

Advanced Battery Tools for Ergonomics and Quality Assurance in Aircraft Assembly

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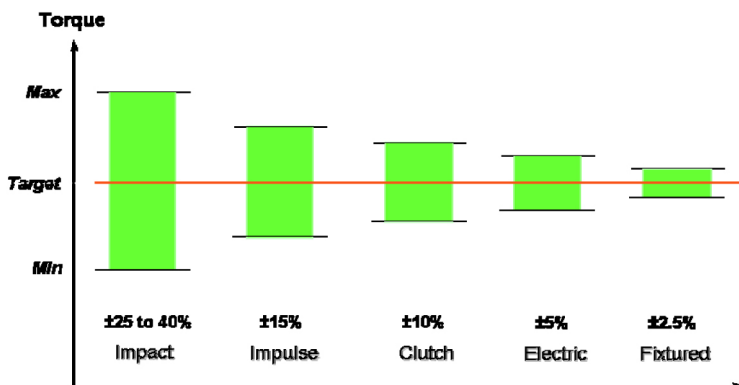
ABSTRACT

The use of advanced battery tools substantially improves both ergonomics and quality in aircraft assembly. The Atlas Copco STB family of tools has built-in transducers, which allows the tool to meet the high demands for tightening accuracy requested by the aircraft industry. STB offers a variety of radio communication protocols including Bluetooth and Wi-Fi to allow torque data to be transmitted to a control unit that stores it for analysis. To trace stored torque data back to the application i.e. traceability, has turned out to be the desired process for critical fasteners in e.g. wing junction. The handheld STB tool can also be setup to operate without a control unit, in case there is no need to transmit and store torque data. For structural fasteners which are widely used all around the aircraft, this way of operating provides added value over a pneumatic clutch tool because of the improved accuracy in tightening as well as cost savings for energy and improved ergonomics. The system allows the operator to choose from several programs either stored in the tool if operated in stand alone mode or available from the control unit if tool is connected. This allows the same tool to be used on different applications requesting different torque settings. Regardless of choice, the STB offers new possibilities to improve assembly quality on both frangible collars and torque nuts. This paper will discuss the implementation of advanced battery tools at some of the largest aircraft assembly plants around and how it has improved the process and reduced assembly errors.

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INTRODUCTION

The aircraft industry has for long used pneumatic screwdrivers and nut runners for their tightening operations. When equipped with a clutch, this kind of technology offers an accuracy of as low as $\pm 10\%$ over 6σ according to ISO5393.



However pneumatic tools are limited in their use since they can't fully detect assembly errors such as wrong torque, missing parts, wrong / faulty fasteners or cross thread. There are many type of fasteners used in the aircraft industry and many of these require proper torque control. Frangible collars which don't require tools with torque control are still very common but the concern for incorrect clamp load drives the industry towards torque control tools also for this type of fastener. In reality there is no way to know that the collar actually shears-off at the correct torque level. Concerns that prevailing torque reduces the installed clamp force contribute to the need for more advanced tightening strategies than just validation of final installed torque. There are many reasons to consider how the installed torque is reached rather than just the fact that it is reached.

CORDLESS BATTERY TOOLS

The aircraft industry has for long been trending towards cordless tools for their assembly processes. Not only are cordless tools more ergonomic to use as they are more silent than pneumatic tools and provides a higher degree of



The reporting STB system collects and reports data via the controller and Ethernet to the production system. It provides the user with full access to all torque traces and all fasteners tightened can be analyzed in case of assembly errors. The controller and tool are often installed on a moveable cart which can be moved around the factory to the desired application. A useful way to ensure that the tool is setup with the right program is to have a barcode scanner connected to the controller or the tool which can be used to scan the application barcode and by that have the right program downloaded from the central server to the controller and to the tool. The same tool cart can be used for any application in the factory but if preferred each build station can have its dedicated cart and all programs can be stored in the controller.

The STB SA has full functionality and can automatically compensate for prevailing torque and holds up to 4 tightening programs. The optional program selector will allow change between the different programs stored in the tool. The STB SA offers many possibilities to detect assembly errors. The prevailing torque compensate strategy will ensure you install the desired clamp load. The post-view torque detects missing parts such as o-rings, lubrication etc.

The transducerized SB tools offers $\pm 5\%$ over 6σ and is able to ensure that all fasteners have been tightened. By doing so, it will warn the operator if any fastener has been hit twice or not at all. It is limited to one torque value but has a built-in two-stage strategy which takes care of many relaxation problems.

The BCPV battery clutch tool shuts-off when final torque is reached with an accuracy of $\pm 10\%$ over 6σ . However, compensation for prevailing torque and verification of torque installed must be done in a second step.

flexibility than corded electric tools, they are also significantly more versatile and offers a much higher accuracy. However, what really justifies the switch from pneumatic tools to electric tools is the high accuracy and the ability to collect data in order to ensure high assembly quality and eliminate the need for witness torques. The range of battery tools starts with the BCP/BCV clutch tools and end with the reporting transducerized STB tools. In between are several variants of the STB which in each step offers new possibilities to detect assembly errors.

UNDERSTANDING TORQUE STRATEGIES

To reach the desired quality in the process of installing bolts and other fastener elements dedicated to the aircraft industry, it's critical to understand how fasteners behave while being tightened. Sometimes it's not enough to safeguard that final torque is within tolerance but also how torque was applied during the run down phase and there after. The most advanced battery tools have a variety of different strategies that help and guide the user to both detect and avoid assembly errors.

- Batch count / Re-hit detection
- Snug gradient
- Two-step tightening

- Prevailing-torque compensate

- Post view torque analysis

Batch count / Re-Hit Detection

Batch count can be combined with any of the other strategies but is rather a strategy for the job than for the installation. It ensures that all fasteners have been tightened and in combination with any of the more advanced strategies it only counts properly installed fasteners. The re-hit feature will tell the operator if same fastener is attempted to be tightened twice. Both strategies can be combined with the more advanced strategies described below.

Snug Gradient

The first step in tightening is to run down the bolt or nut until clamp load starts to build up between parts. The length of this phase is necessary to detect to accurately allow use of angle monitoring. This makes snug gradient rather a support strategy than a stand alone strategy. Angle monitoring is useful as it can help to detect assembly errors such as forgotten washers and avoid use of wrong bolts or pins. The snug gradient strategy determines the "snug point" which is the end of the run down phase. Many of the advanced tightening strategies offered with advanced battery tools require detection of the snug point.