FAA CRITERIA WHEN USING 3D DATA FOR TYPE DESIGN DEFINITION AND MANUFACTURING INSPECTION

BACKGROUND

The usage of electronic tools for the definition, manufacture and inspection of aircraft has grown rapidly in the last two decades. Most applicants now rely on computer aided design tools to define, configure and substantiate new products. In these situations, the resulting type design data is usually in an electronic format. The efficiency of downstream departments such as tooling, manufacturing and quality assurance can be greatly increased by utilizing this type design in the electronic format instead of relying solely on drawings.

Applicants wishing to rely on type design data in an electronic format must develop and maintain policies and procedures to assure integrity of the type design data is maintained throughout the entire process including all downstream operations that depend on this data for product manufacture and acceptance. This document provides guidance on the content of these polices and procedures.

A consequence of many 3D data sets are parts may not comply with necessary but undefined dimensions and processing requirements needed to establish a production approval. A PC or PMA approval is not possible without defined design drawings and processing details that can be readily and easily used for inspection. The MIDO must establish that the design data are enough to produce conforming parts before issuing a PMA or A PC approval. Before a 3D dataset is used, it must be approved by the MIDO and ACO. (Reference subparts B, F, G, K or O).

PURPOSE

The purpose of this document is to provide guidance to applicants on the usage of Digital Product Definition for FAA certified products.

APPLICABILITY

The current trend for part definition is clearly towards 3D modeling in which the parts are designed in electronic space. In many cases, the 3D models are merely used as a design and manufacturing aids and the final product definition remains a fully dimensioned 2D orthographic project drawing. In these cases, the associated drawings are the authorized type design. The associated computer models may only be used for 'reference only' and cannot be deemed reliable, and therefore are not authorized for final acceptance of product or tools. When fully dimensioned drawings are used as the sole authority for the part definition, the drawing and not the model governs. In such cases, part/tool conformity should be done to the 2D drawings, and therefore, all the necessary data to fully define the part/tool must be present on the drawings. Digital data may be used to manufacture the parts, but the applicant must show the resulting parts/tools conform to the drawings that are the type design. In situations where physical masters are referenced to define features such as mold lines, the master tools themselves become part of the type design or at least the definition required to fabricate these tools is considered type design. The guidance in this document is not intended to be applicable to projects that utilize drawings for type design definition, even thou these drawing may have been produced using electronic means.

However, some applicants have requested to provide only 3D models to define the product without any associated 2D drawings, or at least fully dimensioned views. This would be considered acceptable type design data provided the requirements of FAR 21.31 are met. The 3D models must provide all of the information necessary to define, configure, manufacture, inspect, test and maintain the parts in a consistent and repeatable manner. Tolerances for critical features must be clearly delineated, raw materials must be identified, and material and process specifications must be listed for all processes that require close control to produce consistently sound parts. Many state-of-the-art computer aided design, manufacturing and inspection software package are capable of providing this functionality.

However, special precautions must be taken to ensure the integrity of the data in situations were the 3D data is the sole authority. Methods to control model and part configuration must by documented and followed. Policies and procedures must be in place to ensure the data is backed up and safely stored, even in the event of catastrophic disasters. The released data must be protected from unauthorized changes and dataset naming and configuration control procedures must be in place to ensure configuration control to the resulting parts. In addition, the systems used to inspect the parts to the 3D type design data must be validated to prove that the finished parts conform to the type design data in the master datasets. These policies and procedures must be reviewed, approved and audited by the FAA if an applicant wishes to rely on 3D data for the sole authority of type design data.

The guidance in this document is applicable to applicants/projects that intend to rely on electronic data for the final acceptance of parts/tools.

