



Australian Government

Forest and Wood Products
Research and Development
Corporation

Participation in the European Commission Project:

*"Cooperation for Consensus Standardisation
and Interoperability to support e-commerce
in the Furniture Sector - COFURN"*





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Publication: ***Participation in the European Commission Project: "Cooperation for Consensus Standardisation and Interoperability to support e-commerce in the Furniture Sector - COFURN "***

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**Participation in the European Commission Project:
“Cooperation for Consensus Standardisation and
Interoperability to support e-commerce in the Furniture
Sector - COFURN ”**

Prepared for the

**Forest & Wood Products
Research & Development Corporation**

by

E. Shayan and B. Ozarska

EXECUTIVE SUMMARY

Globalisation is today's reality in various sectors of our society. People around the world are more connected to each other than ever before. Goods and services produced in one part of the world are increasingly available in any other part of the world. In this sense there is a need for faster and easier information exchange.

In order to keep up with the emerging digital economy the furniture industry in Europe and other regions is seeking a universal agreement for data exchange between the entities working in this sector. For this reason a Thematic Network "COFURN" (*CO-operation for consensus, standardization and interoperability to support e-com services in the FURNiture sector*) was established in 2001 linking key furniture related organisations such as manufacturers, retailers, suppliers, designers, industrial federations, software houses, R&D centres, universities and standardisation bodies to consider development of a global standard for data exchange in the furniture industry.

The COFURN project is the continuation and culmination of a set of initiatives that started with the European Commission project the FunStep "Development of STEP-based environment for the manufacturer-consumer integration in the furniture industry". The FunStep project was initiated by a technical study undertaken by the Spanish furniture industry in 1994-95 aiming to analyse existing product data catalogues and communication between manufacturers and retailers. This generated the first international initiative of STEP-based standardization (the Standard for the Exchange of product model data) for furniture industry. The FunStep project was completed in December 2000, but its activities were extended under the COFURN project, also funded by the European Commission during its duration period from 2001 till 2004.

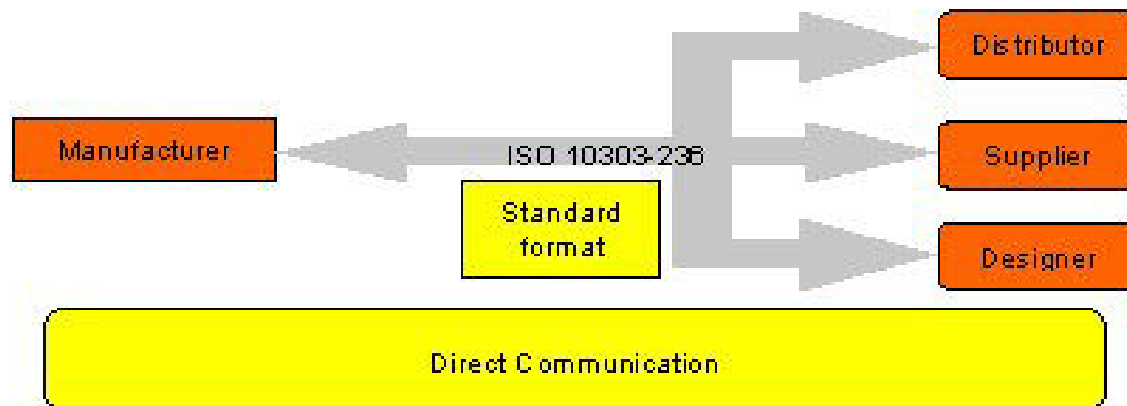
Most of the companies in the furniture-manufacturing sector are SMEs (small and medium sized enterprises). The problem of data exchange between manufacturers, suppliers, retailers and specifiers is considered by the furniture community as the main issue in the implementation of e-business for the furniture sector. The huge number of proprietary systems using different data formats makes the problem complex and difficult to solve. Accordingly the industry needs to establish standards for data management that help in sharing, exchanging and archiving data early and at a lower cost.

Standards are of great value to ease communication between entities. Standards allow an understanding and agreement between several entities that will facilitate integration between companies. They allow direct communication between all agents inside the furniture value chain without the need of translating or changing information.

The Figure below shows how the communication is improved in both directions: communication from manufacturer to distributors, designers and suppliers and vice versa.

As technology develops, there will be more applications that are unable to cope with the market conditions or proprietary tools that cannot be upgraded or extended. Also customers demand more and more information and this information has to be complete, updated, understandable and without errors. Standards are the answer to these problems.

Application Protocol AP236 “Furniture Product and Project Data” has been developed in Europe as part of the ISO10303 standard, known as STEP during the COFURN project and is now in preparation as the Committee Draft document to be submitted to ISO. The scope of AP236 is the exchange of definition data of furniture products and furnishing project data amongst manufacturers, suppliers, retailers, interior designers, and end users. AP236 is the foundation for data exchange in the furniture industry so that all the software involved in designing, manufacturing and selling understands the same vocabulary. Thanks to this vocabulary, the manufacturer will be able to share the product information with other industry partners.



The Australian furniture industry was invited to participate in the European COFURN project, which involves 15 countries. Australia and Canada were the only non-European countries participating in the project.

The Australian consortium consisted of the University of Melbourne, Industrial Research Institute Swinburne and FIAA (Furniture industry Association of Australia). The Australian activities were specified by the International Project Committee based in Europe.

FWPRDC has recognized benefits in Australian participation in this large European project and provided a financial support to enable the Australian consortium to meet objectives specified for this region.

Objectives of European Consortium were:

- Increase industrial awareness on the data exchange problem and disseminate the knowledge about the European FunStep initiative “Development of STEP-based environment for the manufacturer-consumer integration in the furniture industry”.
- Plan dissemination activities to make the Network more representative, contributing to a common platform for data exchange and e-commerce.

- Plan and manage the standard data model evolution AP236 “Furniture Product and Project Data” and co-ordinate industrial implementation. Drive the data model towards an International Standard, supported by the network members providing material for analysis, validation and test.

The Australian Objectives were:

- Dissemination of the COFURN project and its developments to Australian manufacturers, retailers and software vendors.
- Participation in the COFURN strategic meetings and management board meetings.
- Reporting to the European Management Board.
- Provision of Australian data for a furniture dictionary and product data catalogues.
- Validation and modification of a product data model provided by the European consortium.

The project activities were undertaken by a project team consisting of:

- Dr Barbara Ozarska, University of Melbourne, the Project Manager,
- Dr Ebrahim Shayan, IRIS, responsible for design, validation and modification of product data model in Australia,
- FIAA members providing data for product data model and dissemination.

Overall outcomes of the European COFURN Project

- Extensive promotion and dissemination of the FunStep and COFURN initiatives within the furniture industry. As the result more than 200 manufacturers, retailers and sector organisations and 15 software houses from 22 countries have joined the project Network.
- Development of a multilingual on-line dictionary of furniture terms. The dictionary, developed in 10 languages, includes more than 750 specific furniture terms. In the dictionary, it is possible to find furniture terms in any of the languages available, their description, their translation to other languages, related words, photographs of the objects if possible, and movies if available. The development of the dictionary is an on-going process. The current version will be further extended and modified by the European consortium.

The Dictionary is available at: www.funstep.org (select “Dictionary”).

- A survey on “The status of IT implementation and industry awareness in the European furniture industry” was undertaken. The survey which involved thousands of companies, aimed to evaluate the level of the use of IT by the furniture sector. The analysis enabled individual companies to obtain an evaluation of their own competitive position in the market and to make

appropriate decisions on investment in IT, training of personnel or design innovation corporate projects. Recommendations were developed on IT implementation and exploitation.

- The standard data model AP 236 - Application Protocol “Furniture product and project data” was developed and submitted to ISO TC184/SC4. The standard was accepted as the Committee Draft (intermediate stage before the achievement of an International Standard stage).

Summary of the project activities and achievements in Australia were:

1. Dissemination activities:
The COFURN project activities have been widely disseminated within Australia. The dissemination program included industry seminars, visits to individual furniture companies, publications in the industry journals and magazines.
A brochure on the COFURN project was developed and was distributed to the Australian furniture industry. A contribution to the development of the European COFURN brochure and CD was also provided.
2. Participation in the project strategic and management meetings in Europe:
 - Five Project strategic/management meetings were attended by the Project Manager, Dr Barbara Ozarska, The University of Melbourne.
 - Two technical workshops were attended by the project researcher, Dr Ebrahim Shayan, IRIS.
3. Reporting to the European Management Board:
 - Communication with the Project Management Board in Spain was maintained on a continuing basis.
 - Six monthly project progress reports on the Australian activities were prepared and submitted to the Project Management Board in Spain.
 - Reports on the Australian activities were presented to the Project Management Board at the project meetings in Europe.
4. Provision of Australian data for a furniture dictionary and product data catalogues.
The Australian contribution included:
 - Correcting the English translations of 350 furniture terms developed by non-English speaking European members.
 - Adding 400 furniture terms to the existing on-line furniture dictionary.
This work is significant input into the European work on the development of product data catalogues.
5. The Data Model’s validation and modification included:

- A comprehensive study of the data modelling as per STEP standard was undertaken, including the AP236 standard. Application Reference Model (ARM) diagrams were selected from AP214-application protocol for automotive industry and AP225-application protocol for building industry and their relevance was checked with the business needs of furniture industry.
- Some of the relevant application objects, units of functionalities and application assertions, which can be used in the furniture industry, were examined and selected. The data model was designed using the above information and customized as per the requirements and business needs of the furniture industry.
- A database was developed in MS Access and was tested by populating it with the data collected from Wentworth Furniture as a representative of the bedroom furniture manufacturers.
- GoSTEP214, a prototype commercial PDM (Product Data Management) system which was developed based on AP214, was also populated using the same data and the result was compared with the database implemented in this project for validation. The validation was positive. The database was also web-enabled and tested to ensure that it satisfies interoperability requirements. A similar process was applied for Moran Australia, a furniture company which has a different type of production (upholstered furniture). The data model was extended using further components from the existing standards, AP214 and AP225 to accommodate new features of upholstered products not included in the earlier version.
- The results showed that the components which constitute the data model covered the product information in both timber and upholstered furniture. It means that companies which have any database constructed on the basis of standards would be capable of storing and retrieving the data for similar products and electronically communicate such data between themselves. Companies can apply the databases developed with minor modifications. However the purpose of this project was to validate the data model with Australian furniture industry rather than developing generic software for commercial use. This would be a task for software developers. The advantage of the data model is the fact that it is compatible with ISO standards and is therefore portable and interoperable.

Major Benefits to the Australian Industry

- Most of the furniture companies in Australia have their customized software for data management or still follow the legacy system. Based on the literature review and findings, it can be concluded that STEP, which is highly successful in aircraft and automobile industries, can be applied in the furniture industry as well.
- With the standardisation of the product data the Australian industry has an opportunity to be an integral member of a large international furniture market.
- Collaboration has enabled the development of networks with European industry and R&D community.

- The project has enabled access to the European developments in technology and standardization.

Although the COFURN project has been completed in Europe, the work developed by FunStep and COFURN projects is continued under a large “network project” SMART-fm, “A standards compliant framework to support complete integrated product life-cycle information management and electronic commerce for the furniture manufacturing (fm) industry, in the advent of the smart enterprises”.

The SMART-fm is focused on companies’ internal operations that relate to interoperability of software applications as well as the production, management, support processes and the associated organisational issues to be developed in the advent of e-business, extended enterprises and intelligent services. In this sense, SMART-fm will act as a natural extension of the areas not covered by AP236 such as design and production processes.

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PROJECT OUTLINE

The furniture industry is one of the largest manufacturing sector in the world when manpower is considered. Most of the companies in the furniture-manufacturing sector are SMEs (small and medium sized enterprises). The manufacturing phase of the furniture product life cycle as well as the business between manufacturers, retailers, providers, and customers requires a lot of data exchange and handling. For this the industry needs to have a standard of data exchange, which helps them in sharing, exchanging and archiving data at a lower cost and with ease.

The COFURN (*CO-operation for consensus, standardization and interoperability to support e-com services in the FURNiture sector*) project aims to establish a Thematic Network linking key organizations (furniture manufacturers, retailers, suppliers, designers, industrial federations, software houses, R&D centres, Universities and standardization bodies world-wide) to promote the co-operation for consensus, standardization and interoperability for data exchange within and between enterprises and support for electronic commerce activities in the furniture industries sector. COFURN is an added value to the funStep Interest Group initiative.

Australia is participating in the European COFURN, the objective of which is listed below. This report well presents the objective, major research and the outcome of the Australian consortium.

The role of Australian Chapter Coordinator in the COFURN project is to extensively disseminate the European developments to the Australian furniture industry, validate and modify product and project data models according to the Australian specific requirements and facilitate the implementation by the industry. Therefore the project tasks are not typical research activities but relate to the adoption of the European project outcomes in Australia.

OBJECTIVES OF EUROPEAN CONSORTIUM (ref: COFURN final report by European Consortium)

The main COFURN objectives are:

- Increase industrial awareness on the data exchange problem and disseminate the knowledge about the funStep initiative. Plan of dissemination to get the Network more representative, contributing to a common platform for data exchange and e-commerce.
- Plan and manage the standard data model evolution and co-ordinate industrial implementations. Drive the funStep data model towards an International Standard, supported by the network members providing material for analysis, validation and test.

FunStep data model is in a process towards an ISO international standard (NWI stage) it was approved by ISO/SC4 on January 2000, and assigned code ISO 10303-236. It is in process of harmonization with other industrial standards that have points in common (ISO 10303-214, ISO 10303-225, ISO 13584, etc.). It is required to

manage the evolution of the data model by co-coordinating contributions from users representatives and planning the contents for different releases. The objective is to harmonize the user requirements and the software vendor's interests in a single data model and document. COFURN supports the advance of the data model in the standardization process, speeding it up thanks to the collaboration of all the companies involved, providing material for analysis, validation and test when required. Participation in ISO and CEN meetings and CEN/ISSS Workshop has been held to support the activities of the Network.

- Develop mechanism for the support of the fast growth rate of involvement of the industry. Consolidation of the funStep IG organisation worldwide and redefine the framework for membership. Special effort concentrated on East European countries.
- Set up collaboration and liaisons with other initiatives/projects. Co-operation with other related initiatives or projects to enrich the data model and accelerate the process toward an international standard.

WORK DESCRIPTION OF COFURN (<http://www.funstep.org/funStep.htm>)

European COFURN comprises two essential activities, one being the progressive development of communication, dissemination and technology transfer mechanism, the other the co-ordination of resources within the Network and from other relevant initiatives to speed up the process of adoption by the Industry. The specific work to be undertaken was divided into different work packages as follows:

- ✓ Dissemination activities: Organization of Industrial Seminars. Develop mechanisms to update dynamically the web site. Support software houses in STEP implementation issues. Private visits. Publications and newsletters.
- ✓ **Evolution of the data model and implementation issues by means of the organization of Technical Seminars and the start up of over eight Working Groups covering relevant aspects such as e-commerce, parametric, geometric representation, etc., to enrich the model based on the industry requirements. An on-line Dictionary on Internet will be used and extended to make easy the understanding of the model and related terms.**
- ✓ **Extension of the data model towards e-commerce, manufacturing and ERP systems requirements through the gathering of industrial requirements in these specific fields.**
- ✓ **Co-operation and exchange of knowledge with other related initiatives or projects in order to enrich the data model and accelerate the process towards an international standard for the Furniture industries. Attendance to standard and IT related meetings, such as ISO/ TC184 SC4, CEN/ ISSS, PDT Days, IST events, etc. It was planned to present results of the project and co-ordinate actions with other WGs.**

THE AUSTRALIAN OBJECTIVES: -

- ✓ Dissemination of COFURN project and its developments to Australian manufacturers, retailers and software vendors. This includes organization of Industrial seminars. The seminars to be held together with relevant industrial events. This activity involves all members of the COFURN project including Australia.
- ✓ Participation in the COFURN strategic meetings and management board meetings.
- ✓ Australia is required to provide data for furniture dictionary and product data catalogues, validate, modify and implement product data model provided by European consortium.
- ✓ Project management
- ✓ Reporting

FROM THE AUSTRALIAN CHAPTER (ref: COFURN final report by European Consortium)

- Continuing an extensive program for dissemination seminars in every state of Australia.
- Involvement of retailers and suppliers in the funStep initiative.
- Working with selected industry leaders.
- Increasing the membership in funStep-IG.
- Continuing the validation of data model as per the AP236 standards for products, processes and catalogues based on data from selected furniture manufacturing companies

AUSTRALIAN CONSORTIUM

This project brings together manufacturers, retailers, suppliers, designers, and industrial trade associations from the furniture sector as well as research & development centres, academic institutions, software vendors, and consultants. In Australia the FIAA (Furnishing Industry Association of Australia), IRIS and University of Melbourne have taken leading measures in collaboration with other partners from all over the world for the progressive development of communication, dissemination and technology transfer mechanism, and the co-ordination of resources within the Network and from other relevant initiatives to speed up the process of adoption by the industry.

Significant work has been done in these fields by the Australian consortium--

- Dissemination activities- producing some guidelines as a stepping-stone for people who want to understand and implement STEP in furniture and beyond. Increase industrial awareness on the data exchange problem and disseminate the knowledge about the funStep initiative. Plan of dissemination to get the Network more representative, contributing to a common platform for data exchange. A lot of seminars and one to one interaction with furniture industry was done to make them aware of the happenings around the world and about the advantages of standardization.
- An extensive literature survey was done and comprehensive overview of STEP has been compiled to understand the subject. Study of the successful implementation of STEP in automobile and aircraft industries and their relevance to furniture industry has been done. For people to understand STEP principles the learning process starts from the evolution of the concept, how and why was it developed and its advantages. Then it is related to furniture industry showing how it can be helpful to the industry.
- Understanding the data modelling as per STEP standard:
 - Both AP214 and AP236 were studied in detail along with its Application Objects, Application Assertions and Unit of Functionalities.
 - Understanding the ARM diagrams of AP 214 and AP225.

The project responsibility consisted of validating and modifying the data model (provided by European partners) according to the Australian specific requirements. In absence of a data model from our European partners at the beginning of the project, we took an attempt at designing the Data Model as per AP236 standard and using data collected from Wentworth Furniture to populate it. Wentworth Furniture, one of the partners in Smart-fm contributed in collecting live data. The objective was to make a data model which fits in the furniture industry. More work needs to be done on the data model by software experts and ISO standard experts.

- ARM diagrams were selected from AP214 and AP225 and its relevance was checked with the business needs of furniture industry.
- Some of the relevant application objects, units of functionalities and application assertions, which can be used in the furniture industry, were

selected and the data model was customized as per the requirements and business needs of the furniture industry.

