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PRODUCT DATA AND KNOWLEDGE INTEGRATION

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Summary

A major industrial challenge in computer-supported product development today is to establish corporate development across enterprises. Corporative distributed product development and engineering processes require an extensive use of advance information technology. The support to distributed processes and to the management of distributed product data and other engineering information resources is of special importance. This article describes an approach to the integration of the product information and product knowledge management using the proposed information model of product which complies with the STEP (ISO 10303) international standard. The proposed model of product knowledge and data information (PKDIM) is shared between interoperable IEE modules.

Key words: *design knowledge, product data, XML, STEP*

INTEGRACIJA ZNANJA I PODATAKA O PROIZVODU

Sažetak

Najveći dio današnjih zahtjeva industrije u području računalne podrške procesu razvoja proizvoda odnosi se na podršku istodobnom inženjerstvu. Razvoj proizvoda i drugi inženjerski procesi distribuirani između tvrtki zahtijevaju uporabu naprednih informacijskih tehnologija. Pri tome je od posebne važnosti podrška distribuiranim procesima kao i upravljanju distribuiranim podacima o proizvodu. U članku je opisan pristup integraciji upravljanja informacijama o proizvodu i konstrukcijskim znanjem uporabom informacijskog modela zasnovanog na međunarodnom standardu za razmjenu i upravljanje informacijama o proizvodu ISO 10303 – STEP. Predloženi informacijski model konstrukcijskog znanja i podataka o proizvodu koristi se u kao osnova za izgradnju integrirane inženjerske okoline (IEE).

Ključne riječi: *konstrukcijsko znanje, podaci o proizvodu, XML, STEP*

1. Introduction

A major industrial challenge in computer-supported product development today is to establish corporate development across enterprises. Corporative distributed product development and engineering processes require extensive use of advance information technology. The support to distributed processes and to the management of distributed product data and other engineering information resources is of special importance. To link numerous engineering activities such as product design, product analysis and design process planning, an information infrastructure is required. Information infrastructure should describe, represent and exchange the design knowledge and the product information across the network [1].

Existing definitions of information, data and knowledge become inconsistent when examined in relation with each other [2]. Data are often described as information in numerical form or as one or more symbols which represent something. Information is described as data within a context. Confusion arises because definitions of data and information often refer to each other. In general, definitions of information distinguish information from data through a context, implying that this context is present within information and not within data. Data, information and knowledge are relative concepts and they cannot be defined in absolute terms.

Knowledge and product information should be shared among enterprises. When communicating with each other, enterprises may not speak the same "language" or understand particular design solutions adopted by others. This is recognized as an issue that must be addressed. The integration of product information and knowledge management based on a common information model within a distributed system environment lends itself to an integrated engineering environment (IEE) (Figure 1).

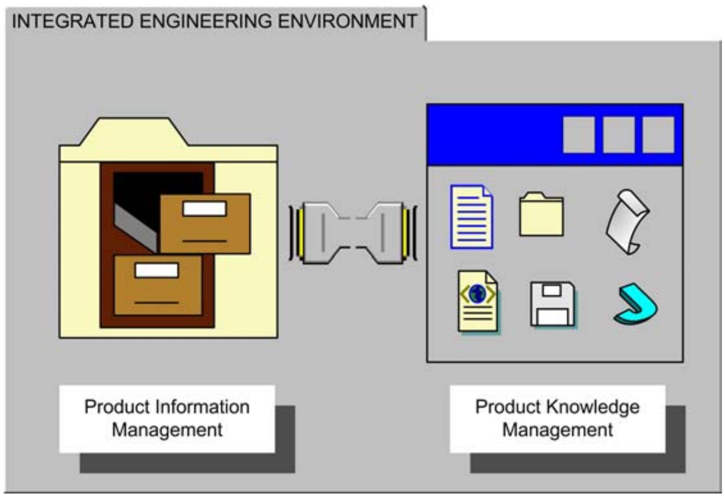

Figure 1 Integrated engineering environment

Slika 1. Integrirana inženjerska okolina

This article describes an approach to the integration of the product information and product knowledge management using the proposed information model of product which complies with the STEP (ISO 10303) international standard. The proposed model of product knowledge and data information (PKDIM) is shared between interoperable IEE modules. Each module can view and extract the specific product information and knowledge required in its context, and is able to process that information. The flow of information and the expected usage of the IEE are determined by the use case approach.

