USING VIRTUAL ASSEMBLY TECHNOLOGY TO DESIGN AND DEVELOP THE ARJ21 BUSINESS JET BASE ON CATIA V5 AND ENOVIA VPM

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Abstract

Virtual Assembly is composed of a series of design activities. It is always covering assembly simulation, clearance analysis, assembly evaluation and information feedback, etc. But, this paper we place the emphasis on design process in VPM. At first, The basic technology of virtual assembly (DPD、CPD、VPM) is analyzed and the method of application of virtual assembly to aircraft design process is described in VPM environment.

1 Background

Since the end of 1980s, with the development of CAD/CAM technology, computer information technology and network technology, America first adopted the aircraft digitalization technology---a revolution of new technology. It is symbolized as full usage of digital definition, digital pre-assembling, digital product design and product data management, concurrent and virtual manufacture. This changed the traditional method of aircraft design and manufacture, which can highly improve design and manufacture level. This technology has been used in B-777 development in Boeing. It has shortened 50 percent of the development duration, decreased 75 percent of the mistake and redesign rate and lowered 25 percent of the cost. This becomes a symbol and milestone of that the digital technology is used in aircraft development.

Faced with continuing competition to develop a high-performance civil aircraft, AVIC1 (The first China Aviation Industry Corporation group) announced a new initiative in June, 2002—ARJ21. AVIC1 concluded that it needed to produce a “21st generation” civil airplane. Being a large aircraft design and research institute in China, FAI also used this technology in ARJ21-700 aircraft development. The first whole aircraft digital mockup has been made in China, which has made great breakthrough in technique. The digital three-dimensional aircraft design should short 40 percent of development duration, decrease 50 percent of the mistakes and redesign rate and lower 30 percent of the cost.

2 The Challenges

This is a great ambition project. But we have to face a lot of challenges. Time is an important factor. To reduce the time required to develop the aircraft—typically a seven to nine year effort that the company had to reduce to four to five years—FAI (the First Aircraft Institute, one subsidiary company of AVIC1) had to transform the ways in which it designed, developed, and delivered a next-generation aircraft. The conventional method was too slow and expensive. FAI needed a new approach for the design on the ARJ21-700. The company is at the cutting edge of technical innovation.

3 The Solution

To win in the civil aviation marketplace, the ARJ21-700 would be based on promising new technology, A systematic, effective product development process is required. FAI elected to work closely with selected business partners to collaboratively design entirely new components

and subsystems in a concurrent, and fully digital way that eliminates physical prototypes.Virtual Assembly is one of the most important key technology during the design process.

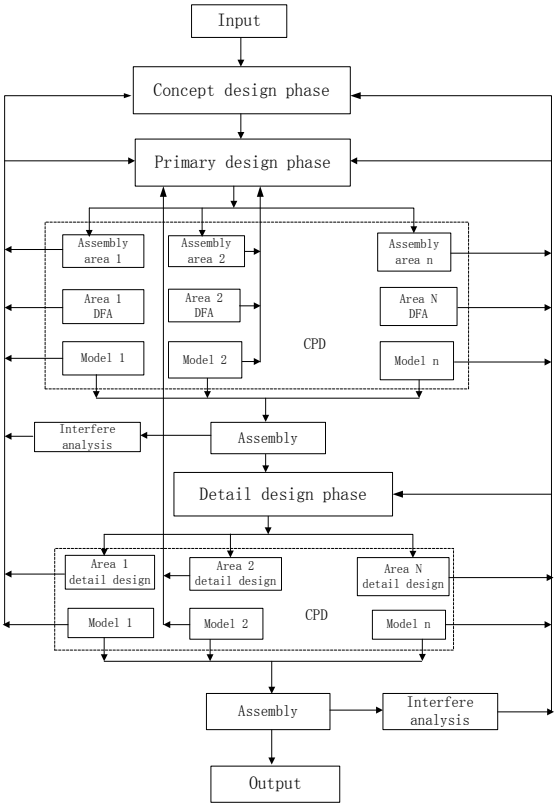

Fig. 1. The Process of Virtual Assembly

FAI and its key business partners, who would be able to cost-effectively, collaborate with one another during the design process based on CATIA V5 and ENOVIA VPM, Computerized models, simulation and rapid prototyping should be used to predict the product concepts behavior and properties early. According to its characters, we divided process of virtual assembly into three design phases.

- ✧ Concept design phase;
- ✧ Primary design phase;
- ✧ Detail design phase.

Virtual assembly provides a platform for collaborative product development base on ENOVIA VPM. This is a platform for process managing. All of the component and subsystem designs that engineers working on the ARJ21-700 project produce. It ensures that the entire aircraft design is under configuration control to retain product knowledge and to reduce redundancy of information.

3.1 Concept Design Phase

Design has been noted to be one of the most important factors for enterprises to succeed in the competitive global marketplace. The wisdom is widely accepted that 80% of a product's cost, size and performance are committed in the first 20% of the design cycle. Concept design phase decided the main the parameter of the design and function of the product. Thus enterprises have to enhance the ability of designing so as to develop cost-efficient and high-quality products. the following works is included:

- ➢ Set up VPM environment ;
- ➢ Layout of structure and system;
- ➢ Creat Master Model space of aircraft .

