

Guest editorial – special issue on applications in industry of product and process modelling using standards

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1 INTRODUCTION

Product and process modelling today plays a key role within the industrial community. In the advent of concurrent and distributed activities, electronic data exchange and the internet, software applications must be ready to communicate and exchange data and knowledge automatically. Standards for data representation and exchange form the basis from which these broad objectives can be achieved and from which reliable integrated environments can be attained. In this context, suitable standards and de facto standards have a primary role, which we can enumerate the ISO TC184/SC4 standards, like ISO 10303-STEP, ISO 13584-PLib and ISO 15531-Mandate, and XML. Because standards are developed under an application context, most are not self-sufficient covering the global requirements. Harmonisation, integration and references between them are important issues that must be addressed to aid the achievement of the objectives. The research community eagerly awaits focused attention on these matters.

The *International Journal of Computer Applications in Technology* has invited research and case study papers for this special issue devoted to the applications in industry of product and process modelling using standards, and has selected 15 contributions from industry, research institutes and academia. Automotive, shipbuilding, building & construction and furniture are examples of industries addressed in this issue.

2 OVERVIEW OF THE PAPERS INCLUDED IN THIS ISSUE

Filos and Ouzounis in the paper ‘Virtual organizations, technologies, trends, standards and the contribution of the European R&D programs’ present state-of-the-art technologies and trends towards inter-operable tools for organisational agility and flexibility, based on distributed business operations. The European Commission has been supporting development of such issues through its various research programs since the early 1980s.

They describe the key signposts of the shift from the industrial to the digital era, highlighting virtual organisations, or ‘organisations without walls’, the collection of geographically distributed, functionally and culturally diverse organisational entities linked through information and communication technologies (ICTs). In this scope, the challenges are driven by competitive market forces and facilitated by governments’ efforts to generate new, more fertile, international legal and regulatory frameworks, towards ‘smart’ organisations. The result is an uncertain, highly dynamic, risky and potentially rewarding environment for old and new organisations (profit and non-profit) in regions, sectors, and society in general.

Since 1990, a normative project has taken place in ISO to define a neutral format for representing families of parts, thus providing for exchanging parts libraries between heterogeneous systems. This multi-part specification, known under the PLib acronym (officially, ISO 13584 ‘Parts Library’), is becoming a series of international standards. Some parts have already reached the international standard (IS) stage,

and some others are still in progress. Suitable not only for the exchange of files containing parts, independent of any application that is using these files, but also more recently this standard has covered an important new requirement for exchanging electronic catalogues containing parts library data.

Pierra, *et al.* in the paper 'From digital libraries to electronic catalogues for engineering and manufacturing', proposes an approach for integrating the data model-oriented view and the document oriented view on the same information, namely parts definition and representation information. It addresses XML document type definition from an information model in the EXPRESS language. Applications of this approach for capturing parts library data and for generating active documents are presented.

'ISO 15531 MANDATE: a standardised data model for manufacturing management', is the paper from A.F. Cutting-Decelle and J.J. Michel presenting the work undertaken within the ISO, i.e., the International Standardisation Organisation, by the ISO TC 184/SC4 'Industrial Automation Systems and Integration/Industrial data' in the field of industrial manufacturing management data, resulting in the ISO 15531 'MANDATE' (MANufacturing management DATA Exchange) standard.

After an overall description of the main features (scope, basic principles) of MANDATE in the field of industrial data, this paper analyses the benefits that can be expected from the use of standards in the domain of management and exchange of manufacturing information. In the first part they depict the industrial needs in the domain of the manufacturing management information, and the requirements for a new manufacturing environment through an information model of a manufacturing system, and a generic structure of manufacturing management systems. The paper concludes by providing some elements related to the impact on the manufacturing industry of the use of standards for managing and exchanging manufacturing data.

