ISO 10303 Application interfaces supported by Genesis environment - The funStep ESPRIT project experience -

P.SOUSA; J.PIMENTÃO; R. GONÇALVES; A.STEIGER
Department Engineering Electrotecnic
Faculty of Science and Technology of New University of Lisbon
Quinta da Torre P-2825 Monte de Caparica
PORTUGAL

Abstract: Typically, software tools from different software houses are modeled in distinct ways, and offering different Import/Export data formats, therefore enabling data communication among them is an arduous task. One possible approach, to eliminate this problem is the development of dedicated interfaces in order to translate the heterogeneous data formats however this direction drives to a high number of interfaces. An alternative approach can be followed with the use of standards. This way it is possible to avoid the development of a high number of interfaces and extend the lifetime of the whole system. The last direction is defended by ISO, which is responsible for the STEP project (ISO10303) in order to produce a methodology towards the creation of an integration process supported by the definition of a standard for the exchange of product data model.
Although, STEP approach seams the best answer, it evolves complex and long processes, which drastically decrease the number of practical implementations so far. Therefore, in the last years, UNINOVA developed the Genesis' environment, STEP compliant, with the objective of providing a set of generic libraries and mechanisms that speed up the integrator's tasks, facilitating the generation of interfaces and decreasing development errors, in order to achieve integration results in a competitive time. This paper presents the funStep ESPRIT project, where the integration problem was considered and where the STEP approach was followed, supported by the development environments produced by UNINOVA.

Key-words: - CAD/CAM, Standards, Models, Integration and Interfaces. CSCC'99 Proc. pp.6411-6415

1 Introduction

The FunSTEP Project (Development of a STEP-based Environment for the Manufacturer-Customer Integration in the Furniture Industry), was a 29 months European ESPRIT IV #22056 project, with 6 partners coming from Germany, Portugal and Spain completed in January of 1999. The general aim of the project was to develop an integrated STEP based environment for the manufacturer-customer integration, and for the support of the information flows in the factory, which is going to be applied initially to the furniture industry.
The consortium was composed by TCP (a software house that was the prime contractor for the project) and Nobila (a kitchen manufacturer) from Germany; AIDIMA (a furniture manufacturers association), ROS 1 (a home furniture manufacturer) and ACA (a software house) from Spain, and UNINOVA (Research & Development institute) from Portugal.

The project developed a STEP based specification of information models regarding development of product, customer orders processing, process planning, and customer's project management, where furniture products are involved. Commercially available CAD/CAM and PPS software application tools were adapted and integrated using a STEP based architecture, which is a result from previous European Commision (EC) projects under ESPRIT and BRITE programs (namely CIMTOFI and RoadRobot projects), refined and improved in the scope of this project.

1.1 The state of the Art in CAD2 (CAD systems for interior design) environment

A wide offer of specialized CAD systems for interiors design is available in the market, but the capabilities for exchanging information among them are quite reduced, because there is no «universal standard» for CAD2 information interchange (i.e., each company, or group of companies, claims its data model to be the «standard»). The result is that

true EDI[1]-based solutions for furniture industry do not exist. [1]
However furniture manufacturers, decoration studios and retailers are acknowledging the need for exchanging graphic and non-graphic product information, independently of the Computer Aided Design system used, because they understood the complete potential on the increasing of flexibility, client satisfaction and consequent business profits involved [3].
The identified information flow that were considered under the scope of FunStep were:

- Transfer of electronic product catalogues to be created in the factory's CAD2 systems, that might be transferred to the retailer shops, thus reducing the amount of paper in circulation, an expedite update of existing catalogues and enabling retailers to use these catalogues in their CAD2 applications.
- Transfer of project information from the retailers to the manufacturers in order to accelerate the ordering process and to reduce the number of errors in this process.

The main problem is that all the entities involved in the process are postponing the decision of changing because they want to be sure that their investment (equipment, training and product libraries) will be secure. A huge step towards system credibility would be its stability, which can only be achieved if a standard modulation for product and interior design projects data exchange is finally defined and tested in day-by-day usage.