- A database was developed in MS Access and was tested by populating it with the data collected from Wentworth Furniture.
- GoSTEP214, a PDM (Product Data Management) system that is made as per AP214 was used, proven commercialized software was populated using the same data and the result was compared with the implemented database for validity.
- Further queries were generated to check the validity of the data model.

Though web based database was out of our project scope, we web enabled the database, just to show that database can be accessed from the web and if all companies use the similar data model to keep their data, it becomes easier for data exchange because of standardization of data.

ON-LINE FURNITURE DICTIONARY

One of the objectives of the COFURN project was the development of a multilingual on-line dictionary for furniture terms. The dictionary, developed in 10 languages, includes more than 750 specific furniture terms eg. raw material, production methods, type of furniture, exchange of orders, resource planning.

In the Dictionary, it is possible to find furniture terms in any of the languages available, their description, their translation to other languages, related words, photographs of the objects if possible, and movies if available.

The Australian Chapter has been actively involved in the development of on-line furniture dictionary. This work included:

- Correcting English translation of 350 furniture terms developed by non-English speaking European members.
- Adding 400 furniture terms to an existing on-line furniture dictionary.

This work has a significant input into the European work on the development of product data catalogues. The development of the dictionary is an on-going process. The current version will be further extended, modified and validated.

The Dictionary is available at: www.funstep.org (select “Dictionary”).

DISSEMINATION ACTIVITIES

Increase industrial awareness on the data exchange problem and disseminate the knowledge about the FunStep initiative. Plan of dissemination to get the Network more representative, contributing to a common platform for data exchange and produce some guidelines as a stepping-stone for people who want to understand the advantages of standardization.

Seminars were organized at IRIS, and Dr. E. Shayan and Dr. Barbara Ozarska had interactions with furniture manufacturers to disseminate the knowledge about STEP and its benefits.

To succeed in the global marketplace, companies in highly competitive fields must be able to form partnerships rapidly. It is becoming less and less viable for a corporation of any size to operate only locally, regionally or even nationally. Business opportunities are global; access is global; competition is global.

1. METHODS FOR DATA EXCHANGE

It has been demonstrated through many cases that information technology is not as productive as it was promised to be. Too many expectations, unexpected failures, inability to respond to changing requirements, are some of the reasons for this dissatisfaction. Complexity in global commerce, sharing and exchange of data are mostly due to incompatibility in IT systems. The exchange of data between dissimilar systems can be within a company, between companies or organizations co-operating on a specific project, within a supplier chain or between customer and company. There is also the need to manage data independently of specific Information Technology systems throughout the life of the product and the need to archive data beyond the active life of specific Information Technology systems. Thus there is a business need to be able to access data created by one computer system from another, where the two systems may be separated organizationally, geographically, or in time [4].

To overcome these problems the solutions are as follows-

- **Adoption or imposition of “standard” systems**- if the problem of data exchange is due to the incompatibilities between different systems, then it can be avoided by adopting a single, common source of computer system within the organization as well as in the supply chain. But the point is that few supply chains are simple to adopt this method so this solution is not all together acceptable.
- **Direct translation**- this allows one computer system to read and write data in the format required by others. A translation process is involved. Software packages that accomplish this translation for a given pair of systems are known as direct translators. Two translators are required to get bi-directional exchange of data between two systems as shown in figure 1. These translators offer very high quality data exchange. But these translators are expensive to get and maintain and have to be upgraded whenever the systems are upgraded. The number of such translators increases exponentially with the number of systems involved.

Example:

For n systems, the number of translators T is

$$T = n(n-1)$$

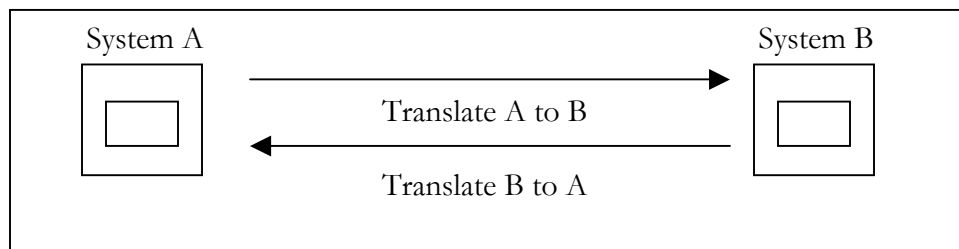


Figure 1: Data exchange using direct translation

- **Neutral format translation-** agreed specifications, such as IGES (explained later) or STEP for data exchange is to be used that can be supported by all systems. It should be universally accepted and understood language for data. Standard file formats are used for the exchange of data. Two translators are used, one to translate from the internal data format of the application to the standard and the second one for the reverse translation as shown in figure 2. Since the specifications are open to different interpretations, there are therefore variations in the quality of the translators. The standards are limited to exchange of geometric information, engineering drawings and some graphical data.

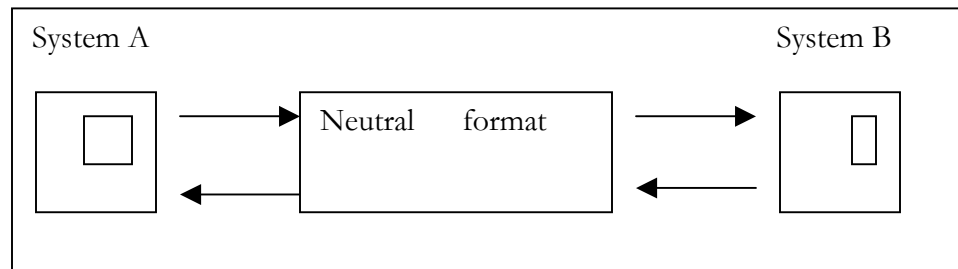


Figure 2: Neutral format data exchange

In a case study performed by Ford Motor Co., STEP (Standard for Exchange of Product Data) supported translators resulted in estimated savings of \$154,300 per year, as opposed to a \$24,000-40,000 per year savings from AutoCAD based translation system. By decreasing the number of translators needed for data exchange, STEP supported programs resulted in additional savings.

The PASC-C pilot program was able to complete the exchange of a product model data package containing the plans and documents for a C-17 plane's horizontal stabilizer. The exchange involved transmitting the graphical, textual, and tolerance information of an older design of the horizontal stabilizer to another company, who had to access and retrieve the information in order to perform a redesign of the product model. Once the redesign was completed, the updated product model was then re-packaged and sent to a manufacturing company to build the new product. In addition, specific information modules, such as tolerance information, were linked to schematic models so that the textual information was available for viewing while examining the schematic model.

- **Direct Exchange-** In this case there is no need of a translator as the data in both systems A and B is in a standard format - STEP format. The STEP provides formats which assist in storage, access, updating and exchange of product data and documentation. This enables the integration of product model information and documentation amongst different systems resulting in overall savings for the industry.

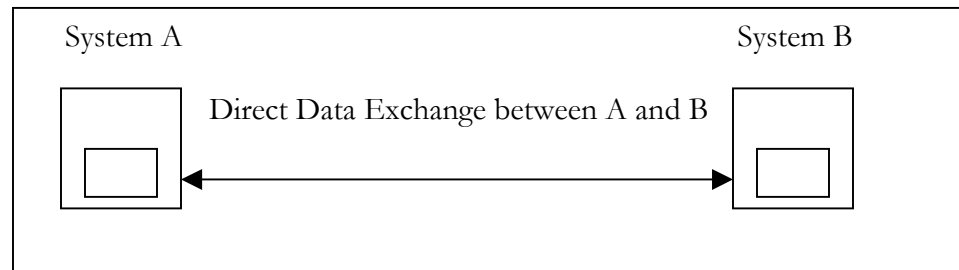


Figure 3: Direct Data exchange

2. DATA MANAGEMENT

Data Management encompasses activities associated with administering and controlling how data is used within an organization, together with planning and implementing the process and systems that are used to take these tasks.

The requirements for exchange and sharing of data are coupled with requirements for the management of data. The tools and techniques of data management gave rise to Product Data Management (PDM) and Engineering Data Management (EDM). Such systems are now widely implemented within industry, providing a level of control over product definition data that is not possible from single CAD/CAM applications.

2.1 DIFFERENT AREA OF FUNCTIONALITY FOR PDM: -

Access management- providing access to data for authorized users.

Product structure definition- describing the structure of a product in terms of components and assemblies

Configuration management- identification of versions of products and of data and their valid combinations

Design review and approval - maintaining records of reviews and the assignments of approvals to products and product data

Action management- including effectively and work-flow information

Thus the PDM systems fulfill requirements for the logical identification of elements of product data within a heterogeneous system and the physical locations of those data elements within one or more computer systems.

2.2 DATA MODEL

A Data Model provides the definition, structure, and format of data. A data model is a detailed description of the various pieces of data required by an application. Data modeling is to capture the characteristics of a real world object or process using a formalized notation. Data modeling is important to be able to exchange information not necessarily complete information, but adequate for a certain purpose (Abstraction). Data modeling is the process

of identifying, documenting, and implementing the data required by an application and usually involves:

- Identifying each piece of data required to perform the business operations that the application is being designed to automate.
- Defining the type, size, and default value of each piece of data.
- Defining relationships between the various pieces of data. (For example, the customer ID is used to relate customer orders to customer accounts that are maintained in a separate table.)
- Defining the integrity constraints required by each piece of data. (For example, the ZIP code must contain exactly five alpha characters, there can only be one customer with an ID value of 12345, and so on.)
- Organizing the data to avoid redundancy and inconsistency while maintaining optimal overall performance—a process commonly known as normalization.
- Defining the operational processes required to effectively maintain the data (for example, scheduled backups, security audits, and so on).
- Choosing a data storage technology to actually implement the model (for example, a Relational Database Management System (RDBMS), a hierarchical database system, an Indexed Sequential Access Method (ISAM) database system, and so on).

The information generated about a product during its design, manufacture, use, maintenance, and disposal is used for many purposes during that life cycle. The use may involve many computer systems, including some that may be located in different organizations. In order to support such uses, organizations need to be able to represent their product information in a common computer-interpretable form that is required to remain complete and consistent when exchanged among different computer systems.

ISO 10303 is an International Standard for the computer-interpretable representation and exchange of product data. The objective is to provide a mechanism that is capable of describing product data throughout the life cycle of a product, independent from any particular system. The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases.

STEP, Standard for Product data Exchange, or officially ISO 10303 “Industrial Automation systems- Product data representation and exchange” is a set of standards whose heritage can be traced back over twenty years. It originated with the basic need for exchange of geometry between simple drawing systems. STEP delivers the capabilities of all preceding related standards efforts in a cohesive package as an ISO standard. STEP is evolutionary because its core capabilities are built from the best parts of other standards efforts over the last twenty years.

3. STEP ADVANTAGES: -

- STEP is a world ISO standard, which is universally acceptable through local and global standards organizations.
- Highly reliable – Testing organizations in USA, Europe and Japan.
- Improves the quality, accuracy and completeness of the exchange of data between systems.
- Increases the re-use of product data information in engineering, manufacturing operations and support functions.
- Integrates CAD models and drawings with other data in a managed product data environment.
- Efficient product data sharing with customers, collaborators, suppliers and sub contractors.
- Employs and maintains a shared product database that can be used by many different disciplines and applications.
- Data accessed through standard interfaces.
- Enhanced quality of data by the use of standard data models and interfaces.

Each of this advantage is proved valid; as there are many organizations worldwide who have already committed to achieving one or more of these by implementing STEP.

3.1 ECONOMIC BENEFITS

The introduction of STEP based methods and systems in Product Data Technology will continue to require major investments of time and cost as well as strategic organizational changes. These efforts must be justified by commensurate economic benefits. It would be very shortsighted to aim at such benefits only from the application in data exchange, although this may be the area of initial success. But the long-range potential of Product Data Technology is much broader. It includes at least the following targets of economic relevance:

- Neutral data exchange between heterogeneous systems in-house (open PDT systems)
- Neutral data exchange with suppliers and customers (fast response to inquiries)
- Long-term archiving of product data (system-independent archives)
- Flexible migration policies
- Paperless product definition (from graphical to digital documents as primary medium)
- Enterprise integration via neutral product databases (CIM)
- Support for life-cycle product maintenance
- Medium for Concurrent Engineering

- Worldwide networking communication of product data in open systems
- Modelling platform for intelligent systems

4. BASIS OF THE STEP APPROACH

The methodology of product description used in the new international standard STEP, which stands for "STandard for Exchange of Product model data", (ISO 10303) is fundamentally different from earlier generations of product data exchange techniques. Some of the basic assumptions in the STEP approach are the following:

- The product model, i.e., a conceptual information model of the product, is described at a semantic level capturing the meaning of the modelling elements in a formalized way, not merely by using syntax conventions (as in current standards like IGES, SET, VDAFS).
- This is achieved by using a formal product modelling language, EXPRESS, a data definition language with object-oriented flavour, and by relying on an axiomatic modelling approach. In this approach a pool of primitive, application-independent modelling elements (STEP resources) is introduced axiomatically. Then all application-specific, higher level concepts are required to be described in terms of these resources by appropriate mappings. The founding of the product models on the same pool of resources is a major prerequisite for the consistency and interoperability of the resulting application-specific information models.
- The conceptual product models are described in EXPRESS in terms of entities with attributes, relations and rules and are organized into schemas.
- The product model world in STEP is the sum of all standardized, partly independent schemas. The standard remains open and extensible.
- Instances of product model data in STEP are exchanged in STEP Physical File syntax (STEP Part 21) or can be accessed and shared via the Standardized Data Access Interface format (STEP Part 22). STEP thus serves as a neutral medium for exchanging and sharing data.
- Product model data instances are interpreted and verified with reference to the conceptual models and subsequently converted into any other desired formats. STEP processors do this. They usually consist of commercially available STEP toolkits and of system-dependent software.

5. INDUSTRY SECTORS

A unified approach toward Product Data Technology is evolving across practically all industrial sectors. The most active participants in these developments, especially in STEP standardization at ISO level, include the following:

- Aerospace

- Automotive
- Architecture, Engineering, Construction
- Electrical and Electronics
- Mechanical
- Process Plant
- Offshore
- Robotics
- Shipbuilding

Furniture industry is making an effort to follow the STEP standardization process.

6. STEP IN DIFFERENT COUNTRIES

To show Australian manufacturers the advantages of STEP, we showed them the usage of STEP in different countries.

6.1 THE UNITED-STATES

The General motors' STEP translation centre has compared the performances of IGES and STEP AP203 for the exchanges of surface model between Unigraphics and Catia and between Unigraphics and ProEngineer.

More than 40 tests have been executed using products marketed for STEP and IGES. The results are the following:

- Tests from Unigraphics to Catia: 99 % of success for STEP and 69 % for IGES
- Tests from Catia to Unigraphics: 99 % of success for STEP and 66 % for IGES
- Tests from Unigraphics to ProEngineer: 99 % of success for STEP and IGES
- Tests from ProEngineer to Unigraphics: 100 % of success for STEP and 98 % for IGES.

6.2 GERMANY:

ProSTEP has performed tests for VDA (Association of industrials from automotive) comparing IGES, VDA-FS and STEP AP214 for the transfer of surface models. Six CAD-CAM interfaces have been tested with the following results:

- 99.8 % of the surfaces have been successfully transferred with STEP
- 99.5 % with VDA-FS and
- 92.6 % with IGES

Concerning the volume of the files and the time passed, STEP and IGES are similar even though the VDA-FS files are much more voluminous and have got a superior execution time.

Once results being obtained, Opel has announced to its suppliers that they should now use STEP for their exchange of surface models.

6.3 JAPAN

From May 1996 to March 1998, a V-CALS working group constituted of representatives from JAMA (the association of the vehicle manufacturers in Japan) from JAPIA (the association of the vehicle part manufacturers in Japan) and CAD-CAM suppliers have been working for the development of the AP214 of STEP standard and for fostering its practical application.

Tests of data exchange on more than twenty industrial cases have been executed on CAD-CAM systems developed within Toyota, Nissan, Mazda, Mitsubishi, Suzuki, Yamaha and Denso. These systems are mainly running with wire frame and surface models and the developed translators were to provide data in conformance with the STEP AP203.

Complementary checking tests have been performed and the obtained results were: -

- a success rate of 90 % for IGES
- a success rate of 95 % for STEP

It has been noted that the translation time and the volume of the files are the same for STEP and IGES

6.4 AUSTRALIA

STANDARDS AUSTRALIA: STEP activities in Australia are under the control of Standards Australia, the ISO Member National Body for ISO TC184/SC4. Its objectives are the development and introduction to Australian Industry of STEP technologies appropriate to Australia.

The federal chamber of the automotive industry (FCAI) and the federation of the automotive manufacturer) have done few tests with STEP and IGES. GM Holden, two design offices and two part manufacturers were involved in the tests. The following systems have been implemented: ALIAS, CATIA, CADD5, IDEAS, ProEngineer and Unigraphics. Tests have shown that for solid and surface model, STEP give better results than IGES.

7. AUSTRALIAN FURNITURE INDUSTRY IN BRIEF

Direct turnover in the Australian furniture industry is almost \$4.9 billion, and indirect turnover in associated industries is \$3.1 billion. Total turnover is almost \$8 billion. In the past decade the reduced level of domestic demand has affected the Australian furniture industry. The Australian furniture industry will thus have to face a series of challenges in the near future: global competition is increasing and the furniture sector is not very export-oriented and extremely fragmented. Australian furniture exports amounts to about \$150 million: the

largest share is destined to the nearby New Zealand market, followed by United States, United Kingdom, Hong Kong and Japan. Furniture imports are worth about \$1.35 billion, with China, Malaysia, Indonesia and Italy being the main furniture providers to the Australian market.

The analysis of furniture distribution channels comprises: specialist dealers and retailers, department stores, large furniture retailers, discount stores.

Most of the considered products are: household furniture, office furniture, contract furniture, kitchen furniture, upholstered furniture, bedroom furniture, living room furniture, outdoor & garden furniture, lounge, non-upholstered seats, seating parts, furniture parts, metal furniture, wooden furniture, sawnwood, wood-based panels, plywood, veneer sheets, particle board panels, fibreboard panels, MDF, wood working machinery.

LITERATURE SURVEY

- An extensive literature survey covering such as electronic papers as well as papers from many journals like Journal of Information Technology, Journals of Systems and Software have been compiled to understand the subject. The literature survey also involved the examination of several electronic databases like EBSCOhost, Emerald, Infotac and White papers from many websites. A full search in terms of books, papers, journals and periodicals articles, conference proceedings, trade papers and input from various Organizations for Standardization have been undertaken to give a comprehensive overview of STEP.
- Study of the successful implementation of STEP in automobile and aircraft industries and their relevance to furniture industry has been done. For people to know what is STEP all about the survey starts from the evolution of the concept, how and why was it developed and its advantages. Then it is related to furniture industry showing how it can be helpful to the industry.