2. Fundamentals

The proposed information model of the product is used as the starting point for considering the Integrated Engineering Environment. Information model is created from two parts. The first part is the model of the product structure based on the STEP standard. The second part is the extension of that STEP product structure with entities that describe the knowledge used in the process of product design. The product design knowledge will be used not only by the actual designer but also by other subjects involved in different phases of the product life cycle. So, this means that the data must be shared and exchanged between various subjects in the product life cycle.

Due to the generic nature of XML technology and its flexibility that results from its descriptive power and the fact that XML provides all essential facilities for implementing STEP data models, the XML is used as a means for implementation of the proposed extended information model.

XML provides all essential facilities for implementing STEP data models. Currently the major use of XML belongs to the field of data transfer and communication between applications [3], although STEP is still better aimed at modeling the engineering needs for information.

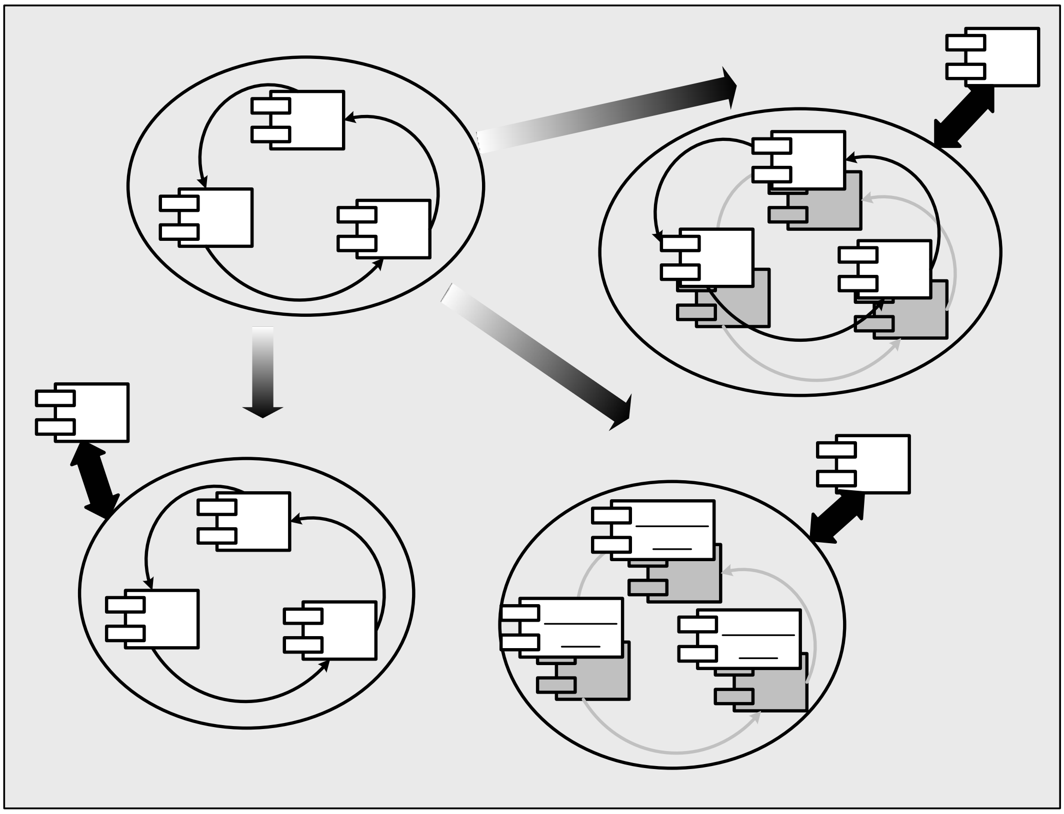

Figure. 2 XML as global IT framework

Slika 2. XML kao globalna IT okolina

The basic advantages of binding STEP and XML for product data integration are:

- Data exchange requires an "agreed" data model. In this case the semantics of the information is defined via STEP compliant scheme of the proposed extended information product model. Based on STEP standard, the rules for defining the structure and syntax of elements used in the appropriate XML file are determined.

