The Implementation and Application of the MBPP Technology in Aircraft Development Process

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Abstract. In this paper, the model based technical requirements of MBPP system Implementation plan is put forward by the application requirement analysis of MBD technology in aircraft development process. Then it is described for the application target, application architecture, implementation process and the main business functions of MBPP system. Based on the application example, the application process of the system is also introduces in the development process of certain aircraft, which has some reference value for the development and application of 3D CAPP based on model.

1. Introduction

With the development of CAD technology, MBD(Model Based Definition) technology is now maturely applied on design end of aircraft product at present. With the realization of the design of "three-dimensional model, parametric information, correlation parameters", which supported the rapid development process of aircraft product and improved the efficiency and quality of aircraft product design. With the implementation of digital manufacturing project and the popularization of numerical control equipment on production line on factory manufacturing line, NC machining and NC molding technology has been applied deeply, witch drives other professional processing ability to fast lifting.While CAPP technology witch is the hub and bridge between product design and manufacturing has not taken revolutionary change. It has became a technical bottleneck between product design and manufacturing that 2D CAPP   still plays a leading role and has not adequately came into process expression efficiency, which restricted the development of the whole level of manufacturing end. Therefore,it has become an active demand of current aircraft manufacturing enterprise in the process of new generation aircraft development to develop MBPP system based on 3d modeling process design and planning,to play the technology advantage of MBD and establish the process design line based on model.

2. Research Target

MBD is an entity to express complete product definition with the integrated 3D entity model.It adds various manufacturing semantic information such as product size, tolerance and technical requirements,making full use of the expressiveness of 3D model.It is a product information definition method witch is more convenient to understand and more efficient[1-2].

The process design of traditional CAPP system   based on two-dimensional CAD environment and two-dimensional graphic information has been unable to meet the requirements of rapid development and production of products[3]. Dou proposed a process oriented plan to express and integrate related informations with process tree based on 3D.The efectiness has been verified[4]. Cezary etc. proposed a process planning procedure based on application of the chain codes for description of the part's selected longitudinal cross sections[5]. Liu proposed a a method to achieve to express and manage the

process information simply and efficiently by using working procedure model was proposed[6]. Deja presented a feature-based reasoning approach for generating machining sequences in terms of part setups and the assignment of machine alternatives[7]. The approach has been verified through an illustrative case study using a sample mill-turn part of considerable complexity.

The goal of this paper is to study the construction technology of model-based 3D process system and the BOM reconfiguration,the 3D process planning and visualization of parts and assemblies based on model,forming a MBPP platform based on model driven.Then the key technologies such as EBOM, PBOM and MBOM dynamic evolution, 3D process planning and visualization expression of parts and assemblies in the process of transformation from design model to process model and manufacturing model are solved.

3. Planning of MBPP System
MBPP is a process planning system based on model, using the three-dimensional model as the carrier of process information and the source of information integration and driving the process planning process and the field production process with model[8].

3.1. Overall Framework
On the basis of the existing resource conditions of the enterprise, we can achieve the model driven visualization process through carrying out the research on model-driven 3D process system construction technology and developing 3D MBPP process system independently to support the integration design and manufacturing. Specifically for:

(1)The data between design and manufacturing and based on 3D models is synchronous and unified;

(2)The design, process, manufacturing and inspection for the same data source are concurrent and collaborative;

(3)Organize, contact,transfer and publish the data based on full 3D model;

(4)With 3D BOM as a single data source, BOM reconstruction, 3D process planning and field visualization technology based on model are used to realize 3D digital process planning of full business process;

(5)Multidisciplinary simulation based on full 3D model.

3.2. Requirements of Overall Functional Architecture
(1)Integration of software tools and system encapsulation

Select CATIA software tools and implement seamless integration of software tools and management environment.

(2)Economical and practical

Through the customized development of the system and CATIA software, the function of product structure division and simulation in DELMIA software is realized.

3.3. Service Demand Analysis
(1)Based on model

The result of process design is a related model of comprehensive information, which inherits the design information and expresses the process manufacturing information. The 3D model is the only basis in the manufacturing process.

(2)Cite and extraction of information

The design dimension, tolerance, annotation and annotation information used in process design should be quoted or extracted from the original design model information. Craftsmen do not repeat manual input to ensure the correlation and consistency between the upstream and downstream data, and ensure the accuracy of the changes.

(3)Dominant change

As much as possible to make the implicit information in the design model (such as size) explicit, rather than re-marking the size and tolerance after projection. Use the system function automatic conversion as much as possibly and reduce manual writing and labeling.

3.4. Systemic Architecture and Function

3.4.1. Systemic architecture
Aiming at the application status of CATIA system and CAPP system in the company, this project takes VPM system as the design platform under CAA environment and realizes the model-based working environment supporting the overall process planning and detailed process design through the secondary development, and forms a B/S architecture of three-dimensional MBPP system, which is mainly composed of process data base platform and process design management function component, process business integration management service, client and so on.

The overall architecture of the system is three levels, including data layer, business logic layer and user layer.

Data layer provides data support and access for business logic layer. It is the basis for supporting the operation of the whole system.Using multi-site replication technology, data is copied from the design institute's source database server (VPM server) to the PDM system database on the manufacturing side. The PDM database table on the manufacturing side is consistent with the VPM database table of the design institute, and the process database used for business processing is a multi-instance-based process database designed independently on the basis of reference to the mature design concept of the PDM system and meeting the requirements of the current business processing mode.It is associated with the VPM database on the manufacturing side.

Business logic layer is mainly responsible for the logical implementation of the system.Such as system user verification, login user privilege settings, functional allocation, components of supporting system applications and other compatible system interfaces are implemented in this layer, and they are the supports for user layer to implement business process.

