

# Object-oriented Aircraft Assembly Model

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**Abstract :** This paper discusses the relevant information for product assembly model, and built aircraft assembly model based on object-oriented modeling method. Via constructing aircraft general structure object model, paper evolves class model to object model. Paper takes a specific model fighter wing-body docking structure for example, illustrating the structure of assembly and modelling method, the object model of docking structure is built and eventually applied to the development of a particular model fighter digital assembly management system.

**Key words :** aircraft assembly model; assembly process resource; aircraft assembly management system

## 1. Introduction

Different from general machine production, assembly take up 50%~80% of aircraft manufacture work, aircraft assembly play a important part in aircraft manufacture [1-2]. With the wider application of digitized assembly simulation, engineer will be able to advance identify and resolve the components assembly interfere problem or unreasonable assembly sequence and so on, guarantee production assembly quality. The implement of production digital assembly is based on digital assembly model, which describes the basic information of the assembly constituent parts and assembly methods, assembly tools. Assembly model is basic data for digital assembly simulation, also is the basis of assembly planning, simulation, appraisal and other research activities.

So building product digital assembly management system, scientific manage all kinds of assembly-body information, assembly process & resources, promoting digital simulation effect and quality become important work. Now researcher use unified modeling language in software engineering to build production assembly model, so object-oriented assembly modeling method appeared, transforming the attribute information of production parts and resources to formalization description language which can be recognized by computer, the work facilitate software engineer architecture system, greatly improve the efficiency of system development. Scholar Tra [3]etal structure entity-relationship diagram model which with a core of relationship between assembly and assembly resource; Sud [4]builted assembly model based on UML, which expresses assembly relationship, kinematic relation, assembly feature and other assembly information. Object-oriented modeling method not only can express object attribute, the relation among objects, but also help software engineer understand assembly model betterly and design function complete management system.

Based on this, paper researches the basis process of aircraft assembly model building based on object-oriented

method, comprehensively expresses all kinds of assembly information, found relationship between assembly program and assembly resource. Aircraft general structure assembly object model is built, and paper takes certain type of aircraft part for example to demonstrate object-oriented assembly modeling method.

## 2. Object-Oriented Production Assembly Model

UML [5-6] method has become main current computer language for software development. Compared with other methods, object-oriented modeling method has a modular structure, the amount of information-rich, better scalability, ease of software development and other advantages [7]. Based on this, paper uses object-oriented method to build aircraft assembly model, laying the foundation for the development of aircraft assembly management system, realizing digital model integrated management such as digital model share, query, add and delete, promoting the efficiency and effectiveness of assembly simulation.

Production assembly model describes all aspects of assembly elements in assembly work process; it is composed of three aspects of the assembly program, assembly body, assembly resources. Assembly body is a kind of dynamic transition part in production assembly process, and composed of lower level part and assembly body according to fit relationship and connection relationship. It mainly describes what to assembly, namely assembly object.

Assembly program is a kind of bodiless knowledge resource, it mainly solve the problem of how to assembly production, one part maybe has some assembly programs, one program could serves some kind of component and parts, then process program and assembly coordinate scheme are two important component of assembly program. Process program refers to the processes used in the assembly process, such as the various machining process, riveting, screwing and other connection process, etc. Assembly coordinate scheme refers to assembly knowledge in assembly process, such as assembly sequence, assembly path planning, assembly cell division, positioning method determine, and so on. The select and use of assembly resource have a direct relationship with the process used.

Assembly process resource is another significant component of assembly model, it mainly solve the problem of what to use to finish assembly work. Aircraft assembly needs not only all kinds of general equipment, but also a lot of special technology equipment according to different airplane model. That process equipment has an important impact on the assurance of the quality of aircraft parts, limit connection

deformation in the assembly process. Making use of object-oriented method to build aircraft assembly resource model is important. Aircraft assembly process resource class model is shown in Fig.1, according to working process, the model is divided into five categories of resources of transport class, clamp class, connect class, adjustment class, measurement class, etc. Transport class describe mode of transport of component and part between workshop and workshop or in

workshop; clamp class describe the positioning and clamping mode of aircraft part before connection; connect class describe connectors and connection tool used in assembly connection process; adjustment class describe subsequent assembly work, such as complement riveting, painting and finishing in assembly, etc; measurement class refer to measuring instruments used in assembly position, connection, adjustment and other assembly work.

