RESEARCH ON APPLICATION SERVICE SYSTEM OF AIRCRAFT BASED ON THREE-DIMENSION DESIGN PLATFORM

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ABSTRACT

Based on the aircraft application service status and requirements, the paper analyzes the application of CAD technology in the areas. A series of key technologies were achieved including product resource management of three-dimensional model, Service regulations management of aircraft maintenance, computer-aided training and evaluation techniques etc. The overall solution of digital aircraft maintenance services system was proposed and prototype system based on three-dimensional digital model was developed. The application of the prototype system has been verified through aircraft maintenance example tasks. Through the research, design data management service during aircraft development lifecycle management was extended to the aircraft application service.

Keywords: *Aircraft Application Service, Lightweight Model, Maintenance Regulations s, Maintenance Training Evaluation*

1. INTRODUCTION

The technology of three-dimensional design has been widely used in the development of aircraft products and improved the quality and efficiency of it. However, in the area of maintenance, traditional maintenance and training is proceeded according to simplex professional rules and working card, and the workers need 2 years before they are proficiency. As a result, the maintenance service occupies a lot of manpower and material resources of the design and development organization. So, an information platform for aircraft maintenance service based on 3D models is necessary, which brings both challenge and chance to the technology of three-dimensional design.

In mechanical engineering, product-related services are usually considered as an add-on to the actual product. Industrial Product-Service Systems deal with dynamic interdependencies of products and services in production. Research areas cover new concepts and methods which enable the machine producers to design the potential services in an optimal way, already during the development of the machine[1]. For design support systems, the activity modeling system is developed for a complete description of activity with context elements. The PSS function modeling system can support the definition of functions and service providers/receivers and their decompositions. The modified service blueprint system is also developed to address relations among activities and functions. The PSS Design Scape is used to capture and visualize the PSS design process. Sample case example is presented to show the effectiveness of the PSS design support systems[2].

In this paper, the application service system of aircraft based on three-dimensional design platform is built to supply necessary information and operational method for the high-efficiency maintenance service of the aircraft. Thereby the efficiency of the maintenance service will be improved, the cost will be reduced and the extension for the design data management towards the area of aircraft application service in the aircraft products life cycle management (PLM) will be realized.

Section 2 of the paper presents status of aircraft application service. In section 3, we propose function and frame of the aircraft application service system. Section 4 presents several key technology of aircraft application service system. Section 5 gives a conclusion to the whole paper.

2. STATUS OF AIRCRAFT APPLICATION SERVICE

2.1 Requirement of aircraft application service

The aircraft application service mainly involves aircraft maintenance, examination and repairmen, stoppage processing and so on. Existing pattern of maintenance training is simple, low in informatization and lack of unified data management platform of application service (maintenance, training, etc.). The technology manual, mainly existing in paper style, has a lot of drawback and can't supply the need of aircraft maintenance in the condition of 3D digital design and manufacture. Besides, enterprises of aircraft design and manufacturing generally use abroad CAD software due to the condition of technology and cost, and can't be widely used in aircraft application service area. As a result, an application service system based on national 3D design platform is desiderated.

2.2 Analysis of CAD technology application status

Comprehensively considering the present application situation of CAD technology in aviation, as well as the actual need of aircraft application service, the problem that the application process of the CAD technology in aircraft application service must face are as follows:

(1) Lacking of tools to translate aircraft design models, that can translate complicated design models into public and lightweight ones.

(2) Lacking of "safe" visual tools without design information to display products, and reshow the assembly and dismounting process to show the principle of the product.

(3) Abroad CAD software are mainly applied to the aircraft design process. Their size, cost, technology demands for users can't supply the possibility for widely use in application service area.

(4) Lacking of CAD platform with public core that can be deeply secondary developed, which is the bottleneck to develop aircraft application and maintenance system independently.