- XML aims at the separation of data and presentation. Using this functionality the same product data (e.g. physical product structure) can be presented in different ways, which is of special importance in heterogeneous product development environments.
- The full integration of product knowledge and structured documentation in product data management systems can be achieved.

The XML provides a global IT framework for the information exchange between existing information systems and for migration between future and existing information systems, thus enabling the coexistence of inherent information systems with the on-demand conversion
(Figure 2.).

3. Extended product information model

A product information model is defined as information model which provides an abstract definition of facts, concepts and instructions about the product. As described in Figure 3, the elements of the proposed extended product information model are entities that describe the following [4] [5]:

- Information binding product data carriers.
- Physical components of the products and structured documents have been identified as major product data carriers in a development process in engineering. These documents could have a further internal structure as well as physical assembly. Hierarchical breakdown structure is a fundamental property of product data carriers. This describes how the product is divided into components, which are in turn divided into subcomponents. Such a structure illustrates the relationships between constituents. Another important property of product data carriers is versioning. Versions are mainly used for two basic concepts. Firstly, version can represent the evolution of product data carrier through successive stages – revisions, or represent a number of parallel alternatives – variants. The third property of product data carriers that has been considered is data status. In design environment, the information, which is stable, consolidated and proven, is treated in a different way than the information that is tentative, untested and possibly incorrect.

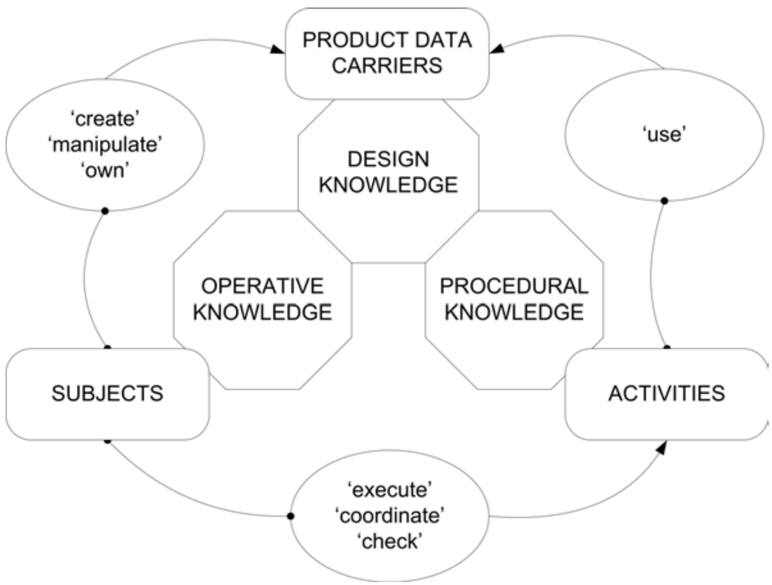

Figure. 3 Knowledge and product data information model

Slika 3. Informacijski model znanja i podataka o proizvodu

- Information relating subjects that create their own data and manipulate product data.
- The subjects' information describes users (project leaders, designers, administrators, etc.) and defines organization of development teams within design tasks (projects).
- Information relating activities coordinated by subjects, in which the product data are consumed.
- The main activities in product development process are: management of hierarchical structure of product components and documents, engineering change management, approval and authorization procedures, design process documentation and history, design tasks assignment and product configuration processes.
- Information binding design knowledge.
- The information generated during a design process can be divided, depending on its structure and format, into: geometric information (geometric description of the product), information about documents (instructions, standards and recommendations), information relevant to inference engines and information about external programs and procedures (calculations, simulations, control).
- Information binding procedural knowledge.
- Information about storage and access protocols, and information required for the design knowledge management and manipulation are the key elements of the procedural knowledge.
- Information relating operative knowledge.

