RAPID VIRTUAL DESIGN AND SYSTEM DEVELOPMENT BASED ON EXTENDED MVC-BASED WEB APPLICATION FRAMEWORK AND INTERACTIVE XML PRODUCT MODEL

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Abstract: To integrate multiple aspects of an enterprise to improve design decision-making and control at all process levels, rapid virtual design based on virtual prototyping simulation (RVDBVPS) is put forward to carry out distributed cooperative product design. Its architecture and key technologies are discussed. To develop the system on Internet/Intranet, satisfy current requirements of Web applications and solve the existing problems in web application development, an extended MVC-based web application framework based on XML on J2EE platform is put forward that is more flexible, expansible and maintainable. According to the characteristics of structured and unstructured product data in Web based distributed cooperative design environment, product design information exchange based on Interactive XML product model is investigated to realize interactive information transaction across heterogeneous platforms.

1 INTRODUCTION

Through virtual prototyping simulation, distributed cooperative designers can gain unprecedented insight into duty cycles that will ultimately be imposed by users and refine the design before it is locked into a hardware configuration (Chen, 2006; Wu et al, 2006). It also permits the user to participate in the product development process on Internet/Intranet, as part of an integrated multidisciplinary team, by letting him operate the conceptual product in advance as if it were already put into operation. Based on virtual prototyping simulation and synthetic design evaluation, the product designed can be evaluated from any number of perspectives in multidisciplinary design optimization in the virtual performance test environment, virtual application environment, and virtual manufacturing environment under the control of a design management system, permitting fundamental trade-offs to be made in product performance, manufacturing processes, support processes, product quality and cost

To satisfy current requirements of web applications for enterprises and virtual enterprises and solve the existing problems in web application development (Yuan et al, 2004; Chung et al, 2002; Li et al, 2002), web application framework based on MVC mode in J2EE platform is adopted to develop various applications on Internet/Intranet. Due to the powerful data description capability of XML, many methods of product data exchange based on XML are applied to realize the description of product data, graphic data, characteristics, and their relationship in distributed cooperative design (Wu et al, 2006; Chen et al, 2003). And, the method of exchanging design semantics instead of 3D model data is adopted to enormously reduce the transmission quantity through network in distributed cooperative design.

2 RAPID VIRTUAL DESIGN SYSTEM

In the paper, rapid virtual design based on virtual prototyping simulation (RVDBVPS) is put forward to carry out distributed cooperative product design to integrate multiple aspects of the enterprise to improve design decision-making and control at all process levels, to raise its competing capability, to realize the common objective, and to accelerate the shift to Internet/Intranet based product design.

On the basis of information integration, the integration of product development processes are realized by integrating organization, technologies, physical resources, human resources and so on. It is Concurrent Engineering (CE) oriented design based on virtual prototypes, virtual environments and simulation. The emphasis is put on rapid generation and evolvement of the virtual prototypes in the virtual environments. It is the application of virtual manufacturing in product design, namely design centered virtual manufacturing on Internet/Intranet.

The main functions of the RVDBVPS system include:

(1) Integrate the product development processes.

(2) Realize close loop product development based on virtual product design and virtual prototyping simulation.
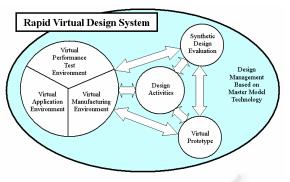
(3) Enhance design decision-making and control at all design process levels.
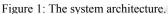
(4) Raise the ability of the enterprise to cooperate, improve, innovate, and develop.

3 SYSTEM ARCHITECTURE AND ITS KEY TECHNOLOGIES

3.1 System Architecture

The architecture for the RVDBVPS system is put forward, as shown in Figure 1. As an engineering information management system, it can provide information for enterprise product strategies, business search and project management. At the same time, it can also be used as a product design decision support system at all design levels. For integrated product and process development, it is a testbed for design decisions. For production, it is a monitor, control, management, maintenance and simulation system to improve production plan scheduling and control.

Figure 1: The system architecture.

3.2 Master Model Technology

As the basic challenges to achieving RVDBVPS are the creation of product and design process representations and their implementation in the virtual design environment. Virtual product design master model technology is put forward for product data management and design process management in the rapid virtual design environment to implement timely design assessments, trade-off analyses, and iterative design optimizations. To carry out distributed cooperation during all product development phases, it is based on a blackboard control system which consists of a design knowledge base containing product models, relations, and constraints, a blackboard where design sources are controlled and coordinated, and a number of design knowledge sources performing simulation, analysis, evaluation and cooperative decision-making.

Management and control of product development processes is based on integrated process modeling. According to the changes of the virtual product master model, the functions of design activities and relations among them are analyzed using function models and object-oriented method. Then, based on process activity networks in different layers, the product development processes are produced or modified dynamically. And then, human resources and physical resources are organized and allocated reasonably in accordance with existing resources and subjective and objective conditions. Finally, the processes are simulated, analyzed, modified and optimized using Petri-nets and so forth.

The data structure of the virtual product master model representing the product being designed is realized with a dynamic feature representation structure to reflect the changes of product design information.

3.3 Multi-Level, Multi-Perspective and Multi-Phrase Synthetic Design Evaluation

In order to assess the product design concurrently and comprehensively, it is needed to dynamically generate lifecycle oriented evaluation models for product design during product development and to carry on multi-level, multi-perspective, and multi-phrase synthetic design evaluation.