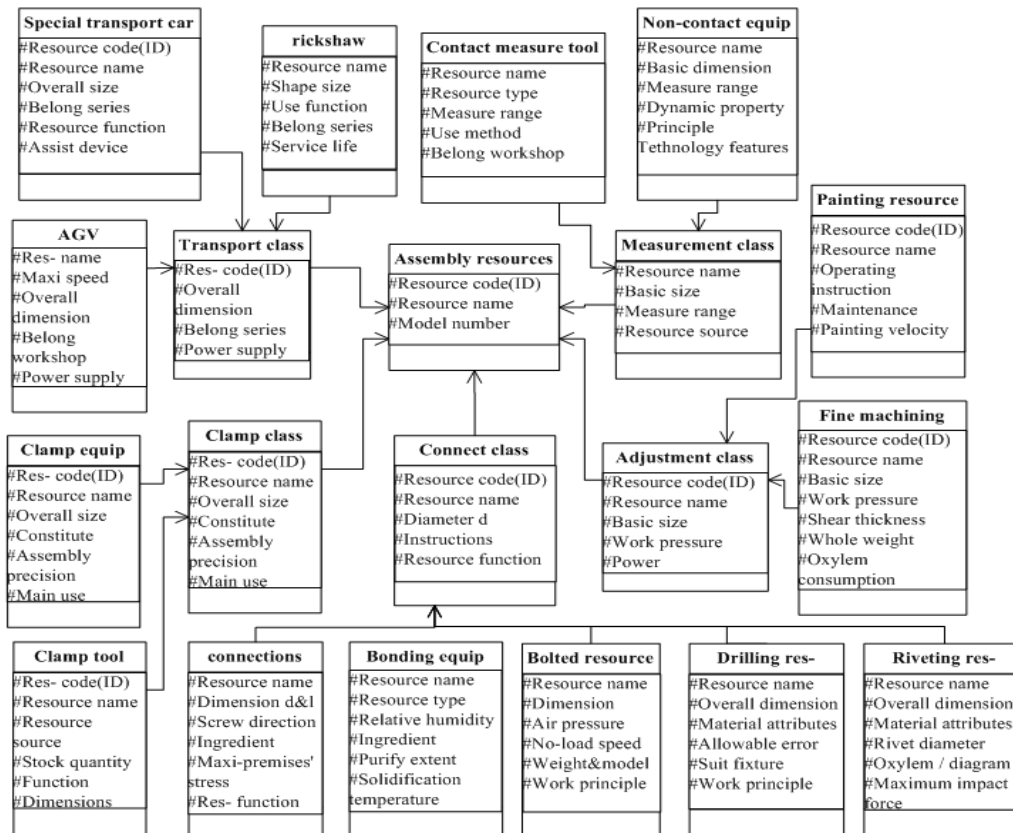


Fig.1 Aircraft assembly process resource class model

### 3. Aircraft General Structure Object Model

Object model describe the relationship between object and object of all kinds of class in certain time, it equivalent to an instance of the class model. Aircraft structure complex, there are a number of large size parts, assembly harmony is high requirement, assembly work is very important. Building digital aircraft assembly system, achieving integrated management of assembly information, assembly structure, process and resource has become necessarily trend of modern aircraft manufacturing, the first step to develop system is building comprehensive scientific general aircraft assembly model.

This paper build aircraft general structure object model is shown in Fig.2. The build of object model realizes the evolution from product assembly class model to aircraft object model, providing guidance method for the build of some certain type of aircraft structure object model. Airplane

assembly is made up of fuselage, wing, tail, engine, landing gear and pipeline and other subassembly. Each subassembly could decompose into multiple next-level assembly and parts. For example, fuselage could decompose into forward fuselage, central fuselage and after fuselage; wing assembly decompose into wing rib, wing beam, wing panel and so on; tail decompose into vertical tail and horizontal tail. Aircraft assembly task is implemented by transport, positioning, adjustment, connection and measurement process, etc, moreover every assembly process are directly associate with the process resource. For example, the bracing of engine is done by engine install car, and engine connect with engine hanger via cone bolts-nuts; fuel tank connect with wing via rubber screw connection way, this process refers to titanium alloy high locked bolts and glue gun, and simply handcart and other resource. This paper mainly thinks about process resource, the class of process resource is listed in the previous section

