Data Exchange in CAD During Iterative Work with Heterogeneous Systems

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Abstract. This contribution is focused on the data exchange during the iterative work with heterogeneous CAD systems. The important cognition is the fact that without an application infrastructure it is not possible to design a universal data format for data exchange which allows mutual transformation of any data without non returnable distortion. The paper shows the data exchange scenarios that help to solve this problem. The proxy management and differential conversion are introduced. The proxy management is based on storing an additional data in the transformed files. The main pillar of the differential conversion is the log of changes and identifiers' mapping. Both strategies are focused on the problems of the cyclic conversions used during the iterative model/drawing creation and both involve the agents that manage additional data structures, which help to correct the data during backward import.

Keywords: CAD, data exchange, differential conversion, iterative work.

1 Introduction

One of the unsolved problems of the collaborative engineering is the heterogeneity of systems and data sharing between them. This contribution is focused on the data exchange during the iterative work with heterogeneous CAD systems. Frequently more than one CAD system is used during a product design – partly by suitability for certain subtask, partly in according to which systems subcontractors and project's participants work. If the product is designed in a sequence of serial phases, it usually is necessary to transform some CAD data in order to be used in another CAD system.

The cases when the development is iterative are frequent. It means the changes from the exported model are again imported to the original model and there usually is very rigorous demand to keep unedited data without changes and to keep the complex quality of the original model. A particular case study follows. Prague, the capital of the Czech Republic, has one global supplier of electric energy. This company has a unified model of the city that contains a map of energetic networks. This GIS operates on the MicroStation CAD system platform. On the other hand the majority of architects and building designers in the Czech Republic use the AutoCAD CAD systems. A problem arises at the moment when the documentation of a connection to an energetic network is processed. The electricity supplier provides the appropriate snippet of the area in DGN format and demands to return this snippet with changes drawn on.

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Because of an automated processing and data quality check-up the strict rules for drawings are defined. The current practice is that there are automated transformations between DGN and DWG formats and also automated additional corrections of them. This scenario leads us to analyse iterative and cyclic data conversions and to generalize of some outcomes. Since in the general more than two CAD systems can be involved in these processes, we have focused also on the idea of generic CAD data format. The paper shows that it is not possible to design any canonical format that ensures loss-less data conversion without a special infrastructure. It introduces an extension of this idea, called proxy management, which shows the way to solve this problem. In the following there is presented so-called differential conversion, that tries to reduce the influence of cyclic conversions between two CAD systems. The basic principles are the identifier mapping [1] and logging of changes.

2 Generic CAD Data Format

There have been several more and mainly less successful attempts to enroot a generic data format. DXF [2], IGES [3], complex STEP and its application protocols [4] and many others can be given as an example. Some of these formats are tightly coupled with particular technologies (e.g. DXF with AutoCAD), which predetermines them for the data exchange between one product and the rest of the world. The others (e.g. STEP) try to establish a canonical data format, that is neutral, focused both on the data exchange between heterogeneous systems, and also on data storing in longer term than is expected lifetime of a CAD system in which the data was created. It is obvious that the goal of generic format is the possibility of loss-less transformation from/to *any* CAD data format. The situations when only one-way transformation is needed exist (e.g. electronic publishing into PDF), but those are specific cases, that cannot be used as the basis of general data exchange mechanisms. In addition to demands for both-way and loss-less transformation is reasonable to establish the demand of unambiguousness. For instance, in a data format of one CAD system a rectangle can be represented either by RECTANGLE entity type or by four entities of LINE type. However the different representation can hide different semantic meaning, defined for example by 3rd party application, by enterprise standard and so on.

Let's define the data transformation as

$$f : X \to Y , \tag{1}$$

where the X is a set that represented the domain of a source format and the Y is a set that represented the domain of a destination format. Then by aforementioned reasons is demanded that

$$\forall X' \subseteq X \text{ is } f^{-1} \circ f(X') = X' \tag{2}$$

and

$$\forall Y' \subseteq Y \text{ is } f \circ f^{-1}(Y') = Y' . \tag{3}$$

That is bijection.

If it is possible to find two CAD systems A, B with inner data representations X, Y, for which the generic format G is intended, such that the transformation *f* defined above does not exist, it is not possible to find the following transformation: