Computer-Aided Design 37 (2005) 957–966

COMPUTER-AIDED DESIGN

www.elsevier.com/locate/cad

Configurable product views based on geometry user requirements

Freddy Fuxin[a,b,*]

[a]Volvo Truck Corporation, Chassis Strategies and Vehicle Analysis, Dept. 26603-AB2V, SE-405 08 Göteborg, Sweden
[b]Department of Mechanical Engineering, Division of Computer Aided Design, Luleå University of Technology, SE-971 87 Luleå, Sweden

Accepted 20 September 2004

Abstract

This paper describes an approach at Volvo Truck Corporation where geometry users' requirements are utilised to define configurable product views. The paper is derived from a research framework on geometry management. The objective of the research framework is to improve reuse of geometry by providing relevant geometry-based product information, so-called geometric product views, through application of configuration management. In order to provide relevant product views, specific fundamental product information must exist. This type of information will vary depending on the different types of product views. Several examples on product view are presented. The product views are realised by a developed configuration management system, an example of a configured product view is presented as proof of concept. The configuration management system is currently under industrial implementation.

Keywords: Digital product development; Digital mock-ups; Configuration management

1. Introduction

Most companies active in traditional mechanical industries utilize and rely on engineering design processes where the geometry models serve as the backbone for product representation in the early stages. As a result, traditional physical mock-ups are replaced in the early stages by so-called digital mock-ups (DMUs), see Fig. 1. The consequence of such a move is that organisational functions that have traditionally relied on physical mock-ups must have access to a digital equivalence in order to complete their assignments. The geometry models originate from the Computer Aided Design (CAD) environment. Accordingly, it must be recognised that the CAD environment and its geometry generation are both extremely important. Furthermore, product development efficiency depends on the companies' capability to exploit their geometry model resources and to make them available to a much wider audience than the traditional engineering design functions.

Complexity is a term used frequently in many publications. Its interpretation depends on the context. Product complexity can consequently be used to describe a product that is composed of thousands of components, and/or where there exists complicated functional interdependencies between the components that form the product. A high level of product variance is another example, which creates product complexity. Complexity can also have its origin in the coordination of interactions between participating disciplines in the development of new products. The product constitution of a truck makes it complex in the sense that it is made from thousands of components that to a certain extent consist of complicated functional interdependencies. Colours, materials and textures are examples of product variance that do not introduce any alterations in geometric space allocation. Henceforth when the term is used, variance refers only to variance that introduces geometric alteration.

In its early stage, the product development process is characterised by innovation and quick iterations. Accordingly, the rate of evolution for geometry-based product information (GBPI) is high. It is therefore crucial to support the communication of this GBPI throughout the extended enterprise in order to ensure that the organisational

* Corresponding author. Address: Volvo Truck Corporation, Chassis Strategies and Vehicle Analysis, Dept. 26603-AB2V, SE-405 08 Göteborg, Sweden.

E-mail address: freddy.fuxin@volvo.com.

0010-4485//$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.cad.2004.09.022

Fig. 1. Example of configured DMU.

functions are productive. The hypothesis is that configuration management is required to be capable of delivering relevant GBPI to a rich variety of geometry users. The motivation is that high product complexity in combination with all the different requirements of the different geometry end-users makes it impossible to manually provide the necessary GBPI. The key to success is to possess deep insight into what the relevant GBPI is and how it should be created automatically.

The underlying research work of this article has taken place at the Volvo Truck Corporation. A framework on configuration management is under development and this is the result of experiences and conclusions made from real cases. Section 2 gives some more insight into the aforementioned research framework. Section 3 focuses on relevant GBPI, that is the product views that are required by different types of geometry user. Section 4 provides some insights to the realisation of product views by briefly presenting an implemented framework on configuration management. Section 5 is a summary and conclusion on the topics discussed.

2. Research framework

The underlying research material of this article was derived when working on the definition and establishment of a so-called Geometry Management Process (GMP) [8], see Fig. 2. The article is the fourth publication in a row of five, which together will form the GMP framework. The reason for setting up such a framework was the insufficient focus on geometry application in scientific/academic product development literature and the inadequacy of the holistic industrial view of the application of geometry throughout the extended enterprise. Both these drawbacks

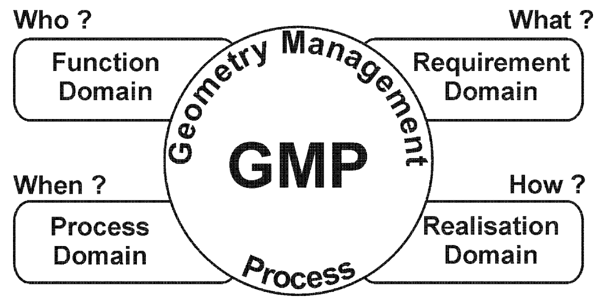

Fig. 2. The principle structure of the Geometry Management Process (GMP).

serve as the objective of the research project, so it is relevant both from an industrial and academic point of view. The objective of the research project is to promote reuse of already created geometry models and in that way to contribute to the elimination of rework.

Rework in the context of geometry models often concerns the difficulty in gaining access to relevant geometry material. The definition of what is relevant can often be traced to some additional type of non-geometric product information that must exist to complement the geometry model. In the GMP framework it is referred to as appurtenant product information, which together with the geometry models constitutes what has been named Geometry Based Product Information, see Fig. 3.

In the effort to systemise and set-up a thorough framework, established methods and tools such as quality function deployment (QFD) and IDEF0 have been applied. The hypothesis has been that the framework is based on four key areas, so-called domains. The contribution of each domain is characterised by the question that relates to each domain, see Fig. 2. Logically there exists a certain chronology between these domains. The chronology is apparent when it comes to answering the questions. The first domain to research was the function domain. It primarily deals with organisational issues and should throw light on who the geometry users are. If it has been established who the geometry users are, the next logical question deals with what their requirements on the GBPI are. Both these domains were addressed in [4]. If it is possible to pinpoint who the geometry users are and also systematically synthesise their GBPI requirements, it is relevant to take process aspects into account, for instance answering the question of when it is possible to support the GBPI requirements of different geometry users. The process domain's contribution to the framework concerns geometric evolution throughout a product development perspective, and the domain is more thoroughly outlined

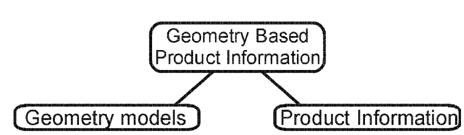

Fig. 3. Illustration of Geometry Based Product Information.