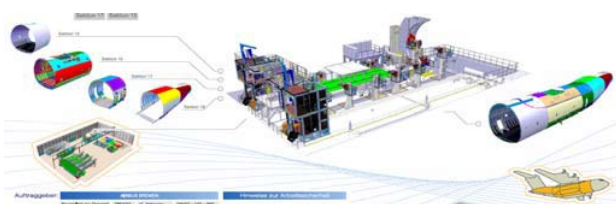


Figure 3: 3D view of station 700 in A400M fuselage assembly line (IFA). Left: station input (4 fuselage sections), center: station view, right: station output

After finishing structural assembly work on the fuselage, the section is transferred to station 600, where cargo ramp and door are installed and other assembly work on secondary structure as e.g. sewing angles and sponson attachments is performed. Hereafter, the section undergoes surface protection in the dedicated station 500. This includes re-protecting the areas that have been drilled and assembled (rivet collars, panel edges) and spraying of TPS, a conservation wax for the bilge area. Past station 500, all structural and protection work has been finished and system installation and furnishing is carried out in the remaining 4 stations. From station 100, the fuselage finally is put on a trailer, towed to the Beluga loading hangar and transferred to the air transportation jig. This air transportation jig is used to bring the fuselage to the Beluga and load it.

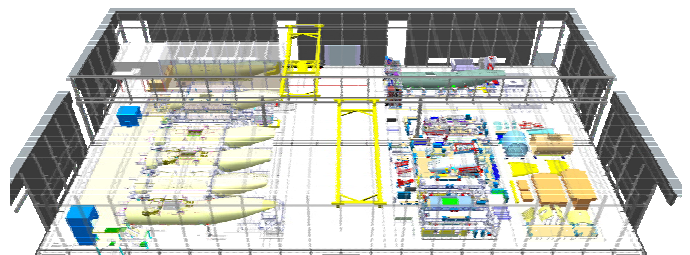


Figure 4: 3D CAD view of IFA (Integrated Fuselage Assembly) hangar at Airbus Deutschland in Bremen

The IFA hangar measures 80 x 130m and is completely covered by a 26t overhead crane. The structural assembly stations are on the right-hand side, those for system installation and furnishing on the left, as well as the surface protection booth (upper left corner in figure 4). An office building directly attached to hangar 400 (not shown) gives space to all personnel working in the assembly line.

A380 VERTICAL TAIL PLANE ASSEMBLY STADE

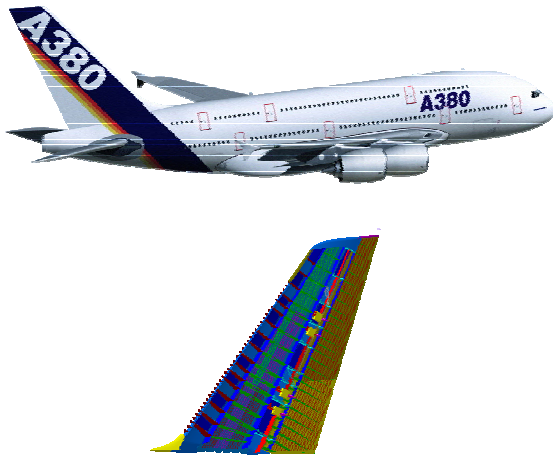


Figure 5: Design view of A380 aircraft (top) and its vertical tail plane (bottom)

Basically, the A380 vertical tail plane assembly in the Airbus site Stade follows a similar flow line concept. Inside one hangar, 7 stations perform structural assembly of the CFRP component and equipping. No separate surface protection is required apart from the sealing operations done inside the stations or riveting system. The 7 stations operate in 6 cycles, so also here, two “pre-assembly” stations operate in parallel.

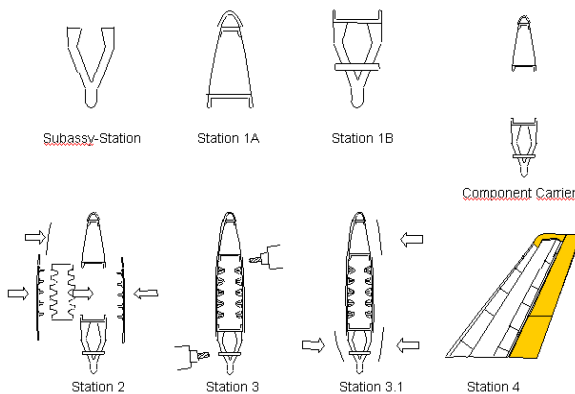


Figure 6: Schematic of the sequence of assembly operations of the A380 vertical tail plane, from top left to bottom right

When the vertical tail plane box has been fixed geometrically by tack-riveting, the automated assembly also here performs the most important structural assembly operation, the riveting of the side panels to the

spar and rib box. This is done in the so-called station 3, where a robotized drilling and riveting system performs single-sided riveting operations outside the vertical tail plane. Subsequent to this box riveting station, leading and trailing edge panels are attached to the box in station 3.1 and in station 4 all remaining system installation and tests are carried out.

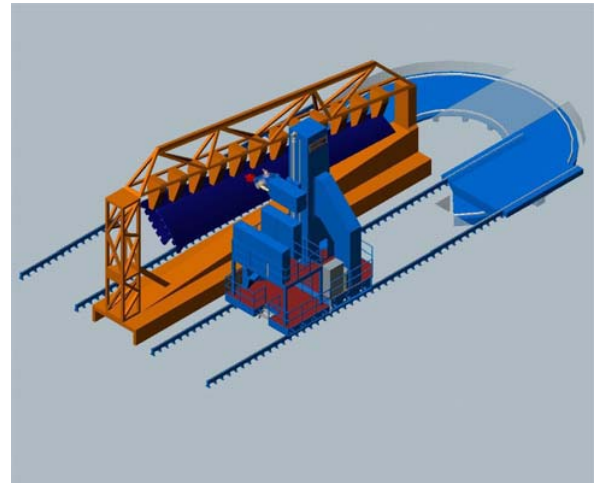


Figure 7: 3D CAD view of station 3 in the A380 vertical tail plane assembly line at Airbus Deutschland in Stade. This station performs riveting of the side panels to the spar and rib box structure

After finishing of station 4 including customer inspections, the VTP is transferred to the adjacent loading area, where it is inclined horizontally again, attached to the air transportation jig which is fixed on a truck trailer. This truck brings the VTP to a port station from where it is shipped to Finkenwerder near Hamburg. From there, the Beluga takes it to the FAL in Toulouse.