The user layer provides business interface for system users. Users can operate through the functions provided by the interface, so as to complete the related business processing.

3.4.2. System function
On the whole, System can realize EBOM/PBOM/MBOM management, process design management and field visualization management. From the business function, the process of process planning is divided into four work. Firstly, generate factory EBOM synchronously from design data source, secondly, add process routes and process assembly to created PBOM based on the EBOM. Thirdly, according to the assembly position, AO , gradually form the MBOM based on PBOM. Fourthly, compile the corresponding technological procedure.

The first item is using multi-site replication technology to extract the design data of aircraft type (EBOM) from the designing institute's(PDM) system database ,and send it to manufacturing the database server ,and then import the design data of draw to the local database of MBPP system. And ensure the PDM system data of design side and MBPP system data is updated on a regular basis.

3.4.2.1. Model based BOM planning
Based on the model ,System can realize the EBOM to PBOM construction planning and also realize the PBOM to MBOM construction and programming of position . based on the batch process effective management, it realize the associated design change and remind. In the process of lower BOM planning that based on the upper BOM ,it realize the information association and in the process of classification by consumption, it provide a error-proofing remind function.

(1)Building PBOM structure
Based on the EBOM model tree structure, it takes the form of "drag" and attributive adding to form PBOM structure tree. It Contains two main job ,the first is building process combination and split; The second is to add technology division of attribute information .The key technical point is to realize the consumption type division based the model . For parts that have been divided, it reminds on the EBOM according to the color and it can't be second divided. The pipeline packaging pieces of VPM system show on the PBOM clearly after division, and it can automatically generate symmetrical part after analyzing the standard file of the NOTE. The PBOM that has been produced can generate two-dimensional process schedule and related reports according to need.

(2)The top layout of MBOM and AO

Based on PBOM tree structure, it forms the MBOM structure tree in the form of "drag" and attribute adding. it Mainly contains MBOM top stance partition, Parts and standard parts from the PBOM to MBOM stance and AO partition on nodes. Then it form AO matching directory In preparation for the process discipline constitution.The key technical points is to realize the top-down consumption type   divide, PBOM information accurate inheritance and associated, and also achieving pokayoke inspection.

(3) The division of the standard parts

In the process of various BOM refactoring, it need to achieve the standard parts of NOTE file accurate resolution ,and ensure the relevance of its upstream and downstream.

In the process of BOM build, Through the design NOTE file parsing, it add the information that division of labor in the form of route to standard parts that based on the dotted line sets increased, and then Divide it into the PBOM and MBOM structure,   and Divided to different position, different process,   For each standard parts have accurate division of information property.Standard parts that Divided into the AO need to achieve information's quick, automatic label and statistics such as row distance, edge distance, specification, quantity, etc. And it can realize instantiation,   which is Used in the assembly process simulation.

3.4.2.2. Model based process planning

The process of assemblies and parts process plan compiling , is the process of refining MBOM content. it forms AO and FO, and finally form MBOM basted on the model.

(1)The compilation of AO/FO

On the node of MBOM components or parts,   AO or FO is chosen and created. The system will create PPR file of assembly or parts. Based on the structure tree of PPR file, compilation work is performed about AO/FO content, information for work steps, operating instruction, autoassociated frocks, tools and standard parts.

For matching parts that used in each work step, automatically check the integrity of it item by item. For matching parts that used in each work step, the assembly integrity check is performed automatically item by item. At the same time, the used parts are hidden in the model structure tree, automatic checking is also performed for consistency of parts quantity and parts status among EBOM-PBOM - MBOM. Lastly,   the AO/FO editing results are converted into simulation file which is used to perform process simulation to verify the process rationality. Then, it is transmitted to MES for field application.

In the process of FO content establishment, process planning can be generated automatically by recognition part features based on process resource and knowledge base, automatic planning process, and decision-making model can also be formed. It can also be realized for rapid programming, construction of processing unit, selection of cutting tools and related parameters, realizing the automation of whole process of programming.

(2) The design change management

After design BOM have changed, the EBOM of system automatically update, and make changes remind. PBOM and MBOM related personnel according to the prompt for manufacturing BOM change maintenance, and Engineer do the work that changes for AO/FO.Among them, the change description of AO/FO based on model tree structure's parametric expression, and Changes instruction can be output on-demand in the format that two-dimensional procedure change the of the single.

4. The Application Verification of System

The MBPP system that develops based on the above planning ideas has been broadly applied in the course of the development of a new type, and support this type of machine developed by parallel process review, process design, data release, the production site visual production process, providing a good technical support to the type machine's development and satisfy the requirement "good, fast and cheap".

AO/FO and PBOM/MBOM were generated for all the structural parts of the whole machine during the development process. The process data generated in the system maintained an association

relationship with the upstream data, which could be displayed in 3d form or exported in 2d form for application as required.

Finally, inorder to guide the production process,the finalized MBOM and AO/FO will be released to the ERP system and the field execution system respectively Tools for on-site demonstration of process documents based on true model or light model and two-dimensional view are embedded in MES system. After receiving corresponding work tasks in MES system, operators can view corresponding three-dimensional or two-dimensional process documents and carry out corresponding assembly and processing operations in combination with simulation process.

5. Conclusion

Process planning based on three-dimensional CAD is one of the hot spots in the field of advanced manufacturing technology. According to the specific requirements of model-based development and production in aviation manufacturing enterprises, this paper developed a BPP system for process design and process information integration in three-dimensional environment, realized process design and process collaboration mode based on full three-dimensional information related model, and significantly improved the efficiency of process design. The results of the project have been applied in the development of several new models, which has important reference significance for research and application based on three-dimensional CAPP.

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