Because there are more than ten million possible cars, an explicit description of each bill of materials would mean the storage of more than ten million trees. While the traditional solutions of configuration management are not adapted to large diversity, ISO 10303 Application Protocol 214 (AP214) provides specific mechanisms to handle this diversity. Specified by the world's leading automotive manufacturers, AP214 proposes the first internationally agreed data model adapted to automotive mechanical design and more generally to the management of products with large diversity.

In order to evaluate the usability of ISO 10303-AP214, GOSSET has been asked by PSA Peugeot

Citroën and Valeo to develop an implementation of the ISO 10303-214 data model, and to demonstrate that it is adapted to the management of implicit bill of materials. The paper from Christophe Viel, 'Management of product's diversity: industrial validation of AP214 reference model', describes the general principles that have been followed to implement the reference model of AP 214 in a relational database system. Then, it presents an extract of the sample data that has been taken from PSA Peugeot Citroën to dynamically validate the data model using this implementation: GoStep214.

S.K. Ong, *et al.* in paper 'STEP-based integration of feature recognition and design-by-feature for manufacturing applications in a concurrent engineering environment', presents a manufacturing feature recognition processor that utilises the high-level information retrieved from a design-by-feature system to generate a STEP-based manufacturing feature model efficiently. In the processor, the interacting and interrelating relationships between features are represented and handled, so problems such as the low-efficiency and error-proneness of traditional feature recognition systems are overcome. Post-processing of manufacturability evaluation can dynamically evaluate the recognised features and provide feedback for the design-by-feature system to modify an initial poor design plan.

In this paper, the feature recognition and design-by-feature approaches are integrated to generate a manufacturing feature model on the basis of STEP 224 (Edition 1) to serve the downstream manufacturing activities in a concurrent engineering environment. The design feature models of a part are created through a design-by-feature system. The relationships between interacting or interrelating features are analysed. On the basis of an attributed adjacency graph abstracted from the B-Rep of a part, and the feature-feature relationships, a feature recognition processor recognises a STEP-based manufacturing feature tree from a design feature CSG tree.

The paper from Silvia Ansaldi, 'On transferring and sharing design intent using STEP methodology', describes the neutral model proposed in ENGEN (enabling next generation mechanical design), for representing some conceptual design information of a product in the STEP framework. Such a model is able to capture key aspects of design intent in addition to the shape representation. Furthermore, a description of the developed processors and their pilot demonstration are given, pointing out the critical issues that have been solved in the project, and those that still require further efforts in technology research.

With the advent of market globalisation, increased competition has required a reduction in time-to-market

for developing new products, leading to the integration and sharing of information among different systems, which are involved in the product development process. Many have been the standards that support the data exchange, but all of them are mainly devoted to share geometric information. Only STEP (ISO 10303) deals with a more ambitious goal to transfer complete information related to the product development process. Furthermore, the evolution of CAD systems, from geometric modellers toward parametric and feature-based systems, has pointed out the lack of consideration of new types of data (e.g., parameters, constraints, rules) in the existing standards. In this context, the presented ENGEN project is an example of research activity for studying how to overcome such a limit, adopting the STEP architecture and methodology.

R. Jardim-Gonçalves and A. Steiger-Garção focus in their paper ‘Integration and adoptability of APs – the role of the ISO TC184/SC4 standards’ on the automatic data exchange among computer applications in industrial domains issue, that has been largely worked out by the scientific and industrial community during recent years. They highlight that in the scope of several industrial activities, the lack of tools and structured data models ready to be adopted to enable immediate connection of applications in networked-based environments, is one of the main gaps identified when seeking global integrated solutions. ISO TC184/SC4 standards (e.g., STEP and PLib) seem ready to help with the solution of this problem, and the adoption of such standards has been opening new possibilities in this area, fulfilling most of the identified requirements.

To support these standards, applications must be prepared with suitable mechanisms and interfaces easily adaptable for fast and reliable plug-and-play in the standard-based architecture, to accomplish the foreseen open platforms. Therefore, data modelling, data share and exchange, reuse of models, automatic code generators and software libraries, together with the possibility to incorporate expertise and knowledge representation, is a challenge to face when working in environments supported by heterogeneous platforms and concepts, as is the case. Nevertheless, to include mechanisms for conformance testing will more quickly assure interoperability among the applications joining the platform.

