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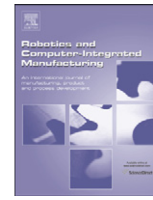

Implementing ISO standard 10303 application protocol 224 for automated process planning ☆

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ABSTRACT

Gashed application landscape and heterogenic systems are still preventing efficient and automated product development. Process planning especially is an important step that determines most of the costs in production or the success of obtaining a potential order. As the step between design and production, process planning is important for manufacturing a product in an economic manner. This paper provides a discussion about necessary requirements for automated process planning and an efficient product development. Additionally we present our intended idea to innovate the product design under the focus of automated process planning. Therefore we present some aspects relating to feature based design, standardized product data representation with ISO 10303 and neutral data exchange with STEP (Standard for The Exchange of Product model data). Relating to this, we are focusing the application protocol (AP) 224 and, because of missing implementations, we reveal our approaches for the implementation of this protocol. This includes the generation of a feature library with the GeneSEZ generator framework that applies the Model-Driven Architecture (MDA) framework developed at the University of Applied Sciences, Zwickau. Another point is the description of an ACIS based library that realizes the visualization of the related geometry. Finally, our implemented EXPRESS interpreter is introduced, which generates necessary files for data exchange with STEP-files. This Design Module (DM) is described in detail.

1. Introduction

Small- and medium-sized enterprises (SME's) are confronted with intensifying globalization, world economic crisis and highly competitive markets nowadays. Customer orientation, flexibility, wealth of variants and getting along with intensified cost pressure are essential factors of success and also great challenges. In Germany, and especially in Saxony, mechanical engineering is one of the most important branches. Therefore we want to focus our attention especially on machining parts because a great plenty of individual variants of customer inquiries are typical in this area. SME's are forced to give cost estimates as fast and exact as possible to obtain potential orders and execute them cost-effectively afterwards. A very fast created or maybe completely generated quotation is only possible, if the same or similar orders were already executed and all required parameters like manufacturing processes, manufacturing effort or accruing costs can be derived automatically. After receiving an order, the offer data, including cost estimates, design and manufacturing decisions, are required again for initializing the manufacturing process. An optimized product development is then hampered by a very heterogenic software landscape caused by different context-dependent applications resulting in different inconsistent product descriptions or incompatible file formats.

For a more efficient product description and interpretation within different application areas modern approaches are focusing not only on geometric product description. The goal is also an enhancement of those geometric models with extended product information and standardized data exchange. Additionally it is pursued to provide complete product information through the entire product life cycle, any information independent from any system, at the right time, on the correct place.

In the area of the product design and product modeling, feature technology is a very promising approach. For our purposes, ISO standard 10303 is covering both issues. It provides a solution for integrating application systems from different areas of the product development and the description of complete, extensible, reusable and interpretable product models. Therefore the standard provides so called application protocols (AP). Each protocol covers a special application area of the product life cycle. In this context we have identified application protocol 224 (AP 224) – *Mechanical product definition for process planning using machining features* – which supports the product description with interpretable features. In this paper we present our ideas about the application of AP 244 for a more efficient product development,

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continuous product data integration and automated process planning. Additionally we demonstrate our approaches for the implementation of application protocols. Therefore this paper is organized as follows: The second section will discuss current problems of product design and product development in short. Feature technology itself and corresponding terms and concepts as well as our intended solution are presented in section three. Finally we present our current work, including concepts for the implementation of application protocols of the ISO standard 10303.

2. Background

The design process is a fundamental stage of the product life cycle for the creation of new products or the optimization of any existing idea. It does not matter how the designer goes ahead, the only important aspect is the result [1]. Furthermore Cross [1] mentioned that most of the design decisions are based upon intuition and subjective experience. In general, those decisions are not part of the design model although they are very important for process planning and creating the product because they consider functional or nonfunctional requirements.