Knowledge about the knowledge, particularly about the design knowledge must be addressed and dealt with. The role of the user and his permissions to alter the design knowledge data must be managed. Also various levels of security can be imposing on design knowledge generated during the design process.

4. IEE architecture

In the IEE system two different subsystems may be identified: product knowledge management and product information management. The former deals with geometric information and the information related to geometric FBD model on a higher level, and the latter deals with the data about the product these. The fact is that both of this subsystems share data about the product at some level. So, the approach used as the ground point in considering the IEE system is information sharing. The user can start using the IEE system for any of two subsystems and achieve the same goal.

Depending on the data the designer has about the product, he/she can start creating an abstract structure of the product and attaching all the non geometrical information about the product, create technical documents or geometric representation models. This approach is similar to Top-Down design paradigm. During the process of building the abstract structure of the product, the designer can add knowledge relevant to product development available to him/her at the time. All the information the designer attaches to the product will be available to him at later stages of product development, e.g. embodiment or detailed design. In another approach, the designer can start with the creation of physical representation of the product, e.g. geometric FBD model.

During the process of creation of the geometric model of the product, the designer can create new or attach the existing information about the product. It is presumed that the designer in the process of creation of the geometric model will create information about the product relevant to this development stage, e.g. the information about parameters, material used, design decisions, design rules. In other words, the designer will create knowledge repository about product design. Except for the information relevant to the design of the product, the designer can create the information about the product that is at a higher level of abstraction.

The information required or generated in either subsystem will be transferred to and from the storage as the XML document. In that way a neutral format for data exchange is ensured, so other tools needed in daily work of a designer can create or retrieve data and knowledge.

Of course, simultaneous access to the data and knowledge shared between different product components or different products must be enabled. This requires the user access level control and the security system.

5. Product knowledge management

The product knowledge management part of the system consists of:

- Design knowledge management module which controls the process of creation, removing, viewing and usage of the design knowledge. It ensures validity and integrity of the created knowledge. Depending on the user's role and rights, it enables his/her access to the specific method for knowledge manipulation.
- Operative knowledge management module which handles the auxiliary data about the design knowledge, e.g. user, data and time, security levels, access rights etc.
- Procedural knowledge management module which includes all procedures and knowledge that are required for data retrieval or creation for system level testing.
- CAD Application Interface which handles the connection between the design knowledge and the topological and geometric information stored in the CAD model of the product. It enables the manipulation of the geometric model from the IEE subsystems and ensures data consistency between CAD model and the storage. Because of the diversity in the filed of the CAD applications this module must be highly configurable.

6. Product information management

The modules of the product information management system part are as follows:

- Product structure & structured documents management module which includes procedures for definition, classification and description of the product components properties and related documents, as well as relationships between them. To ensure efficient storage and data retrieval, a methodology for data classification has to be established according to the specific needs of the particular design office.
- Design actions and request manager module which includes activities that create or use product data. Among the required functionality of data processing support are: easy data capture, indexing and storage; fast data browsing and retrieval; multi-view data representation; data transformation between models/views and consistency management. The key property is that the user needs to be able to 'get at' assemblies and subassemblies data by a variety of routes. Every modification must be captured separately, because different versions can represent the evolution of a product through development stages.
- Project and user management module which covers user rights, design task assignments, project planning and control. The main interest is the flow of work through design activities in which design data need to be created, modified, viewed, checked and approved by many different people, perhaps several times over.

Therefore, it is very important for project leaders to control the progress of the project, influencing on the product development time and expenses.