To cope with the global competition, entrepreneurs enthusiastically pursue ISO 9000 certification to demonstrate that an extended enterprise is capable of producing high quality products and services. Document management is the key criteria for companies to comply with requirement of ISO 9000 certification. The paper ‘Using ISO I0303 data standard and XML standard web technology to enable ISO 9000 document management’ from Yin-Ho Yao and

Amy J.C. Trappey focuses on Web-based electronic document management for ISO 9000 compliance.

Documents consisting of quality-related information and knowledge must be managed and shared among supply chain partners. Thus, using ISO I0303 standard data models and XML standard Web interfaces to implement document management systems, is essential for quality assurance for extended enterprises. Based on ISO 9000 guidelines and the architecture modelling of integrated information system (ARIS) technique, this research derives the data requirements for ISO 9000-based document management and presents a scenario for quality-related document flow. ISO I0303 is applied to map the ISO 9000 required data to standard data entities and the corresponding XML schema. An implementation example is developed and shown to demonstrate the entire concept at work. The research not only enables the pursuit of ISO 9000 certification and compliance within extended enterprises and supply chain partners, but also facilitates global, web-based document management and exchanges.

‘Collaborative and standard design and manufacturing model’ is the paper from P. Ghodous, *et al.* It addresses the collaborative product development, stating the requirements for a shared understanding of product among many experts concerned by design, manufacturing, quality control, marketing, etc., working concurrently on different subparts of a more global project. In a collaborative engineering environment, different types of experts in different disciplines are involved in product development. Each of these experts has their own viewpoint about the product and its development processes. To facilitate the communication of information in this type of environment it is necessary to find some solutions for representation, integration and communication of different experts’ viewpoints.

The objective of this paper is to provide an approach for representation, integration and communication of different experts’ viewpoints in design and manufacturing phases. Firstly, they describe the problems related to a collaborative environment and the current research works. Then they explain how each viewpoint can be represented using STEP standard. As a case study, they describe the different viewpoints that can be defined on a ‘display light’ product and an approach for developing an integrated model.

The paper from R. Rabelo ‘Interoperating standards in multiagent agile manufacturing scheduling systems’, presents an implemented framework that deals with the high level of heterogeneity that a multi-agent scheduling system should tackle when the legacy systems and component-based approaches are considered. Perspectives from different types of information sources to the scheduling system are taken

into account, namely the information that comes from the supply chain and from the internal/heterogeneous planning and shop floor supervision systems. The utilisation of standards for inter-tools communication, information exchange and information modelling ascends in significance within this context. The framework and the system prototype developed – called HOLOS – comprise what can be described as an ‘interoperation among standards’, and it is discussed and illustrated with some examples.

The current scenario of industrial environment is characterised by an effort to produce an ever-increasing variety of products, in lower quantities, with higher quality, lower costs and within shorter production times. The utilisation of standards is seen as a base for an agile and lean reaction of the enterprise both in its normal operation and in the presence of unexpected events.

In 1995, the Japanese Ministry of Construction established the Public Works Supporting General Information System (general name: Construction CALS/EC Research Group) to consider the introduction of the CALS/ES concept in public works. The Japan Construction Information Center is in the process of organising a consortium in accordance with the Construction CALS/EC Action Program that has been established by the Ministry of Construction (MOC). The Center is currently engaged in the development and testing of an infrastructure base for the distribution of drawing data (CAD data) with a view to creating a shared environment for the smooth exchange of data among all users, including public owners.

The paper ‘Standard development for CAD data exchange in Japanese construction field’ from Katsumi Fujii gives an outline of the efforts that are being made in this context and a general overview of the nature and progress of the efforts undertaken by this consortium, especially in public works projects, where a large variety of information has to be prepared and used as the projects make progress. Information relating to the design or structure of construction works, such as design conditions, and the calculation of construction costs, warrants special attention.