CONCEPTUAL ORIGINS FOR PRODUCT DATA EXCHANGE

The quest for a common output format among design automation tools did not start with STEP. STEP in many ways can be seen as the result of various U.S, industry, government and international efforts.

In 1977, the European aerospace industry recognized a major problem on collaborative projects was the inability to exchange shape information between the different surface definition systems then existing in the various companies. In general these systems had been developed internally, using different mathematical formulations and were generally incompatible. The European Association of Aerospace Industries developed a common exchange format, based on a simple surface type, which allowed the companies for the first time to exchange surface geometry, which was then used internally as the basis for creating all other geometry. The format was used on few occasions, but the advent of more complex surface types, integrated into vendor systems, caused it to fall into disuse [13].

More problems in different industries resulted in more organizations like American National Standard Institute (ANSI), Consortium for Advance Manufacturing- International (CAM-I), NASA, IGES and lot more to further the work of standardization for data exchange. Below is the diagram which shows different organization evolving and how STEP came into existence [14][15][17].

HISTORY OF STEP

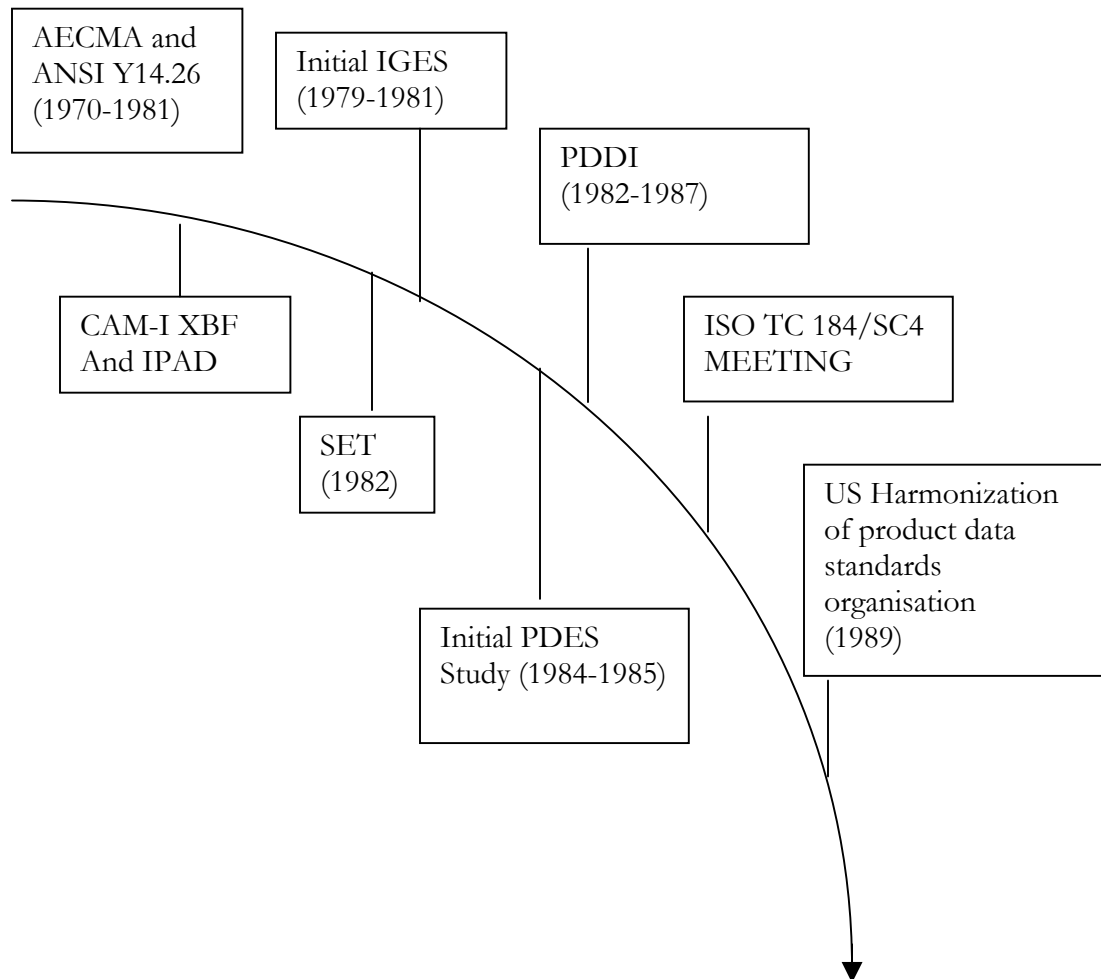


Figure 4: Historical sequence of event responsible for STEP development [12]

**Refer Appendix for details of History of STEP

HARMONISATION ACTIVITIES

Overlapping of standards was found and reported by CALS (Continuous Acquisition and Life-Cycle Support)/EIA (Engineering Industries Association) which offered a matrix showing which lifecycle steps were captured by which of the four ANSI standards, came out a scope for each standard based on this matrix, and declared harmonization effectively accomplished. This proposed solution was rejected by industry, as noted in CAM-I EAP R-90-EAP-01, which criticized the Report's conclusions. Milton Piatok of Boeing summed up industry's viewpoint in a letter to ANSI in 1989 [19]:

“An electronics company which performs all the steps in the design process, using heterogeneous computer systems, work stations, and factory NC (Numeric Control) machinery and robots would have to support all four standards (IPC, IGES/PDES, IEEE, EIA) At worst, this could mean not only having to implement the software to support each standard, but also having translators between each pair.... Such an approach (if it were feasible) would be cumbersome, error-prone, time-consuming, and costly”.

In November 1989, NIST accepted the leadership of the harmonization effort, which was later formalized as the Harmonization of Product Data Standards (HPS) organization under the Industrial Automation Planning panel (IAPP) of ANSI. The major accomplishments of the HPS organization were to propose a methodology and a process for harmonizing the four ANSI standards, and to publish the first version of a coordinated information model as ANSI/HPS-100 “HPS information Federated Model Description”. The HPS proposed the following process to guide harmonization, which reflects the group’s early belief that the four standards would eventually be completely represented within STEP [19].

Process	Guidance for Harmonization
Gather Models	Gather verified conceptual models for the subject area of current focus from each of the relevant standards organizations.
Federate	Every element is added to the federated model in the data dictionary. Elements are classified. Unique identical and conflicting coverage is identified. Conflicts are resolved by creating generic elements that each conflicting element can be mapped to. The Federated model contains each conflicting element as well as resolving elements.
Test	Define mapping between standards through the generic portion of the federated model. Create test vehicles (test cases) for the subject area of interest in the original standards Compare before and after files of test vehicles document mappings.
Harmonize	Derive harmonized model from tested, generic portion of federated model.
Submit for Standardization	Submit portions of harmonized model as candidate application reference models (ARMs) in STEP as they are ready. The harmonized model may also be submitted for national standardization. Hold public review.
Integrate with STEP	The portions of the harmonized model submitted for standardization within STEP will be integrated with STEP resource models in accordance with STEP procedure.

Develop CDIMs	Aps,	Develop application protocol (AP) and context-driven information model (CDIM) for subject area of interest. The AP will reference the mappings between the harmonized model and each standard. Identify information voids that none of the standards cover.
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Table 1: HPS's Proposed guideline for harmonization of four ANSI standards

The groundwork for continuing international collaboration was aided through these guidelines. The HPS was moved under the Computer Integrated Manufacturing (CIM) standards Boards of ANSI and then deactivated as leadership in the area was transferred to the international arena under IEC Technical Committee (TC) 93. Through its working groups, IEC TC 93 continues to develop a federated model to aid the interoperability of electrical information exchange standards. NIST representatives continue to play an active leadership role within IEC TC 93 to build supporting electrical and electronic standards.

WHY STEP?

Data Interoperability is a critical issue from the top-floor boardroom through to the shop floor of plant operations. On the top floor, reliable interoperability of engineering data is vital to give an enterprise control and choice in the way it develops its strategies. Data Interoperability is an issue for both business and technical management. For business managers, improved control of interoperability results in more choice – of design, production, distribution and service partners. This choice helps drive costs down while enhancing flexibility and responsiveness. For technical managers, interoperability problems lead to delay, cost, and quality problems, usually requiring diversion of skilled engineering resources away from value-adding activities.

The current approach to the data interoperability problem is to write ad-hoc data interface programs for each pair of communicating systems. Experiences show that development and maintenance of these programs is expensive in terms of both time and money. Worse, the total effort required increases with the square of the number of communicating systems. Finally, these hard-coded interfaces support only the information transfer anticipated during development, and not "pull-on-demand" transfers [1].

The information generated about a product during its life cycle - design, manufacture, use, maintenance, and disposal, is used for many purposes. The use may involve many computer systems, including some that may be located in different organizations. In order to support such uses, organizations need to be able to represent their product information in a common computer-interpretable form that is required to remain complete and consistent when exchanged among different computer systems.

If every system always used the same data to represent the same information - identical names, structure, and representations - then the data interoperability problem would go away.

A key notion in data element standardization is that one fully defines the semantics and representation for each attribute of each entity type. (More precisely, one has a library of data element definitions, and each attribute is bound to one of those definitions). That is, all of the properties of the data element are known and standardized. This facilitates information exchange between systems that use a standard data element. No translations are required, because the name and representations are known to be the same.

Here the ISO 10303, an International Standard for the computer-interpretable representation and exchange of product data, comes into picture. The objective of the standard is to provide a mechanism that is capable of describing product data throughout the life cycle of a product, independent from any particular system. The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and archiving.

Sufficient lifecycle support ensures that information across all of the dimensions of a product is sustained over time. Information is essential to the maintenance and production of a product, and must be maintained as long as the product is in use. Information must therefore be stored in a format that can be accessed and retrieved now and in the future [2].

Formats used to store information, however, have changed with time. New and more efficient formats have not always been compatible with the previous ones. In addition, each translation of information from one format to another may result in information loss. Many products have maintained their usefulness, but the formats and procedures used for maintaining and translating information were incapable of replicating the information for the product exactly [3]. The transfer of information from one format to another has led to costly correction and regeneration of lost data.

Electronic formats are the preferred formats for storing information today. Problems related to the updating, exchange, or transfer of the electronic representations of the product, or product model data, are viewed as technological barriers, which increase the cost of operations. The life span of a product and its associated information exceeds the life of today's rapidly changing computer technology. Yet, technological change is demanded by industry. Industries update their software to reduce costs or to meet competition in the design of new products, but the information for older product models may remain unchanged. To be reusable as technology changes, data must be translated or encoded into the newer formats [4].

Current industrial trends encourage the practice of electronic commerce, i.e., the exchange of product model data among business via Internet or other network connections [5]. Electronic commerce requires that information be interoperable among companies involved in the exchange. Because product model data are often stored in formats that vary across companies and application programs, information often cannot be accessed, stored, or retrieved by others involved in the exchange. Translation into neutral formats that all application programs can use, such as **STEP (Standard for exchange of product data)**, make the product model data access simpler and more suitable for long-lived products and projects.

One goal of STEP is to establish a way to compile all product model data and document it into a single product package that can be stored, transmitted, exchanged, accessed, and

manipulated for electronic commerce exchanges. For e.g. AP232 is the STEP application protocol that incorporates different forms of product model data and documents into one package.

1. COST OF MANAGING DATA

The costs for translating data between two different computer environments includes the cost of the translation system used and the cost of correcting any errors made by the translation system. Translation of data can result in changes, e.g., information loss or the addition of spurious information. To correct such errors, companies must incur the cost to retrieve any lost information or remove information that appeared as the result of translation. Companies must also support costs for the translation equipment. However, not all computer applications or platforms have translators that allow you to translate directly from one format to the next. Instead, a series of translators may be required to translate information from one format to another. Not all applications have translators that allow a direct one-to-one translation. Other translators may be needed depending on what kind of translators are available and which ones can be used to put the data into the desired format [4].

STEP helps to cut costs by increasing interoperability of data. Because the STEP format is neutral, fewer translators are needed for many exchanges. The cost of the STEP translator can possibly eliminate the cost of several direct translators. The cost of training employees to encode new information in STEP assures support for the product over a long period of time, so that it is retrievable, accessible and exchangeable. STEP provides neutral formats that help to assist the storage, access, retrieval, manipulation, update, and exchange of product data and documentation. Neutral formats of documentation and data enable the integration of product model information and documentation, which results in overall savings for industry.

2. STEP OBJECTIVES [14]

The scope of STEP includes all product data for any stage of the product lifecycle for any industry.

- STEP supports the complete and unambiguous exchange of product data between application systems.
- STEP supports the complete and unambiguous archiving of product data.
- STEP enables the lifetime availability of support and sharing of product data between application systems.
- STEP provides improved reliability and efficiency from other standards.
- STEP supports upward and downward compatibility of implementations. STEP is extensible and must support change.
- Compatibility with other standards is a requirement of STEP.
- Implementations of STEP shall be testable to facilitate user acceptance of the standard.

3. PRODUCT DATA EXCHANGE

Product data exchange is the transfer of product data between a pair of applications. STEP defines the form of the product data that is to be transferred between a pair of applications. Each application holds its own copy of the product data in its own preferred form. The data conforming to STEP is transitory and defined only for the exchange purpose [36].

In *Figure 5*: CATIA, Unigraphics and ComputerVision are different applications. The figure shows that data is exchanged between pair of applications using STEP standard.

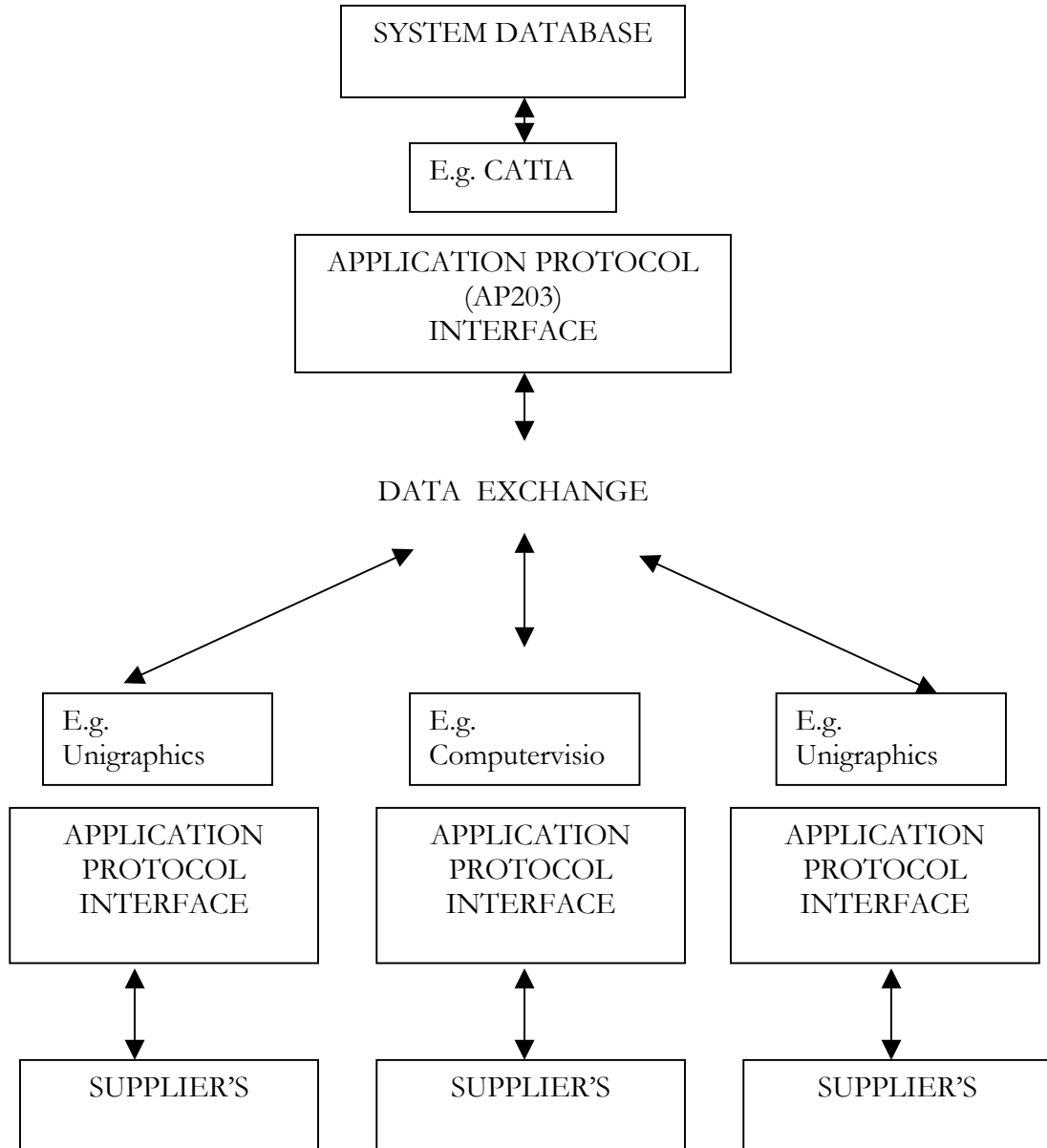


Figure 5: Example for Data Exchange

Here STEP AP203 compliant translators enable the user to convert all forms of mechanical design geometry, as well as assembly and attribute information, from CATIA to STEP and from STEP files into CATIA and similarly from STEP to Unigraphics and Unigraphics to STEP. In addition it supports Configuration Management (CM) data, CM data defines and controls the configuration of a products definition.

4. PRODUCT DATA SHARING

Product data sharing is the access of and operation on a single copy of the same product data by more than one application, potentially simultaneously. STEP supports the interfaces between the single copy of the product data and the applications that share it. The applications do not hold the data in their own preferred forms [4].