Under the support of computer network systems and various databases, the product design process management and control module administrates product design synthetic evaluation activities that provide product related evaluation information based on the virtual environments and virtual prototyping to cooperating designers, realizing the integration of product design and synthetic evaluation. The implementation of product design synthetic evaluation includes the following four aspects:

(1) Product design synthetic evaluation planning and control.

(2) Dynamically generation of evaluation models.

(3) Synthetic analysis and evaluation functions.

(4) Product redesign and optimization process based on synthetic evaluation information of the product design.

4 SYSTEM DEVELOPMENT BASED ON EXTENDED MVC-BASED WEB APPLICATION FRAMEWORK

In order to develop the system on Internet/Intranet, an MVC-based web application framework is extended with XML to make it more flexible, expansible and maintainable. An XML style interface and mapping interface mechanism are adopted to realize interactive information transaction across heterogeneous platforms. To validate the extended MVC-based web application framework and XML interoperable information model, both are applied to develop a machine tool distributed cooperative design system for virtual enterprises.

The scheme to extend the framework with the technologies of XML, XSLT and Xbean is presented. The standard format of XML and the powerful conversion function of XSLT can help extend the limited function of the View part in the MVC-based web application framework.

The data in XML format can be represented in any other required form by combining XML with

XSL. An extending scheme for the MVC-based web application framework is presented as follows. Firstly, an XML creator is set up using XBean to transform the data gathered from user's request interfaces or JSP feedback pages into XML document. Then, the extendable stylesheet list is programmed according to the special requirement of terminal equipment. Finally, the prepared XML document can be transformed into the corresponding data format as terminal client equipment requires using XSLT. The extended MVC-based web application framework is shown in figure 2.
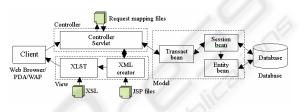

Figure 2: Extended MVC-based web application framework.

5 PRODUCT DESIGN INFORMATION EXCHANGE BASED ON XML-BASED INTERACTIVE MODEL

XML models of product design information are mainly applied to two fields. On the one hand, in the process of cooperative design, by XSL stylesheet mapping, the same design information can be displayed diversely on different application platforms to provide favorable man-machine interaction interface. On the other hand, through the data mapping interface programmed with Java, the product design information can be transformed and operated in different application systems, such as relational database systems, CAD/CAM systems, or post-processing equipments.

The XML information model and its multiply displaying as well as interactive information processing are realized in machine-tool distributed cooperative design system that is designed for virtual enterprises. The interactive information processing model based on XML is shown in figure 3.

At the customer layer, the designers input the related characteristic parameters of machine-tool design through man-machine interactive interface. The design information is stored in network as XML document tree structure. The intermediate layer is

composed of XML server and Web server. Web server transfers the XML information according to HTTP. It can be parsed and transformed by XML server to generate the operation instruction for the local graphic software such as AutoCAD, and then the corresponding design drawing can be plotted according the feature parameters and displayed on the interactive design interface in time by the data-mapping interface and XSL stylesheet. The designers can vary the product design parameters to modify the design drawing and store the current result into a relational database in the database layer. The result can then be consulted or edited by other designers. The efficiency of distributed cooperative design can be greatly improved by transmitting the design semantics expressed with XML data rather than 3D solid model data.
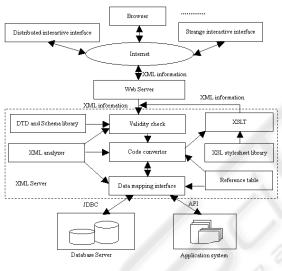

Figure 3: XML data exchange.

6 CONCLUSIONS

Rapid virtual design based on virtual prototyping simulation is put forward to carry out distributed cooperative product design on Internat/Intranet. Its architecture and key technologies are discussed. To overcome the deficiency of the View part at the client end caused by the limitation of JSP, the MVC-based web application framework based on JSP/Servlet/EJB on J2EE platform is extended with XML. The key technologies and method to create, transform and display XML documents are expatiated. XML is applied to the description of structured and unstructured elements, characteristics and their relationship in distributed cooperative

product design. A method of product data exchange based on XML is put forward to exchange design semantics instead of the 3D model data. Thus, the display and modeling requirements can be satisfied in distributed cooperative design. The extended framework and data exchange method based on XML are proved feasible and valid by system development of the machine tool distributed cooperative design system for virtual enterprises.

REFERENCES

Chen, L., 2006. Design of collaborative virtual environment based on PC. In *Computer Integrated Manufacturing Systems*. CIMS, Beijing, China.

Wu, B., Huang, H., Tao, Y., 2006. Digital design of virtual prototype based on multidisciplinary design optimization. In *Journal of Wuhan University of Technology*. Wuhan University of Technology, Wuhan, China.

Yuan, Z., Zhang, Q., Yang, J., 2004. Solution on enterprise application integration based on web services. In *Computer Integrated Manufacturing Systems*. CIMS, Beijing, China.

Chung, J., Lee, K., 2002. A framework of collaborative design environment for injection molding. In *Computers in Industry*. Elsevier Science B.V.

Li, M., Cheng, Y., Zhao, B., 2002. Collaborative application platform for small and medium-sized enterprise. In *Computer Integrated Manufacturing Systems*. CIMS, Beijing, China.

Wu, B., Wu, Y., Xi, L., Fu, S., 2006. Research on XML-based typical parts and components design system. In *Computer Integrated Manufacturing Systems*. CIMS, Beijing, China.

Chen, Q., Hua, J., Zhang, Y., Ying, K., 2003. Design of an XML-based collaborative documents model. In *Journal of Software*. Chinese Academy of Sciences, Beijing, China.