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INTEGRATED ENGINEERING ENVIRONMENT

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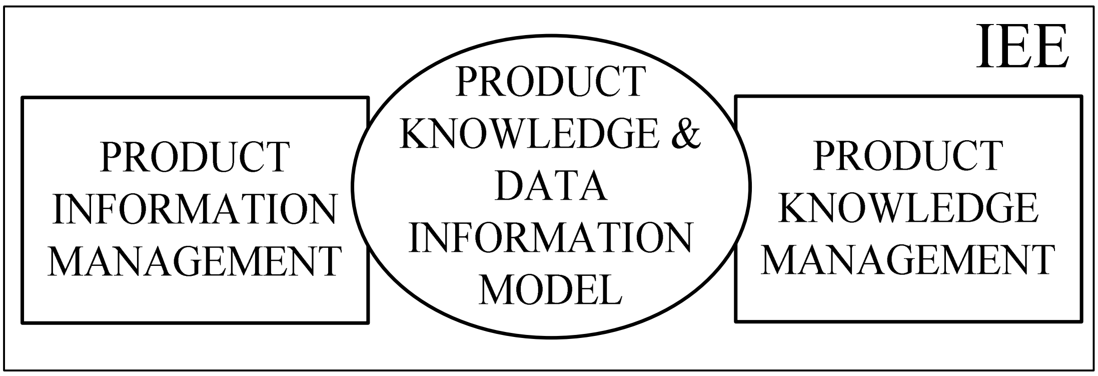
1. Introduction

Today's major industrial challenge in computer-supported product development is to establish corporate development across enterprises. Corporative distributed product development and engineering processes require extensive use of advance information technology. Especially important is the support of distributed processes and the management of distributed product data as well as of other engineering information resources. 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 design knowledge and product information across the network [Storga, e.a. 2001].
Existing definitions of information, data and knowledge become inconsistent when examined in relation to one another [Saeema, e.a. 1999]. 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 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 communicate with each other, enterprises may not speak the same "language" or understand the particular design solutions adopted by others. This is recognized as the issue that must be addressed. The integration of product information and knowledge management based on common informational model within distributed system environment lends itself to an integrated engineering environment (IEE) [Figure 1].



management using the proposed information model of product which is compliant to the STEP (ISO 10303) international standard. The proposed product knowledge and data information model (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 the information and the expected usage of the IEE are determined using the use case approach.

2. Fundamentals

The proposed informational model of the product is used as the start point for considering the Integrated Engineering Environment. Informational model is created from two parts. 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 knowledge used in the process of product design. The product design knowledge will be used not only by the actual designer but also by the other subjects involved in different phases of 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 the means for implementation of the proposed extended informational model.
XML provides all essential facilities for implementing STEP data models. Currenty the mator use of XML belongs to the field of data transfer and communication between applications [Ehrler, e.a. 2000], although STEP is still better aimed at modeling the engineering needs for information.

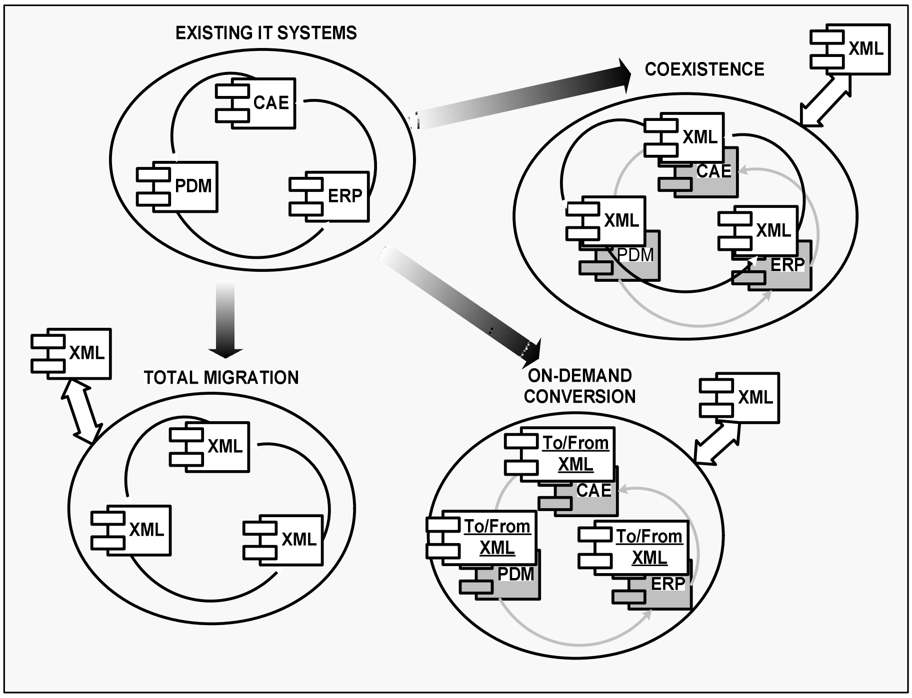


Figure 2. XML as Global IT Framework

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

- Data exchange requires an “agreed” data model. In this case semantic of the information is defined via STEP compliant scheme of proposed extended informational product model. Based on STEP standard, the rules for defining the structure and syntax of elements used in appropriate XML file are determined.
- XML aims the separation of data and presentation. Using this functionality the same product data (e.g. physical product structure) can be presented in different ways, what 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 information exchange between existing information systems and migration between future and existing information systems, thus enabling coexistence of inherent information systems with the on-demand conversion (Figure 2.).