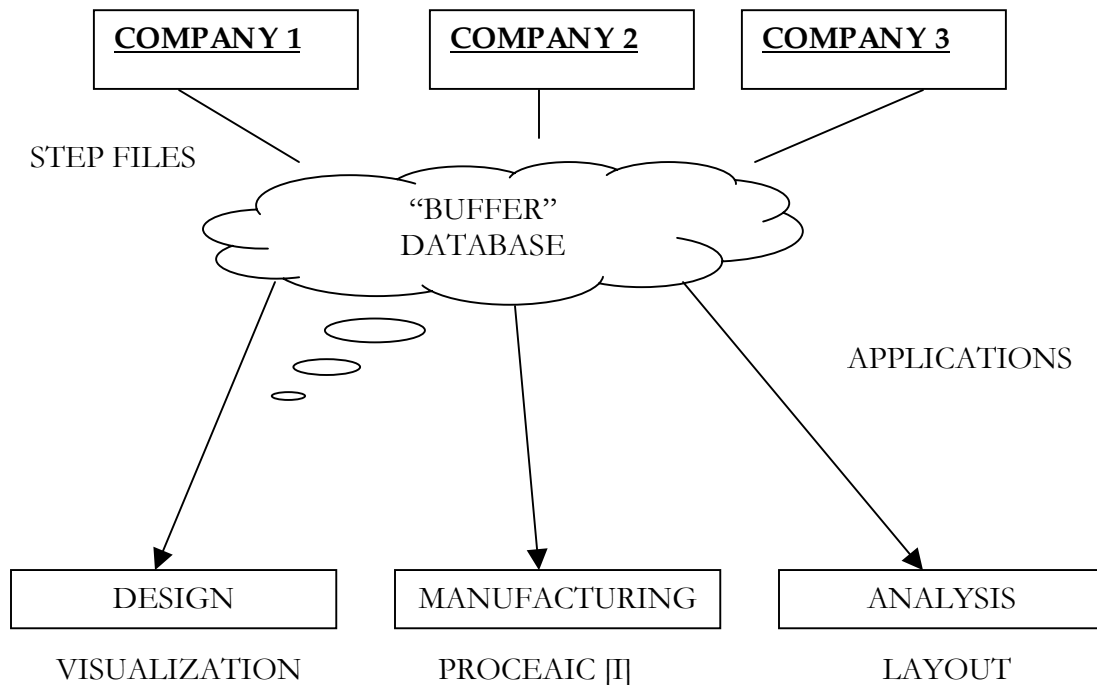


Figure 6: Product Data Sharing

5. PRODUCT DATA ARCHIVING

Product Data Archiving is the storage of product data, usually long term. STEP is suitable to support the interface to the archive. Archiving requires that the data conforming to STEP for exchange purposes be kept for use at some other time. This subsequent use may be through either product data exchange or product data sharing. Early in the development of ISO 10303, SC4 [39] recognized that the scope of the standard was extremely large. The Complainers and Grippers Ad Hoc Committee noted this as an issue in its 1987 report. SC4 assumed it unlikely that any one organization would implement the entire ISO 10303, due to

its large scope.[4] Therefore, it made sense to separate the standard into parts, where an organization would implement only the subset of parts needed to satisfy the requirements of their operations. Secondly, SC4 assumed that the appropriate way to subdivide the large scope of STEP into parts was by views of product data; meaningful exchanges of product data happen only when the applications share a common context.

Another primary concept contributing to the architecture was that the content of the standard is to be completely driven by industrial requirements. This, in combination with the concept that the re-use of data specifications is the basis for standards, led to developing two distinct types of data specifications. The first type, reusable, context-independent specifications, are the building blocks of the standard. The second type, application-context-dependent specifications (application protocols) are developed to satisfy clearly defined industrial information requirements. This combination enables avoiding unnecessary duplication of data specifications between application protocols.

SC4 determined that computer-sensible standards specifications were necessary to facilitate reliability and efficiency.

SC4 also determined it necessary to separate the data definition from the exchange format and the data access language to best facilitates data exchange, data sharing and data archiving. Separating data specifications from the method of implementation has two advantages: data specifications may be extended without requiring changes to the implementation method and a single data representation may be used with each implementation method.

Some of the STEP compatible softwares used in Industries are: -

- Unigraphics.
- Pro-Engineer.
- CADD5.
- Catia.
- ALIAS.
- IDEAS.
- AutoCAD.
- Patran.
- Nastran.
- Ansys.
- Astro.
- Rasna.

6. STEP ARCHITECTURE AND ITS COMPONENTS

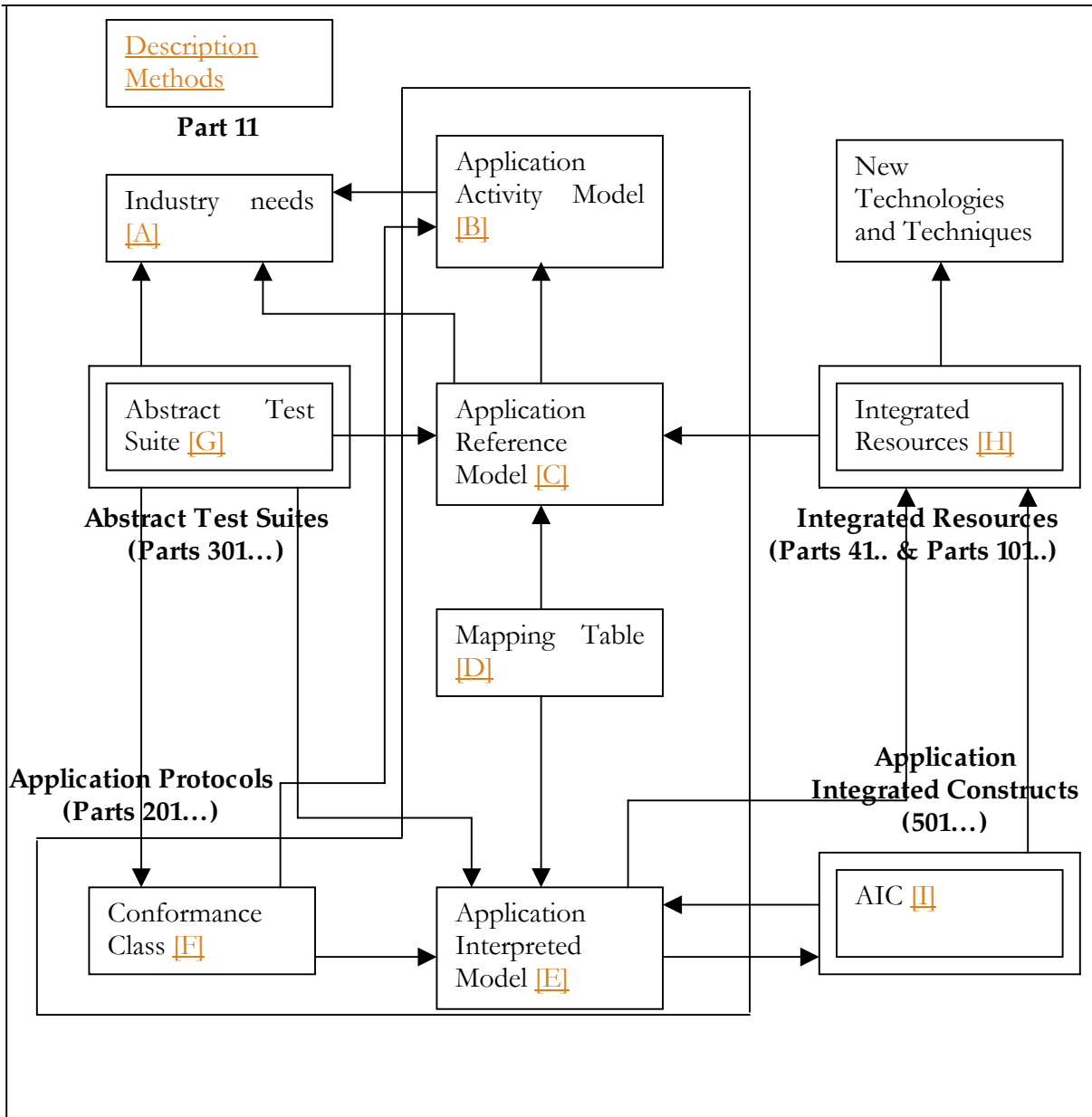


Figure 7: STEP Architecture and its Components [47]

Direction of the arrows in the diagram specifies “existence dependence”, i.e. object at the “tail” of the arrow is dependent on the object at its “head”.

*** See Appendix for details of Components of STEP architecture

7. RELATIONSHIP OF STEP ARCHITECTURE TO DOCUMENTATION OF STANDARD

STEP Architecture supports the development of standards for product data exchange and product data sharing. It is based on the following principles as per the industry requirements:-

Principles [4]: -

- STEP defines architecture for product data, providing stability and extendibility.
- STEP supports and requires traceability of data to industry needs.
- The role of STEP is the standardization of industry application semantics.
- STEP defines the requirements for implementation of product data exchange, based on a separation of data specifications from implementation forms.
- STEP defines the requirements for the assessment of conformance of implementations.

8. APPLICATION PROTOCOLS

An AP is the part of ISO 10303 that defines the context and scope for the use of product data and specifies the interpretation of the STEP integrated resources in that context to satisfy an industrial need. Additionally an AP enumerates the conformance requirements and conformance classes for implementations of the AP. The design of APs permits the reuse of STEP integrated resource constructs to ensure consistent implementations and the exchange of relevant data among diverse computer applications.

The AP methodology provides: -

- ◆ The means to define industry requirements and to ensure that these requirements are fulfilled by STEP standards.
- ◆ The means of extending the STEP integrated resources to address new application requirements in a consistent manner.
- ◆ The means to validate the AP and to ensure that implementations are testable.
- ◆ The STEP vendor with a specification that can be used in developing useful and reliable software products.
- ◆ A useful scoping mechanism for a particular industrial domain.
- ◆ An effective means to document industry semantics.
- ◆ The basis for conformance testing of STEP implementations.

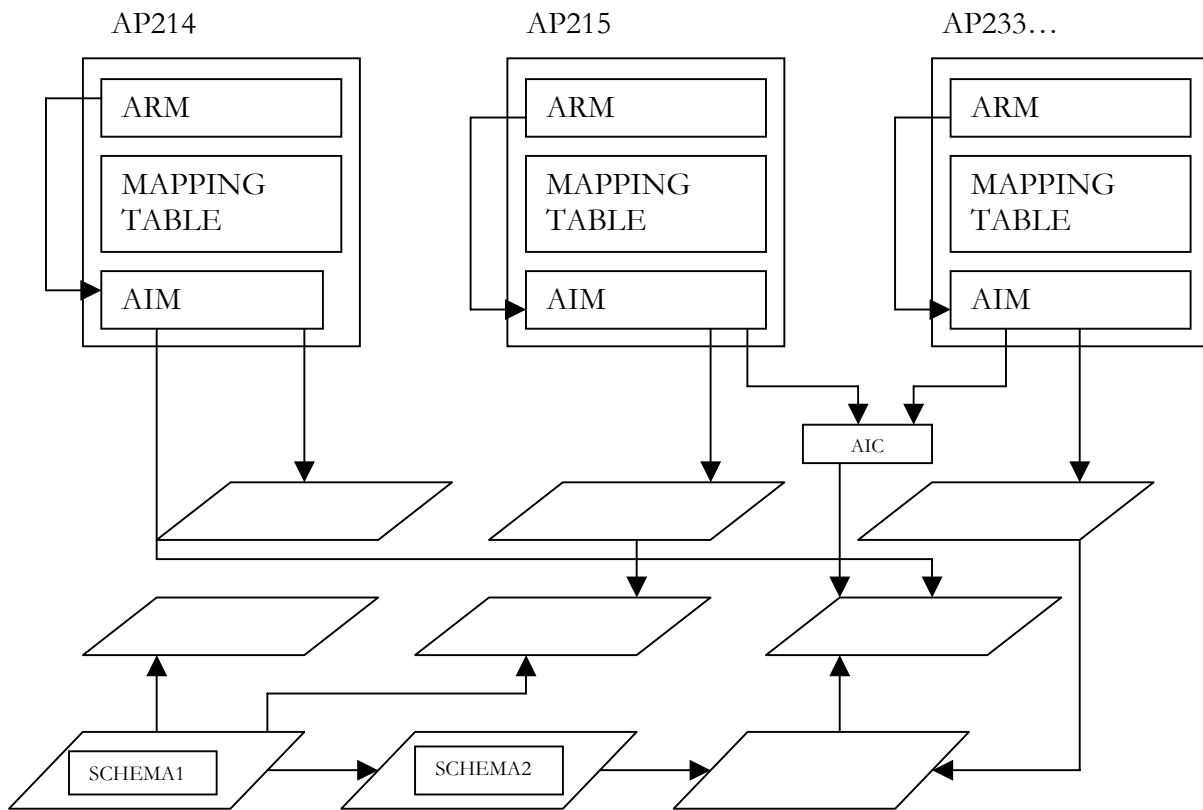


Figure 8: How an Application Protocol works [4]

Application Protocols employ three types of information models (further discussed in detail in chapter 2). These models are application context-dependent: -

- Application activity model (AAM)
- Application reference model (ARM)
- Application interpreted model (AIM)

The Automotive industry and Aerospace industry have successfully implemented STEP and the most successful application Protocol AP214 has helped the industry in effectively using STEP to exchange, share and archive data [6].

****** See Appendix for The Major Components Of Application Protocol and details about AP214, AP225 & AP236**

9. OVERVIEW OF AP236 [7] [8]-

Application Protocol for exchange of Furniture Product Definition (FPD) data and Interior Design Project

The manufacturing phase of the furniture product life cycle as well as the business between manufacturers, retailers, providers, and customers requires a lot of data exchange and handling. For this the industry needs to have a standard of data exchange, which helps them in sharing, exchanging and archiving data at a lower cost and with ease. The Application Protocol AP236 for the furniture industry by ISO TC184/SC4/WG3 N1106 is based on the reported experience and methods adopted from those already implementing the STEP standards.

This part of ISO 10303 specifies an application protocol (AP) for exchange of Furniture Product Definition (FPD) data and Interior Design Project (IDP) data among manufacturers, suppliers, retailers, interior designers, and end users. The exchanged data can include product libraries and catalogues, decoration projects including specification parameterization and graphical information. This representation of products intends to cover the whole furniture domain, including bathrooms, offices, etc.

The specification defined in recent publication of CWA Rev 14249 sets out to define an open solution that can support the exchange of Furniture Product Definition (FPD) data and Interior Design Project (IDP) data among manufacturers, suppliers, retailers, interior designers, and end users. The exchanged data can include product libraries and catalogues, decoration projects including specification, parameterisation and graphical information. This representation of products intends to cover the whole furniture domain, including bathroom, office, kitchen, etc.).

This international agreement that makes possible the realization of the objectives mentioned above is ISO 10303-236, also referred in this document as Application Protocol (AP) 236.

The major focus of the AP is on explanation and proposal of a methodology to represent furniture products and the catalogues including the use of expression and parameters for example in situations where the price depends not only on the product components, but in one or more parameters of the product such as dimensions, kind of cut or and other specifications.

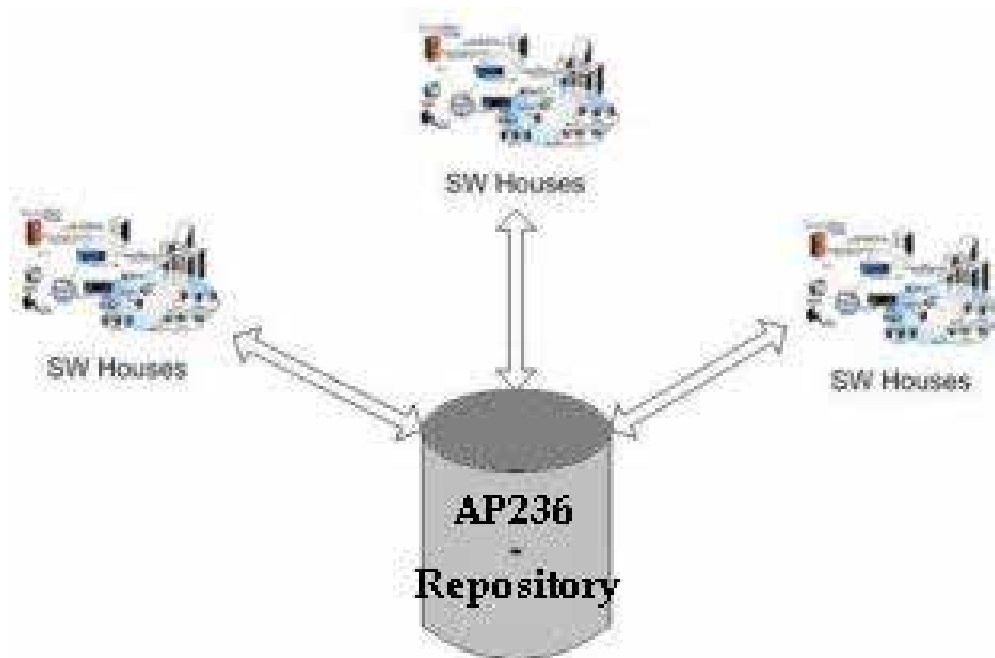
DATA MODELING AS PER STEP STANDARD

“Product data” is the physical and functional characteristics of a product. This information is used, for example, to describe the products of a company, their design and how they are manufactured. The efficient flow of product information within a company is critical to driving down cost, reducing cycle time, and improving quality. Reusing the information, not entering the same data many times for different processes or projects, is faster, cheaper and avoids introducing errors into the system.

Engineering and manufacturing companies are collaborating more and more with other companies to bring a product to market. So the need for interoperability of their product data also increases. These companies need to share and exchange their product data throughout the supply chain. In the long term, they not only will safeguard their investments in data (software and hardware) by re-using results from one application in others, through use of data exchange and in knowledge because of less re-learning, but also they will prepare their organisations for these new technologies which are changing the way business is done and they may create new business opportunities for their own companies.

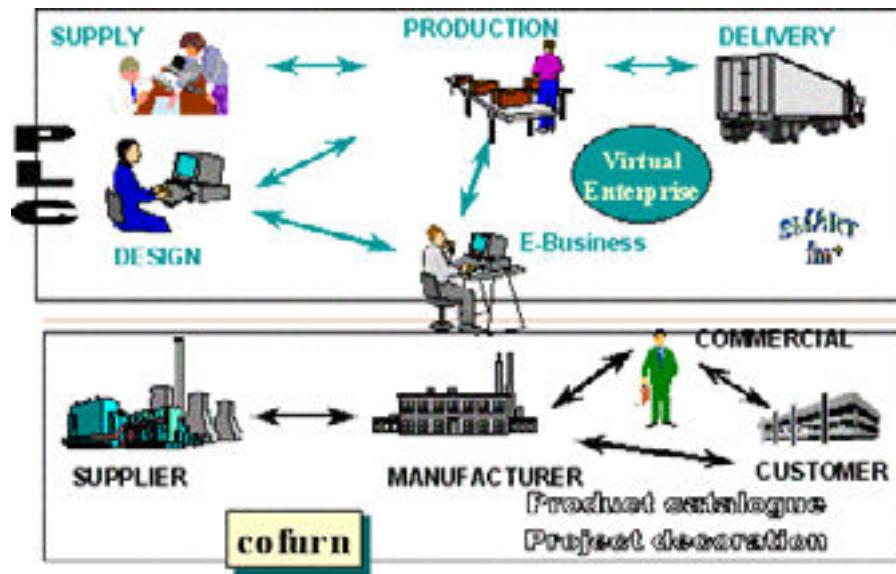
STEP, or ISO 10303, is the Internacional Standard that modelizes the product data. STEP plays a critical role in interoperability, enabling companies to effectively and efficiently exchange and share their product data around the world. FunStep initiative is focused on standarisisation projects related to the furniture industry, defining scenarios in order to validate the advantages of the standard for the furniture sector. These scenarios test the exchange of design, manufacturing and catalogue information of products during all their life cycle. This project is known as ISO 10303-236 or simply Application protocol 236 (AP236).

