

Composites Assembly and Fastening Automating Grip Length Measurements to Generate a True As-Built Kit List

Roger C. Richardson and Tom Stewart
Delta Sigma Company

ABSTRACT

With composite skins and structures, the exact thickness of a part stack is indeterminate, and thus the fastener grip length for any particular hole cannot be known with certainty, from engineering data alone. A common practice on the assembly line is to provide “overs and unders” - that is, one or two grips lengths above and below the expected fastener length. Unless all of the fasteners are kept line-side which slows production operations, pre-kitted fasteners will require a tremendous amount of return-to-stock. Test fitting every fastener before sealant application and/or delivering 200-400% more fasteners than are needed for the task are not a good value for production.

This paper will discuss the development processes and production applications of making fast, accurate stack thickness measurements that are correlated to each particular hole, creating the as-built kit list, and then delivering the kitted fasteners to the production line in the order that they will be installed. With every fastener location known to have the exact grip length required for its as-built condition, production line workers can stay strictly focused on value-added work. The ability to grip up to 40 fastener locations per minute allows the technician to move at an increased rate during the measurement process. By simplifying the installation and semi-automating the measurement, the assembly process can see immediate improvements.

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INTRODUCTION TO CURRENT FASTENER INSTALLATION PROCESSES

Due to the variation inherent to composite skins, determining the correct fastener to insert into a specific location can be challenging for a technician. A typical process for a non-automated fastener installation into a composite skin begins by using a manual grip length gauge to measure the part thickness at each location. The worker must then stop and create a record of the value. This is typically a simple action such as, writing the value directly onto the surface of the part or onto a printed drawing. The advantage of writing it onto the surface of the part is that the worker does not have to move from where the work is being completed to record the measurements, this saves time and provides an easy to read value for an already identified location on the part. The advantage of recording the value on a paper drawing is that the paper can be used as a kit list used to gather a full set of fasteners quickly and accurately. Performing both actions allows the user to have the grip of

the part number identified and available to create a kit list, but sacrifices time.

If a kit list is not utilized, the technician may have a local stock, which means time spent traveling between the stock and the part. The technician may be able to carry a fastener tote with several different part numbers in individual compartments, but this risks contamination between the compartments. Some systems deliver fasteners that were kitted in advance, but include “overs” and “unders.” This is typically, two grip lengths in either direction of the engineering data. If the drawing calls for 10 fasteners with a length of 4 grips, the kit would provide 50 fasteners, 10 of each length 2, 3, 4, 5, and 6. This ensures the correct value is present in the correct quantity, but also ensures that 80% of the delivered fasteners will be returned to stock or disposed. If the workstation must install 15,000 fasteners a day, by using “overs” and “unders” kitting, 75,000 fasteners will be delivered and 60,000 will be returned to stock. Reducing the “overs” and “unders” to just ± 1 grip length still yields a huge restocking problem, with 45,000 fasteners being delivered and 30,000 being returned to stock. Pre-kitting fasteners provides benefits, such as adding treatments to the

fasteners that can be removed from line side processing, but without accurate grip values, the cost of restocking and extra preparation is too high.

After the data is recorded and the fasteners are gathered, the worker must prepare to install the fasteners. The technician will reference the work instructions to determine the part number at a specific location and reference the surface of the part or the recorded data sheet to determine the grip length. This grip length must then be verified to be within the engineering tolerances specified within the work instructions. This process must be carried out for each individual fastener until all are installed. All of the installation is traditionally performed with the aid of 2D paper drawings that relate to the 3D part. This ensures the technicians are constantly orienting to the part and increasing their rate of producing an error.

An experienced worker will be able to memorize a large portion of the work instructions to help bring the total time spent installing fasteners, but this carries a high risk. Just one incorrect fastener can lead to hours of rework. If the instructions are memorized, the workers have a larger chance to make an error. The odds of an error increase faster when the process receives a large number of revisions. As the revisions change, so too must the memorized work instructions, which means habits must be broken. Complicated processes can be challenging to memorize as well. It is not uncommon for a task to have several variables, such as: part number, promoter, sealant, washer, and torque. In this scenario, the technician must memorize 5 parameters for each fastener location. The risk of error due to incorrect memory is too great and numerous paper documentation references are unavoidable.

3D OPTICAL PROJECTION INSTALLATION WITH GRIP GAUGE ASSISTANCE

By utilizing an optical projection system, every step after the initial measurement can be automated. A wireless grip length gage can be implemented to work in conjunction with an optical projection system. The projectors display a location on the surface of the part. The operator moves to this location, inserts the measurement probe into the fastener location, and squeezes the trigger. Instantaneously, the gage communicates with the database, built into the projection system, and the value is recorded. The value is then checked against the engineering tolerances and the system returns either an accepted or unaccepted value.

If the value is accepted, the operator simply moves to the next location and takes another measurement and the process would repeat until the task is completed. If the value is unaccepted, the optical projection system would display a red marker on the location indicating that the value was out of tolerance and needs to be measured again. If the measurement is taken again and the value is accepted, the database does not flag the location. This could be caused by the operator

allowing the probe to catch on a burr or the gage not being flush against the surface.



Figure 1. Using a wireless grip gage to measure the highlighted location

If the value is not accepted after several attempts to re-measure, the location is likely problematic. The system will allow the user to skip the location or return to the controller console and override the value manually. The operator can choose to wait until all the locations without problems are measured before returning to the console to deal with any problems that may have occurred. At the console, the operator will scroll through the table of locations looking for any red values. At each problematic value, there will be the option to override the value with a manual data entry. This would be used if the operator is able to measure the location with a manual gage and receive a different results for the value the wireless gage receives. If the manually measured value matches the digital measurement, the operator has the options to leave the value out of tolerance and attempt to build the assembly with that erroneous value. The system assumes that the operator is using superior knowledge to build the assembly and that it could not be built with the engineering tolerances. Because this value was measured wrong, it is flagged and can be tracked for further study.

As measurements are taken, the grip gage will display the value that is being measured on the LCD screen located on the rear of the device. This allows the operator understand what is being sent to the console without having to leave the area where work is completed and check the values.