DEFINITIONS

Authority Dataset – The undisputed source of approved design data that can be used for product/tool manufacture and quality assurance acceptance.
CAD – Computer-Aided-Design – any computer system, program or process used to design, configure and document the product design.
CAI – Computer-Aided-Inspection – any computer system, program or process used to inspect product including Computer Measuring Systems (CMS), Coordinate Measuring Machines (CMM), laser trackers, Computer Aided Theodolites (CAT).
CAM – Computer-Aided-Manufacturing – Any computer system, program or process used to manufacture product including Numerically Controlled machines (NC).
Dataset – a named compilation of related data made accessible on the computer system. A dataset can be a collection of computer files.
Derivative Dataset – A reproduction of all or part of a master dataset that may be required for downstream operations such as CAM and CAI.
DPD – Digital Product Definition – Utilizing electronic format to fully define the product.
Master Dataset – A dataset that contains the original engineering definition of the product, tool or loft surface. This data is typically used/copied by numerous derivative datasets to support the downstream processes.
Native Dataset – A dataset in the electronic format of the system used to produce the dataset (i.e. not translated).
Reduced Dimension Dataset – A dataset which does not include all the necessary dimensions to fully define the product.
Reference Only Dataset – A dataset not authorized for design, manufacturing and inspection.
Translation – the process of converting data from one electronic format to another electronic format.

PROCEDURES

Responsibilities 14 CFR section 21.165 states in part, “It is the responsibility of a production certificate holder to establish and maintain a quality control system for any product, so that each article will meet the design provisions of the pertinent type certificate.” If Digital Product Definition is the sole authority for the type design, then the applicant must provide and adhere to the policies and procedures necessary to ensure that each production article (including accountable tools) produced from the digital data meets the type design. A procedure describing the system for the management of the digital data and DPD must be submitted to the FAA for review and approval prior to certification. The procedure must define the process for storing, protecting, and revising the electronic database. The procedure document must be called out on the MDL with a statement to the effect of "the electronic database must be maintained in accordance with FAA approved revision of procedure document XXXX." The procedure shall also be an integral part of the applicant’s Quality Assurance System. In most cases the applicant’s Quality Assurance organization shall be responsible for administration of the CAD/CAM policies and procedures. The requirements of the CAD/CAM procedure shall be flowed down to all suppliers that also utilize DPD in the manufacturing and inspection process.

Configuration Management

1. The applicant shall have documented procedures to control and maintain the configuration of the entire CAD/CAM/CAI system including all data. The procedures manual must contain at least the following elements:

    a. Responsibilities -

    b. Configuration Management

        1) Hardware - All computer hardware required to support the CAD/CAM/CAI system shall be identified and recorded. No changes to the established hardware configuration shall be made unless authorized by the controlling group. Prior to approval of any changes to the hardware configuration the revised configuration shall be tested in a controlled environment to ensure no adverse effects to data or other systems will occur

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        2) Software - All software used in the CAD/CAM/CAI system for design, manufacturing and inspection shall be identified and recorded including revision/build level. Any temporary fixes (patches) shall also be identified and recorded. The hardware operating system software level shall also be identified and controlled. No unauthorized changes shall be made to the software configuration. All changes shall be controlled and tested prior to usage on the production system. Extreme caution should be exercised before making software changes to ensure no adverse effects will occur to legacy data or the downstream manufacturing and inspection processes. The applicant shall use procedures independent of the software developer to ensure that all software and subsequent revisions accomplish its intended function

        3) Data - All datasets used in the process shall be uniquely identified and controlled. The applicant shall establish and follow written procedures for the formal release of DPD datasets to ensure only authority datasets of the correct revision level are used in the

production and inspection process. In work and obsolete data shall be segregated in secure directories. Data that does no meet the requirements to the DPD QA plan shall be marked as 'reference only' and not used for product acceptance purposes.

c. Traceability - Derivative datasets used for downstream operations such as CAM and CAI, or in the design process, which contain data extracted for master datasets shall be traceable to the original master dataset. An example of this would be tooling datasets which are based on all or a portion of an engineering (product) dataset. In the event that data must be translated from a native format to another format, the resulting data shall be verified to ensure a correct translation. Records of this verification process shall be maintained. Any discrepant translated datasets shall be segregated and flagged for corrective action.

d. Inspection and manufacturing capability – 3D dataset must to completely define part geometry. All the design dimensions, processes, materials, finishes, etc required to produce a product in conformity with the intended type design must be fully and easily accessible by any person that needs it. There shall be little effort in obtaining the detailed design information for the purpose of manufacturing and inspection.