3. FUNCTION AND FRAME OF THE AIRCRAFT APPLICATION SERVICE SYSTEM

Combined with the status , requirements as well as the rules of the aircraft application service , focused on researching the definition of

maintenance process and maintenance information sharing, based on 3D digital models and national CAD platform, this paper build tools that support digital prototype models lightweight and models translating and editor of product maintenance tutorial. Finally, this paper develop a digital aircraft application service system that supply function of maintenance and operation information release, application feedback information collection and analysis, maintenance task training and assessment, and management of operation and maintenance regulations templates. The function of the aircraft application service system includes:
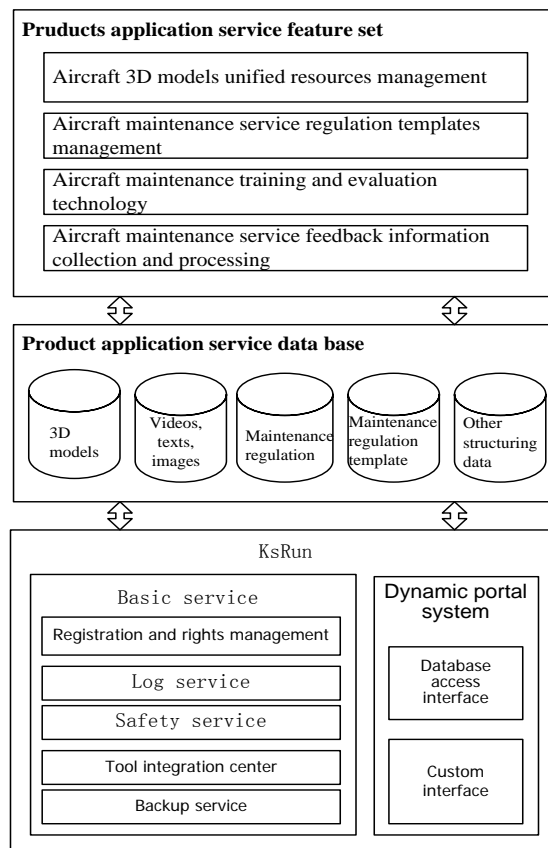

Figure 1: Frame of the Aircraft Application Service System based on 3D Design Platform

(1) Management of 3D models unified resources. It mainly includes development maintenance and loading of model resources of products, tools, and 3D tutorial, translating of models and various browse patterns based on 3D assembly, creation and playback of maintenance process based on lightweight models, management of use rights, settings of system and so on.

(2) Management of aircraft maintenance service regulation templates. It mainly includes description of operation and maintenance process based on

process expression, definition of 3D products operation and maintenance task based on lightweight models, effective organization of information that contains words, images, animations, and 3D models based on improvement and optimization of existing maintenance course production, and development of product maintenance regulation editor based on 3D visual environment.

(3) Technology of aircraft maintenance training and evaluation. Three roles are present in this module: administrators, teachers and students. Students use the system for aircraft maintenance training and aircraft maintenance test, and feedback the problem in the training and test. Teachers manage the content of the courses and tests, and evaluate the maintenance task training. Administrators are responsible for system user management, rights management, creation of training courses and so on.

The frame of the aircraft application service system is shown in Figure 1.

4. KEY TECHNOLOGY OF AIRCRAFT APPLICATION SERVICE SYSTEM

4.1 Aircraft 3D models unified resources management

3D models have large amount of data and low efficiency in online transmission and display, which can't meet the application requirement in maintenance. Aiming at this current situation, this paper does research on technology of aircraft products' information optimization based on present 3D aircraft design platform. Also, this paper developed 3D models transmission and lightweight tools, supporting construction of models and maintenance process. Aiming at the different characteristics of the products' maintenance and design process on 3D model data, this paper raises a data management model including libraries of models, tools and 3D maintenance courses based on multiple type and maintenance models. Finally, this management model achieves unified organization and management of 3D models' data. The frame of the 3D model unified resources management module is as shown in Figure 2.

4.2 Aircraft maintenance service regulation templates management

After defining the standard of regulation template's node data, this paper develop edit and manage function of regulation based on research of key technology about collaborative editing, release, management, check, integration of regulation

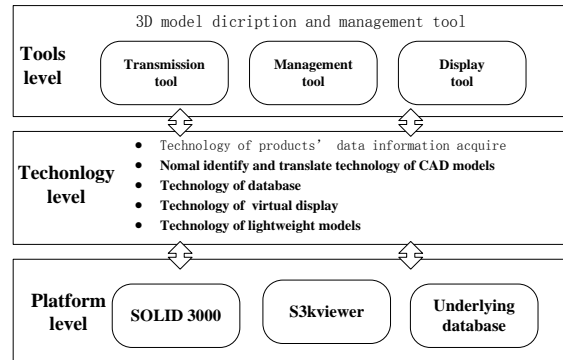documents. The technology research framework is as shown in Figure 3.

