From digital product development to an extended digital Enterprise

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Abstract: The modern world-wide (so-called global) economy has a deep influence on the way people and companies think and behave, in such way as to streamline the whole development and manufacturing process, now with a distributed, flexible and integrated structure. Collaborative software is changing the way companies do business. Applications that facilitate communication early in the design cycle and throughout the manufacturing process save manufacturers time and money.

Key words: Digital Product development, Virtual enterprise, Life-cycle engineering, collaborative Product Definition management (cPDm), Web Portals, Collaborative technologies

1. INTRODUCTION

The challenge of providing a global product line as a response to an utmost need to comply with an increasingly demanding and competitive market involves changes to the political, technological, financial, cultural and social sectors. The trends of this evolution indicate that the future will take us to a world that is more and more global, "small" and connected through a world-wide communications network, which is increasingly more integrated, powerful and available to everyone. Simultaneous and decentralised development make the required document management control more and more severe and accurate throughout the several phases of the

The original version of this chapter was revised: The copyright line was incorrect. This has been corrected. The Erratum to this chapter is available at DOI: 10.1007/978-0-387-35492-7_50
G. L. Kovács et al. (eds.), *Digital Enterprise Challenges*

product life cycle, starting from the first idea until reuse and recycling. Because of the major trend towards business decentralisation, collaboration technologies become an important component of those changes as operations are outsourced through supply chains, new strategic partnerships are formed in extended enterprises, and facilities are dispersed around the world. Figure 1 illustrates the evolution from the function oriented enterprises in the past to a new form of networking enterprises today. The vision is to implement company Units with focus on networks that will be virtually defined and organised. In a partly virtual company all participants of the supply chain will be integrated in an IT-based, sensible innovation, order fulfilment and sales process. This integration includes the complete product and factory life cycle.

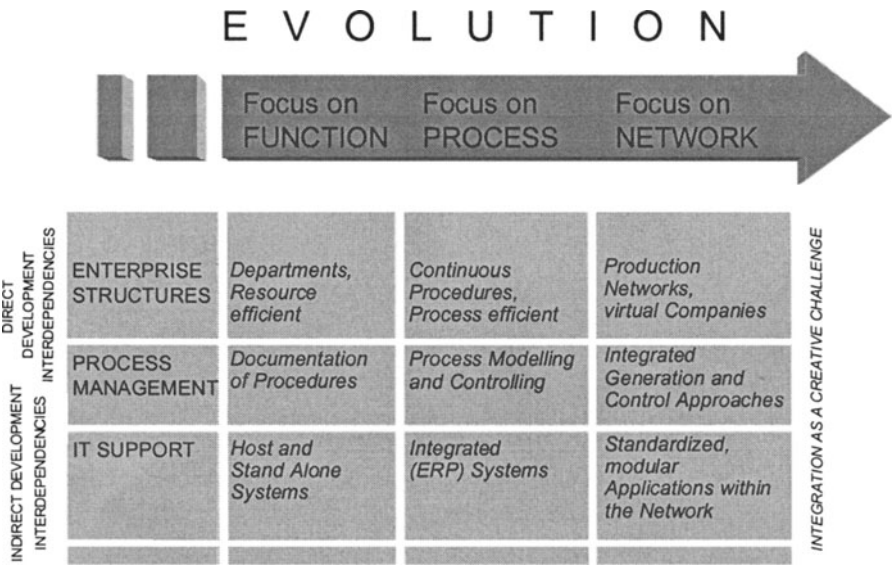

Figure 1. From Traditional Business to an Extended Enterprise

Information Technology (IT) offers an efficient way to build these new evolution paths (Jacucci, Olling, Preiss, Wozny, 1998). Also, as a major responsible for the availability of resources provided to the research and development of new technologies, Information Technology keeps on contributing in a large scale towards product development processes to be supported by digital solutions, keeping customers, suppliers, collaborators and partners connected on a world-wide basis, and focussed on the development of a same product as outlined in Figure 2.

With these new technological resources, Collaborative Engineering becomes an effective global reality. Product Data Management (PDM) environments evolve to a concept that is closer to the collaborative Product

Definition management (cPDm), in which the spirit of shared development with creativity, flexibility, speed in communication, for faster decision making, and synchronism of activities will generate products in a better, cost-effective and faster way (Miller, 2000).

