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The networked manufacture application service platform for the equipment manufacturing industry base in north-east China

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In this paper, a detailed analysis of the industry structure, characteristics, and demands of the equipment manufacturing industry base in north-east China is given. Two modes of networked manufacturing systems for the industry of north-east China are presented. The system architecture of the networked manufacturing application service platform based on J2EE (Java 2 Platform, Enterprise Edition) is discussed, and its technical characteristics and main functions are given. The workflow-centric customized platform configuration and application process management method are investigated. Application service systems for networked collaborative design and distribution are developed. Finally, the advancement and practicality of the platform are illustrated by a case study.

Keywords: Equipment manufacturing industry base; Networked manufacturing; System architecture; Application service; J2EE

1. Introduction

Networked manufacturing is an advanced manufacturing paradigm. It provides a new way of doing business and management for an enterprise worldwide through advanced networks. It can especially upgrade the capability of product development and service ability. It changes the conventional purchase and sales modes of an enterprise. By using a networked manufacturing system, enterprises can select collaborative partners globally, and the time period of product development can be significantly shortened. Good results have been obtained by the applications of networked manufacturing in several overseas companies, such as American AMANET company and Boeing company. A 24-hour collaborative design team is established in Boeing, which shortens the product cycle by 50% (Liu 1999). The American AMANET Company allied itself with dozens of enterprises and workshops to form a dynamic network alliance through the established Virtual Enterprise Project Management system. In recent years, effective investigations in networked manufacturing have been carried out in China (Liu 1999, Jiang 2003), for example, application in distributed design and manufacturing of robots, application of networked manufacturing in mould design and manufacturing, and development and application of networked manufacturing systems in Xian-centric industry zones. Using these applications, the distributed product design, resource sharing, and professional Application Service Provider (ASP) service have been realized.

China's manufacturing industry is growing up rapidly (Shu 1998), typically in Shanghai city, Jiangsu Zhejiang, and Guangdong provinces, and north-east China. Different economic regions in China have their specific development characteristics. The economy in Guangdong province is characterized by medium and small-sized towns and private corporations with the following characteristics: high product speciality, medium and small-sized corporations, extroverted, perfect coordination matching functions of circumjacent regions, paying attention to the foreign market, and close relationships. The Changjiang Delta is one of the earliest industry bases and has a complete economic industry environment. It has formed an industry structure, in which Shanghai-based large backbone industries are the figurative head and Jiangsu and Zhejiang

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economies are the two wings, with good industry distribution.

North-east China is the research and production base of many industries, including aerospace, aviation, petroleum, chemical engineering, machine manufacturing, metallurgy, power machinery, heavy machinery, and motorcycles. It stands on an important strategic and economic position in the development of national defense and economy. According to statistics (Liaoning Social Economical Statistic Material Collection 2003), the production of steel, raw iron, and steel materials in Liaoning province includes nearly 20% of the national yield, and the production of pure alkali and NAOH include nearly 20% and 10% of the national yield, respectively. The yields of power, base oil, natural gas, original coal, machine tools, drive equipment, aircraft parts, shipbuilding, metallurgy equipment, mine equipment, transformers, and automobiles also play important roles in the country. In the environment of economical globalization, north-eastern China's industry base has impending needs for upgrading its traditional industries by using information technology to improve total competition capability.

North-east China has an integrated industry system with distinct advantages. With many years of development, north-east China has developed the following unique characteristics:

- It has a set of dominant industries and complex products which are difficult to manufacture.
- It has an advantage in that these products can form a complex set of equipment systems, such as a turbo generator plant, or a set of mining systems.
- It has high technique products and customers mainly from enterprises that undertake China's national key projects.

The economical region of north-east China pays much attention to product, it mainly focuses on large-scale industries, and at the same time pays attention to the special characteristics of each city's industries. As we know, there are several existing networked manufacturing modes developed for the industry sector, for special manufacturing towns, and professional ASP for a set of small and medium-sized enterprises. However, these existing modes cannot satisfy the specific information needs of China's north-eastern regional economy characteristics, so there is a need to define suitable modes of networked manufacturing for supporting industry in north-eastern China.

In this paper, two networked manufacturing modes that support north-eastern Chinese large-scale equipment-manufacturing industries and characteristic industry groups are presented. Then, the realizing method of the networked manufacturing system to support large-scale leader core industries is introduced. The functions and key technologies of collaborative design, collaborative manufacturing, and manufacturing resource sharing with workflow technology are discussed. A specialized application service system that can meet the needs of different industries and industry groups is design and developed, and a typical application is demonstrated to validate the system.

