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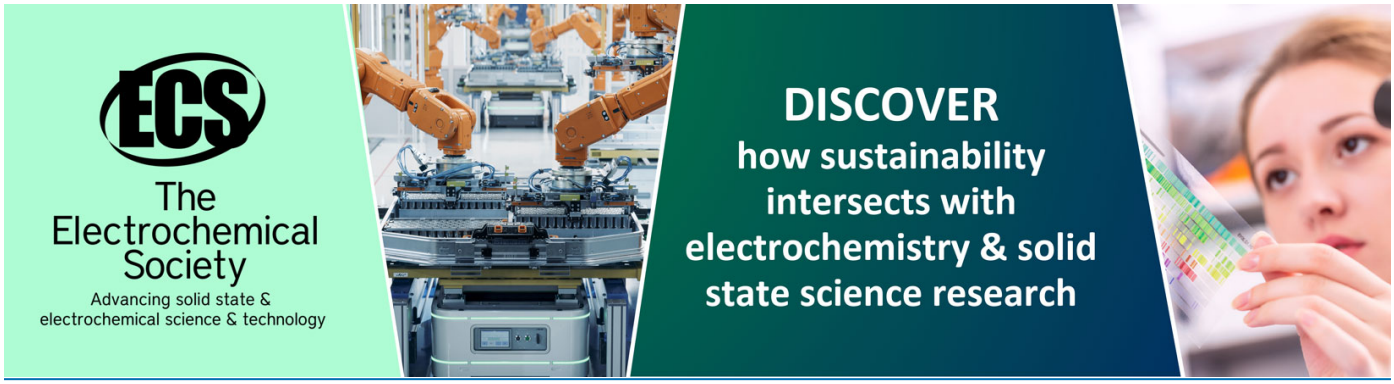

Research on Design Collaboration of Aircraft Digital Mock up for Suppliers

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Abstract. Supplier design collaboration based on digital mock up is an important feature of the globalization and digitization of modern aircraft development. Supplier design collaboration based on digital mock up can organize all design engineers in different locations and time around the world, make them working in a unified design environment. It can overcome the shortcomings of traditional aircraft development, and improve the efficiency of aircraft development and shorten the development time greatly. This article introduces the advantages of supplier design collaboration based on digital mock up, focuses on the classification, general requirements, process and data management of supplier design collaboration based on digital mock up. It provides relevant reference and help for supplier design collaboration of digital mock up.

1. Introduction

With the development of digitization and information technology, the design collaboration of digital mock up for suppliers has changed traditional aircraft development completely. It has transformed the collaborative technology from the physical mock up of the aircraft to the digital mock up, and also transformed the collaborative management from a manual serial process to a digital parallel process. All the partners and suppliers use digital collaborative methods to transfer design information and work results in an orderly, safe and fast manner with agreed rules, and realize the division of labor and cooperation in aircraft development. The design collaboration of digital mock up can enable engineers and engineering companies to work more effectively with all stakeholders in achieving rational agreements and performing collaborative actions across various cultural, disciplinary, geographic, and temporal boundaries [1]. By the means of digital collaboration, the digital definition, digital manufacture and digital management of products can be realized, which can greatly shorten the development cycle, reduce the costs and improve the design quality.

Companies in the aerospace and defense (A&D) industry have a high value business, who need to significantly advance their collaborative product development capabilities[2]. The global supplier collaboration of digital mock up is an important key for technology and business success in modern aircraft development. In the 1990s, the Boeing 777 aircraft implemented digital design and collaboration first. It made about 238 independent teams composed of more than 8,000 people work in