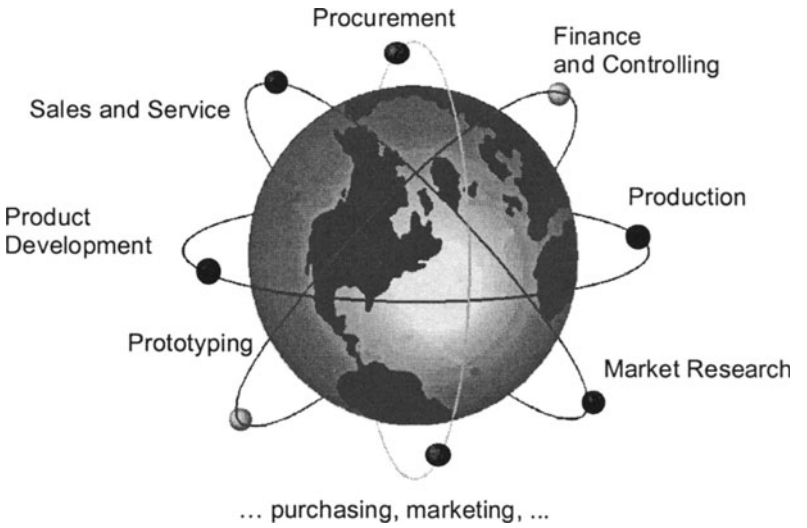

Figure 2. Networking enterprise

Beside the technological challenges cultural and organisational issues present the greatest obstacle to overcome (Baake, Haussmann, 1998). For exchanges to be of value, organisations have to determine how overall processes must be configured, where information should be route, and who should handle these tasks. In many cases, long established procedures will be affected, and the resulting trauma may not be fully understood. But industry gains additional experiences with the use of exchanges, this experience will help all companies make better use of them and achieve higher value as a result (Miller, 2001).

2. GLOBAL DATA MANAGEMENT

Companies throughout the manufacturing industry recognise that global data management is becoming a competitive necessity. Information must be structured and available to the several teams involved (designers' view, production view, marketing view etc.) so that safe and accurate information can be timely shared by everyone. As a data integration and management

technology, PDM (Product Data Management) manages product data throughout the extended enterprise as depicted in Figure 3, ensuring that the right information is available for the right person at the right time and in the right form. In this way, PDM improves communication and co-operation between diverse groups, and forms the basis for organisations to restructure their product development processes and institute initiatives such as concurrent engineering and collaborative product development. The result is faster work, fewer errors, less redundancy, greater co-operation, and smoother workflow. This translates into bottom-line money savings and time reductions (Smith, Reinertsen, 1998).

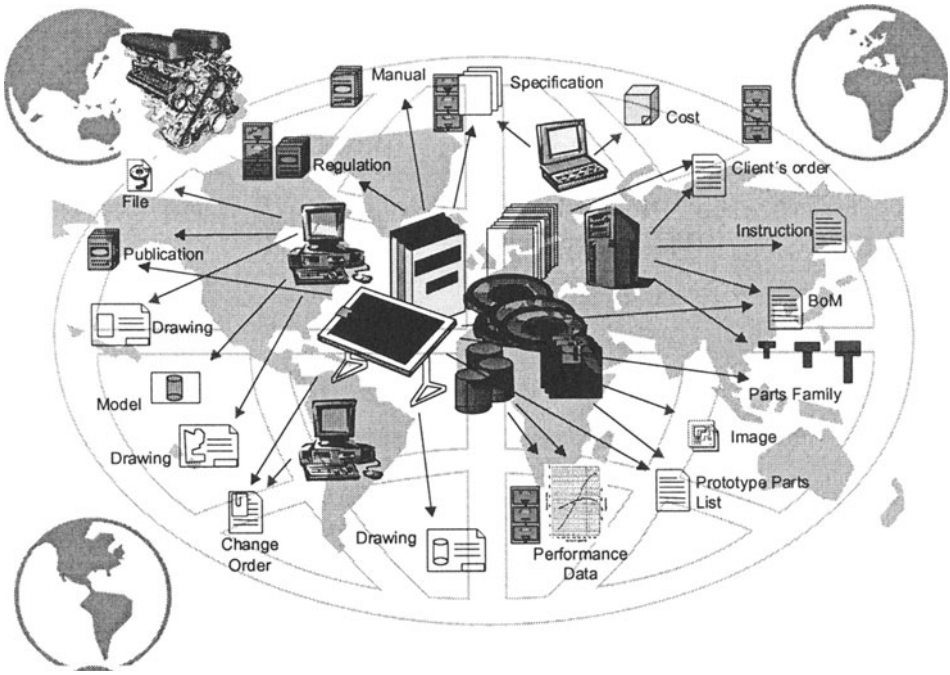

Figure 3. Global Data management

With PDM becoming more pervasive throughout a broader range of companies, the use of the technology is expanding beyond design activities to include information management throughout the product lifecycle. In this way, PDM works closely with ERP in managing product definition, product production, and business operations support from the early conceptual stages of product development, through manufacturing, and finally to product support. (Miller, 1999). A major Brazilian example is the implementation of