1.2 FunSTEP project objectives

Within the specified environment the FunSTEP project objectives were defined and can be enumerated as follows: [4].

- Development of a common product and interior design project (herein referred to as the «project») data model for furniture (ISO10303-STEP based);
- Implementation of the required translators for some commercial CAD2 systems, for furniture product design and management;
- Development of testing and certification methods of commercial CAD2 systems, to be funSTEP model compliant;
- Development of a common method for data exchange;
- Demonstration of the ability of such updated systems for working with the designed method in an industrial environment.

2 FunSTEP's project architecture

In order to achieve the proposed objectives, a FunSTEP's architecture was defined. The proposed architecture enables integration of tools, maintaining the same end-user environment, based on a step-by-step changing process while keeping the whole system working. This feature is the core of the architecture's philosophy and it assures a good industrial receptivity, seeking compatibility between product data libraries for the industry.
It is possible to identify three basic environments, within the architecture:

1) the modeling environment, where the project and product data models for furniture were defined;
2) the development environment, where tool interfaces were produced;
3) the conformance environment, to which all CAD2 systems must be submitted in order to be considered FunSTEP's compliant products.

2.1 The modeling environment

The modeling environment was the entourage used to produce the FunStep's product and project data models that were used for interfacing between different CAD2 systems. The nature of furniture data imposed that the product models should be based in a parametric methodology in order to allow variable parameters to produce a well defined, self consistent, model where values are assigned to parameters [5]. The ISO 10303's defined STEP methodology was used to produce the required models.
According to this methodology, the steps for the definition of a model are to produce:

1) An AAM - Application Activity Model,
2) An ARM – Application Reference model, and
3) An AIM – Application Integrated model

In this scope, an AAM was created using the IDEF0[2] methodology [2]. The AAM is achieved in three steps:

1) the definition of the requirements;
2) the specification of the functionalities;
3) the design of an implementation that meets the requirements and performs the functions.

In the construction of the ARM and the AIM contributions from ISO10303, ISO13584 Parts

[1] Electronic Data Interchange

[2] Integration DEfinition for Function modeling

Library (Plib) and the ISO14959 (Parametrics) working results were considered. The tool used to support the two later stages of the modeling process was an EXPRESS-G editor. The figure 1 depicts the complete modeling environment described.

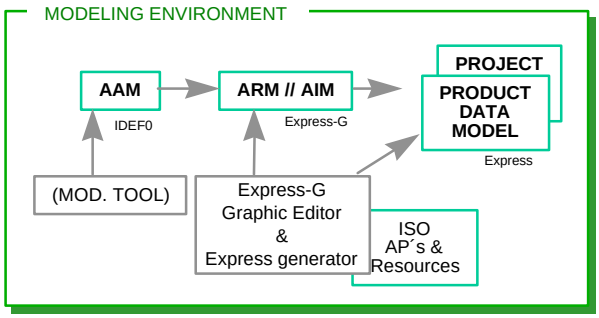

Fig. 1 - FunSTEP's Modeling environment

2.2 The development environment

The development environment is based on ISO standardized approach, STEP (ISO10303). Although the STEP approach seams the best answer to the integration problem, it involves complex and long processes, which drastically decrease the number of practical implementations so far. In order to avoid these problems UNINOVA created a development environment, STEP compliant, supported on a commercial STEP-based persistence platform, which is called the Genesis's environment. Genesis environment supports the integration process of a new tool, characterized by the development of an ADM - Application Dependent Module. The ADM is a module that provides a translation between the tool's internal data structure to the standardized data repository.

The purpose of the ADM is to guarantee that the CAD2 internal data is correctly translated to/from the FunSTEP's data model; thus assuring that it is possible to store/read all the data in/from a standard neutral format (ISO10303 - Part #21).

The aim of Genesis' environment is to provide a set of generic libraries and mechanisms to speed up the integrator's tasks, facilitating the generation of interfaces and avoiding development errors, in order to achieve integration results in a competitive time.

