APPLICATION REPORT

PartInspect M
3D quality inspection of turbine blades

The measuring unit ‘micrometre’ as a benchmark for product quality: The production of turbine blades for the civil as well as for the military aircraft manufacturing is determined by extremely tight shape and size tolerances. High-quality products are the defined production goal; at the same time, the manufacturing costs also play a very important role. The finished product has to be one hundred percent right, as the functionality and in particular the performance efficiency in relation to the kerosene consumption of a modern aircraft machine does to a great extent depend on its more than 1000 turbine blades per engine!

Objective and measuring object

When it comes to the quality inspection of these highly complex free-form surfaces, tactile inspection methods cannot keep up to par both with regard to time and quality: For the inspection of a single turbine blade, a coordinate measuring machine requires between 30 and 60 minutes, whereby only individual points of the object geometry would have been captured. The PartInspect offers the ideal alternative for this challenging task, delivering highly precise results in a time and cost saving manner.

GE Aviation is worldwide one of the biggest manufacturers of aircraft engines for the civil and military aviation, of jet engines, of jet engine based motors for applications in the shipbuilding industry, as well as of turbine fans. As part of the GE production process, each individual turbine blade is run through a thorough and meticulous quality control procedure in order to verify that the predefined specifications have been adhered to down to the minutest detail. The measuring objects are, for instance, made of titanium, and their dimensions range between a few centimeters to about one meter. The surfaces of the turbine blades can be forged, rolled or polished and are in parts very shiny; yet, an essential requirement of the inspection process it to forego the time-consuming pre-treatment with matting spray.

Measuring system and setup

To ensure a top precision and reliable quality inspection of their turbine and compressor blades, GE Aviation applies the breuckmann measuring system b-INSPECT, the predecessor of the PartInspect. Using this completely self-contained measuring station, the data acquisition of the measuring object is accomplished on the basis of the intelligent combination of Breuckmann’s well proven and long established stereoSCAN system with specific measuring technologies patented by GE. Thanks to this method, the pretreatment of the measuring object with anti-reflection or matting agents can be omitted and its entire geometry, including even most difficult surface areas, can be three-dimensionally captured in a very short span of time. This technique has been developed and specifically adapted to the requirements of the aviation industry by GE Aviation in close cooperation with the Breuckmann head office in Germany and Breuckmann’s sales partner Accurex Dimensional Measurement in the USA. It has since been successfully applied by GE Aviation for the production and quality control of their turbine blades.

The PartInspect operates on the basis of an adapted structured light projector together with a software specifically developed for this particular application. The measuring chamber is readily accessible to easily position the blades for measurement as well as for system maintenance purposes. A robust turn tilt unit allows for the complete data acquisition also in those areas which are very difficult to access; if the measuring objects shall be automatically placed into their measuring positions, the station can be additionally equipped with a six-axis robot. To ensure precise data acquisition results directly in the production environment, the measuring station is dust-protected.
Workflow

The project process consists of two main phases: In the first phase, the measuring system captures the complete object surface and generates a highly precise three-dimensional representation of the object geometry. This step is then directly followed by the quality control phase – if considered necessary, also fully automated – for which a special inspection module for turbine blades is being used (e.g. PolyWorks | Inspector™, Rapidform® XOV/Verifier™ or Geomagic Studio®). The intuitive and user friendly software design offers the possibility to compare complex scanning data sets with the CAD data sets and based on the respective results, to generate conclusive first sample inspection reports or production test protocols. The workflow in detail:

1. Measurement and data evaluation
   - Set-up of the PartInspect, the measuring object and the robot or the turn / tilt unit
   - Automatic digital and spatial measurement of the entire object surface
   - Evaluation of the three-dimensional object geometry and respective visualization
   - Transfer of the 3D data in STL or PLY format to the inspection software

2. Quality inspection
   - Import of the CAD reference model
   - Definition of the inspection criteria: The scanning system is able to evaluate all relevant turbine blade parameters such as concave / convex contour, thickness, chord, twist / warp / stagger, platform and bow. Also evaluated are parameters such as lean & centrality, center of gravity, contour of leading edge and trailing edge as well as the complete blade contour.
   - Loading the three-dimensional scan data
   - Automatic inspection process including reporting through generation of measuring protocols and archiving
   - Visualization of the results as desired, e.g. by means of two or three-dimensional false color representation, tables with nominal values or tolerances

Conclusion

Thanks to the high-standard data quality together with its efficiency regarding the factors of cost and time, computer aided quality control (CAQ) combined with optical measuring technology provides a highly efficient technique to compare the three-dimensional actual data of highly complex objects with the target data of their respective CAD models. Even slightest deviations from the specifications of the production target are swiftly and easily identified, immediately providing the engineer with detailed information for appropriate adjustment measures in order to ensure that the production is executed in full compliance with the predefined specifications.

By using the latest cutting-edge 3D inspection technology in the form of the PartInspect together with a powerful and sophisticated software, GE has replaced the conventional tactile measuring approach with a highly precise, time and cost saving quality control procedure based on a complete surface measuring technique.

This all encompassing inspection method not only results in a much shorter inspection time, but even more importantly, also generates significantly more conclusive and easier transferrable measuring results. The interpretation of these results is instantly channeled back into the production process. Thus it is directly contributing towards any immediate production optimization measures, as well as in the end result, towards the overall product quality of all turbine blades manufactured by GE Aviation.

Contacts / Links

GE Aviation, Cincinnati, Ohio, USA — www.geae.com
Accurex Measurement, Inc., Swarthmore, USA
www.accurexmeasure.com

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AICON 3D Systems GmbH
Biberweg 30 C | D-38114 Braunschweig
tel. +49 (0)531 58 000 58
www.aicon3d.de | info@aicon.de