Additionally it is essential to consider the following stages of the product life cycle during the design process. Designers and developers should be responsible for co-determination of the whole process chain and not for the design and development stages themselves. In practice, they do not and cannot consider those aspects [2]. Given the fact that there are several actors during the product life cycle with very different information needs, it is quite obvious that product data exchange and access is a crucial instrument for product development and corresponding application systems. Because of different points of view and different information demands within each context a continuous product data integration is required on the one hand but really difficult to realize on the other hand. Today, because of increasing computing power, products are mostly drafted virtually before their real manufacture. This step can be addressed with computer aided design (CAD) that is done using systems like CATIA, ProEngineer or Autodesk Inventor. They all have their own file formats and are not really compatible with each other. Furthermore the design data is required for later CAx application like computer aided process planning (CAPP) or computer aided manufacturing (CAM). To optimize the entire product development, it is necessary to provide one extensible product model within each application system. Such consistent product data integration is still not supported. Existing information has to be adopted manually, which is very time-consuming and error-prone. In summary, it can be stated that the design model is a fundamental building block of product development, which must be accessible and extensible with different information from different points of view at any time.

Another substantial aspect to be ahead over competitors is the automated interpretation of the design model, e.g. to forecast the feasibility or to give an exact cost estimation. With 3D models you can simulate the construction of assemblies and thus detecting mistakes in the early stages of the product development. Analyzing and calculating expensive parts without producing any expensive prototype is another advantage. For marketing it is possible to create an illusory picture of the finished product although it does not exist yet.

Finally the product model data representation is important for automated process planning. The fundamental geometric data models are limited to the representation of geometry and topology with primitive elements. Solid models like boundary representation (b-rep) support a complete shape definition but there is no opportunity to interpret the resulting shape to derive manufacturing processes to produce the product. Extended product information associated with the geometry like measurements or tolerances has to be modeled using primitives like lines and free text components maybe on different layers [17].

Shah and Mäntylä [14] described the information provided by geometric models as microscopic data at low level. Instead of this, effective product development requires macroscopic high level data, including geometric information. The matter of fact is that we need a complete and extensible product model providing context-dependent information, including geometry and extended product information like surface finish, material properties, dimensions and tolerances.

3. Feature technology

As discussed in Section 2, we require high level product models that can be reused during several stages of the product life cycle and automatically interpreted. Therefore macroscopic data representing the required product information dependent on the current application area for automatic interpretation of the product model is needed. *Feature modeling techniques* are an approach for enhancing the virtual product development. Relating to the geometric description of a part a *feature* can be seen as the definition of a general shape, contour or form. Engineers associate knowledge and properties with features that allow conclusions about their form, shape or function. They encapsulate components of the geometry, which are important for design and product definition. The term *feature* can be defined as follows:

- Features are semantically significant and distinct entities in one or more engineering viewpoints [13].
- A feature is an object for the description of an assembly, a part or a shape with object-specific geometric and semantic properties [2].
- Features are objects for the description of work pieces, which have got functional, geometric and technological properties. They can also present specific application-oriented data like time, costs or physical properties [3].

As shown, there are different definitions for a feature. Finally it can be stated that a feature is a context-dependent named object, whose name implies its meaning, significant properties, function or a resulting form. They are classified as form, tolerance, assembly, functional and material features [11].

For instance, a simple hole can be defined as a design feature object with its significant attributes that are position, direction, diameter and depth. Fig. 1 illustrates a part with some form-defining features. Those high level macroscopic objects support,

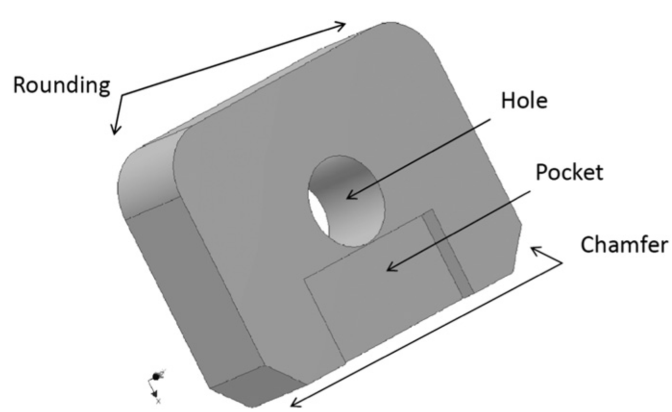

Fig. 1. Feature assignment to part aspects.