The Product Design Information Imaging at the Construction Stage in 3D-model Creation Tree

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Abstract

This article devoted to information content of the designed product 3D-model. Possibilities of modern CAD-systems allow creating 3D-model by lots of different ways by basic operation manipulation. This is not only provides 3D-model various design parameters for its representation, but the designed product perceived by differently structure. However, the product as a design object – is a system that has a functional structure, the main attributes system. The functional structure – is a set of elements with a fixed semantic content (assignment) in subject area. The authors propose an approach to representation the designed product functional structure in its 3D-model creation tree in a CAD-system. This approach achieved by a semantic generalization of the basic operations of the system and provides 3D-models maximum information content on the construction engineering stage.

1. Introduction

The designed product informational 3D-image is present its at an enterprise during the manufacturing process. Today it especially clearly demonstrated by CAM-systems popularity. Modern CAE/CAD-systems development

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reinforced 3D-models position in research and development (R&D) stage of the product lifecycle (PL) [1,2]. The consequence is a complete imaging of the product in its operation principle (which provide CAE-system) and technical construction (formed in the CAD-systems) [3, 4]. For the construction design stage the most important and basic information – it is just the product functional structure. The materialization of the functional structure is contained in the construct structure – a kind of design solution at the stage of technical design. CAD-systems is completely determines it by the 3D-model creation process – basic operations sequence [5].

The informativeness of 3D-model is imaging design data required for the current product lifecycle stage [6]. Representation its construct is the CAD-systems basic functionality. Regardless of the creation methods, design solution in the form of 3D-model characterized by the completeness of its construction design, i.e. $\text{Mod}_{\text{prod}} = \text{Constr.}(\text{Prod.})$. Most informative of a three-dimensional model provided with the functional structure of the product imaging. This 3D-model is a fully product component of digital mockup [7].

2. Designed Product 3D-model Information Content

2.1. 3D-model Data Representation

The product is a materialized result of design activities, determined by the initial data in the terms of reference form. The product imaged in the CAD-system by 3D-model – is design solution of construction engineering stage:

$$\text{CAD} : \text{Prod.} \rightarrow \text{Mod}_{\text{prod}}^{3D},$$

where, $\text{Mod}_{\text{prod}}^{3D}$ – designed product 3D-model.

Directly 3D-image is a "consequence" of CAD-system basic operations performing, hierarchically arranged in a 3D-model creation tree [5]. Design product data imaged by 3D-model, is contained in the basic operations constituting the 3D-model structure basis [8].

Within the Constructive Solid Geometry (CSG) technology, 3D-model is a collection of constructive geometry element (CGE), ordered in accordance with the use of Boolean operations to them to obtain the required 3D-geometry. 3D-model by boundary representation technology (B-Rep), images only faces that make up the resulting 3D-body. But CAD-system is stored all information about all built CGE involved in the model creation process [3]. That is, the CAD-system imaging the 3D-model as a process, allowing you to edit any stage of its creation.

2.2. Constructive Geometry Element

Constructive geometry element (CGE), presented in the work [9] under "a feature's" term is an object with specific behavior and the structure of the data. The term is relevant within the CAD-systems: It refers to an ordered set of basic operations, along with the conditions of their implementation, and the restrictions imposed on the values of the parameters describing them. At the present time such a direction as "Feature-based Modeling" is known, based on the presented definition of CGE. Three-dimensional model is a CGE superposition, hierarchically ordered and interconnected by Boolean operations [3]:

$$\text{CAD} : \sum_{i}^{n} \text{GCE}_{i} \rightarrow \text{Mod}_{\text{prod}}^{3D},$$

CGE – is a generalization to the macro level, a carrier a fixed meaning in terms of used CAD-systems functional [10]. These macro functions are implemented by a set of rules and attributes superimposed on the implementation of the basic operations of the system. The CGE main peculiarity is that the macrofunction of its construction is not an abstraction, but action with clearly fixed meaning in the CAD-system – is "geometric model construct element creation". That is, it displays the meaning exclusively in geometry without a physical or other meaning.

2.3. 3D-model System Structure

The product 3D-model structure, as noted above – a structured CGE set. It has the form shown in Figure 1. As designed product example considered sleeve nut from the coaxial connector composition. The 3D-model structure as
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