Apart from the development of the standard data model, the funStep group (COFURN is a part of this group) is involved in its implementation by developing tutorials about the AP236 data model and AP236 implementation tools to translate the internal structures of companies of very different profiles to the structure of the data model. The aim is to make available a wide range of tools to avoid the companies worry about the physical implementation (Access, SQL Server, XML...). Work is in progress in these areas by funStep.



The AP236 - Repository is the place where all the "Furniture product and project data" are stored. At this phase, it is based on a MS SQL Server using the MS Access environment. For future works, the repository will be based on XML, Part #21 of ISO with an environment tool to support the data exchange.

The following picture indicates the different sectors associated to the furniture world, and all of them are being studied by FunSTEP-IG.



The successful use of STEP by different industries like automobile, aerospace and ship industry motivated the furniture industry to get an application protocol developed for the furniture industry. AP236 is the application protocol for the furniture industry. This AP236 structure based on AP214 (**application protocol for automotive mechanical design processes**) is mainly referred to the modelling of furniture products and their features, their classification in product catalogues, and the geometric representation. The definitions which are described in AP225 (**application protocol for building industry**) are being used in AP236 for the modelling of the furnishing project, mainly those related to space definition. Some data modelling requirements in AP236 are not managed in AP214, as for example pricing Information, and more specifically price calculation based on product characteristics.

In addition to the AP214-based structures for the representation of product catalogues, the AP236 is alternatively using the ISO PLIB standard for the publication/exchange of industry-standard dictionaries and manufacturers' catalogues.

The ISO 10303-236 architecture is based on 4 major group of UoF: subset of UoF of ISO 10303-214, subset of UoF of ISO 10303-225, UoF for expression_representation and the UoF for property_expression_extension.

UNITS OF FUNCTIONALITY USED IN AP 236

From AP225

G1 = simple geometry

G2 = analytical geometry (includes G1)

G3 = complex geometry (includes G2)

S1 = space definition

S2 = building structure & semantics (includes S1)

From AP214

P = project definition

C = catalogue definition

Which are further subdivided based on the structure in AP214

E1 external_references

PR1 item_property

S1 product_data_management

S2 element_structure

S3 item_definition_structure

S4 effectivity (may be deleted)

S6 classification

S7 specification_control

P1 geometric_presentation

APPLICATION OBJECTS USED IN AP236 & VALIDATION OF THE DATA MODEL USING WENTWORTH FURNITURE

151 Application objects out of 567 application objects of AP 214, are taken for AP236 and 42 are taken from AP225. So In all, 193 application objects are considered for AP236. To consider the detailed study of all the application objects and their assertions refer to the document ISO TC184/SC4/WG3 N1106: ISO/WD 10303-236 Industrial automation systems and integration — Product data representation and exchange — Part 236: Furniture Product Data And Project Data (22nd July 2002).

At the beginning of the project, the working group of ISO TC 184/SC4 was in the process of finalizing the ARM diagrams so the project has used the ARM diagrams in AP214 and AP225 and their relevance to the furniture industry to customize a STEP compatible Data model for furniture Industry. A company, **Wentworth Furniture**, was chosen to collect furniture product data. The data collected from the company was used to populate the data model and also was populated in GoSTEP214, the software based on AP214 (the software is not

marketed anymore). The validation suggested the correctness of the data model. The Database was web-enabled. A web site was made for the company - Wentworth Furniture. The web site was connected to the STEP formatted database. It retrieves and updates data from and in the database respectively and allows the viewer to order products and suggest changes.

The plan was to customize a data model for Wentworth furniture as per the existing protocols in STEP standard. The process undertaken to achieve this is explained below: -

1. The understanding of the furniture industry and its products was achieved by visiting couple of furniture manufacturing companies, talking to experienced employees, seeing the manufacturing process, understanding the business needs and the information needs of the industry.
2. The visits were narrowed down to Wentworth Furniture and data was collected from this particular company.
3. The latest edition of AP236 available was used as a reference. The developing committee of AP236 has suggested the use of AP214 and AP225 as the superset of AP236.
4. Both AP214 and AP225 were studied in detail along with their Application Objects, Application Assertions and Unit of Functionalities and their usage.
5. ARM diagrams were selected from AP214 and AP225 and their relevance was checked with the business needs of the furniture industry.
6. Appropriate Application Objects, Units of Functionalities and Application Assertions, which can be used in the furniture industry, were identified, selected and data model was configured as per the requirements and business needs of the furniture industry.
7. A database was developed in MS Access and was tested by populating it with the data collected from Wentworth Furniture.
8. GoSTEP214 is a PDM (Product Data Management) system that is made as per AP214 and is used in the automotive industry. It is proven and commercialized software. GoSTEP214 was populated using the same data and the result was compared for validity. A similar type of PDM system can be made for the furniture industry by software vendors after the AP236 is complete.
9. Further queries were generated in MS Access to check the validity of the data model.

1. DATA MODEL AND ITS REPRESENTATION

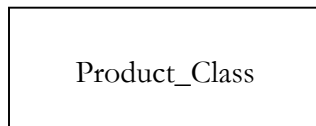
Data model in an AP is represented using a graphic schema, by which the main concepts of the data model (“entities”) are represented by boxes with the name of the entity and the relations among entities are represented by oriented lines (the circle represents an arrow, that points to the relevant entity).

Each line going out from a box represents an attribute of the entity named in the box, the name of the attribute is written on the line and the value of the attribute is given by the entity (box) to which the relevant line points.

The schema illustrated in the figure can be transformed in a set of tables. Each entity represents a table, each attribute represents column of the table (entity) and each row of the table represents a real example of the relevant entity. The tables together form a database. (Refer figure 10)

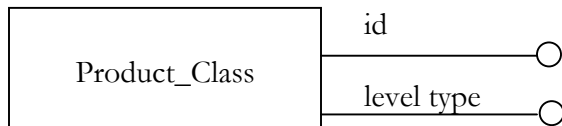
As per the diagram: -

1.



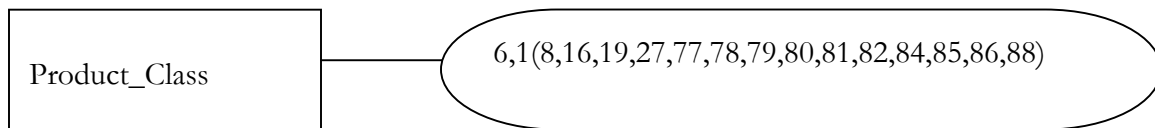
Application Object [Entity (Table)]

2.



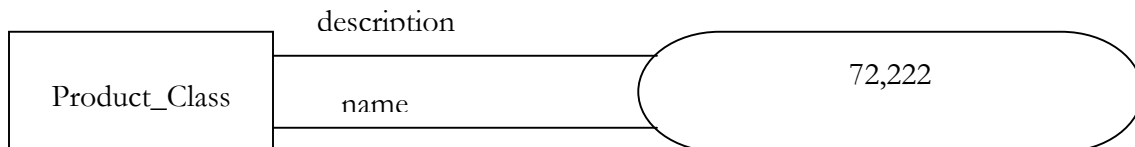
id = Attribute of Product_class
level_type = Attribute of Product_class

3.



- 6 represents that the origin of Product_class is at G6 ARM diagram i.e. on the same page.
- Product_class links to pages G8, G16, G19, G27, G77, G78, G79, G80, G81, G82, G84, G85, G86, G88.
- On G8, G16, G19, G27, G77, G78, G79, G80, G81, G82, G84, G85, G86, G88 Reference No is 1 for the Product_class.

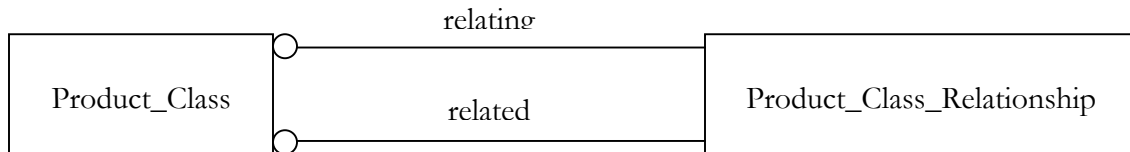
4.



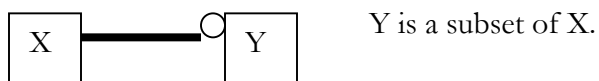
- String_select is an Application Object.
- 72 represents that the origin of Entity string_select is at G72 ARM diagram.
- It does not link further anywhere, as there is no bracket.
- On G72, Reference No 222 is for string_select.
- The attribute description is for Product_class.

- Each Product_Class refers to zero or one Multi_language_string in the role of description. Each Multi_language_string acts as description for zero or more Product_class objects. This assertion is established through string_select.
- Each Product_class refers to zero or one Multi_language_string in the role of name. Each Multi_language_string acts as name for zero or more Product_class objects. This assertion is established through string_select.

5.

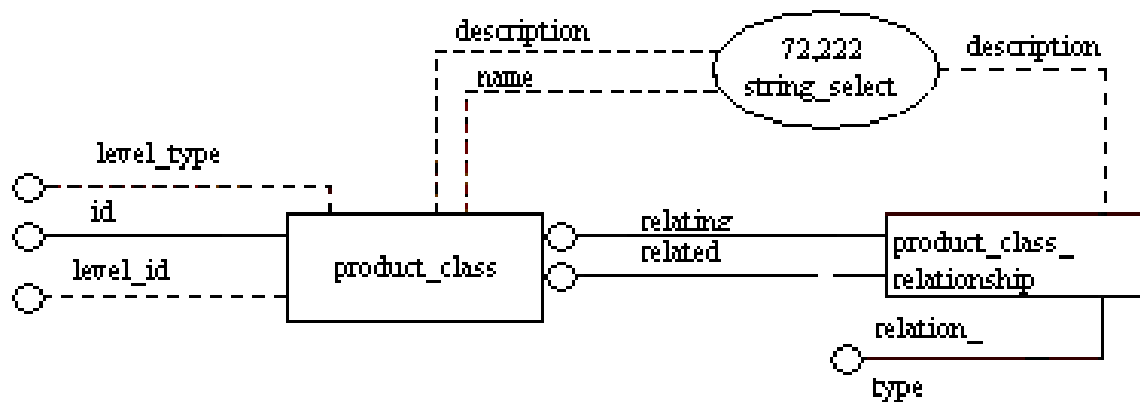


- Product_class objects that are related to each other by a Product_class_relationship (Application Object) do not inherit any characteristics from each other.
- “relating” and “related” are the attributes of Product_Class_Relationship that links Application objects Product_class and Product_Class_Relationship.
- The “related” specifies the second of the two Product_class objects related by the Product_class_relationship.
- The “relating” specifies the first of the two Product_class objects related by the Product_class_relationship.
- Each Product_Class_Relationship is related to exactly one Product_Class. Each Product_class is referenced by zero or more Product_class_relationship objects as related.
- Each Product_class_relationship is relating to exactly one Product_class. Each Product_class is referenced by zero or more Product_class_relationship objects as relating.

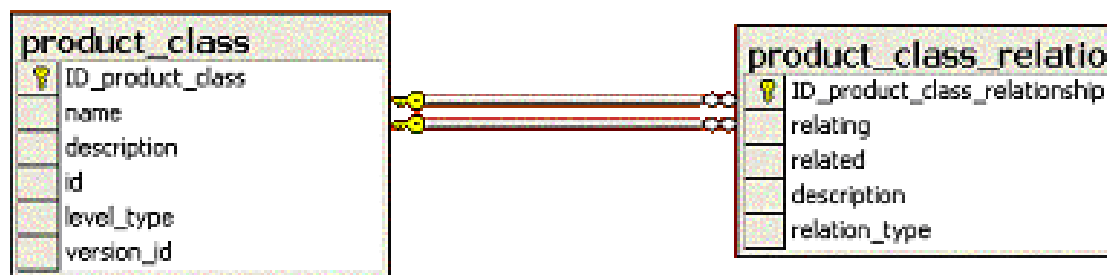


Y has all the attributes of X + its own attributes

To have a better understanding, the product class in Express-G representation in AP is presented in the following figure:

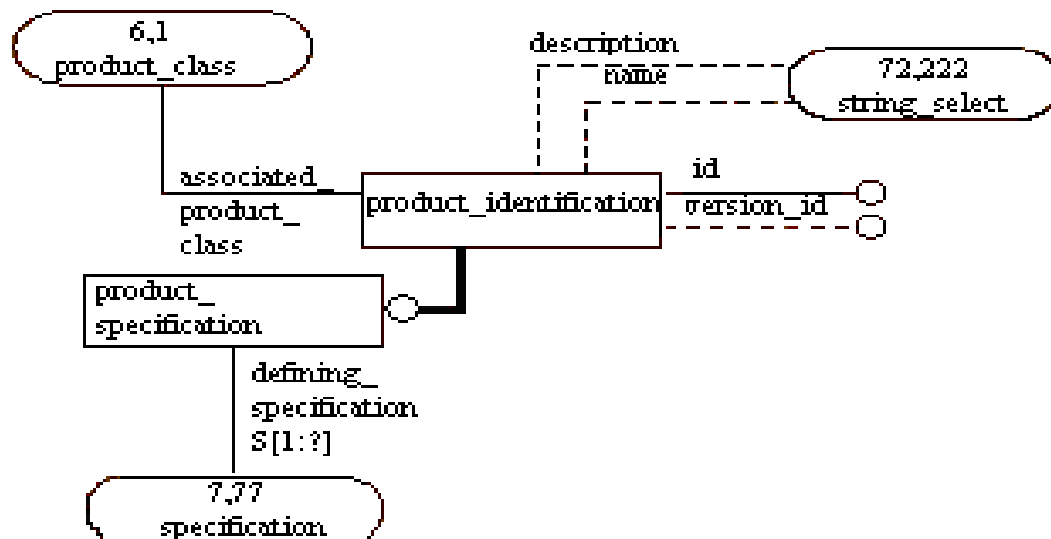


The representation of the **product_class** entity and the **product_class_relationship** in a relational Data Base representation is:

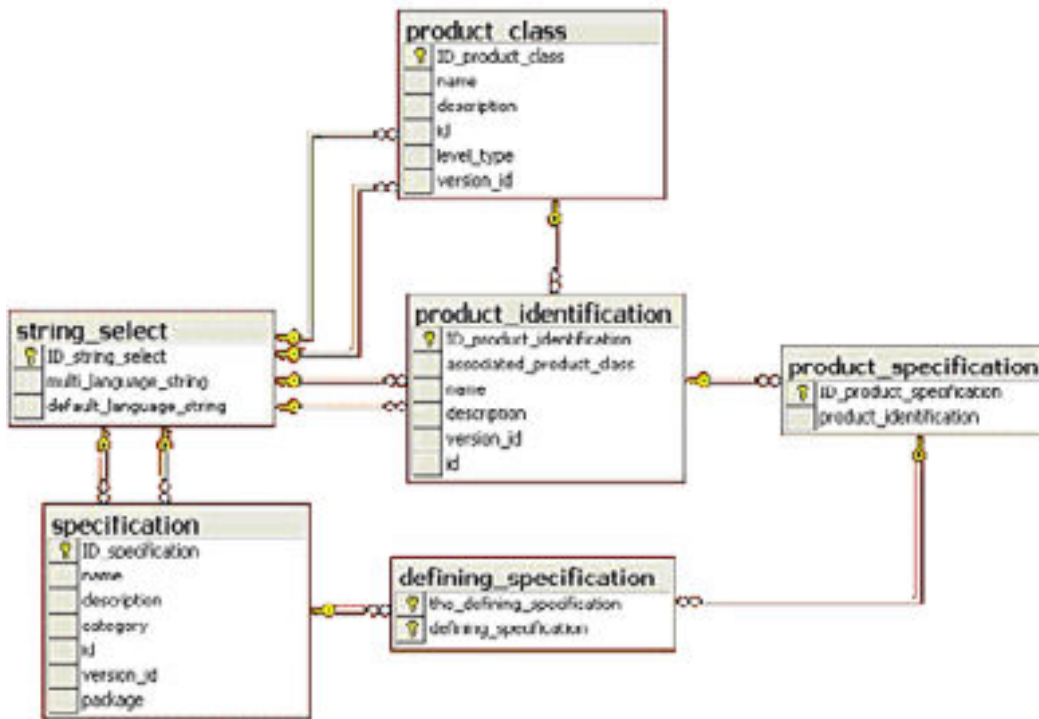


The adoption of the model in the scope of the AP236 needs to be represented by a table named **product_class** and another that allows the representation of the hierarchy named by **product_class_relationship**. The relation between these two tables will represent the hierarchy between several product classes.

Another example of Express-G representation in AP is presented in the following figure:



The product_identification is associated to the product_class through the attribute associated_product_class" and is associated to specification through the entity product_specification using the attribute "defining_specification". These connections are represented by the relational data base by the next relationships presented in the following picture.:-



The association between the product_identification is direct by relating the foreign keys 'associated_product_class" of the product_identification table to the key "id_product_class" of the product_class. For example, associating a product_class named by "tables pieces class" with a product_identification named by "tab_blue_cut1". All the names are described in the table string_select through an id that makes the connection.

tables from the database (Database is in CD). Data collected from another company- Moran Comfort was also used to populate the database to see robustness of the data model.

Tables for Wentworth Furnitures

This table shows the different collections for the company.

A Product_class is the identification of a set of similar products to be offered to the market

Table 1. Product_class

int_id	id	version_id	level_type	name	description
pcl1	RUS		0	Rustler	collection
pcl10	PRO		0	Provence	collection
pcl11	TAN		0	Tandarra	collection
pcl12	PEW		0	Pewter	collection
pcl13	LOU		0	Louisville	collection
pcl14	PLA		0	Plaf	collection
pcl15	WFG		0	Wentforth Forge	collection
pcl16	RSS		0	Rustler Single	collection
pcl2	ALB		0	Albany	collection
pcl3	ADO		0	Adobe	collection
pcl4	CLA		0	Classique	collection
pcl5	FER		0	Ferral	collection
pcl6	COS		0	Cosmo	collection
pcl7	CHA		0	Chandon	collection
pcl8	EME		0	Emerald Hill	collection
pcl9	NEW		0	New England	collection

This table shows the different specifications that can be required for the products.

A Specification_category is the definition of a set of specification objects serving the same purpose

Table 2. Specification_category

int_id	id	description	implicit_exclusive_condition
spc1	siz	Size	TRUE
spc2	ndr	No. of Drawers	TRUE
spc3	ndo	No. of Doors	TRUE
spc4	col	Colour	TRUE
spc5	typ	Type of Dressing table	TRUE
spc6	des	Desk Type	TRUE

This table gives the different components in the rustler collection.