e. When drawing is used to facilitate production, they must call out the dataset for the 3D model including the dataset revision level (which may not necessarily be the same as the drawing revision level). The drawing must include a note that the acceptability of the electronic database method of type design control is contingent upon the company possessing the equipment necessary to measure points in space for conformity determination, and on the company having QC procedures for the maintenance and use of this equipment 3D dataset are mainly used when Computer Aided Manufacturing (CAM) and Computer Aided Inspection (CAI) are developed and used together to produce the part. E.g. simple geometrical machine parts, fittings, etc. The data set must be able to determine that each part conforms to the approved type design and is in a condition for safe operation. Before a 3D dataset is used outside of a Computer Aided Manufacturing (CAM) and Computer Aided Inspection (CAI) system the 3D dataset must:

1) Be shown by a successful conformity inspection that each article can and will be consistently produced to the intended type design and is in a condition for safe operation.

2) Clearly provide instructions, and or specifications that completely define the required dimensions, processes, materials and finishes with sufficient detail to allow repeatability of manufacturing.

3) Clearly and without difficulty present detailed information about fit, form, function, interface dimensional characteristics, inspection and acceptance tests, functional requirements, performance criteria, Etc.

4) Clearly, show in 2D or other type of data all critical dimensions, attributes, etc. (Note: Some 3D data sets have the capability to show all critical and required dimensions, attributes, etc simply by placing the cursor over the view and double clicking on it.

5) Not contain terms, information or the lack there of, which the design details are subject to human interpretation.

6) For other parts, associated 2D drawing for inspection purposes that shows part (e.g. isometric view or other with suitable views and reference dimensions to aid in visualizing the part) and has material callouts, process definitions, tolerances etc. to complete definition of the part.

7) The part geometry can be defined by a tool, as long as the tool is fully defined, controlled. The tool becomes part of the type design data. For example, a molded part may be a product of the tool that is made and inspected to 3D data. Inspection of the tool is essential so a conforming part can be produced.

d. Media Security - The applicant shall use establish and maintain procedures to ensure the integrity and security of all datasets used in the design, manufacturing and inspection process. All controlled data shall be stored in secure environment with read/write and password protection. A backup plan shall be established and maintained to ensure recovery of data in the event of file corruption or catastrophic disaster. The backup plan shall include provisions for remote storage of full backups to minimize the impact of any type of disaster that could occur at the local facility. Encryption protection shall be used when data is electronically transmitted outside the secure facility to prevent tampering of data

e. Produceability and Process Verification - The robustness of the entire CAD/CAM/CAI process shall be verified prior to usage for product acceptance. The applicant must establish and maintain a system that verifies that no distortion of model data occurs throughout the process from the master dataset to derivative datasets regardless of the number or type of translations required during the process. The applicant must provide objective verification that the geometric data used to inspect and accept product is geometrically identical to that on the master dataset used to define the type design. The applicant may use random point verification methods for each and every translation or verify and control the process to ensure stability.

f. Problem Reporting and Corrective Action - The applicant shall establish and maintain procedures to address: reporting problems, investigating and identifying root causes and preventive and corrective actions.

g. Equipment Certification and Calibration - The applicant establish and maintain procedures to address the process for certifying and calibrating all equipment using 3D data.

h. Data Exchange Methods -

i. Training -

j. Audits - The applicant shall establish and implement a plan to audit all aspects of the CAD/CAM/CAI process to assure compliance with the requirements of the polices and procedures. Results of the internal audits shall be documented and available for review by the FAA. All suppliers to the applicant who utilize authority datasets in the manufacturing and inspection process shall also be included in the audit plan. The FAA may include the CAD/CAM/CAI process as part of its review of the applicants quality control system

k. Data Retention - Data maintained by the applicant/TC holder must be made available the FAA for such routine activities as production inspection, surveillance, designee changes reviews, or

for any other reasons deemed necessary by the FAA. It must be recognized that type design records are permanent and may not be destroyed. The applicant has sole authority and responsibility for all digital data and must ensure that the appropriate steps are taken to protect this data. In addition, the applicant must provide easy and timely access to the data to support the FAA mission.

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