a PDM solution at Mercedes-Benz Brazil in compliance with a world-wide decision for the whole DaimlerChrysler group.

Advanced data management environments, such as the one developed by DaimlerChrysler group provides a Client/Server architecture with world-wide range, what enables an independent co-operation development. These environments include the introduction of Digital Mock-Up, numerical simulation, management of digital prototypes, and consistent product documentation (Baake, Haussmann, Stratil, 1999). One of the most important tasks in the implementation of global PDM solutions is the definition and installation of IT and process technologies, taking into account the issues concerning the development of a global and multicultural project.

3. VIRTUAL PRODUCT DEVELOPMENT

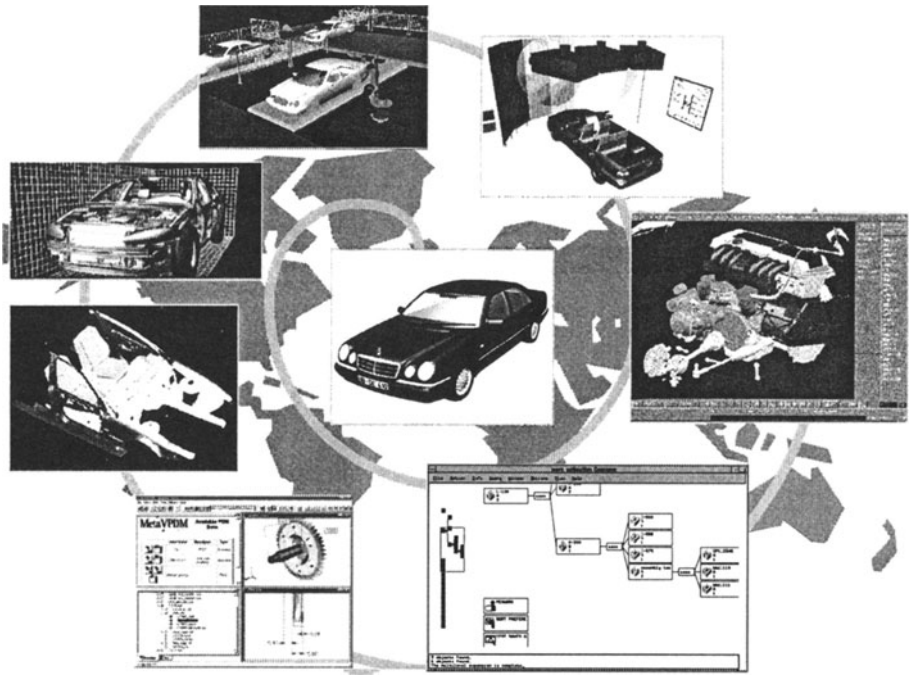

Figure 4. Virtual Product Development

The generation of virtual prototypes as outlined in Figure 4 is becoming every day a closer reality due to the new available technologies, and it is

increasingly consolidated as an essential requirement in accomplishing new projects. Virtual manufacturing technology can be applied when new models have been designed using digital engineering tools and the production process is about to be developed.

3.1 Digital engineering

Virtual prototypes distinguish themselves within the product development cycle by making available simulation phases, providing accurate information on physical and mechanical functions of certain systems groups of a product. Within a virtual environment we are able to analyse the application of parts from different projects in order to reduce final production costs without the need of building physical prototypes.