A Product_identification identifies a manufacturable object, or expected as so and is a member of product class.

Table 3. Product_identification

int_id	associated_product_class	id	version_id	name	description
pi1	RUS	RUSB		Rustler Bed	
pi10	RUS	RUSSPD		Rustler Single Pedestal Desk	
pi11	RUS	RUSDH		Rustler Desk Hutch	
pi12	RUS	RUSCM		Rustler Cheval Mirror	
pi13	RUS	RUSBC		Rustler Book Case	
pi2	RUS	RUSBSCH		Rustler BedSide Chest	
pi3	RUS	RUSBSCB		Rustler BedSide Cabinet	
pi4	RUS	RUSDTL		Rustler Dressing Table Large	
pi5	RUS	RUSLB		Rustler Lowboy	
pi6	RUS	RUSTB		Rustler Tallboy	
pi7	RUS	RUSLCH		Rustler Lingerie Chest	
pi8	RUS	RUSTVA		Rustler TV Armoire	
pi9	RUS	RUSFLW		Rustler Foot Locker Wardrobe	

A *Class_category_association* is the association of a *Specification_category* with a *Product_class*.

Table 4. *Class_category_association*

int_id	associated_product_class	associated_category	mandatory
cca1	pcl1	spc1	TRUE
cca2	pcl1	spc2	TRUE
cca3	pcl1	spc3	TRUE
cca4	pcl1	spc4	TRUE

A *Specification* is a characteristic of a product. A *Specification* discriminates one product from other members of the same *Product_class*. A *Specification* refers to a *Specification_category* that completes the semantics of the *Specification*.

Table 5. *Specification*

id	int_id	version_id	name	description	package	category
kin	spec11		King		0	spc1
que	spec12		Queen		0	spc1
dou	spec13		Double		0	spc1
kis	spec14		King Single		0	spc1
sin	spec15		Single		0	spc1
one	spec21		One drawer		0	spc2
two	spec22		Two drawer		0	spc2
thr	spec23		Three drawer		0	spc2
fou	spec24		Four drawer		0	spc2
fiv	spec25		Five drawer		0	spc2
six	spec26		Six drawer		0	spc2
sev	spec27		Seven drawer		0	spc2
eig	spec28		Eight drawer		0	spc2
nin	spec29		Nine drawer		0	spc2
ond	spec31		One door		0	spc3
twd	spec32		Two door		0	spc3
thd	spec33		Three door		0	spc3
lib	spec41		Light Brown		0	spc4
dab	spec42		Dark Brown		0	spc4
dtl	spec51		Dressing Table Large		0	spc5
dtl	spec52		Dressing Table Small		0	spc5
dsp	spec61		Desk Single Pedestal		0	spc6

A Class_specification_association is an association of a Specification with a Product_class.

Table 6. Class_specification_association

int_id	associated_product_class	associated_specification	association_type
csa1	pcl1	spec11	0
csa10	pcl1	spec31	0
csa11	pcl1	spec32	0
csa12	pcl1	spec41	0
csa13	pcl1	spec42	0
csa2	pcl1	spec12	0
csa3	pcl1	spec13	0
csa4	pcl1	spec14	0
csa5	pcl1	spec15	0
csa6	pcl1	spec21	0
csa7	pcl1	spec22	0
csa8	pcl1	spec23	0
csa9	pcl1	spec24	0

A defining_specification is an association of a Specification with a Product identification.

Table 7. Defining_specification

int_id	product_specification	specification
B_dou	pi1	spec13
B_kin	pi1	spec11
B_kis	pi1	spec14
B_que	pi1	spec12
B_sin	pi1	spec15
bscb_do1	pi3	spec31
bscb_dr1	pi3	spec21
bsch_dr3	pi2	spec23
flw_do2	pi9	spec32
Lb_do2	pi5	spec32
Lb_dr2	pi5	spec22
lch_do2	pi7	spec32
lch_dr4	pi7	spec24
pd_do1	pi10	spec31
pd_dr2	pi10	spec22

int_id	product_specification	specification
Tb_do1	pi6	spec31
Tb_dr1	pi6	spec21
tva_do2	pi8	spec32
tva_dr2	pi8	spec22

The tables listed above are linked referring the ARM diagrams listed in AP214 and AP225 and using the Application Objects, Application Assertions and Units of Functionalities of AP236. More tables are attached in the appendix. The relationship is established in MS Access and it is also attached in the appendix.

Tables For Moran Comfort*

Table 1. Product_class

int_id	id	version_id	level_type	name	description
pcl1	OLI		0	Oliver	collection
pcl10	RUS		0	Russell	collection
pcl11	WAL		0	Wales	collection
pcl12	BLA		0	Blake	collection
pcl13	MIL		0	Milton	collection
pcl14	SAL		0	Salisbury	collection
pcl15	HIG		0	highbury	collection
pcl16	WES		0	westwood	collection
pcl2	CHA		0	charton	collection
pcl3	HAV		0	havana	collection
pcl4	CAS		0	Casino	collection
pcl5	CLU		0	club	collection
pcl6	NEO		0	neo	collection
pcl7	PIC		0	pico	collection
pcl8	APA		0	apartment	collection
pcl9	OSL		0	Oslo	collection

Table 2. *Specification_category*

int_id	id	description	implicit_exclusive_condition
spc1	siz	Size	-1
spc2	tow	type of wood	-1
spc3	tos	type of spring	-1
spc4	col	Colour	-1
spc5	fab	Fabric	-1
spc6	lea	Leather	-1

Table 3. *Product_identification*

int_id	associated_product_class	id	version_id	name	description
pi1	OLI	OLIS		Oliver Sofa	
pi2	OLI	OLICH		Oliver Chair	
pi3	OLI	OLIOT		Oliver Ottoman	
pi4	RUS	RUSS		Russell Sofa	
pi5	RUS	RUSCH		Russell Chair	
pi6	RUS	RUSOT		Russell Ottoman	
pi7	HAV	HAVS		Havana Sofa	
pi8	HAV	HAVCH		Havana Chair	
pi9	HAV	HAVOT		Havana ottoman	

*(Database in CD)

3. QUERIES

Queries were generated to check the validity of the data model. Some of the major queries are listed below: -

1. *This query retrieves different product design collections for Wentworth Furniture.*

```
SELECT [Sheet1_product_class].[name]
FROM Sheet1_product_class;
```

name
Rustler
Provence
Tandarra
Pewter

name
Louisville
Plaf
Wentforth Forge
Rustler Single
Albany
Adobe
Classique
Ferral
Cosmo
Chandon
Emerald Hill
New England

2. *This query retrieves different components of Rustler collection.*

```
SELECT [name]
FROM Sheet3_product_identification
WHERE associated_product_class="RUS";
```

name
Rustler Bed
Rustler BedSide Chest
Rustler BedSide Cabinet
Rustler Dressing Table Large
Rustler Lowboy
Rustler Tallboy
Rustler Lingerie Chest
Rustler TV Armoire
Rustler Foot Locker Wardrobe
Rustler Single Pedestal Desk
Rustler Desk Hutch
Rustler Cheval Mirror
Rustler Book Case

3. *This query retrieves the specifications associated with Rustler Lowboy, a component of Rustler collection.*

```
SELECT [name]
```

FROM sheet5_specification

WHERE sheet5_specification.int_id IN (SELECT specification FROM sheet7_defining_specification WHERE sheet7_defining_specification.product_specification = (select int_id from sheet3_product_identification where name="Rustler Lowboy"));

name
Two drawer
Two door

4. *This query retrieves the specifications associated with Rustler bed, a component of Rustler collection.*

SELECT name

FROM sheet5_specification

WHERE sheet5_specification.int_id IN

(SELECT specification

FROM sheet7_defining_specification

WHERE sheet7_defining_specification.product_specification = (select int_id from sheet3_product_identification where name="Rustler Bed"));

name
King
Queen
Double
King Single
Single

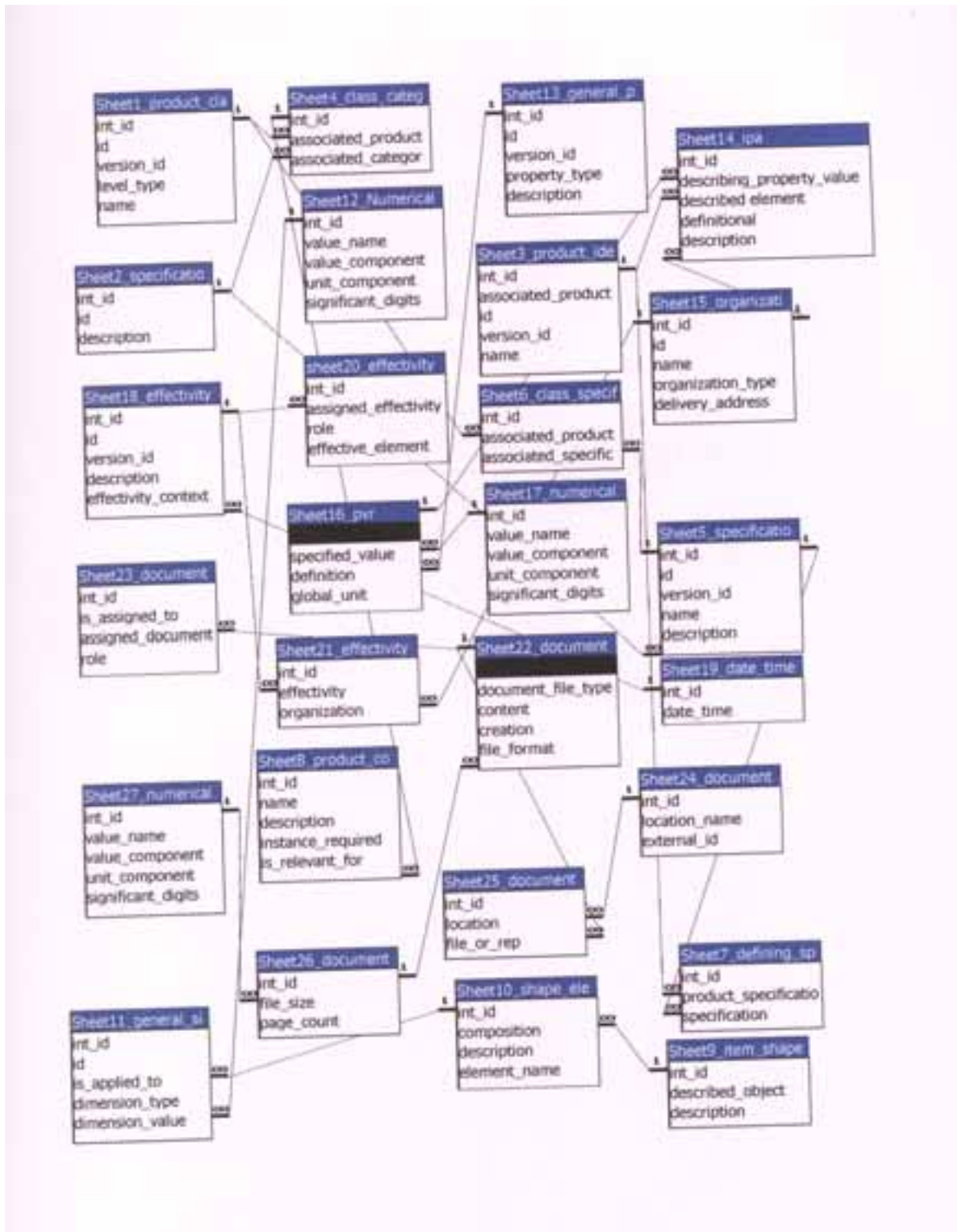
5. *This query retrieves all the retailers for Wentworth Furniture.*

SELECT name

FROM Sheet15_organization where organization_type =101;

name
Captain Snooze
Bedshed Cannington
Sundrys

4. RELATIONSHIP DIAGRAM



A funStep tools CD is provided and information about the CD is given below.

How to use the CD:-

1. Install the Microsoft SQL Server 2000 Desktop Engine (MSDE)

The first step consists on the installation of the Microsoft SQL Server 2000 Desktop Engine (MSDE). This is done just by clicking on the link available. MSDE is installed on your computer, so you can use the SQL Server Database Engine without really having to install it Microsoft SQL Server. After this step a reboot to the computer needs to be made so that the Database Engine is launched.

2. Install the AP236 Database viewer

Because MSDE does not provide any interface on the Database, it is necessary to install the AP236 Database viewer. This is no more than an access interface working with the SQL Server Engine.

3. Create the Database

The final step consists of creating the AP236 Database itself. This is an automatic process, but has to be initiated manually just by clicking on the file “run.bat” that has been copied to your computer on the previous step. After this final step the AP236 Database is ready to be used.

3.1 How to use the Database

If it is needed any help on how to access for the first time, there is a video available on the CD "how_to.wmv".

4. Tutorials

The tutorials provide the required information to the user adopt the AP236 model.

- Tutorials
 - Data Model Tutorial

provides the information related to the conceptual understanding of the AP236 model, giving to the user an approach of the meaning of each entities that compose the model.
 - Implementation tutorial

provides the information related to the knowledge of interfacing with the MS Access environment to access the MS SQL Server Data Base that represents the AP 236 model.

WEB ENABLING OF THE DATABASE

A web enabled database is client /server application that resides on an internet/intranet server, and is accessed via a web browser like Netscape Communicator or Microsoft Internet Explorer

Advantages of web enabling of a database [9]:

- Interactivity-dynamic pages
- Global accessibility
- Portability
- Enables online data collection
- Easy maintenance of changing information
- Low maintenance and support costs
- High performance and optimized technology
- Global Information Dissemination and Retrieval
- No expensive proprietary software or hardware to buy
- No long distance telecommunications charge
- Geography and time no longer matter
- Online catalogue

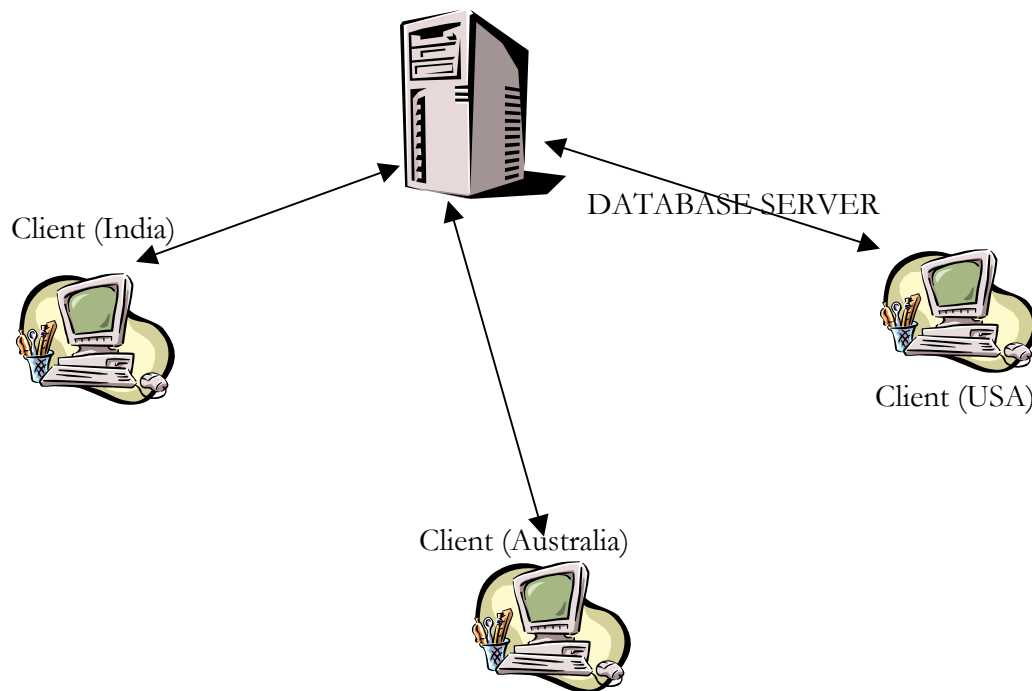


Figure 10: Networks Of Computers

The web catalogue for the furniture industry using the STEP standard features the following product information.

Represent furniture families and their properties

- Get different prices depending on different features (finishing, colors, front styles, handles, etc.)
- Handle price groups
- Represent manufacturer rules to calculate prices for special products
- Add restrictions and relationships between different features (valid combinations)
- Represent catalogue information in a compact way using tables
- Easy map application information into tables
- Description of components
- Measurements
- Geometry
- Topology
- Accessories and appliances.

The following information refers to the interpretation of the identified usage scenarios of the web enabled STEP database:

I. Product Information is represented by a manufacturer on Internet to enable its easy access by the retailers and other manufacturers, which results in faster and precise business transactions between the two parties.

II. Whenever there is a change done in the database of the company, its business partners can keep themselves updated through the web site.

III. The business partners can suggest changes to the product information. They can also modify details if given the authorization to do so.

IV. The customer can order a product with suggested changes.

V. This effort can be furthered by web enabling other companies' STEP database. And since different catalogues will be referencing to the same standard product definition, products from multiple and/or distributed catalogues could be browsed in a homogeneous way.

WEB-ENABLING THE POPULATED WENTWORTH DATABASE.

Web-enabling was not a part of the project responsibility. The web development in the report is an extra work done by the project team to demonstrate that database can be accessed from web and if all companies use the similar data model to keep their data, it becomes easier for data exchange because of standardization of data.