3. Extended product informational model

A product information model is defined as information model which provide an abstract definition of facts, concepts and instructions about the product. As described on the figure 3 the elements of the proposed extended product informational model are entities that describe the [Bojcetic, 2001] [Storga, 2002]:

- **Information binding product data carriers**.
  As the major product data carriers in engineering development process, the products physical components and structured documents were identified. A document could have a further internal structure as well as physical assembly. Hierarchical breakdown structure is a fundamental property of product data carriers, which describes how the product is divided into components, which are in turn divided into subcomponents. Such a structure illustrates the relationships between constituents. Further important property of product data carriers is versioning. Versions are mainly used for two base concepts. Firstly, version can represent the evolution of product data carrier through successive stage – revisions, or represent a number of parallel alternatives – variants. The third main property of product data carriers that have been considered is data status. In design environment, the information, which is stable, consolidated and proven, is treaty differently from information that is tentative, untested and possibly incorrect.
- **Information binding subjects that create own and manipulate product data.**
  The subjects' information are describing users (project leaders, designers, administrators, etc.) and defining organization of development teams within design tasks (projects).
- **Information binding activities coordinated by subjects, in which the product data are consumed.**
  The main activities in product development process are: product components' and documents' hierarchical structure management, engineering change management, approval and authorization procedures, design process documentation and history, design tasks assignment and product configuration processes.

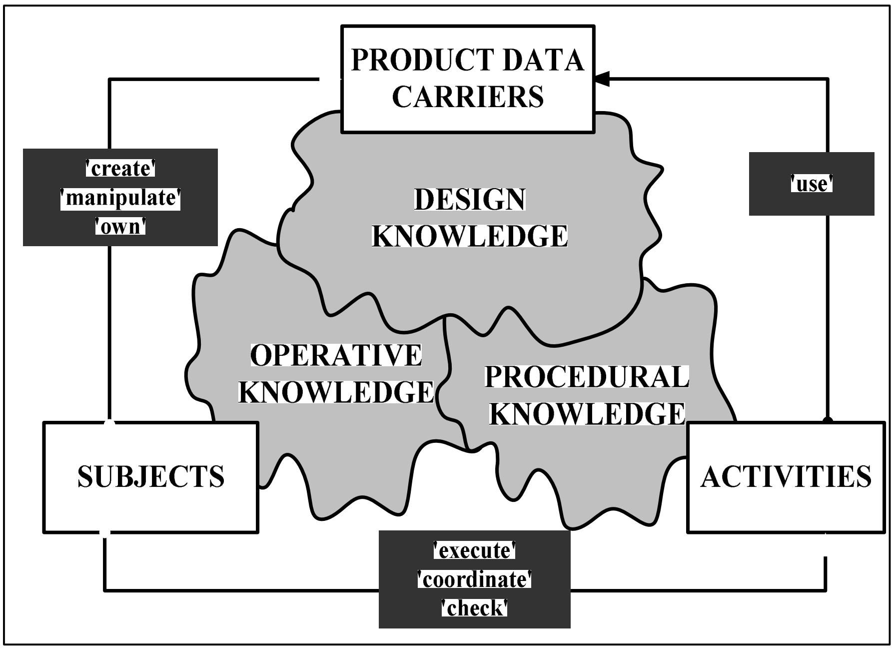


Figure 3. Knowledge and product data informational model

- **Information binding design knowledge.**
  The information generated during design process can be divided, depending on their 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 design knowledge management and manipulation are the key elements of the procedural knowledge.
- **Information binding 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 impose on design knowledge generated during the design process.