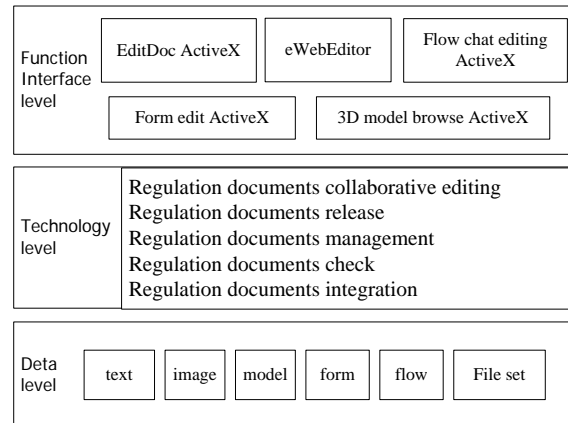*Figure 2: Frame of 3D Models Lightweight Description and Management Technology*

Figure 3: Framework of Technology Research

4.3 Aircraft maintenance training and evaluation technology

As shown in Figure 4, the frame of Aircraft maintenance training and evaluation technology includes four levels. They are interface, function, technology, and data level. At the bottom, the data level is used to store user's information, training courses, lightweight models of parts, test data, user data, test questions and papers, usage record of system and so on. The technology level is used to realize the function and manage the access of function level to database, such as technology of access control based on characters, editing of network multimedia tutorials based on lightweight models, method of evaluating training effect, AJAX interaction technology and so on. The function level supply tools, including course learning, task training, training evaluation, training test, online test, news announcement, course discuss, real-time chat, mail, system settings and so on. The interface level supply rights to users according to

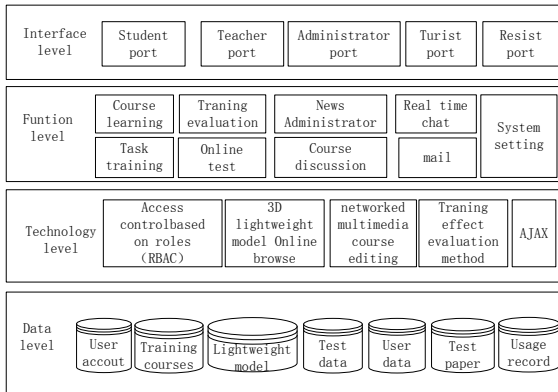corresponding function list, hiding the rightless data and functions.

Figure 4: Frame of Aircraft Maintenance Training and Evaluation Technology

5. AIRCRAFT APPLICATION SERVICE SYSTEM IMPLEMENTATION AND APPLICATION VERIFICATION

Based on Maple Tree, the aircraft application service system is developed on Solid3000 and secondary development API, and it's preliminarily verified combined with aircraft maintenance task.

(1) Model transformation and lightweight

All kinds of CAD files (Catia, SolidWorks, NX 、Pro/E, .x_t, .STL, etc) are translated to S3Kvw by using S3kVwConvert OCX ActiveX. The interface is shown in Figure 5.
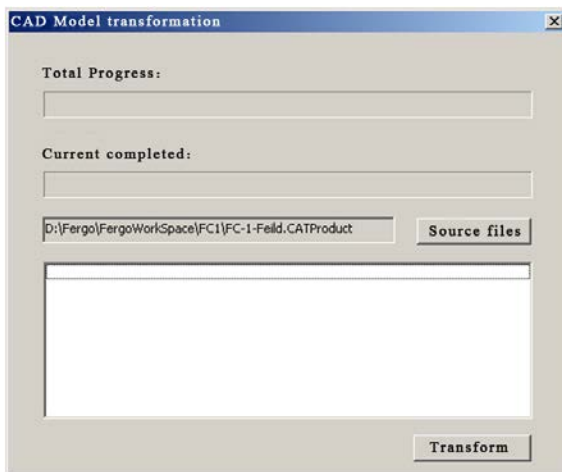

