

## **Tolerance Based Machining and Paperless Machining**

Tolerance Based Machining (TBM) helps companies move their programming to Industry 4.0 procedures and Smart Manufacturing, by providing a solution to the challenges that lead most machine shops to continue using paper drawings.

Moving to paperless machining is difficult because CAD/CAM models rarely include all the information that machinists need. However, with the advent Product Manufacturing Information (PMI) and Model Based Design (MBD), all the necessary manufacturing information can now be added directly to the 3D solid model.

Tolerance Based Machining (TBM), CAM software now recognizes and uses Product and Manufacturing Information (PMI) – such as dimensions, tolerances, and GD&T information – as well as Model Based Design (MBD) data in the 3D model.

By leveraging this information in the 3D model, TBM automates the CNC programming process and helps programmers eliminate the cost of the manual tasks involved when using 2D drawings. The result is a dramatic reduction the time required to generate CNC programs for parts with close tolerances and surface finish requirements.

Tolerance Based Machining reads the CAD dimensions, tolerances, and surface finish symbols and can automatically select the correct machining strategies to meet the tolerance and surface finish requirements. TBM includes support for milled, turned, and mill-turn parts, as well as the ability to read Geometric Dimensioning and Tolerancing or GD&T symbols, ISO 286 designators, surface finish symbols, and conventional dimensional and tolerance information.

MBD data, also known as Product Manufacturing Information (PMI) data, is an essential element of Smart Manufacturing and Industry 4.0. Using a smart digital twin or 3D solid model with dimensions and tolerances provides an unambiguous single source for design, manufacturing, and quality control.

Using MBD and TBM the design and manufacturing information including the dimensions, tolerances, and surface finish requirements are all stored within a single file. As a result, all the CAD/CAM and MBD data is fully associative and the CNC program updates automatically to changes made to the design.

TBM is most effective when combined with other CAM automation tools such as advanced feature recognition and intelligence-based machining. Advanced feature recognition (AFR) recognizes machinable features and adds them to the model so that programmers can utilize the technological advancements of feature-based CAM. Intelligence-based machining takes this a step further and captures preferences and best practices and can automatically generate the operations and toolpaths for all part programs moving forward. This technology is user configurable and allows companies to easily configure the system to fit their specific quality requirements.

With full CAD/CAM integration, feature-based programming, intelligent machining using MBD, and Tolerance Based Machining, CNC programs can now be generated in seconds rather than hours, cycle times can be reduced, production increased, and quality significantly improved.