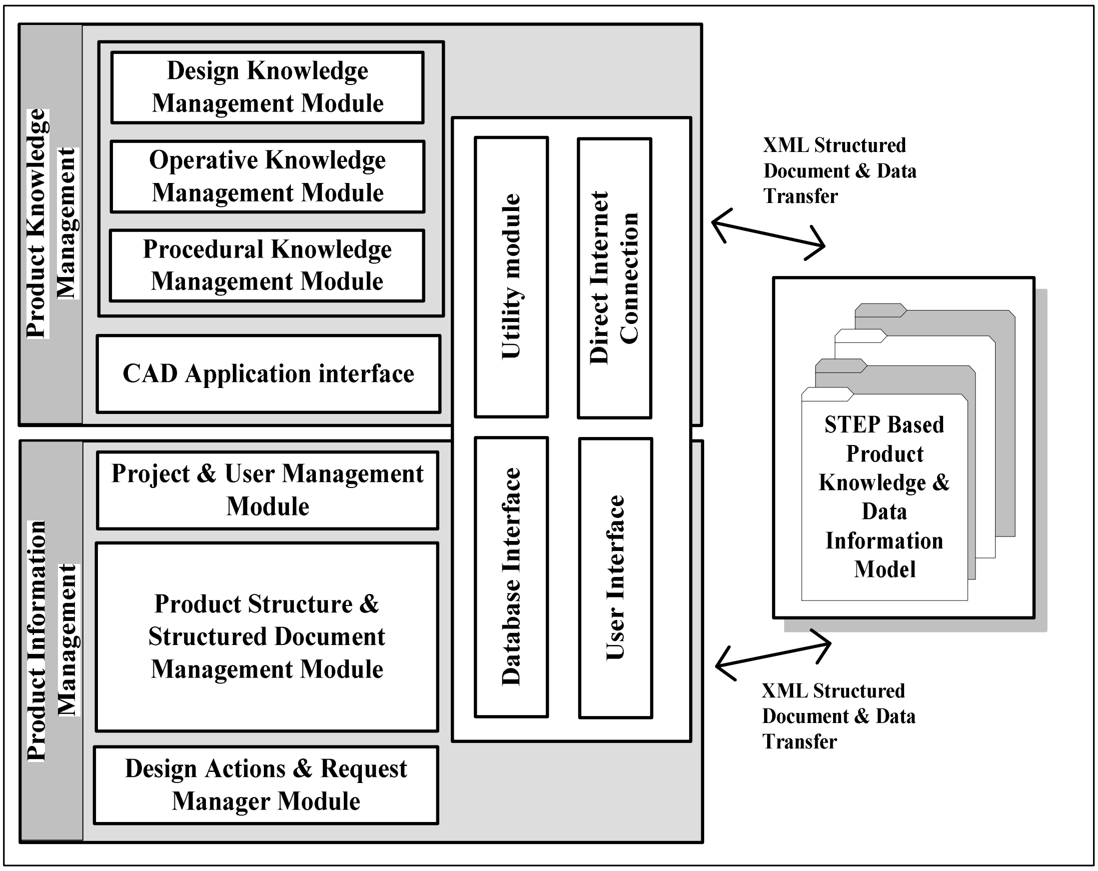
4. The IEE architecture

In the IEE system two different subsystems may be identified: product knowledge management and product information management. The first one is dealing with geometric information and information bind to geometric FBD model on the higher level, and the second one is dealing with the data about product itself. 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 IEE system is the information sharing. The user can start using the IEE system for either of subsystems and achieve the same goal.
Depending on the data designer have about the product he/she can start creating abstract structure of the product and attaching all the non geometrical information about product, create technical documents or geometric representation models. This approach is similar to Top-Down design paradigm. During process of building abstract structure of the product designer can add knowledge relevant to product development available to him/her at the time. All the information designer attaches to the product will be available to him at the later stages of product development e.g. embodiment or the detail design. In another approach designer can start with the creation of the physical representation of the product e.g. geometric FBD model. During process of creation of the geometric model of the product designer can create new or attach 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. information about parameters, material used, design decisions, design rules. In other words designer will create knowledge repository about product design. Except from the information relevant to the design of the product, designer can create the information about the product that at the higher level of abstraction.
Information required or generated in either subsystem will be transfer to and from the storage as the XML document. In that way neutral format for data exchange is ensured, so the other tools needed in daily work of designer can create or retrieve data and knowledge.
Of course simultaneous access to the data and knowledge shared between different product components or different product must be enabled. This requires a user access level control and the security system.

4.1 Product knowledge management

- Design knowledge management module - controls process of creation, removing, viewing and usage of the design knowledge. Ensures validity and integrity of the created knowledge. Depending on user role and rights enables his/hers access to the specific method for knowledge manipulation.
- Operative knowledge management module - handles the auxiliary data about the design knowledge e.g. user, data and time, security levels, access rights etc.
- Procedural knowledge management module - includes all procedures and knowledge that are required for data retrieval or creation and procedures for system level testing.

- CAD Application Interface - handles the connection between design knowledge and the topological and the geometric information stored in the CAD model of the product. 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.



4.3 Auxiliary modules

- Utility module - includes group of tools for handling external files, error handling procedures, help management and system integration control.
- Direct internet connection module - main purpose of this module is to establish connection to particular web services [Storga, 2002] or to client.
- Database interface module - enables connection with the database or multiple databases remotely installed where product knowledge and data is stored.
- User interface - enables user interaction with the system.

5. Conclusion

Proposed Integrated Engineering Environment system (IEE) based on STEP information model and the XML paradigm enables usage of state of the art network technologies for concurrent product development. Data and knowledge exchange, including the design knowledge and technical documents as the components of the product structure and 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 [Storga, 2002][Bojcetic, 2001]. Both subsystems show the potential for integration and in that way creation of the core of the IEE system. Next step in research will be realization of the proposed IEE system.

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