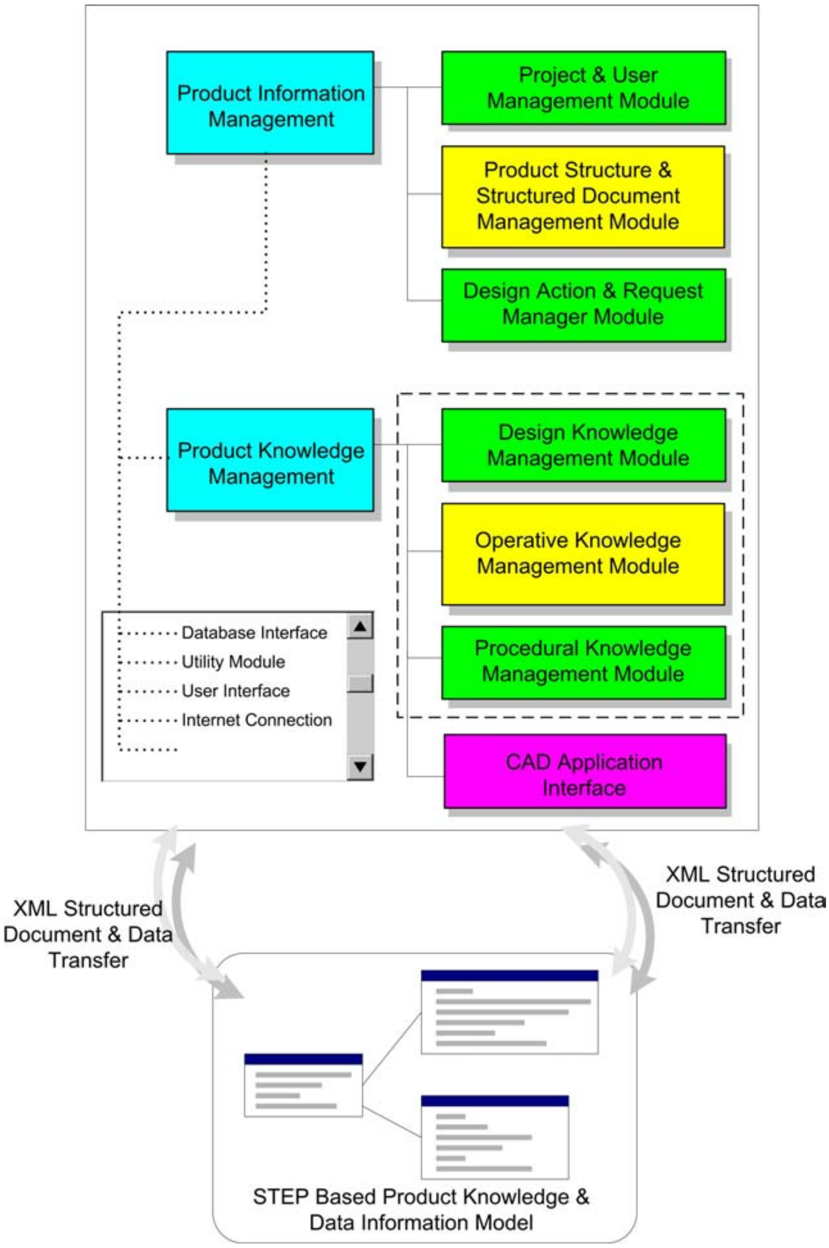

Figure. 4 IEE Architecture

Slika 4. IEE arhitektura

7. Auxiliary modules

The main responsibilities of auxiliary modules are to ensure a proper function of the system. The auxiliary modules are as follows:

- Utility module which includes a group of tools for handling external files, as well as error handling procedures, help management and system integration control.
- Direct internet connection module which main purpose of this module is to establish connection to particular web services [4] or to the client.

- Database interface module which enables connection with the database or multiple databases remotely installed where the product knowledge and data are stored.
- User interface which enables the user interaction with the system.

8. Conclusion

The proposed Integrated Engineering Environment system (IEE) based on STEP information model and the XML paradigm enables the usage of state of the art network technologies for concurrent product development. Data and knowledge exchange, including the design knowledge and technical documents as components of the product structure and the creation of the distributed virtual engineering environment, is achieved. Beside, other tools that a designer uses in their work can be also integrated in the process of data and knowledge creation and retrieval.

The subsystems of IEE are separately created and tested [4][5]. Both subsystems show the potential for integration and in that way creation of the core of the IEE system. The next step in research will be the realization of the proposed IEE system.

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