parallel, completed the digital definition of more than 100,000 parts, realized the digital per-assembly of the whole aircraft. It brought huge returns to Boeing, the development time is shortened by 40%, engineering rework is reduced by 50%, design changes are reduced by 93%, design costs are reduced by 94%, and assembly problems are reduced by 50%-80%. on the B787 aircraft, the Boeing built the global collaborative environment (GCE) , it made 135 workplaces, 180 suppliers, and 6000 engineers around the world to design and collaborate efficiently in real time. Each supplier of the B787 aircraft uses the uniform standards for conceptual design, product design, product manufacturing and product support in the same DMU design collaboration environment. The global design collaboration has played an important role in the global production of Boeing 787 aircraft. Among the more than 4 million components of the Boeing 787 aircraft, Boeing is only responsible for about 10% itself, and the rest of the production is all done by the 40 partners around the world. The B787 is the fastest and lowest cost in Boeing history. Airbus summarized the experience of the A380 project on the A350 project, integrated different versions of CATIA and PDM systems used by the different countries and suppliers. It established a global unified collaboration platform and built a global collaborative digital mock up environment. About 4,000 engineers worldwide cooperated in a unified digital platform. Based on the concept of DMU AS MASTER, the A350 aircraft has built about 30,000 digital three-dimensional models and 17 million data links. The design department and the manufacturing department of all the aircraft collaborated on the same digital mock up environment, and greatly promoted the efficiency and accuracy of data transfer between the upstream and downstream of the design. The A350 has realized the design collaboration of global suppliers based on digital mock up.

2. Collaborative Classification

ALL the suppliers involved in the development of aircraft can be divided into Class I, Class II and Class III accordance to the importance of their products which they are responsible for. The Class I suppliers are responsible for products that are critical, complex, have independent functions, endanger safety when they fail, and cannot be fully or economically verified at the time of receipt, such as fuselage, stabilizers, turbines, landing gear, system equipment, etc. The Class II suppliers are responsible for general supporting products and structural parts that may reduce performance in the event of failure and can be fully verified at the time of receipt, such as important mechanical and electrical products, rubber products, forging and castings, etc. The Class III suppliers are responsible for products other than those provided by Class I and II suppliers, such as raw materials, process media, special supply services, etc.

The Original Equipment Manufacturer (OEM) needs collaborate with various suppliers during the whole aircraft development. The Class I and Class II suppliers usually need collaborate with OEM to complete the products which they are responsible for. There are many types of supplier design collaboration of DMU. According to the design collaboration process with OEM, the supplier design collaboration can be divided into: the full process design collaboration, the design process collaboration, and the manufacture process collaboration. According to the aircraft products that the supplier is responsible for, it can be divided into: the collaboration of large section structure, the collaboration of small structure, the collaboration of system pipelines and the collaboration of system equipment. According to the collaboration time of the supplier's design engineers, it can be divided into the real-time collaboration and the non-real-time collaboration. According to the geographical distribution of the supplier's engineers, it can be divided into the collaboration in the same place and in the different places. All the design collaborations need be determined by OEM and supplier at the beginning of aircraft development.

3. General Requirements

No matter what kind of design coordination method is adopted, the OEM and suppliers should confirm the design coordination requirements based on digital mock up.I mainly include:

3.1. Content requirements for design collaboration

OEM and suppliers should define the development phase, related tasks and responsibilities of the supplier design collaboration based on DMU, and confirm the main deliverable and completion standards of each phase.

The whole process design collaboration supplier which collaborate with the OEM from the conceptual design to the manufacture of the aircraft development, it should reach an agreement with the OEM on the main deliverable and completion standards of the DMU at each stage.

The design process collaboration supplier which collaborate with OEM in the preliminary design and detailed design stages of aircraft development, it should confirm the main work completed in the preliminary design and detailed design stages and the completion standards for the DMU model.

The manufacture process collaboration supplier which collaborate with OEM after the detailed design stage of aircraft development, it should complete the work accordance with the requirements of the OEM. And at the same time, They should reach an agreement on the format, version and collaboration platform of the DMU for the collaboration.

3.2. Data exchange requirements for design collaboration

3.2.1. Data format requirements

Generally the suppliers should follow the same CAD model data format of the OEM. If it cannot be unified, the international common format STEP or IGES can be allowed [3].

3.2.2. Exchange frequency requirements

Suppliers should confirm the frequency of data exchange in each design stage with the OEM according to the classification of their own design collaboration. Generally, the frequency of data exchange in the overall plan definition and preliminary design stage should be higher than the frequency in the detailed design stage to meet the rapid design iterations in the early stage.

3.2.3. Collaboration mode requirements

According to the CAD software and PDM system used by collaborative suppliers[4], design collaboration methods can be divided into two methods: platform collaboration (homogeneous collaboration, heterogeneous collaboration)[5] and data package collaboration (design context data package, single data package). The collaboration mode requirements should be formulated according to different collaboration modes, mainly including data reception and transmission requirements, data inspection and storage requirements, etc.

