Deviations modeling in an integrated open source computer-aided tolerancing software

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The control of geometrical variations is a very important task in geometrical dimensioning and tolerancing (GD&T). The defects seen in every workpiece are inevitable and come from the inherently imperfections in the materials, the manufacturing processes used to obtain the final geometry and other environmental variables. In fact, it is not only impossible to manufacture a workpiece of perfect shape but also to measure it without a certain degree of uncertainty.

Due to the complexity of systems nowadays and to the digitalization of the engineering activities, the tasks in GD&T are now performed in computer-aided tolerancing (CAT) tools that are based on the nominal product model that comes from computer-aided design (CAD) software. There exists a reasonable amount of commercial CAT tools like the Functional Tolerancing and Annotation (FT&A), ANATOLE 3D, Quick GPS, eM-ToolMate, MECAmaster, among others, that are fully or somehow integrated to the CAD software like CATIA V5. The proprietary software can be slow on the implementation of new paradigms for product model like the Skin Model and it can result expensive for companies.

The Skin Model was introduced as a central concept in GeoSpelling language and it aims at unambiguously describe and represent the geometrical product information, including the form defects, across the different domains involved in the product development and the different stages of the design process. It can be considered as non-ideal virtual model of the physical interface of a workpiece with its environment. Since it is a theoretical model, its implementation is done through what is called Skin Model Shapes (SMS). For this work, the deviation modeling of the defects was done using Random Gaussian fields that are a type of generalized stochastic process. The integration of the open source environment was achieved using the tools from Politopix and PolitoCAT, both based on the OpenCascade kernel, importing the nominal and discrete geometry from an external CAD software. An example of the generation of SMS using the integrated system is shown in the figures below.

The initial stage of implementation of the platform will be shown. Since it is an open source tool, it allows the user to enrich the deviations modeling with their own routines. Knowing the PolitoCAT is at the base a tool for tolerance analysis using prismatic polyhedra, the user could decide to complete this activity inside the software, or just use it as a deviation modeler.