Methodology for optimizing the structure of associative CAD models

Summary

The dissertation is an attempt at a new approach to the process for optimizing the structure of associative models in Computer-Aided Design (CAD) systems. This process is realized through the implementation of the author's methodology of *Unambiguous Modeling*.

The discussion of issues related to modeling in computer-aided design systems began with the presentation of premises that could confirm the legitimacy of conducting verification research in this area. Considering the current state of knowledge, a research problem was formulated, and the aim of the dissertation was defined, which was to present a new, effective methodology for optimizing the structure of associative CAD models. Next, four theses of the dissertation were propounded, through which the author drew attention to the importance of the input data of the created 3D model and the role they play in this process. In order to place the author's methodology of *Unambiguous Modeling* in the discussed topic, the historical outline of CAD systems was reproduced and the key techniques of creating 3D models in these systems were described. Then, the subject of the author's research was presented in detail, including: a description of the influence of the oriented geometry on the modeling process in modern CAD systems, formulation of the guidelines of the *Unambiguous Modeling* technique, as well as the implementation of this technique to several exemplary CAD models. An important element of the verification research was a successful attempt to implement the proposed methodology to other research on the efficiency of CAD modeling techniques, and thus - to revise their conclusions and establish new ones - considering *Unambiguous Modeling*.

Thanks to the proposed methodology, it has become possible to eliminate the geometric ambiguity characteristic of the oriented geometry used in modern CAD systems, and thus – used in the process of creating 3D models, without involving advanced modules of these systems in this process. To formulate the guidelines for *Unambiguous Modeling* – the *Unambiguity Procedure* and the *Neutrality Procedure*, the author used software tools based on the basic assumptions of each modern parametric CAD system. In this way, the availability of the proposed methodology has not been limited only to users using the most advanced software.

Optimization of the structure of associative CAD models is not a frequent subject of research and development in the scientific and economic spheres. The author made an attempt to draw the attention of these spheres to the above subject by showing the benefits of this optimization. These benefits were revealed during the verification research, in which the geometric transformations of the exemplary 3D models did not have a negative impact on the topological and geometric stability of these models. Thus, the theses propounded at the beginning of the dissertation were confirmed.

Key words and phrases: 3D model, CAD system, oriented geometry, geometric ambiguity, associativity, parametricity, optimization, methodology, procedure

Fields: mechanical engineering