3.2.4. Data permission requirements

Collaborative suppliers will need DMU models for design collaboration, including their own data and the OEM's data. It should formulate Data permission requirements based on the different classifications of supplier. Data permission requirements mainly include data usage requirements and data security requirements.

4. Collaboration Process

The general process of supplier design collaboration based on digital mock up is shown in Figure 1.

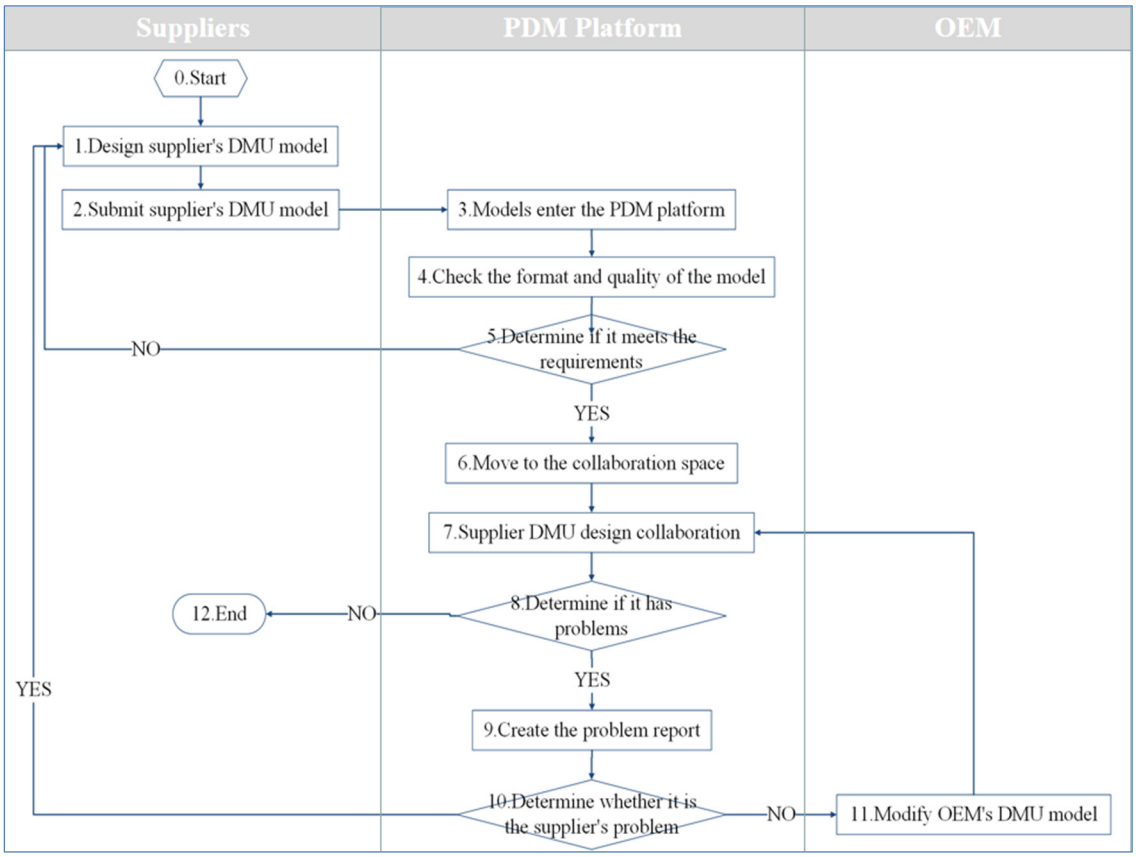

Fig. 1. The general process of supplier design collaboration

The collaboration process mainly include:

- Start
- Design supplier's DMU model
- Submit supplier's DMU model
- Models enter the PDM platform
- Check the format and quality of the model
- Determine if it meets the requirements
- Move to the collaboration space
- Supplier DMU design collaboration
- Determine if it has problems
- Create the problem report
- Determine whether it is the supplier's problem
- Modify OEM's DMU model
- End

5. Collaboration data management

The collaboration data management will be explained by the data management and control use cases between Supplier A, B, C, D and the OEM in the PDM system .