2. Networked manufacturing mode of China's north-east region

2.1. Demands for networked manufacturing

The complementarities and complete set relationship between cities, products, and raw materials had been considered when the north-east region of China was constructed. This has evolved into a strong manufacturing base and backup service enterprise chain, which includes a heavy industry plant, engine and generator equipment manufacturing enterprise, aircraft-manufacturing company, automobile plant, metallurgy factory, petrochemical industry, light industry, and electronics industry, etc. Enterprises within the north-east region have formed a very good industry ecosystem with the following four aspects:

1. A group of predominant industries with strong supportive service relationships with each other. Figure 1 shows an example of this relationship with large mining equipment as the final product. In figure 1, every circle represents a manufacturing enterprise, and the product name of the enterprise is labelled in the circle. All these enterprises cooperate to help produce large mining equipment.
2. The supportive service of raw materials, such as the Anshan steel plant, the Benxi steel plant, and especially the Liaoning steel plant, provide raw materials for equipment building enterprises such as automobiles, blowers, motors, locomotives, ships, etc.
3. Small- and-medium-sized enterprises provide the supportive service of accessories and parts for large-scale leader enterprises, such as Dalian, Dandong, and Chaoyang automobile parts providers offering a backup service for assembly factories such as the No. 1 automobile factory, Harbin airplane factory, Shenyang golden cup car company, etc.
4. The backup service is provided among the different small and medium-sized enterprises, for example the collaboration and backup service provided between the petrochemical industry and machines of Liaoyang city and Daqing city.

Although there are several predominant industries and products in north-east China, there are still certain

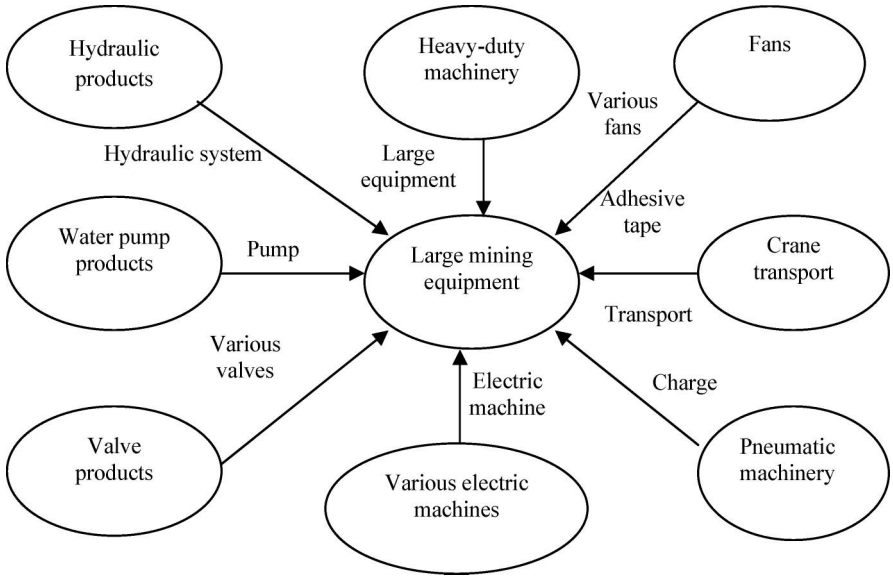

Figure 1. Typical relationship between enterprises in north-east China.

problems in meeting the challenge of economy globalization and information technology. The main problems are:

1. There is a lack of valid information communication channels and means; a large number of manufacturing assets are not utilized effectively; and manufacturing resources cannot be shared and allocated optimally.
2. Because of the high cost of production and circulation, and poor collaboration between enterprises, the current Chinese north-east base only has the fundamental ability to assemble large equipment or set of equipments, it hardly has general competitive capabilities and integral competitive predominance of the overall industry chain or even the overall region.

To resolve the above problems, networked manufacturing is needed imminently. By applying techniques such as supply-chain management, customer-relationship management, and electronic commerce in the north-east industry base, the business collaborative ability between enterprises can be improved. By utilizing collaborative design and collaborative manufacturing techniques, the capability of cooperative backup and product innovation can be enhanced. By efficient sharing of information, manufacturing resources can be better used.

