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A knowledge based application for industrialization design

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Abstract

After being designed, a product has to be manufactured, which means converting concepts and information into a real, physical object. This requires a big amount of resources and a careful planning. The product manufacturing must be designed too, and that is called Industrialization Design. An accepted methodology for this activity is starting defining simple structures and then progressively increasing the detail degree of the manufacturing solution. The impact of decisions taken at first stages of Industrialization Design is remarkable, and software tools to assist designers are required. In this paper a Knowledge Based Application prototype for the Industrialization Design is presented. The application is implemented within the environment CATIA V5/DELMIA. A case study with a simple Product from aerospace sector illustrates the prototype development.

Keywords: PLM; Assembly Design; Industrialization Design; KBE; Product Structures.

1. Introduction: Assembly process in aerospace

As mentioned by Mas et al. (2009), engineering projects in aerospace field are characterized by high investments and objectives in the long term. These projects require a thorough organization in the manufacturing processes design and planning. According to Mas et al. (2012), it is essential to improve the methods efficiency. As mentioned by Mas et al. (2008), the assembly process is a key step in any aerospace Product Lifecycle (PL) with near the 30% of the final project cost. As pointed out by Zha et al. (2001), it has high strategic importance because of its impact over the final quality and time to market. According to Mas et al. (2008), the assembly process must

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be carefully planned in the PL phase called Industrialization Design (ID), which includes tasks such as modeling the assembly system dealing with facilities and transport issues; and designing and planning the operations.

As mentioned by Rekiek et al. (2002), the utilization of Digital Manufacturing (DM) tools makes the developing time shorter and improves the Design process and the Assembly Process Planning. In Rekiek et al. (2002) and in Anselmetti and Fricero (2012), DM tools are named as a very useful mean to execute most of the tasks related with such stages. Several authors, Butterfield et al. (2005), Anselmetti and Fricero (2012) and Mas et al. (2012), point out as key characteristics in a CAD/CAM tool, an approach integrated in the PL and the possibility of quickly defining multiple scenarios. Literature shows that the current tools are still insufficient to satisfy the PL needs.

1.1. Definition of Product Structures during the Assembly Design

Several authors, such as Pardessus (2004), Hu et al. (2011) and Mas et al. (2012), maintain that Assembly Design requires a methodology that supports the simultaneous development of ID and Product Design, adequate to represent the Product structure and define the assembly process. As presented by Pardessus (2004), in AIRBUS Military, the methodology for the first steps of ID is based on sequentially defining structures known as Product Model views: As Design, As Planned and As Prepared.

According to Pardessus (2004) and Mas et al. (2012), from specifications, the As Designed view is created, as part of the Product Design. Components are settled according to their functionalities. The first task within ID consists on creating the As Planned view from the As Designed structure, by resettling components in subassemblies which will be made-up in a station in the Assembly Process. Then, Joints between components are defined. Each Joint connects two components that will be coupled in the Assembly Process. The As Prepared view is defined by ordering the execution of the Joints involved in the As Planned sub assemblies. It implies a sequence in the main assembly operations. Fig. 1 shows the most important ID tasks in an IDEF0 diagram.

1.2. Limitations in the Assembly Design using Product Structures Definition

The Assembly Design following the described method presents several improvable aspects. According to Mas et al. (2008), many important decisions are taken without considering some implications, i.e. during the As Planned definition, defining the fuselage and the wings as the first sub assembly to produce may imply transporting it, as a single product, between two locations instead of transporting a smaller subassembly to the first location and, separately, transporting the wings to be mounted. At plant level, if the wings are added firstly, moving the resulting subassembly to execute subsequent operations will require more powerful jigs and cranes.

According to Butterfield et al. (2005), developing the same alternative with an increasing level of detail may make difficult to explore other alternatives to find the optimum configuration. Available CAD/CAM and Digital Manufacturing tools do not provide utilities or modules to guide and assist designers when exploring alternatives and making decisions. From the findings of Mas et al. (2012), the designer must create each alternative separately and manually, the comparison between alternatives must also be manually done.

Rekiek et al. (2002), Butterfield et al. (2005), Anselmetti and Fricero (2012) and Mas et al. (2012b), mention also the limitation related to the need of the product redesigns, which often implies repeating steps in the simulation and planning modules of the Digital Manufacturing tools.

2. Proposed solution

In this section, a solution for improving the Assembly Design is presented. The specific problem is described and then the adopted solution is proposed: the developed application.

2.1. Problem to be solved

The main target is to give the user a wider perspective of the whole project when creating a manufacturing solution for the industrialization of an aerostructure, so the designer can define several alternatives and know the