Variation Aware Assembly Systems for Aircraft Wings

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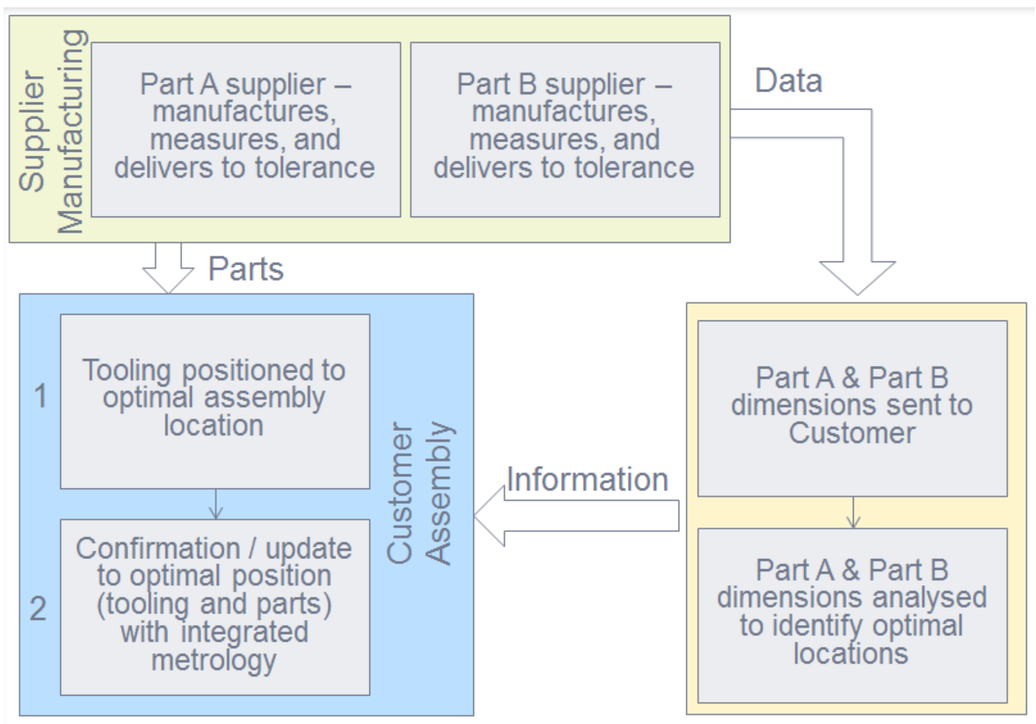
The Industrial Need

The traditional tooling philosophy in the aircraft wing assembly industry primarily utilises large scale hard tooling fixed into the ground with reinforced concrete to achieve the required dimensional tolerances. Although its use is proven within the industry, it comes with many drawbacks: regularly recertification, lack of flexibility to design changes within the part family, lack of data extraction, lack of knowledge about forces required, a focus to only achieve within tolerance band (but not more accurate) and high cost custom built designs. These assembly tooling practices inhibit future flexibility and account for approximately 5% of the total build cost of the aircraft. A new tooling approach is required to ensure delivery of the future committed orders.

Research Strategy and Developments

This research examined current practices and evaluated existing solutions before embarking on developing new concepts for self-calibrating and self-adapting fixtures able to react to variation in key product characteristics.
The **Variation Aware Assembly (VAA)** framework has been developed to improve the process capability and cycle time of specific aircraft wing assembly operations. The VAA system adapts to the dimensional variation of the parts to enable precision assembly towards nominal dimensions. Motion controllers, integrated metrology and best fit algorithms work together to precisely position components ready for fastening. Implementing an assembly philosophy that focusses on achieving nominal dimensions will improve manufacturing quality and lead to fewer concessions / rework. The automation of this process will ensure that its quicker, more accurate and with improved governance compared to the manual assembly method.
The first experimental test rig (trailing edge rib assembly) demonstrated the capabilities of using high precision linear actuators coupled with a laser tracker to assemble non-rigid aircraft wing components. The next test rig, a rib insertion operation, will enable a better understanding of the VAA process capability and provide comparison to current industrial practices.

The VAA Process



Main research objectives:

1. Identify the key assembly parameters to be used for VAA systems for aircraft wing assembly
2. Develop the decision making tools, using best fit assembly algorithms and assembly placement strategies, to enable world class process capability levels
3. Identify and assess the hardware possibilities of the proposed tooling systems
4. Develop the hardware and software to connect together for an automated solution
5. Formulate a structured methodology that enables a systematic approach to VAA system implementation within the Aircraft Assembly industry
6. Conduct a detailed performance assessment to identify the process capability improvement of the VAA system