3.2 Primary Design Phase

Primary design phase is the key of virtual assembly to optimize and control design process of aircraft design. At the same time, It is the key of creating digital prototype also. The following works is included:

- ➢ Define assembly area ;
- ➢ Define 3D solid model ;
- ➢ Assembly and define constraint;
- ➢ Assembly simulation;
- ➢ Stress control .

3.3 Detail Design Phase

In the detail design phase more detailed and sophisticated models are needed completed the whole prortype of aircraft.

- ➢ Making the digital assembling on aircraft coordinates;
- ➢ Checking the interference or other uncoordinated problems;
- ➢ Inform the designers of the interference or uncoordinated problems;
- ➢ Use the new model to digital assembling, until no interference or uncoordinated problems;
- ➢ Approving and release the model.

3.4 Basic Technology of Virtual Assembly

3.4.1 DPD(Digital Product Definition)

Digitalized Product Definition, the first step of the fully digitalized aircraft design, which sets up a digital model of the parts including geometric model, process model, resource model, etc. using related software (Such as 3-D CAD Design software, Process modeling software, Resource Modeling software, etc.). The information described by the definition can meet the digital requirement in different period of product life. It not only defines the digital model of each part, but also their interrelated information between each other. This is the only accuracy model to be used for the later work and period, and can be perfected continually. The single drawing shown to custom becomes an entire digital model containing all kinds of information of the product (include geometric model, process model, resource model, etc.). The aircraft product data becomes the only data resource and master model, so that it is possible to make concurrent product definition.

3.4.2 CPD(Concurrent Product Definition)

Concurrent product development is a process that the aircraft and its design are integrated and concurred. It emphasis that all designers should think over the influence of all related factors in the entire product life from its concept design to its end of life, so that the development can be successful while all the problems are found and solved in the early time. Only when full 3-dimensional digital design is used in product development, and aircraft product definition is concurred by using virtual assembling technology, it is possible that latter design is brought forward. Because aircraft design is a process contains many factors conditioned each other, each factor might influence quality and performance. The ideology and feature of different specialty or study will be shown in aircraft digitalization and aircraft model through developing concurrent product. This is a successful method in aircraft design.

3.4.3 VPM(Virtual Product Development Management)

Whether the digital product definition or virtual assembling and concurrent product development, one supporting platform is needed for the application of all technologies. This platform enables all engineers and managers to deal with the work easily. In the course of the whole development, digital aircraft is the core of the process, which can promote product to be updated and can cooperate with design. It can also provide the drawing of product structure tree to manage geometric model, engineering analysis model, resource model, procedure model parts and its installation to the whole product. This technology can manage and compare different configuration of product. The CAD/CAM/CAE/DMU and virtual product management can be used alternately to optimize design, coordinate the mockup, posit space management, maintain simulation, etc.

4 Application in ARJ21-700

The successful application of aircraft

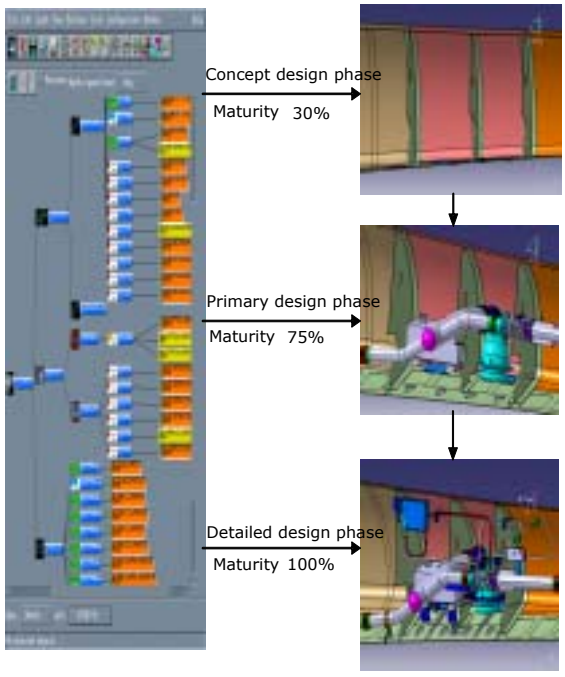

Fig.2. The Application of Virtual Assembly

digital design in ARJ21-700 brings Chinese aviation digital design into a new stage, which shortened the difference with advanced

countries, and caused strong attention in the world. Digital design and manufacture is the only advanced technology for rapidly new aircraft development. The first whole aircraft digital mockup has been made in China, which has made great breakthrough in technique.

5 The Benefit

The implementation of the virtual assembly technologies based on CATIA V5 and ENOVIA VPM at FAI is still a work in progress. The design and development of the ARJ21-700 remains on schedule, and the business jet is on track to reach the critical milestone of beginning test flights by mid-2008. The digital three-dimensional aircraft design has shortened 40 percent of development duration, we hope to decrease 50 percent of the mistakes and redesign rate and lowered 30 percent of the cost.

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