Figure 5: S3kVw transformation User Interface

(2) Lightweight model display

This system implements the function of displaying all views of models and user's interactive view, such as loading, adding various

view mode and text label, editing, rotating, translation, is permitted.
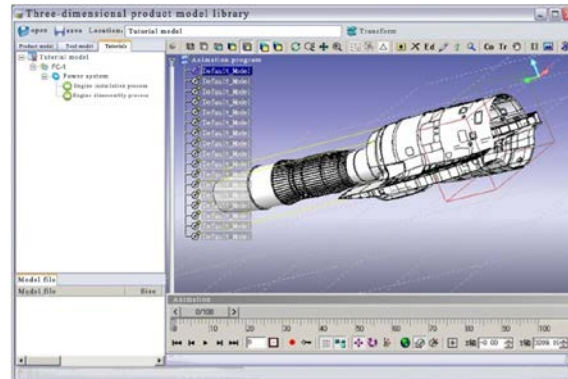

Figure 6: Lightweight Model Display based on S3Kviewer

(3)Maintenance regulations template management

First, the structure of maintenance regulations is defined, that is the nodes it contains and the organization model of it. The nodes include text, image, form, flow, files set and so on. After that, each node is defined, edited to build maintenance regulation template. The definition of maintenance regulation structure is shown in Figure 7.
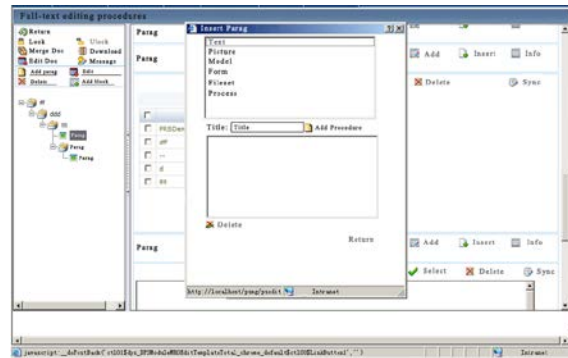

Figure 7: Definition of Maintenance Regulation Structure

(4) Aircraft maintenance training and evaluation

In the login page, the training course and course schedule of the students are listed. The students can click on any chapter to start the maintenance training and the system will record the schedule. In the teacher login page, the training courses that they are in charge are listed. They can click on any courses to the editing page, where they can change the course content and structure, add or change the test, and check all the students' report of the course. The edit page of maintenance course is shown in Figure 8.
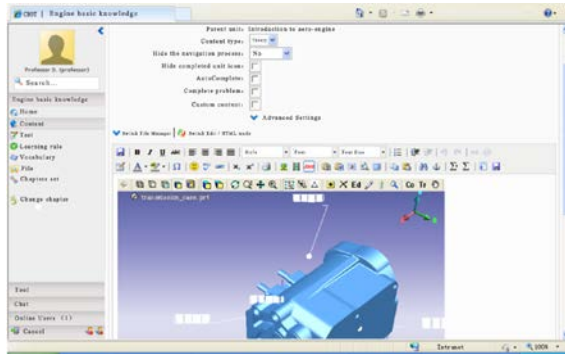
Figure 8: Edit Page of Maintenance Course

6.   CONCLUSION

From the angle of aircraft PLM, this paper raised and implemented aircraft application service system solution based on Solid3000.

(1) From the comprehensive security fields, which is weak in 3D models but strongly needed in application, this paper builds the aircraft application service system based on 3D models and CAD platform. Combing with the standard knowledge of the aircraft application service fields, using creative embedded CAD software application development and integration mode, this system can translate models into lightweight ones, edit maintenance courses, release maintenance information, collect and analysis information of feedback, train and evaluate maintenance task, manage maintenance regulation template and so on.

(2) This system implanted domestic 3D CAD components into the aircraft application system and solved the impossibility of deep develop due to the abroad non-public CAD software. It found an embedded 3D design system development pattern faced specific industries.

(3) Involving a lot of fields of aircraft product, such as development, usage, maintenance and training, the aircraft application service system connect a lot of departments together, expanded the usage of 3D CAD from design, analysis, manufacture to comprehensive security, and make the aircraft maintenance informationalized. Also, it raised a new military aircraft integrated security application mode and provided new application space for domestic 3D CAD software's development.

In addition, a lot of work still needs to be done. such as the efficiency of model transmission and lightweight should be improved further. And Application service system is how well integrated with design system.

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