Skeleton-based Generative Modelling method in the context of increasing functionality of virtual product assembly

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Abstract

Generative Modelling methods are becoming more popular. Despite the fast and dynamic development of CAx systems, well-described procedures of Generative Model creation do not exist. The lack of the described systems and their methodologies means that only a small group of engineers have knowledge and experience to create and use such type of models. In this paper, the authors try to highlight two methods of Generative Model preparation. These methods are the results of the authors’ experiences in working with such types of models. The first method is based on cooperation with external models which are input elements into a Generative Model. Input elements (geometrical or parametrical) are one of the most important things in the process of automatic model generation. The second described method is based on an input element in a wireframe form. The paper highlights areas of application and some advantages and disadvantages for each of the presented methods.

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1. Introduction

Continuous and dynamic development of Computer Aided Design (CAD) makes the traditional approach to the design process less efficient and thus it is replaced by new more advanced techniques. An example of those methods is Generative Modelling (GM). This technique has been developing since the 1980s and the idea behind the method is automation of routine design tasks [1]. At the beginning were automated only simple geometrical objects such as a cylinder, a cube, etc. With further development of CAD systems and an object programming language, more
complex objects were automatically designed [1][2][3]. Use of GM techniques allows automatized or half-automatized generation of a CAD model of a part’s feature, a part, or even a whole assembly. In Fig. 1 is shown a flowchart of how the GM works. To enable implementation of the process of automatized generation is a need for Knowledge-Based Engineering (KBE) methods. Use of KBE methods allows the use of design knowledge directly into the model [3][4][5][6][7]. Considering the need for the use of the knowledge engineering technique, the technique of object programming, and advanced modelling technique, only a small group of designers are developing such type of the models. That situation causes a lack of improved and well-described methods of the GM’s preparation [4][6][8][9][10][11]. More information about the GM’s techniques can be found in literature positions [1][2][3][9].

![Fig. 1 The Generative Model flowchart](image1)

### 1.1. The integration of knowledge into a CAD model
To allow proper working of the GM, it is necessary to integrate knowledge directly into the design. This approach makes it so that the GM can automatically and independently do a process of selection and verification and finally generate the CAD model of the proper design solution [1][4][8][10][11]. The process of knowledge integration needs to know the technique of knowledge engineering. The process of knowledge acquisition and formalisation of acquired knowledge into a Knowledge Base or a Knowledge Model form is a time-consuming process whose effects will be seen in the future. The typical process for Knowledge Base/Model creation is presented in Fig. 2 [4][6][8][9][12][13][14].

![Fig. 2 The process of Knowledge Base/Model creation](image2)

To acquire required knowledge, cooperation with an expert in the proper discipline is necessary. It is possible to work directly with an expert or with an expert’s elaborations such as standards, catalogues or professional literature. Knowledge engineers have a challenging job to do because many of experts do not want to share knowledge and experience which they have collected over the years of work [3][6][9][15]. The next problem with the knowledge acquisition process is the approach of the company to knowledge engineering tasks. Usually, a design office does not collect information about finished projects such as what problems occurred during a project, how they were solved, what unique approach was used, etc. That knowledge is lost because a designer may change companies or simply forget what he or she did a few months or years ago. Additionally, it is tough to force designers to do some extra work such as taking notes during the project or keeping up detailed documentation about his/her operations in projects[7][8][10][11]. To input knowledge into a CAD system is necessary to having a proper system and the right modules. For example, in the CATIA system, it is required to have a Knowledgeware module, or Knowledge Fusion in Siemens NX. Also, designers must have advanced knowledge and experience using advanced CAx systems [7][8][10][11].
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