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ScienceDirect
Engineering Applications of Artificial Intelligence 20 (2007) 677–690
Engineering Applications of ARTIFICIAL INTELLIGENCE
www.elsevier.com/locate/engappai

Application of MOKA methodology in generative model creation using CATIA

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Received 9 November 2006; accepted 20 November 2006
Available online 30 January 2007

Abstract

The paper presents the method of generative model creation in CATIA system. The method covers not only the very process of model creation in CATIA system but also the whole complexity of the process, beginning with knowledge identification and acquisition and finally with explanation system creation that facilitates and justifies the usage of generative model itself. The method, in one of its parts, uses MOKA methodology and in particular its informal knowledge model and knowledge representation for generative model, which is special for CATIA.

Keywords: Generative model; Knowledge-based engineering; Knowledge representation; CATIA; Knowledge acquisition; Protégé; Integrated design

1. Introduction

Currently, computer aided design (CAD)/CAM/CAE systems are commonly used in designing in a form of separate programs or integrated systems. Contemporary CAD systems usually use technologies that quite recently formed novelty e.g. parameterization, solid and surface modeling, virtual prototyping, etc. At the present phase of development of these systems, the main focus of interest lies in the knowledge application in designing that would allow further improvement in designing process and designing object—knowledge-based engineering (KBE). By definition (Stokes, 2001), KBE system is a usage of suitable computer software for acquiring and reusing knowledge on a product and process in a possibly most integrated way. The usage of KBE systems is naturally connected with reusing of knowledge that has been obtained from previous projects. Therefore, it is especially beneficial in the case of routine designing, design family or designs that is successive in the natural product development.

Routine designing constitutes one of the basic categories of designing. It is mainly based on repeated actions that form a backbone of a given group of designing processes (designing processes are understood as work on projects within one company, which can be allocated to the same family e.g. designing of various tooth gearboxes).

Tasks that are done in a routine way generally do not cause unexpected problems but they are tedious and thus time consuming and expensive (from economical point of view). According to Stokes (2001), percentage share of routine tasks in designing process represents about 80% (Fig. 1). Apparently, it is an estimated value and final share of routine tasks depends on an individual design. Nevertheless, predominance of routine tasks in designing process is the main reason for getting interested in designing process of KBE systems.

Creation of a good project depends largely on creativity of the designer himself. In other words, in order to have a good project it is advised to devote, in optimal solution, much more than 20% of designing time for creative actions (Fig. 1).

In order to make it possible, it is necessary to reduce time devoted to routine tasks significantly. One of the methods of aiding routine tasks is the usage of KBE technique (Hopgood, 2001; Kusiak, 2000; Stokes, 2001).

Contemporary KBE techniques are used first of all to aid routine designing processes that means that the role of an

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doi:10.1016/j.engappai.2006.11.019

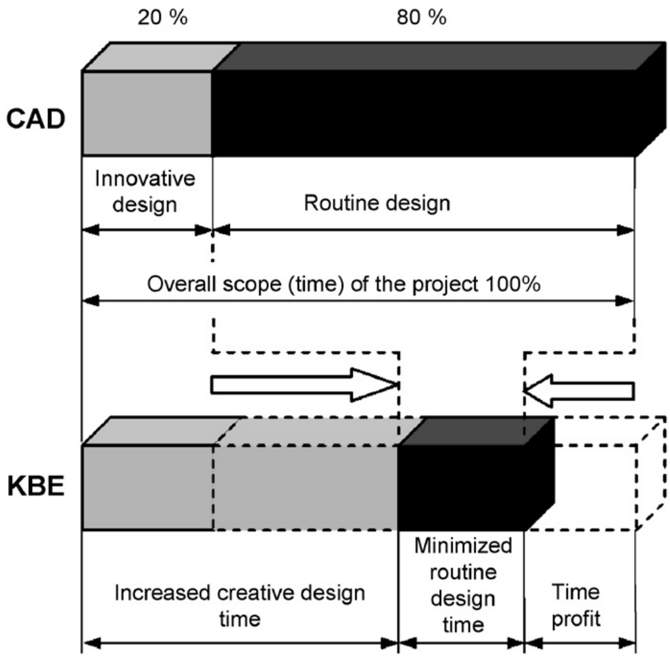

Fig. 1. Influence of KBE usage on time of main design tasks.

engineer in a designing process has not been diminished but only the scope of tasks has been changed, which results in radical change in the amount of time devoted to innovative and creative actions. Assumption that (...) usage of KBE techniques will never substitute human actions (Stokes, 2001) is one of the fundamental assumptions of KBE systems creators.

It is obvious that a scope of KBE techniques is in a way limited. Here are some reasons that stand behind uselessness of KBE techniques in some circumstances (Guida and Tasso, 1994; Stokes, 2001):

- it is not possible to isolate and define particular phases of designing process,
- constantly changing production technologies,
- knowledge on a product or process is for some reason non accessible,
- problem is simple enough to solve it in a simpler way without KBE techniques,
- a company does not want to or cannot or has no need to implement KBE techniques.

Despite studies carried toward formal application of knowledge in designing process, few complex solutions of KBE systems integrating methodical application of knowledge with modern functions of CAD systems (Sandberg, 2003; Revelle et al., 1998) have been created. On the other hand, there is a large group of CAD systems that have relatively big possibilities for representation and knowledge record in a form of ready-for-use functions. Nevertheless, the main assumption for their application is correctly identified and obtained knowledge connected with particular processes and their rules, structural and functional entities of the designer product and their constraints. The lack of integrated methods of knowledge identification, obtaining and storing in the system, which would later be used in a formal way, constitutes the main obstacle for the application of these functions. CATIA (Skarka and Mazurek, 2005) can serve as an example here.

2. Knowledge representation in CATIA system

CATIA system has module structure with specialized functions grouped in module. Knowledgeware module forms a specialized module grouping functions connected with knowledge and allowing to expand design features with knowledge elements. It has some submodules and the most important of these are:

- knowledge advisor,
- knowledge expert,
- product knowledge template,
- business process knowledge template.

They comprise many functions that allow automation of the choice of design features with the use of different forms of knowledge representation by ready made tools:

- Parameters—basic tool to parameterize a component.
- External parameters—to reference features of separate parts.
- Published parameters—defining relations at the assembly level between parameters (similar to constraints).
- Formulas—to reference features in form of formulas.
- Design tables—to determine dimensional families of product.
- Rules and checks—to implement determining product features in conditional way to match rules relevant to the company practices.
- Power copy, user features, document template—enable reuse of entities of product.
- Reactions—which can add a behavior to a component.
- Sets of equations—to solve equations and inequalities
- Scripts.

Additionally, there is a possibility to use extra program tools (CAA RADE, 2006) for model extension created in CATIA system to a generative model.

2.1. Generative model

Generative model differs from geometric model, which is a typical output of advanced CAD system. When geometric model is a model of a designed product with fixed features (dimensions and configuration) then the generative model is a generic representation of the product. Generative model (Fig. 2) is built on the basis of geometric model that is enhanced by the engineering rules that determine the design. It is a kind of application that generates for determined functional requirements which