Consider the situation of a north-east industry base; its main demands for the application of networked manufacturing technology and system are as follows:

1. The demand of networked manufacturing in market development: by using networked manufacturing technology and system, the collaboration between enterprises can be strengthened, manufacturing resources and capability can be shared among enterprises, and thus the integral ability for complete set production can be significantly improved. Through the dynamic alliance of enterprises, a virtual company can be formed to meet market demands or nationally important large-scale projects. Each partner in this alliance can exert their speciality to improve the ability to obtain a bid, to reduce the cost of sales and collaboration, and to extend the quota of the market.
2. Demand of networked manufacturing in complex equipment design: by building up shared accessory databases, enterprises can take account of the available resources of other enterprises when designing products. Through the networked collaboration design technique among the partners, the design ability for complex equipment or large projects can be strengthened.
3. The demand of networked manufacturing in collaborative capability of production: by building the capability resources databases, the dynamic status of the machinery and production progress can be accurately obtained. Based on the manufacturing resources status, the workload of key numerical control manufacturing centres and devices can be scheduled through online resource allocation. The production process can be arranged in an equilibrium step, thus increasing the utilization of the manufacturing resources and at the same time reducing production costs.
4. Demand of customer service, external relationships and technical support: by using networked

communication, the connection with customers can be tighter and online technical support can be provided, thus improving customer satisfaction levels.

2.2. Networked manufacturing mode

Enterprises with different manufacturing modes need different network realization modes. The networked manufacturing mode of the north-east industry base and its ASP service can be realized with the following two patterns (Wu and Wenlin 1999):

1. For large-scale manufacturing groups and the preponderant productions, networked manufacturing systems should be built with the core enterprise as the centre and should organize customers, providers, and cooperators together to realize networked coordinated design and manufacturing, customer management, and supply-chain management, etc. That is, the correlative enterprises are contacted as a member in the industrial chain, in which enterprises would share manufacturing resources. This pattern could increase the total competition abilities of the group and decrease the product cost, and then form a strategic alliance for the sake of common market benefits.
2. For small and medium-sized enterprises and supportive service enterprises, networked manufacturing pattern could use the ASP service system to improve the supportive service quality and competitive capabilities. By linking small and medium-sized related supportive service enterprises together through different 'spider nets', the antenna of each net can again link to other networks within the region, to improve the competitive capability of nearly all the supportive service enterprises.

Thus, the networked manufacturing systems for a north-eastern industry can be built in two different modes. One mode suits large-scale manufacturing groups, which have functions of manufacturing resources sharing among business partners, production supporting service provision, collaborative product design, material flow arrangement and delivery, business collaboration, etc. Conversely, the construction of the ASP networked system can provide support to small and medium-sized enterprises. In the ASP mode, the system is built with each special industry sector as the major focus, and around this focus a number of services are provided, such as consultation service, client registration, safety login, selling, purchasing on the network, and the special services demanded by each industry sector. The large-scale manufacturing group can use the ASP network to communicate with their customers, suppliers, and partners, too. The small and medium-sized enterprises can use the ASP service to communicate between partners. The two patterns mentioned here are complementary, and both help in constructing a manufacturing network for the old industry base in north-east China.

3. Platform structure and its main functions

3.1. Platform configuration

Since the networked manufacturing system operates under a network environment, it is convenient for the maintenance and upgrade of the system to using the Browse/Server (B/S) structure. Since the operation of the system will be on different hardware and software platforms, in order to ensure the openness and extensible characteristics, the public service platform of the north-east networked manufacturing system adopts the J2EE (http://java.sun.com/j2ee/, Foster and Gannon, XXXX) standard and selected DIRECTOR as the portal development platform. The JNDI, XML, XSLT, JSP, SERVLET, and EJB techniques are used to develop the system. The structure of the system is shown in figure 2. It includes an Integrated Development Environment (IDE) and seven layers which are described according to a bottom-up sequence as follows:

1. Infrastructure layer. The lowest layer of the system is the infrastructure layer. This is composed of a computer system, a memory system, a database system, a network system, a firewall system, an anti-virus system, an attack-detection system, and a CA authentication system. The computer system and network system adopt a cluster architecture, whereas the memory system adopts a Server Area Network architecture.