Domenico Biondi, *et al.*, describes in ‘A product data manager supporting a new co-design methodology for SMEs’, a product data manager supporting the definition and the negotiation of the product data within a co-design network of SMEs: the described tool is part of the results of Esprit Project 25360 COWORK (concurrent project development IT tools for small medium enterprises networks). This software tool aims to support the establishment of co-design networks of SMEs and is the result of Esprit Project 25360 COWORK (concurrent project development IT tools for small medium enterprises networks). In particular the focus in this paper will be on the Standardised Product

Model and on the software module implementing the model itself.

The scenario that led to the development of such a toolkit was the recognition that today SMEs are often required to provide fast answers to customer requests for products tailored to individual requirements: consequently it is then quite common that SMEs working in the same industrial sector are oriented to cooperate with each other in order to reach a market objective that is out of reach of a single enterprise, and that can be achieved better from a consortium of enterprises. Often the cooperation is a real collaboration among the companies in the design of the new product.

The paper from Tarek M. Hassan, ‘Macro and micro models for large scale engineering processes’, reports on macro (on an organisational level) and micro (on process level) models developed within two major research projects, aiming at improving the competitiveness of the large scale engineering (LSE) construction sector. The studies presented in this paper were undertaken within two major research projects; one European and the other national.

The first project is otherwise (European Large Scale Engineering Wide Integration Support Effort) which is part of the European ESPRIT (European Union’s information technologies research in technical developments) program (ESPRIT 20876) and studies the macro model based on investigations of the emerging trends in the LSE sector. These trends concluded that different parties working in LSE projects should be modelled on a macro level as a ‘virtual enterprise’. The second research project was a national UK project funded by the EPSRC (The Engineering and Physical Sciences Research Council) which aimed to study, model and simulate the design process, for a better understanding of the whole process and to allow the analysis of the effects of design changes during a project.

The use of computer-aided design (CAD) technology in the marine industry has evolved from a drafting-based design tool to a three-dimensional product-oriented information database, used for design, evaluation, production and service life support. One of the most significant enhancements to current CAD technology has been the incorporation or integration of non-graphic attribute information with traditional graphics data.

The paper ‘Application of data exchange standards to improve shipbuilding productivity’ from James L. Mays reports on this expanded information database data, that has been enabling the marine industry to expand CAD use to activities such as engineering analysis, production control and logistics support. Therefore, the trend toward the integration of previously separate database systems for design, material, fabrication, etc.,

has resulted in a need for better and more complex data exchange mechanisms capable of handling this expanded information base. The development of an international standard is underway to facilitate ship product model data exchange among business partners and their customers.

In the paper 'Infrastructures for collaboration in virtual organisations', P.M. Wognum and E.C.C. Faber address the problem that many organisations are currently facing, forced to collaborate with others in renewing their products and processes to stay competitive, to enter new or to retain their current markets, or to get easy access to new knowledge. Management of collaboration between two or more organisations is, however, still not well understood, given that about half of the collaborative endeavours fail. A methodology to support management of collaboration is still lacking. To build such a methodology, knowledge is needed on the process of collaboration.

This paper presents an approach that can support the gradual building of knowledge on the process of collaboration. The approach, resulting from the Esprit IV project 23286 FREE (fast reactive extended

enterprise), can be viewed as a first step towards building a methodology to support management of collaboration. The concept of infrastructures for collaboration will be introduced, stressing the integral nature of collaboration management.

ACKNOWLEDGEMENTS

The guest editors of the Special Issue on Applications in Industry of Product and Process Modelling using Standards of the International Journal of Computer Applications in Technology would like to thank all authors publishing in this issue for all their support and understanding during the revision and publication process.

The guest editors gratefully acknowledge the assistance provided by Dr. Mohammed Dorgham, Editor-in-Chief of this International Journal, and the more than 20 anonymous referees who reviewed the manuscripts (each paper was reviewed by three referees).