The Database developed in MS Access (shown above) was web enabled. This was done by making a website for the Wentworth Furniture and connecting it to the Database. The specifications are: -

Database: - MS Access

Frontend: - HTML

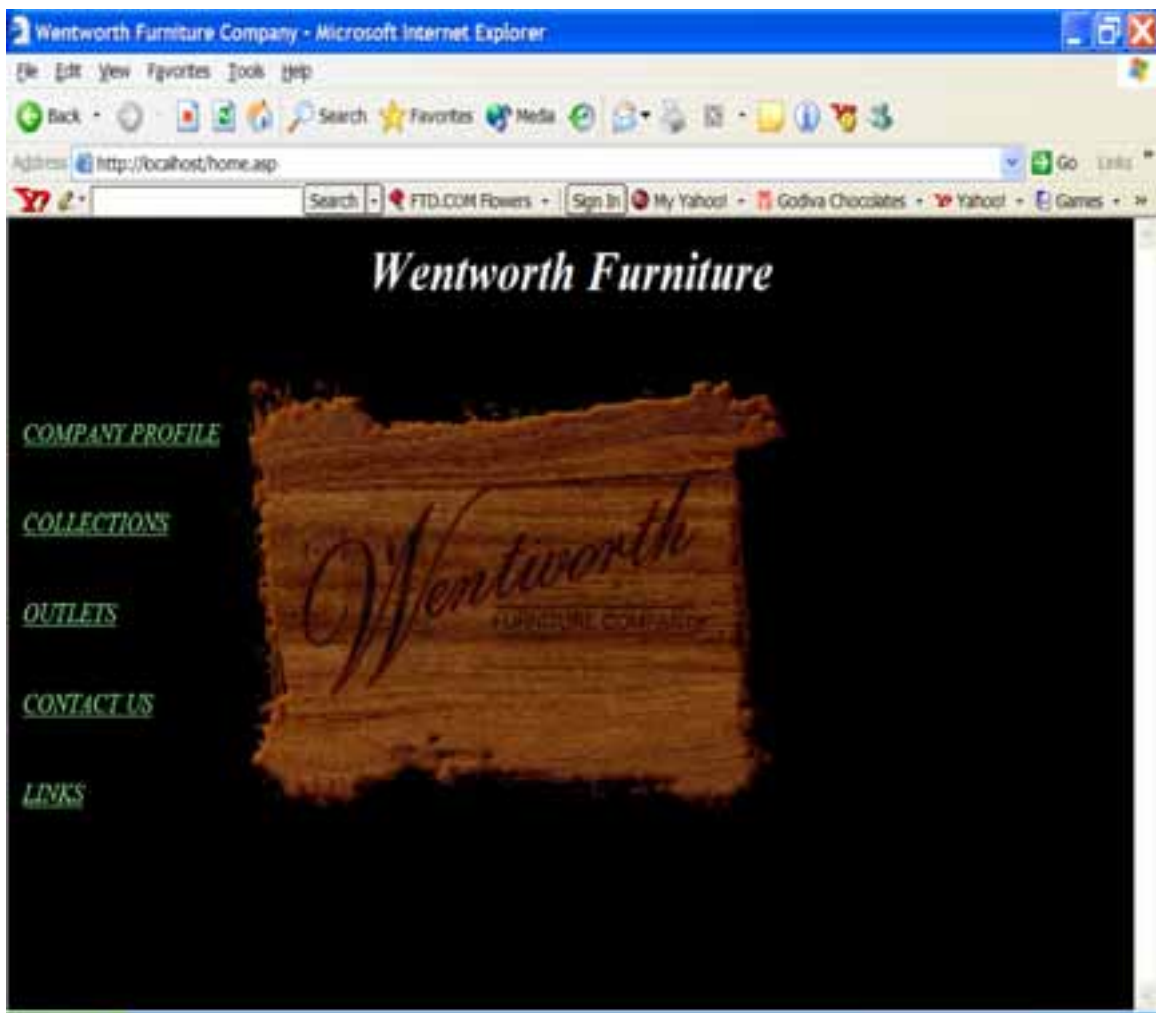
Language: -Active Server Page (ASP)

The runnable URL is: - **http://localhost/home.asp**

Server Path: - Internet Information Server (IIS) is being used

C:\Inetpub\wwwroot\ “filename”

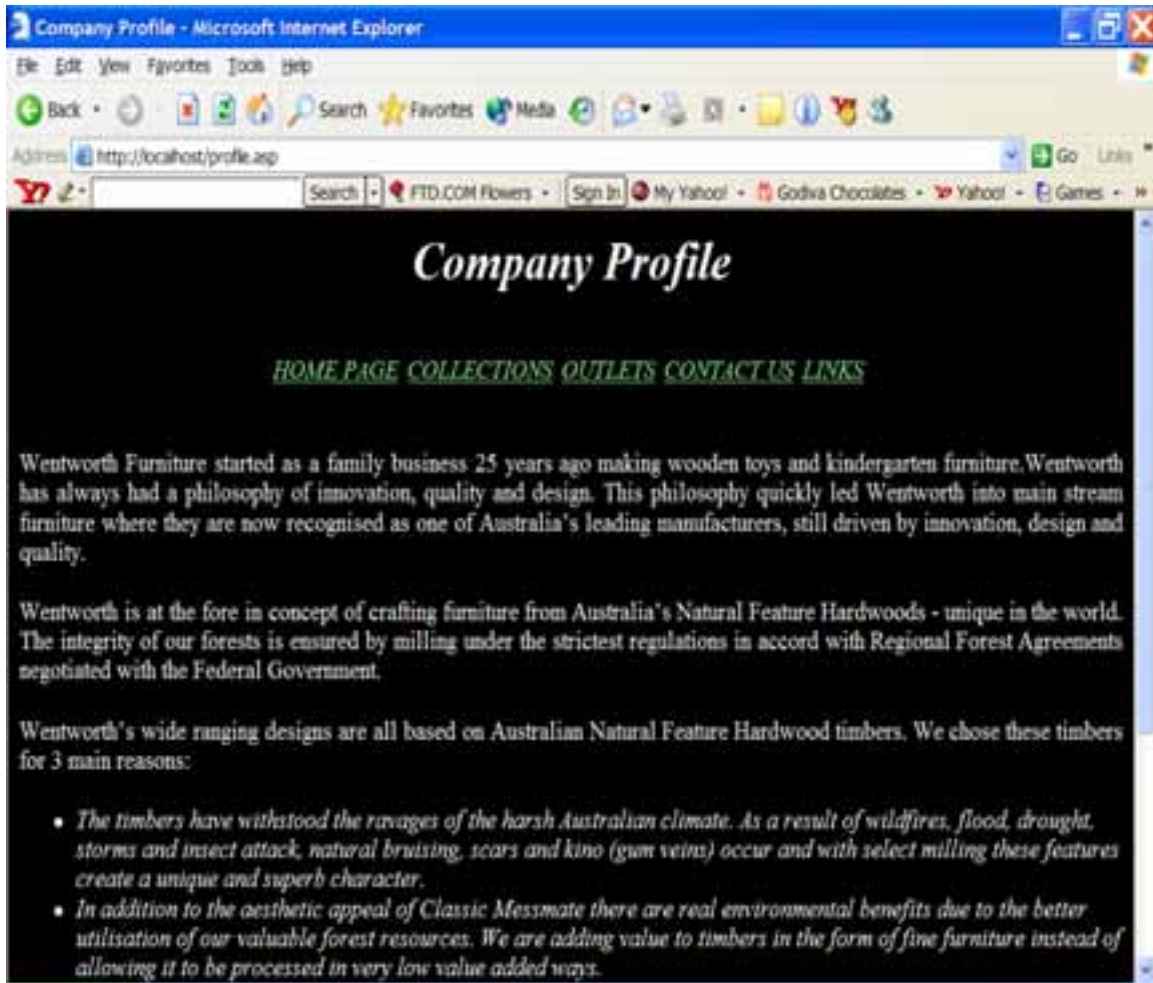
The website has been explained in the pages below. It shows the data retrieval from the MS Access database and also the insertion of data in the database. The changes made in the database also bring changes to the dynamic pages of the website.



Page 1

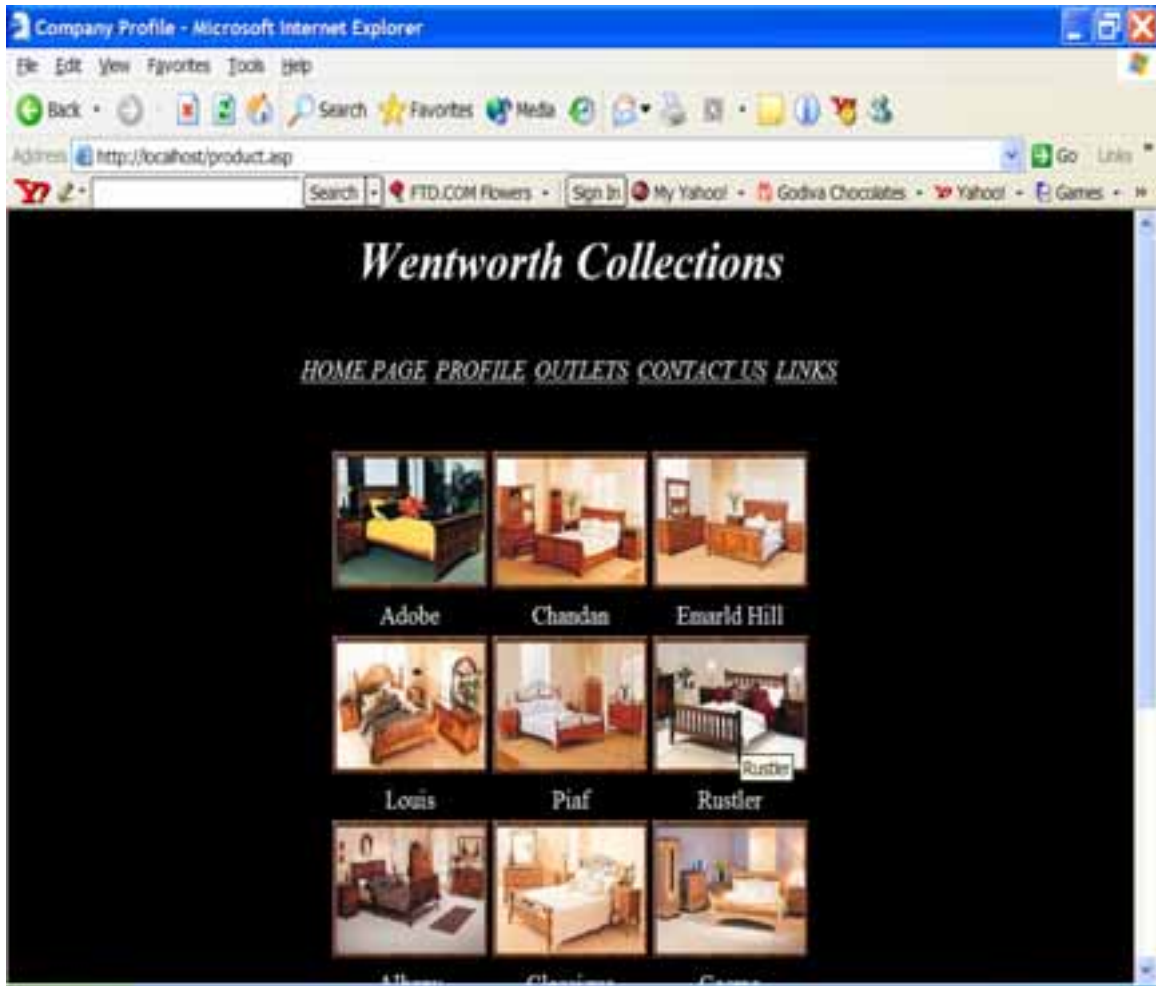
This Web page is the home page. The URL for above is <http://localhost/home.asp>. This page provides access to various links leading to information about the company, different

product design collections, its outlets, contacts and important links. When the user clicks on the COMPANY PROFILE link, he gets access to the next web page shown below.



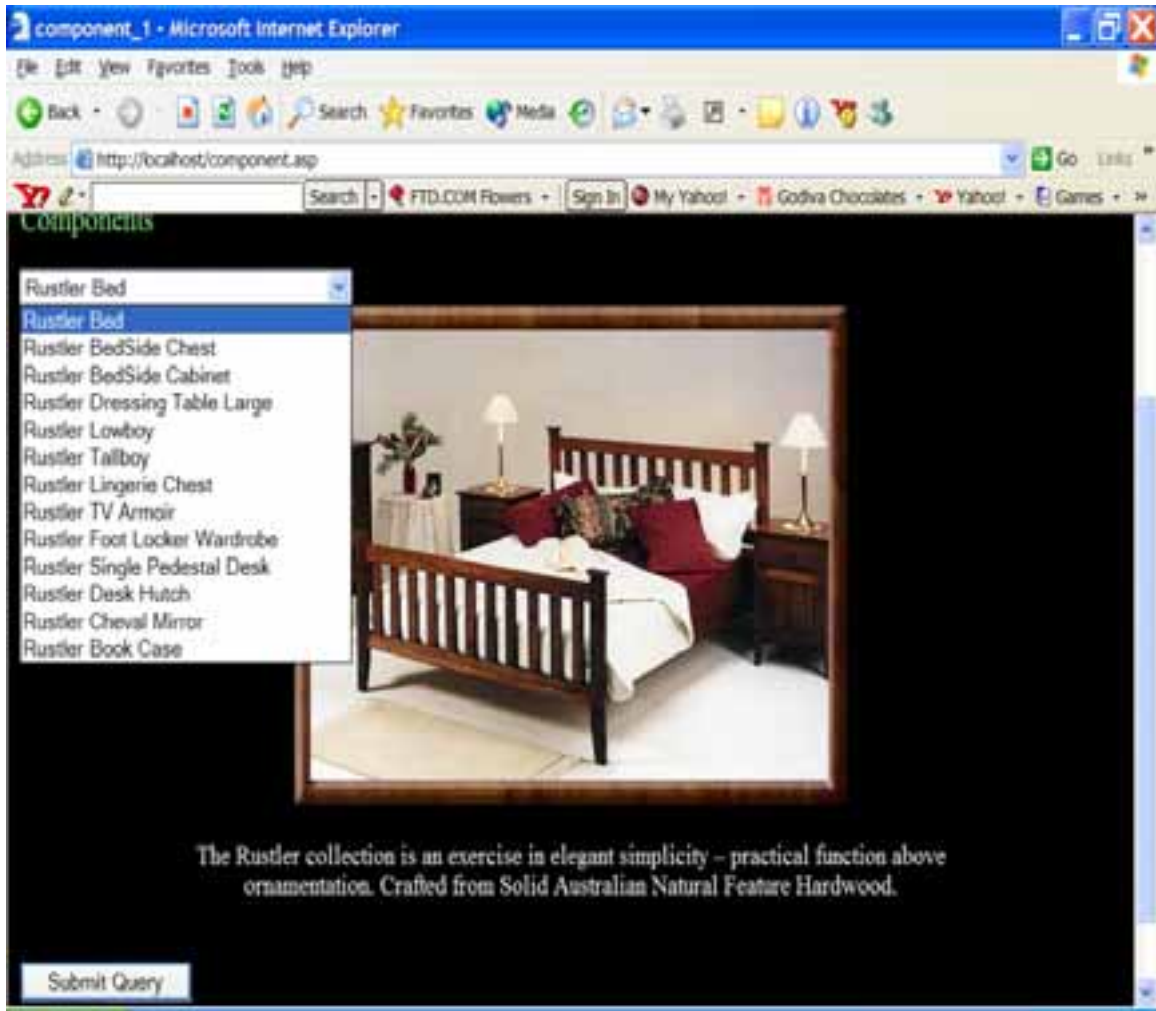
Page 2

This web page gives the general information for the Wentworth Furniture Company. When the user clicks on the COLLECTIONS link, he gets access to the next web page shown below.



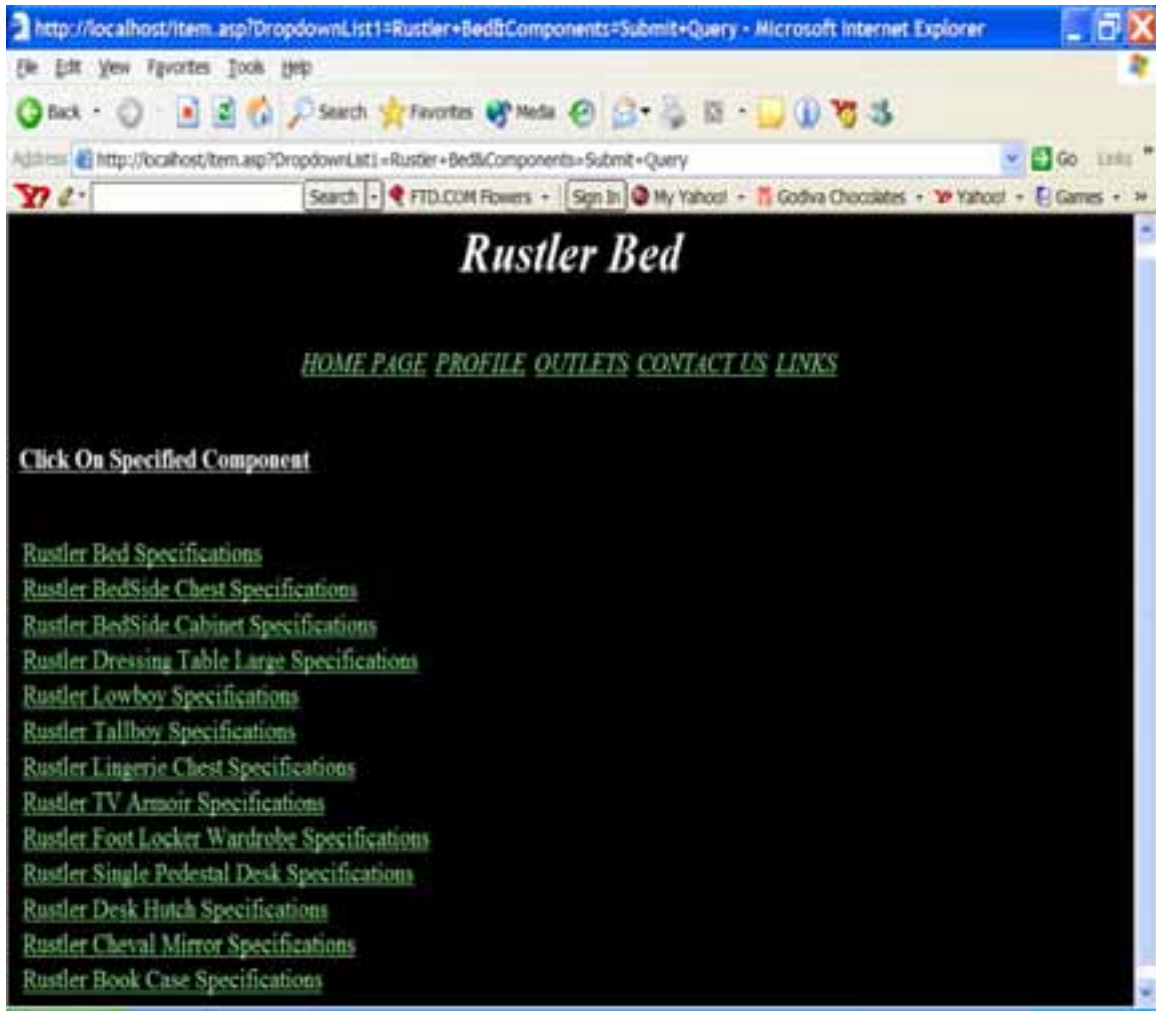
Page 3

This web page displays the various product design collections for Wentworth Furniture. The user can view figure showing the components for the relevant collections. Since the data was collected for the Rustler collection, the Rustler link is active and leads the user to the next page shown below.