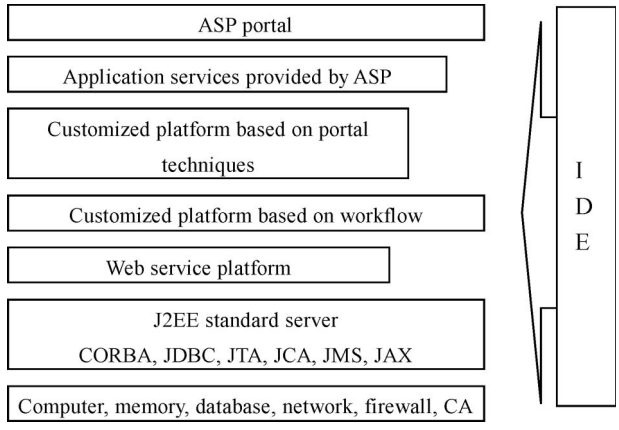

Figure 2. ASP platform architecture.

2. Application server layer. The application server is the middleware platform of the system and has the ability to integrate with the application system and data (Lau 1998). In this layer, the application server adopts the J2EE standard server, which not only provides a multi-layer distributed application model and a set of development programming techniques but also divides application logic into a multi-layer that supports a corresponding server component. The component runs on a distributed server component container (such as a Servlet component in a Servlet container, EJB in an EJB container), and the containers communicate through corresponding protocol in order to coordinate the components.
3. Web-services technique-support layer. This is very important for networked manufacturing (Galor 1995, Guyuan 2000). The system adopts Web-service techniques based on the J2EE standard to develop, configure, and manage large-scale service presentation and navigation of services. It boots with the logic, which is not only convenient for application integration between the application program and the ASP for the users, but also lays a solid technique foundation to construct the larger application and simplifies the development work of ASP applications.
4. Workflow technique support layer. This platform provides Business Process Management and Business Process Integration functions by utilizing the workflow technique. The system provides a graphical workflow modelling tool that can define and modify the business processes. All the processes can be automatically executed by the workflow engine system. Workflow can connect the functional components used during the business process execution period through corresponding logic definition and handling process invocation on the platform.
5. The customized platform layer. The networked manufacturing platform needs to manage numerous customers' authority and to complete the valid assignment of the customer authority to various application services. The portal technique is used to build the required system which can provide various common services for application service development, including user authority management, content management, search engine, security management, catalogue management, rule engine, etc.
6. Application service layer. Various practical applications are developed based on the above five layers. These applications provide functions needed by customers through the Internet. The applications include abstracting the functional models that enterprises need from the application system and re-encapsulating the functional modules into individual application solutions to offer to users.
7. The ASP portal layer. The platform provides a consistent application interface for users through the ASP portal. The user can perform service querying, user registration/entrance, requirement announcements, bid commitments, as well as other operations through it.
8. The IDE. The system adopts IDE to improve the efficiency of development and application. The EAI integrated service platform of SilverStream extend Composer and SilverStream extend Director of SilverStream Corp is used to develop the workflow platform and the portal platform. The SilverStream extend workbench development tool of SilverStream Corp is used as the IDE platform.

3.2. Main functions of the system

The main functions of the system include information release and browsing, application configuration management, individuation configuration management, management of user authority, self-help creating the website system, user application service request and acceptance process management, an ASP service, user statistics, enquiry and network throughput statistics and ASP application service, etc.:

1. The main website. The main website is the main gate for information release and browsing. It is based on an existing Chinese Equipment Manufacturing Net and provides functions such as a news centre, resource sharing, enterprise Yellow pages, announcement of supply-and-demand requirements, attractions for investors, online forums, etc. Its function focuses on providing information. Now, it provides the technique standards for equipment manufacturing industry, the standard part library, and more than 20 000 pieces of product information from different enterprises.
2. The platform configuration and the application process management.

3.2.1. Platform configuration. The core system of the platform adopts a component development pattern that meets the requirements of standards based on J2EE. The development environment DIRECTOR is used as a fundamental development platform. It employs JNDI, XML, XSLT, JSP, SERVERLET, and EJB techniques to achieve the main functions of the platform. The main functions of the platform are described as follows:

1. Individuation configuration of the platform. The application components of the system can flexibly configure the content of a system by authorized

customers through the authorization of the platform, choose the components expediently, define the interface style freely, define the layout without any limitation, and provide the user with abundant individuation functions and the flexible portal style.