Although the development environment was used to produce the CAD2 system interfaces based on the FunStep data model, it is a generic environment enabling the production of any system interface provided that its model is described in using EXPRESS.

The structure of the ADM, in the funStep architecture, can be divided into a Tool Dependent Library (TDL) and a Tool Independent Library (TIL).

The automatic generation of the TDLis not possible to perform, since it involves the development of a translator between the standard data model and the tool's internal data model. Since each tool has a dedicated and specific process it is imperative the development of a dedicated TDL.

Oppositely, TIL is based on SDAI (ISO10303 - Part #24 the standard's way to communicate with data repositories) and on the data model, which enables the use of an automatic process for its generation. For that purpose, an application called Genesis (the source of the name for the environment), was created to generate C++ code (classes and methods tailored to the specific manufacturing environment) that implements the FunSTEP's EXPRESS model.

This code serves as the temporary structure to support the data to be exchanged between the CAD2 internal and the final standard repositories.

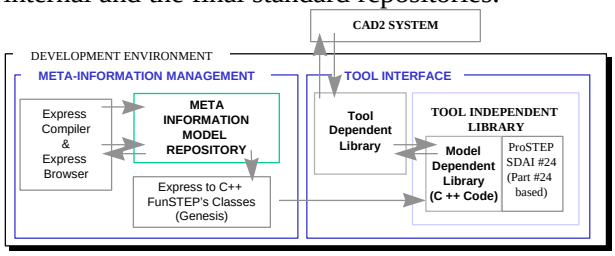

Fig. 2 - FunSTEP's Development environment

The Genesis's code is produced to interface with a set of libraries responsible to work as intermediary between SDAI call and the C++ methods and increasing the programming level.

These libraries can be described as followed:

- SDAI virtualization – Hiding the SDAI particularities avoiding programmers specialization and increasing programming level;
- Memory management – Memory management in order to automatically create and destroy the objects that represent the SDAI-model entities;
- Data base virtualization – Hiding the data base particularities and centralizing all the non-normalized interactions in order to decreasing the difficulties of changing between existing commercial databases.
- SDAI library - SDAI library supports the interface with the final repository.

The usage of the Genesis environment has drastically reduced (estimated to be more than 60%) the tool interface development time. Moreover, the generated code, as well as the best practices forced by its usage, is contributing for the reduction of the

number of errors produced, originating a drop in the maintenance costs.
The figure 2 depicts the FunSTEP's Development environment.

2.2.1 The complet process STEP-BY-STEP

Within Genesis' environment, the integration of a set of tools, involves performing following steps:
1) If an ISO Application protocol (AP) – a standardized model for a given trade exists, then select this AP; otherwise, a detailed data analysis of each tool must be made towards the creation of a consolidated Schema (described in EXPRESS) in order to represent the data structure of the global transfer necessities among the systems being integrated.
2) The EXPRESS model must be compiled into the STEP commercial platform to store the model as meta-data inside the STEP-based persistence platform, allowing its access thorough SDAI.
3) Genesis is then used to generate the TIL for tool's ADM, which is then linked with several generic libraries presented on the previous point and the dedicated library TDL produced by the CAD2 vendors. [6]
The figure 3 depicts the ADM structure and the basic modules' functionality.

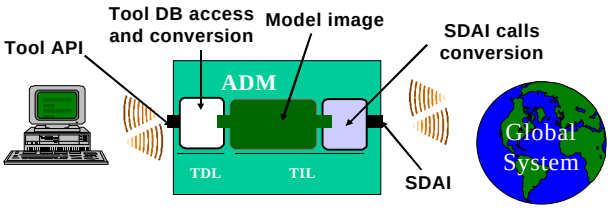

Fig. 3 -ADM structure and modules functionality

2.3 The conformance environment

The conformance environment grants FunStep's conformance certifications to CAD2 systems. A conformance certificate will assure that the CAD2 system abides to the specification of FunStep; i.e. can reliably read and write FunStep's product and project data.
The core of the conformance environment is the «conformance testing application» that, based on rules[3] and on the product and project models, generates a testing library and a set of operations to be executed by the applicant CAD2 system. The certification process has two phases:

[3] A set of constraints that define the tolerance limits for certification of the CAD2 system.