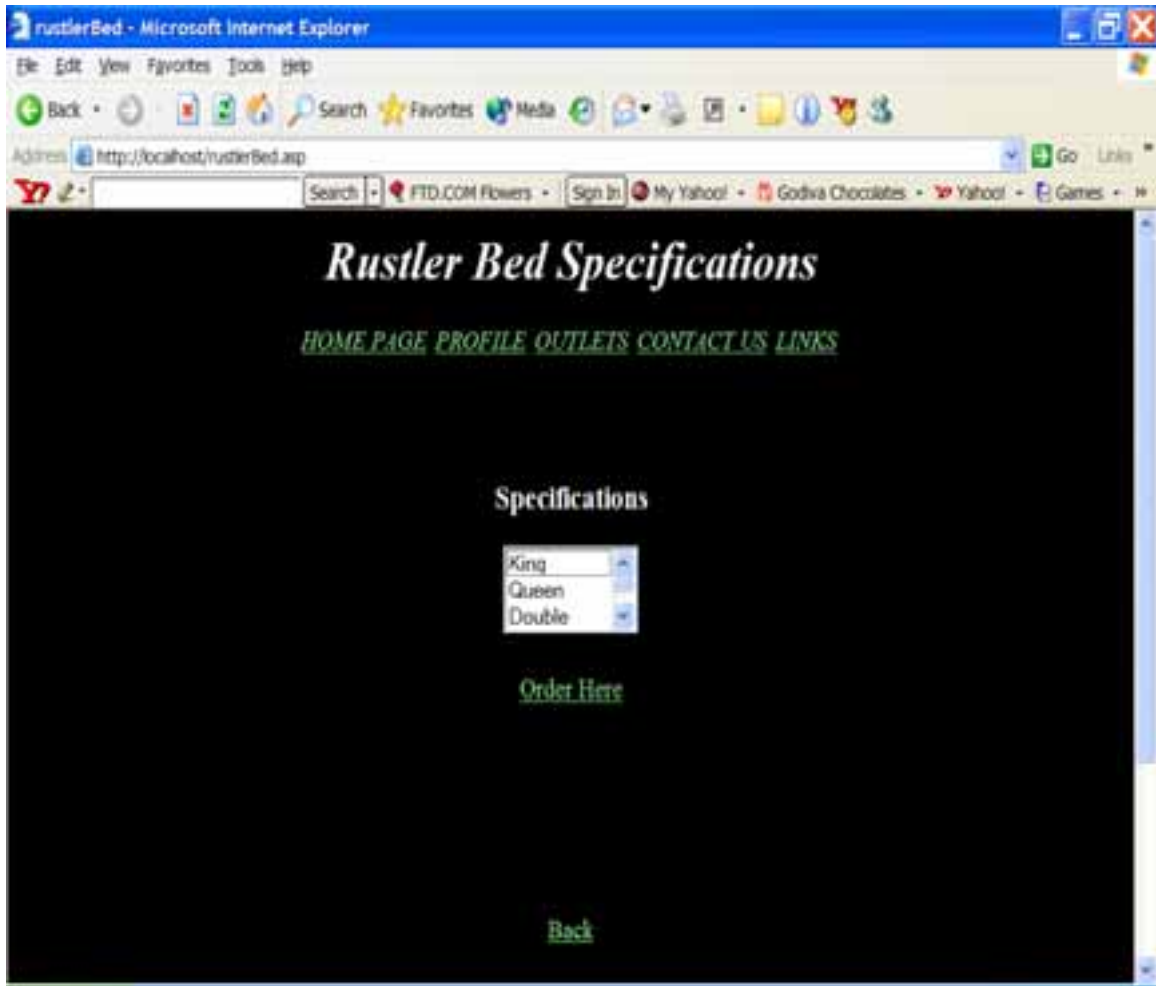
Page 4

This web page allows user to access the different components for the Rustler collection. It also gives the bigger version of the figure with general information on Rustler Collection. It is connected to the database in MS Access. The web page designed is dynamic and updating the database in MS Access leads to updating in the website as well. The user can select one of the components of the Rustler collection and click on the “Submit Query” button to see the specifications associated with that component. In this case Rustler Bed is selected which leads the user to the next web page shown below.



Page 5

This web page lists the links to specifications of different components of Rustler Collection. In this case the user has to select “Rustler Bed Specifications” to get access to the specifications of the Rustler Bed. This web page is dynamic as well as the heading for the web page changes as per the selection made in page 4.



Page 6

This web page lists the various specifications associated with Rustler Bed. The web page designed is dynamic and updating the database in MS Access leads to updating in the website as well. The user can order the component by clicking on the "[Order Here](#)" link. This takes the user to the next web page given below.

Company Profile - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Search Favorites Media

Address http://localhost/rustleDetail.asp

Search FTD.COM Flowers Sign In My Yahoo! Godiva Chocolates Yahoo! Games

RUSTLER Collection Details

[HOME PAGE](#) [PROFILE](#) [OUTLETS](#) [CONTACT US](#) [LINKS](#)

[Back](#)

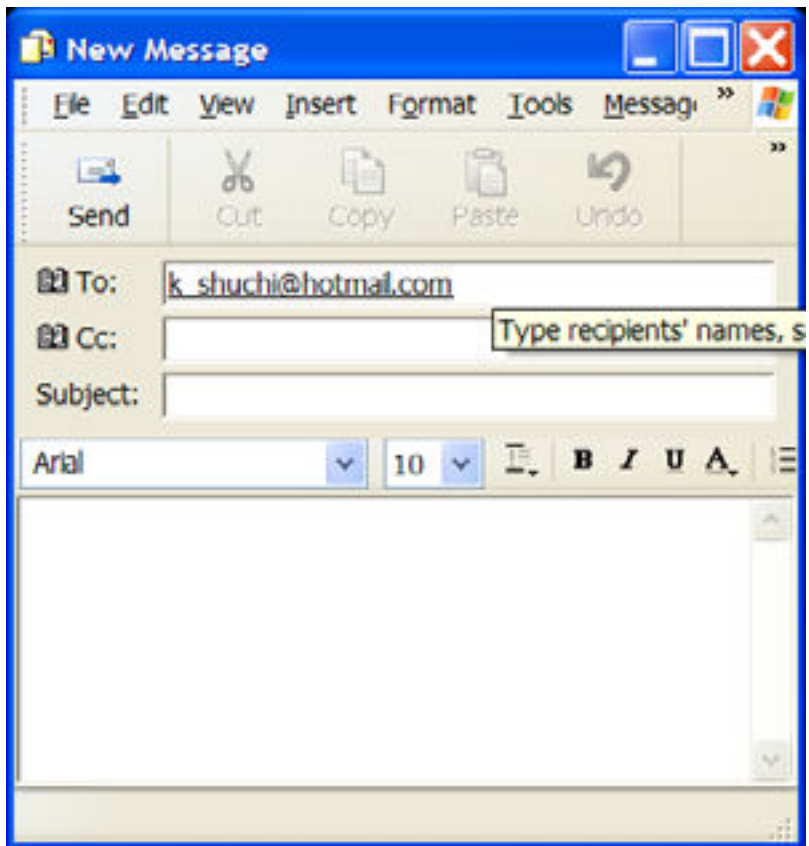
ITEM NAME:	Rustler Bed King	QUANTITY:	1
FIRST NAME:	Shuchi	LAST NAME:	Kumar
ADDRESS:	17/47-49, Robinson Road		
CITY:	Melbourne	STATE:	VIC
COUNTRY:	Australia	POST CODE:	3122
PHONE NUMBER:	03-98191534		
E-MAIL ADDRESS:	shuchikumar@rediffmail.com		

Page 7

Here the user enters the details and presses the “Submit Query” button, which will confirm the details, entered by the user on the next web page given below.

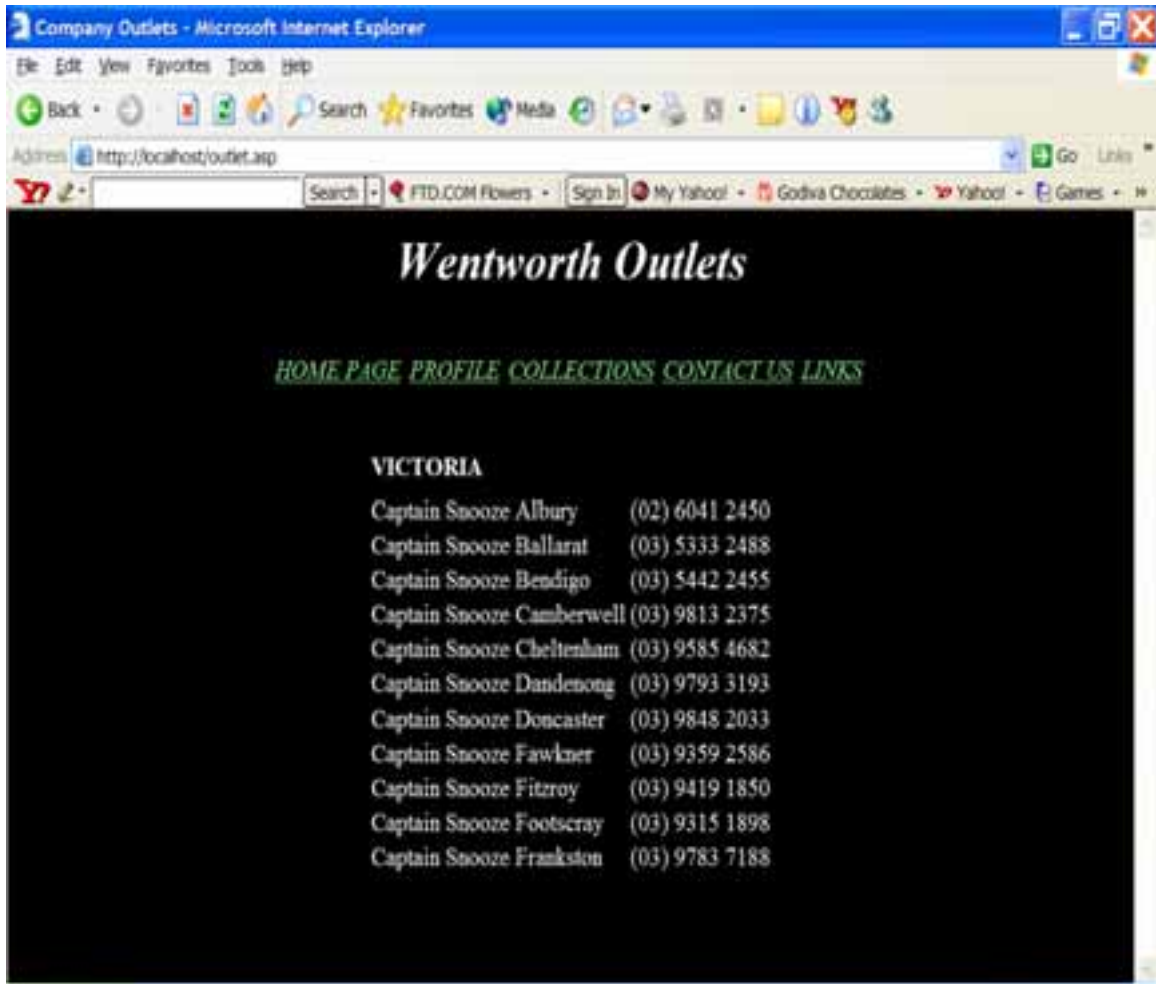


This web page confirms the details entered by the user. If the details are not correct the user can use the “Back” link to go back to page 7 and re-enter the details. If the details are correct the user can click on the “Click to Send Details & Enter Suggestions in the Mail Box” option, which adds the details entered by the user in the database and an order number is automatically generated. The web page shown below is displayed for the user to write suggestions.



Mail Link

The user can enter suggestions, which would be sent to the assigned email address.



Page 9

This web page displays the different Wentworth outlets for the Rustler collection in Victoria.



Page 10

This web page gives the important links associated with Wentworth Furniture.

Following Chapter provides the conclusions, the limitations and the future enhancements, which can be achieved using this research study.

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

The previous chapters shared the knowledge gained from various papers, people, articles and books about STEP, its usage, its advantages and its future. They extended the understanding of STEP to configure a data model for the furniture industry from existing components of STEP application protocols. This model may contribute to the development of AP236, which is in its development stage. Populating it with data collected from furniture companies checked the validity of the data model. The database was Web-enabled and was tested. This chapter further deals with the overview of this research, recommendations and limitations of this research.

1. DISCUSSION

- The exchange of data between dissimilar systems can be within a company, between companies or organizations co-operating on a specific project, within a supplier chain or between customer and company. There is also the need to manage data independently of specific Information Technology systems throughout the life of the product and the need to archive data beyond the active life of specific Information Technology systems. Thus there is a business need to be able to access data created by one computer system from another, where the two systems may be separated organizationally, geographically, or in time. To satisfy these needs STEP was developed.
- The backbone of the STEP standard is the Application Protocol (AP), which is the only permissible vehicle for implementing the STEP standard as per the Industry needs.
- The Automotive industry and Aerospace industry have successfully implemented STEP and the most successful application Protocol AP214 has helped the industry in effectively using STEP to exchange, share and archive data. Efforts are being made to implement STEP successfully in furniture industry as well. STEP has been successfully adopted and implemented by companies like Boeing, Rolls Royce, Holden, Toyota, Ford and is being used in NASA for US Defence as well. Projects are also undertaken for its implementation in Australian Defence. Hence looking at the outcomes and experiences with the other industries, it is a high chance to be successful with Australian furniture industry.
- The furniture industry is the largest manufacturing sector in the world when manpower is considered. Most of the companies in the furniture-manufacturing sector are SMEs (small and medium sized enterprises). To make the companies competitive in the emerging digital economy and smart organizations, the use of modern information technologies and standards between all agents involved in the furniture life cycle and business has to be considered. The manufacturing phase of the furniture product life cycle as well as the business between manufacturers, retailers, suppliers, and customers requires a lot of data exchange and handling. For this reason the industry needs to have a standard of data exchange, which would help them in sharing, exchanging and archiving data at a lower cost and with ease. Here STEP may play a significant role.

- The furniture industry worldwide is investing in development of Application protocol for furniture industry named AP236-- **application protocol (AP) for exchange of Furniture Product Definition (FPD) data and Interior Design Project**. The AP is being created in a modular fashion, reusing components of existing, validated standards and therefore reducing the time and cost to develop, implement, and deploy standards-based solutions. PLIB enables the development of industry-standard dictionaries of products and components that can in turn be used by manufacturers to publish product catalogues in an open format on the World Wide Web. The AP is a subset of 10303-214 and ISO 10303-225. The work is still going on this Application protocol. The FunStep Interest Group provides support for furniture data exchange. FunStep is a non-profit organization with open membership. It currently has 144 members from 19 countries, 35% of which are furniture manufacturers, 24% R&D organizations, 22% software houses and 16% retailers.
- All over the world, many people are involved in finding a robust model for furniture industry. Many demonstration projects and research projects are carried out to develop a final version of AP236 with all the ARM diagrams and mapping to integrated resource.
- The aim is to make a standards-based framework that supports the complete product life cycle (PLC) in the furniture manufacturing (fm) industry in the advent of e-business. This framework will support a two level approach to business-to-business (B2B) electronic commerce: interoperability among B2B user applications and interoperability among B2B e-commerce platforms.
- STEP Data when precisely modelled and implemented in furniture industry surely can result in effective data exchange, data sharing and data archiving for the furniture industry, which, in turn will result in cost effective and faster data interoperability and integration within the company as well as with other companies.
- Initially the cost would be a predominant factor but to bring any change in an industry initial cost can be considered as an investment.
- The initial and ongoing difficulty with the interpretability for different CAD systems can be eradicated from its roots. Different types of CAD and PDM systems can be easily integrated using this standard and hence minimize the use of complex and costly translators.
- STEP will allow suppliers to make complete, system independent catalogues of their products available to customers and to potential customers. These catalogues will include not only pricing and ordering information but also specifications and other appropriate product data. This will allow customers to access catalogue part data for use in CAD or CAE, as well as automatically generating necessary ordering information from bills of material.
- STEP will enable suppliers or manufacturers to make product information in standard form, it will enable customers to circulate to tender to potentials suppliers or to supply product definitions to subcontractor for manufacture.

- Web-enabling the STEP formatted Database will provide improved communications between manufacturer, customers and supplier. Information Dissemination, Information Retrieval, information updating all will be achieved by Web enabling the database.
- The adoption of STEP standard as the means of managing data will be instrumental in highly flexible networks, just-in-time supply, and information flow in the supply chain. The formation of AP236 is aiming to get the furniture industry people start making their databases and data management in STEP format. The emphasis is on that but that doesn't mean that the different applications used by the furniture companies have to be removed immediately. It should be phased out gently. Translators that translate to STEP format now can integrate the different applications used. This results in just one translator for one application to be used for translating from that application to any other application rather than one translator between every two combination of applications.
- In the project, the understanding of the furniture industry and its products was achieved by visiting different furniture manufacturing companies, talking to experienced employees, seeing the manufacturing process, understanding the business and information needs of the industry. The visits were narrowed down to two companies and data was collected from these two companies. Both AP214 and AP236 were studied in detail along with its Application Objects, Application Assertions and Unit of Functionalities. The ARM diagrams were selected from AP214 and AP225 and their relevance was checked with the business needs of furniture industry. Some of the relevant application objects, units of functionalities and application assertions, which can be used in the furniture industry, were selected and the data model was customized as per the requirements and business needs of the furniture industry. The data model was tested by populating it with the data collected from Wentworth Furniture. Further queries were generated to check the validity of the data model. The database was web enabled to provide better information flow and data retrieval from and updating into the database.

2. CONCLUSIONS AND RECOMMENDATIONS

This project covers the major aspects of ISO 10303. There are so many other aspects of ISO 10303 which can be dealt with individually and in detail. The focus of the research being mainly on Application Protocol for Furniture Industry and customizing a data model as per the STEP standards and web enabling the database, a lot of issues were just given a perfunctory glance.

The ARM diagrams of AP214 and AP225 were used to customize a data model for furniture industry as per the STEP standard. Data was collected from a furniture company and the data model was populated to check the correctness of the model. Due to time constraint, the data was collected from only one company and the data model was populated. For a robust validation of the model, the data needs to be collected from different companies with

different products in different conditions. Further research can be done on data model validation.

Queries were generated for further validation. Populating the data model and generated queries proved the correctness of the model. This particular data model may be of help for the development of proposed AP236. This particular data model can be further enhanced and some of the aspects, which have not been considered by the authors, can be further considered in the future studies.

The web enabling of database can be furthered by web enabling STEP formatted databases of different companies so that catalogues could be browsed in a homogeneous way.

This project has been structured to be used as a guide for people intending to learn STEP and also as a reference material for other ongoing project in this field.

Since the scope of AP236 does not cover the processes, it is recommended that if the developing committee of AP236 also considers the process (manufacturing as well as business) it can be much easier for the furniture industry to get a guideline for the business process as well as the manufacturing process. But that will again need some time and involvement of experts in industrial engineering and business administration.

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