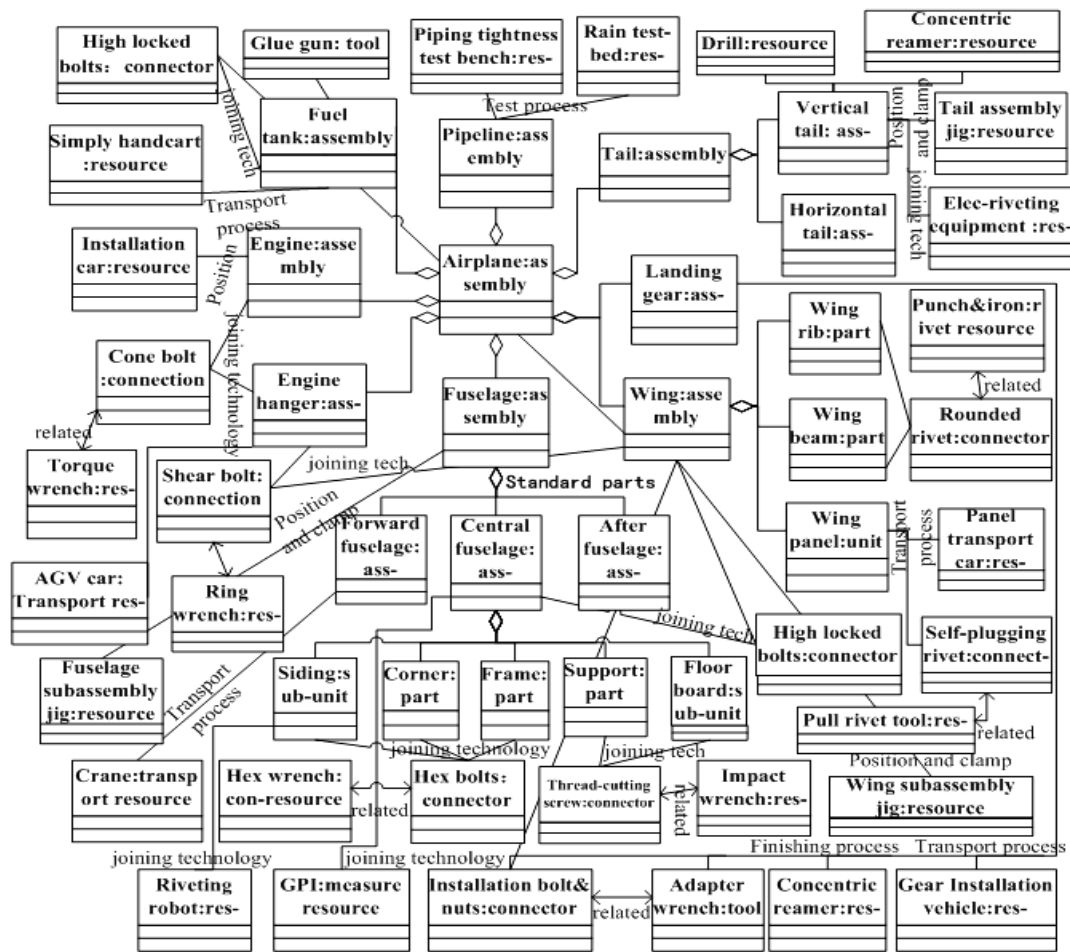
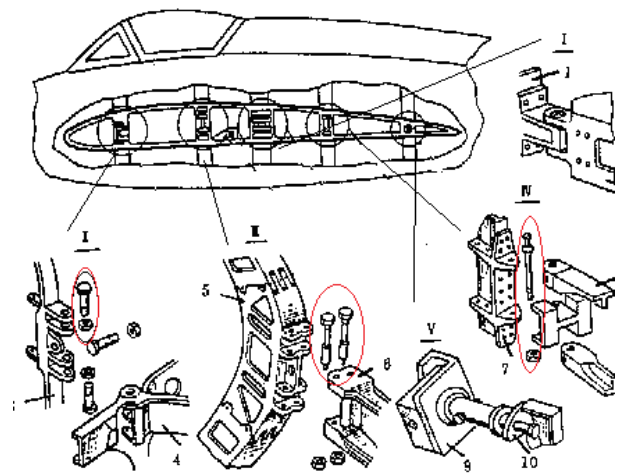


Fig.2 Aircraft general structure object model

#### 4. Implementation Instance

Large aircraft components assembly is the major work of aircraft final assembly section, assembly quality has significant influence on aircraft overall performance, it decides the success or failure of aircraft manufacturing. Paper take certain type of fighter wing-body docking structure for example, to build assembly model, research its structure feature and used assembly resource, it could be deemed to a case of aircraft general structure object model. Fig.3 shows a type of fighter wing-body docking structure, the structure includes fuselage frame and wing beam joint and other parts. As show in the picture, this fighter wing-body mainly assembly together with bolts and lugs. A type of fighter Wing-body docking structure object model is shown in Fig.4. This model describes the wing-body docking structure assembly constitute, and expressing the connection relation between object and object, and assembly resource used by those process.