1) the reading phase – to certify the system's ability to read data produced from certified CAD2 systems, and
2) the writing phase – to certify its ability to produce standardized output.
Let's have a closer look to the process of certification.
The reading phase is characterized by the CAD2 loading the testing library, the results are analyzed and the «reading info results» report generated.
In the writing phase, the applicant CAD2 performs the set of operations defined and generates an output library, containing the resulting project(s) and product(s). This library is then read by a set of certified CAD2 systems that generate «writing info reports».

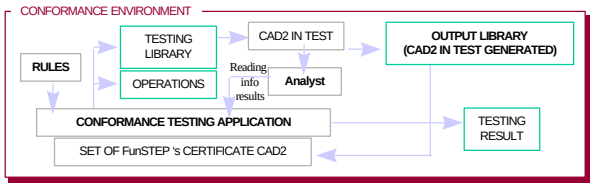

Fig. 4 - FunSTEP's Conformance environment

The conformance application evaluates these reports and, if accepted, issues the conformance certificate to the CAD2 applicant. The figure 4 depicts the FunSTEP's conformance environment.

3 funStep project results

The application of the FunStep architecture is expected to produce profound impacts in two different areas:
a) In furniture manufacturers and customers by:
- assisting the creation of compatible systems on the market;
- assuring retailers investment;
- improving customer service;
- reducing customers' error rate and increasing manufacturers' response;
- Reduction of non-productive workload;
- Empowerment of Electronic Commerce.

b) In CAD2 System suppliers by:
- increasing actual market size;
- Increasing customer's reliance on CAD products;
- Decreasing development resources applied to third parties' libraries translation;
- A new way to improve the systems: data exchange modules via telecommunications.

It is our strong believe that this work will contribute to offer a better future to CAD2 software market development.
In the final demonstrator that took place in the Cologne (Germany) furniture exhibition, it was possible to transfer product and project information between the two CAD2 systems of TCP and ACA.

4 Conclusions

The proposed architecture respects the fact that company's software tools are modeled in different ways. Its basic idea is to create an easy Import/Export data process, turning data communication between the tools, into an easy task to carry out. FunStep's approach enables integration, maintaining the same end-user environment, based on a step-by-step changing process while keeping the whole system working. This feature is the core of the architecture's philosophy and it assures a good industrial receptivity, seeking compatibility between product data libraries for the industry.
The adoption of a unique interface for data interchange leads to the fact that, in the future, integration of new tools in the global system can be done effortlessly.
It is our strong believe, based on our previous experiences where we used a similar approach, that the presented STEP-based architecture is an adequate proposal for solving the industrial's internal (manufacturing) and external (business) integration problems.
The Genesis's development environment was successfully used and it drastically contributed to the reduction of the time consumed on the tool interface development (estimated to be more than 60%). Moreover, the use of an automated process reduced the number of errors produced, originating a drop in the maintenance costs.
It is expected that, with time, as the commercial tool's builders absorb these technology, the effort needed to keep the global system will be drastically reduced, as well as an increase in the number of different product data libraries (e.g. product catalogues).
An international FunStep Interest Group (FSIG) was created, and it is obtaining a great industrial response both from software providers and end users.
A combination of the efforts of the FSIG and of a new project called «FunStep-AP», is expected to lead to the creation of an Application Protocol for the furniture industry.
Another project «ECOS» devoted to the Electronic Commerce aspects of the furniture industry is now starting and is expected to give a valuable contribution to the effort that is being put on the creation of synergies for the use of EDI in the furniture industry.
A presentation of the FunStep project on one page is available, whose purpose is to present in short a concise overview of the architecture (see: http://www.uninova.pt/funStep)

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