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Workflow Based Inspection of Geometrical Adaptability from 3D CAD Models Considering Production Requirements

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Abstract : Driving forces for enhancements in production are trends like digitalization and individualized production. Currently, such developments are restricted to assembly parts. Thus, complex freeform surfaces are not addressed in this context. The need for efficient use of resources and near-net-shape production will require individualized production of complex shaped workpieces. Due to variations between nominal model and actual geometry, this can lead to changes in operations in Computer-aided process planning (CAPP) to make CAPP manageable for an adaptive serial production. In this context, 3D CAD data can be a key to realizing that objective. Along with developments in the geometrical adaptation, a preceding inspection method based on CAD data is required to support the process planner by finding objective criteria to make decisions about the adaptive manufacturability of workpieces. Nowadays, this kind of decisions is depending on the experience-based knowledge of humans (e.g. process planners) and results in subjective decisions – leading to a variability of workpiece quality and potential failure in production. In this paper, we present an automatic part inspection method, based on design and measurement data, which evaluates actual geometries of single workpiece preforms. The aim is to automatically determine the suitability of the current shape for further machining, and to provide a basis for an objective decision about subsequent adaptive manufacturability. The proposed method is realized by a workflow-based approach, keeping in mind the requirements of industrial applications. Workflows are a well-known design method of standardized processes. Especially in applications like aerospace industry standardization and certification of processes are an important aspect. Function blocks, providing a standardized, event-driven abstraction to algorithms and data exchange, will be used for modeling and execution of inspection workflows. Each analysis step of the inspection, such as positioning of measurement data or checking of geometrical criteria, will be carried out by function blocks. One advantage of this approach is its flexibility to design workflows and to adapt algorithms specific to the application domain. In general, within the specified tolerance range it will be checked if a geometrical adaption is possible. The development of particular function blocks is predicated on workpiece specific information e.g. design data. Furthermore, for different product lifecycle phases, appropriate logics and decision criteria have to be considered. For example, tolerances for geometric deviations are different in type and size for new-part production compared to repair processes. In addition to function blocks, appropriate referencing systems are important. They need to support exact determination of position and orientation of the actual geometries to provide a basis for precise analysis. The presented approach provides an inspection methodology for adaptive and part-individual process chains. The analysis of each workpiece results in an inspection protocol and an objective decision about further manufacturability. A representative application domain is the product lifecycle of turbine blades containing a new-part production and a maintenance process. In both cases, a geometrical adaptation is required to calculate individual production data. In contrast to existing approaches, the proposed initial inspection method provides information to decide between different potential adaptive machining processes.

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