Here we assume that the supplier A: Partner, Structural design and manufacture, Direct access to the OEM's platform. The supplier B: System pipeline supplier, Pipeline design, Manufacture and delivery,Collaborate by using design context. The supplier C: Structural component manufacture supplier,Responsible for the manufacture and delivery, Indirect access to the OEM's platform. The supplier D: System equipment supplier, Responsible for the finished products, Collaborate by using data package. The collaborative data management is shown in Figure 2.

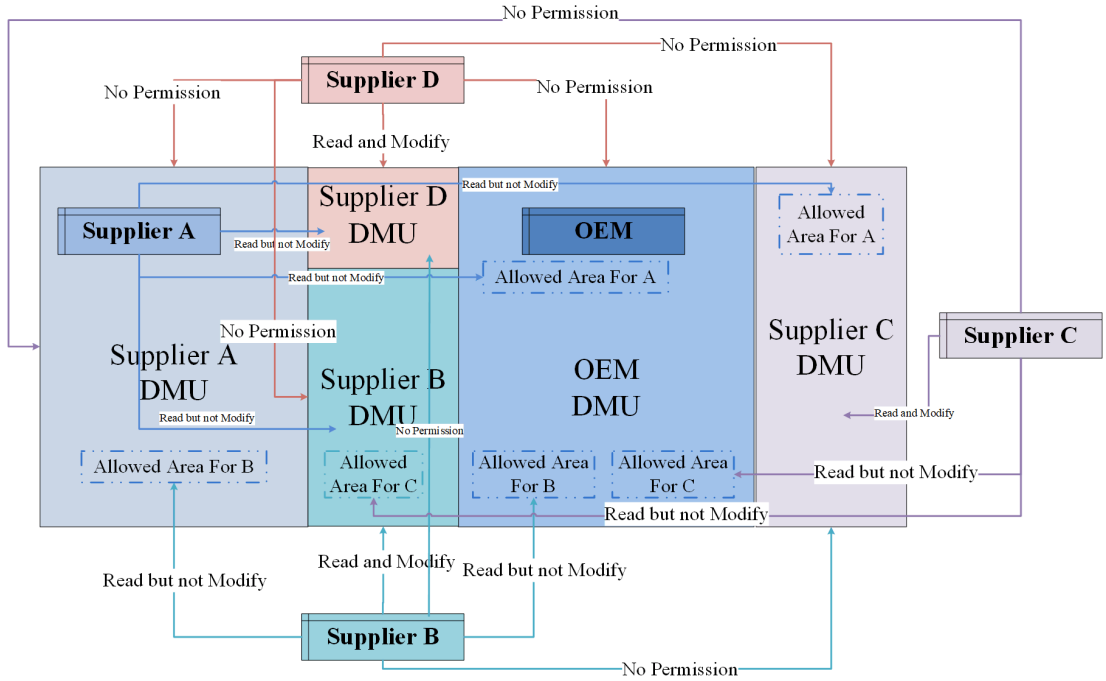

Fig. 2. The collaborative data management

The DMU models of all the collaboration suppliers are managed by the OEM's PDM platform. The OEM has the right to read and use the models of all the collaboration suppliers, but cannot edit and modify the models of them.

Supplier A is the OEM's partner, and has a higher authority to read and use the model of the OEM's DMU. Supplier A can read and use the modes of the OEM with the open permission, and can read and use all the DMU models of suppliers B and D.

Supplier B is the system piping supplier. It can read and use the DMU model which opened by OEM for its own piping designing. According to the work needs and the agreement between two parties, supplier B can read and use part of the DMU model of supplier A. Supplier B does not have permission to read and use the DMU model of suppliers C and D.

Supplier C is the manufacture supplier. It can apply for reading and using the DMU model of the OEM, supplier A, and supplier B within the scope of the work.

Supplier D is the supplier of finished product for system equipment. It only needs to modify and use the model they are responsible for,and has no permission to use and read DMU models of other suppliers.

6. Conclusion

With the increasing complexity of modern aircraft development, the international collaboration will become more and more extensive. The aerospace industry has formed a supplier cooperation system which the OEM as the core and the OEM, suppliers and sub suppliers closely linked. Supplier design collaboration based on digital mock up can organize all design engineers in different locations and time around the world, make them design and development the aircraft in a unified environment. Supplier design collaboration based on DMU enables all aircraft suppliers to collaborate globally under a unified digital platform, method and process to carry out aircraft digital design, manufacturing, final assembly and testing. It has brought a huge innovation in aircraft development.

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