The procedures for the construction and checking of physical prototypes are very expensive and time-consuming, and can also cause delays or cost increase during the development process. The major reason for these additional costs is the non-inclusion of changes occurred in the development during the construction of these physical prototypes. At the end of these prototypes' construction, assemblies and subassemblies may not represent the project's reality anymore. The digital prototyping techniques (e.g. Digital Mock-Up – DMU), embedded in the PDM environment, minimises this possibility, as the physical elements are not incorporated into the process. In addition, the digital analysis is always based on most recent/updated information or on a severe release control. Major benefits of the digital prototyping technology application are:

- Work developed on a shared virtual environment;
- Evaluation of maximum and minimum distances;
- Fast responses to the development teams;
- Change forecast and management;
- Analysis and Simulations of assemblies/disassemblies;
- Optimisation of physical prototype manufacturing, when necessary;
- Interference/collision analysis and control;
- Provision of managerial information throughout the development;
- Possibility of detailed evaluation of digital prototypes by work teams located at other plants.

3.2 Virtual manufacturing, the next step

When new models have been designed and the production process is about to be developed, virtual manufacturing technology can be used to increase the automation level as shown in Figure 5. Not only during the engineering phase the automation level is quite high due to different virtual product development technologies mentioned above, but also digital manufacturing, over the last years, has moved out of the laboratory and is now part of the business process.

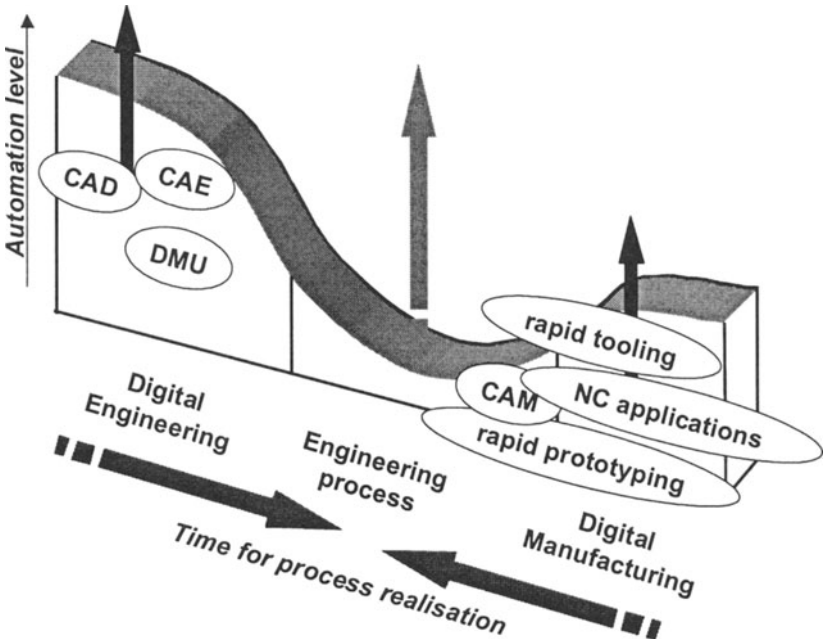

Figure 5. Different automation levels

This technology allows users to do design both for assembly and manufacturing before the design is frozen. One sure way to improve the manufacturing process is to make sure the model is correct when reaching the shop floor (Reinertsen, 1997). Computer-aided design packages are equipped to allow collaboration so that everyone involved in the design process is working on the same model version using a common database as outlined in Figure 6. Thus, virtual manufacturing tools allow engineers to share models with those who handle product design, manufacturing engineering design, and industrial engineering design for layout and facilities.