1—fuselage 13 frame ; 2—wall beam joint ; 3—16 frame ; 4—front beam joint ; 5—22 frame ; 6—main girder joint ; 7—25 frame ; 8—diaphragm beam joint ; 9—28 frame ; 10—flap tracks joint

Fig.3 A type of fighter wing-body docking structure

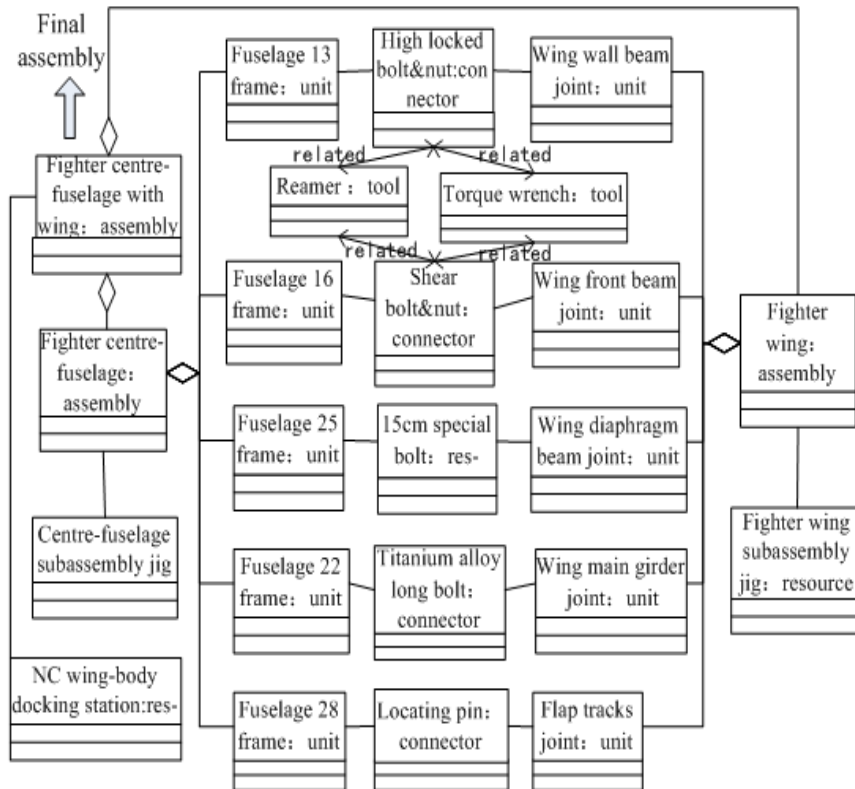


Fig.4 A type of fighter Wing-body docking structure object model

As show in picture 4, fuselage 13 frame component connect with wing wall beam joint via high locked bolt and nut, connection hole is finished by reamer, bolt and nut are twisted by torque wrench; 16 frame assembly connect with front beam joint via shear bolt and nut, and use relational reamer and wrench to assembly component; fuselage 25 frame component connect with diaphragm beam joint via 15cm install bolt; fuselage 22 frame connect with main girder joint via titanium alloy long bolt; fuselage 28 frame component connect with flap tracks joint via locating pin connector. Wing assembly is assembled by wing subassembly jig resource; centre-fuselage is assembled by fuselage subassembly jig. Wing-body docking is finished in numerical control wing-body docking station, at last we get fighter centre-fuselage with wing, next it will participate in large aircraft components final assembly docking.

## 5. Conclusion and Future Work

Paper uses object-oriented method to build aircraft digital assembly model, this model has the integration, development, comprehensiveness, stability and other characteristics, and built a type of fighter wing-body docking object model, verifying the effectiveness of the method. Structuring aircraft general structure object model based on the class model of assembly program and assembly process resource, paper

describe aircraft composition and assembly process of part and specific assembly resources for complete the process, The evolution of the the assembly class model to the object model is realized. The modeling method effectively improves product assembly modeling efficiency. Realizing similar data integration and sharing, and avoiding a large number of data redundancy , paper provides sample for object-oriented method be applied in complex mechanical product assembly modeling.

## 6. References

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