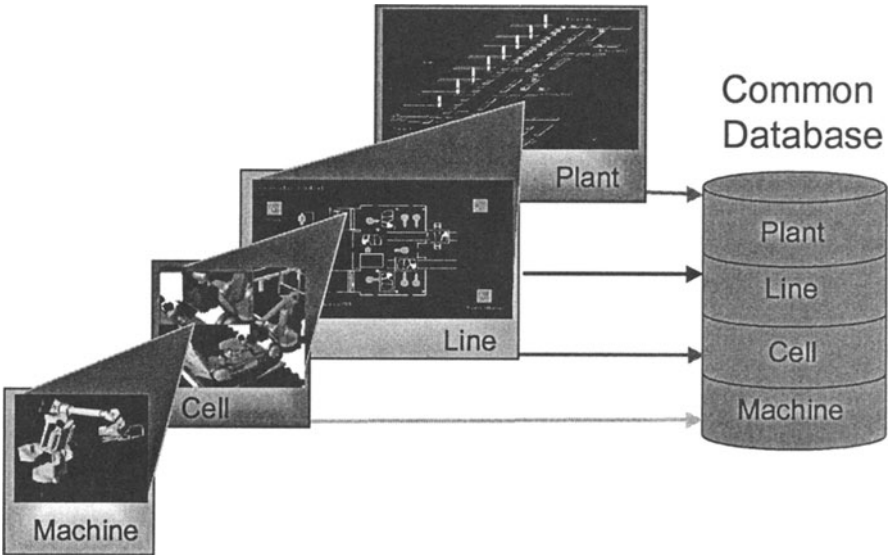

Figure 6. Digital Manufacturing

4. INTERNET TECHNOLOGY IN COLLABORATIVE DEVELOPMENT PROCESSES

Collaboration supports decentralisation of engineering and manufacturing operations by providing a framework for distributed working across the extended enterprise, supporting processes with integrated tools and production information, providing methods to help users visualise and access information supporting data consistency and integrity in a shared environment, and allowing geographically distributed product development through dispersed teams. Thanks to the power of the Internet and the proliferation of Web-based software, collaboration can be accomplished in a cost-effective manner. The provided tools and services bring to the same global information network all the fundamental elements for the development of products, integrating clients, partners and suppliers through Engineering, product design, product documentation, product simulation, change management, process and factory planning, sales, purchasing etc. The most far-reaching impact of collaboration technology is not to speed up current methods of operation but rather change the way that companies

operate. Specifically, Web-based collaborative tools are facilitating major shifts in organisation, workflow, geographic distribution, and relationships between companies. Undoubtedly, manufacturers that encourage employees to collaborate with partners, suppliers, customers, and each other will surely save time, reduce costs, and bring products to market faster than the competition.

For the integration of all the processes, technologies, products and services involved, controlled and safe access portals have been developed under the Web environment. These portals provide access to several databases as depicted in Figure 7, with information made available all over the world for the collaborative product development.

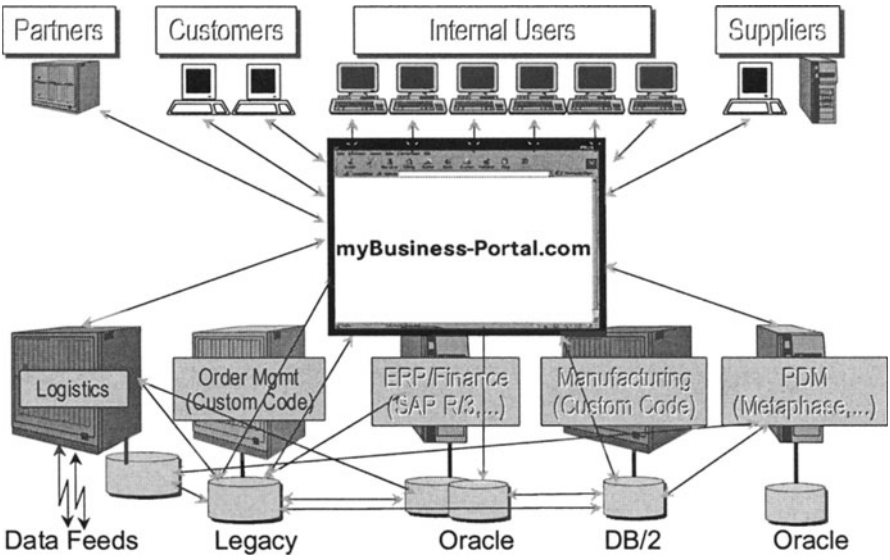

Figure 7. Business Portal concept

Thus, the product life cycle can be managed, and the knowledge acquired throughout this period (bad and good experiences) can be applied to new developments.

5. cPDm – cOLLABORATIVE PRODUCT DEFINITION mANAGEMENT

Nowadays, with the availability of a broad range of more sophisticated technological resources, mainly in the e-business world, by means of data base accesses through specific portals as shown in Figure 8, the product development cycle becomes much more comprehensive. With these technologies the world of Product Data Management and the world of Enterprise Resource Planning (ERP) are getting closer and more integrated. By implementing e-business technology together with PDM concepts we have the so-called collaborative Product Definition management with a tremendous impact on the ways companies operate. A major change in enterprise computing is on the way as companies apply best-practice processes in combination with a wide range of technologies including data management, collaboration, visualisation, collaborative product commerce, component supplier management, and others.

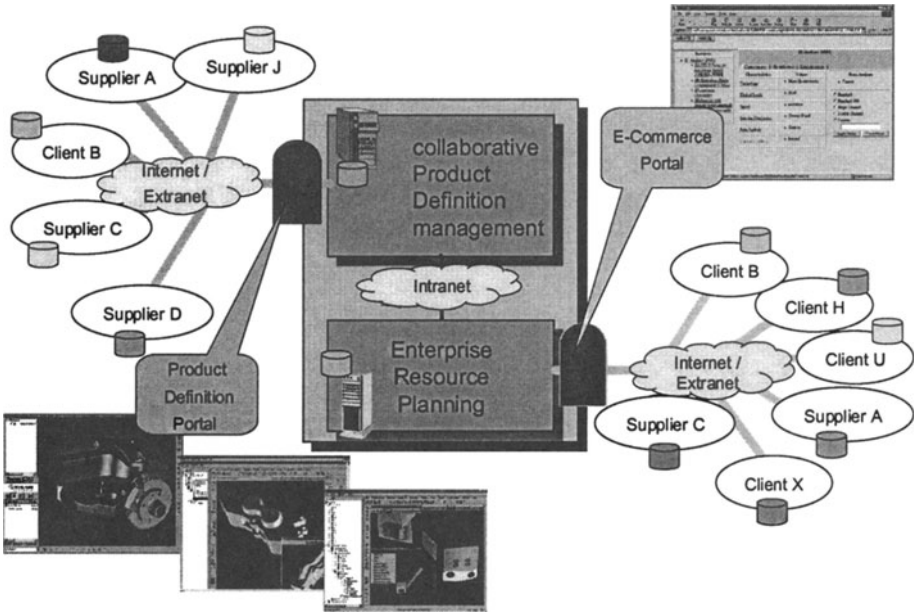

Figure 8. PDM Evolution: cPDm by using Portal technology

The vision of cPDm requires companies to expand their view beyond CAD management to management of the entire product definition, from the design phase of product development to the entire product lifecycle, and

from the engineering department to the extended enterprise. The broadened vision reflected by cPDm is changing the industry in two ways: first, users and suppliers are shifting their focus from technology to solutions targeted at specific business problems; and second, the focus is shifting from data management to business processes. Companies are concerned with the best way to change their overall business processes and leverage technologies on an enterprise-wide basis.

In the past years, companies would implement product data management technology and then try to adjust their practices to fit the new system. In contrast, organisations are presently turning this order around by first assessing and re-engineering their processes towards strategic corporate goals. Then, they select and implement technologies that can best facilitate these corporate processes. This shift in focus towards process-based solutions is an evolutionary step in corporate computing. But some newer technologies are having a revolutionary impact by providing a quantum jump in the speed with which new processes now can be implemented. Web-based systems can broadly disseminate information and support widely distributed operations. Collaborative tools allow dispersed teams and groups to review and discuss designs of parts and assemblies, and work together in jointly developing products. Web technology and collaborative tools are becoming powerful drivers for the industry and are increasingly being focused on applying e-business fundamentals to the product definition process.

The pace of improvements in cPDm-related technologies continues to accelerate, and companies use these tools to implement process change faster than ever.

6. CONCLUSION

To introduce a digital enterprise means to radically redesign/streamline the processes. Fundamental changes to the business processes interfere with all organisation areas. When a process undergoes a reengineering process, the activities involved suffer multidimensional changes, the working units change from departmental functions to process teams, and the staffs' working rules change from controlled approach to a policy that is totally aimed at the commitment, involvement, initiative, creativity and responsibility (empowerment).

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8. BIOGRAPHY

Uwe Baake received the Dipl.-Ing. degree in electrical engineering from the University of Siegen in 1990, and the Dr.-Ing. degree in computer science from Darmstadt University of Technology in 1995, Germany. In 1990 he joined the Computer Science Department of Darmstadt University of Technology, working in the Computer Aided Design Area. From 1995 to 1998, Dr. Baake worked at the Corporate Research and the headquarters of the Commercial Vehicles division of Daimler-Benz AG. From February 1998 to December 2000 he was responsible for the Process and Technology Department of debis humaitá IT Services L.A. and since 2001 he has been head of the Business unit *Engineering and Manufacturing* of debis humaitá.

Osmir Torres received the Bachelor degree in Mechanical Engineering from the University of Sao Paulo in. He graduated in Computer Science by the Fundação Armando Alvares Penteado in. He started his professional activities at General Motors in 1972 in the implementation of new technologies. He developed his activities at DaimlerChrysler Brazil in the implementation of CATIA CAD/CAE/CAM environments. He has been working since 1995 at debis Humaita IT Services as a Consulting Manager for the implementation of technologies applied to Digital Product Development.