2. User-authority management. User management provides the administrator with the function of management and authority definition of the platform user, component, and roles, thus enabling the administrator to control the users, components, and roles through a portal. The functions include:
   - User management. The platform provides the networked management interface for administrators, which can create users and user groups by the roles defined in the system. This can define corresponding roles for the users and the user groups. Through the association of the component and the role, the users and user group can be given the authority to visit certain components. At the same time, every user can set up their extended attributes and record their basic information.
   - Component management. The system provides the homologous control interface for the existing component in the system. The interface can assign the authority of roles for the existing component in the system. The user that has the role authority can visit the component.
   - Authority management. Authority management provides user authority management for the user and component.

3.2.2. Application process management. A visual workflow modelling tool and a workflow engine are developed as the core of the application process management function. With the support of workflow management, the application service users, system supervisor, and application service providers can easily fulfil the functions of description and management of overall process, including applying and checking the application service, realization of service application, examination, and reply for service providers.

The workflow management system is developed according to the WFMC standard. This uses Node, Link, and WorkItem elements, and the visual interface to define a workflow model. It can cope with batch processes and provide a dynamic sorting function that does not need page refreshing. This will optimize the network-information flow and realize integration with other subsystems. The main function includes:

1. Management of service type. This fulfills the application service coding according to their different type for the convenience of index.
2. Management of application service. This provides the application service management interface for the administrator, which is convenient for maintenance.
3. Application services register workflow. This provides the platform for the service register and management of foreign area and makes the service developer and system administrator work together, even when they are at different places.
4. Discharge statistics. Bind special IP address to the customer. The network discharge during a particular time is computed according to the IP address. Then, the real expenses can be achieved by using the current spending standard in this time segment.
5. Enquiry of a customer's information. This involves inspecting basic information such as the start date of applying the service, the name of the customers' service, etc. for the user.
6. The application service customer's information enquiry. This involves inspecting the user times of a particular application service and basic information for the particular customers. The usage situation of the server can be known using this module.
7. Work flow of applying application service. It addresses the procedures on how to apply the application service, offering the entrance of the application service to the customer, and provide the examination and approval platform to the system administrator.

The self-creating website module provides a fast creating website function for enterprises. Based on a website template, users can use self-help creating website tools based on the web to quickly configure individual information-release sites; this also provides information-content management based on the Web. The self-creating website module has the following functions: a preview website, website name management, online HTML editor, second-level column and information category management, graph and text mixed makeup content management, multi-style web page template, picture management, code inserting management, various home-page makeup styles, network link management, advertisement management, message board management, customer feedback, and password management.

3.3. Platform realization environment

The north-east China industrial base networked manufacturing service platform adopts a B/S structure. It sustains the development and operation of Web services and the application integration based on Web services, and it provides the data integration based on workflow. The client interface is realized using HTML and Java Applet. The

middle layer is a Web application server, and it provides a search function for the corresponding JSP or servlet according to users' requests, and then feeds the HTML or XML files created by the JSP or servlet back to users in the form of an HTML file. Business logic is realized in J2EE web programs by the EJB component.

3.4. Key techniques of implementation

During the process of designing and implementing the networked manufacturing ASP platform, the following key technique problems are studied and the implementation methods for these are put forward.

1. Manufacturing-resources categorizing and its system architecture. The rational categorization of manufacture resources and establishment of systematic architecture are very important for the system. There are many kinds of manufacture resources, and the quantity of manufacturing resources is also huge, so it is difficult to find a suitable resource without an efficient index and categorical method. In order to make full use of the public manufacturing resources for different enterprises in different districts, a categorizing system is developed. The system categorizes the manufacturing resources by industry sectors and geographical areas. The developed system adopts the three-layer architecture, as shown in figure 3, and it is constructed based on J2EE techniques:
   - Data layer: the data model of various manufacturing resource libraries based on a relational database model is designed. SQL Server database management system is selected as the physical database management system.
   - Operation layer: EJB is used to describe the optimal index for manufacturing resources and the operation logic for resource data.
   - Express layer: the visual expression of query and index of manufacturing resources is presented in this layer.
2. Metadata application based on XML. In the product design system based on ASP, the platform of information sharing is the key to providing various information services. To facilitate users' searching for large quantities of data and resources, and for data access across different platforms, the system describes various kinds of data using metadata based on XML. First, various types of data provided by different information systems are analysed and classified; then the metadata model that can describe all kinds of data is designed. Extensible Markup Language XML is used to describe the metadata model. Thus, the data under the circumstance of ASP can be effectively described and managed. After setting up a core metadata model by XML, information resources are marked uniquely by XML, and various resources can be sorted in the standard way according to owners, types, models, etc., thus facilitating indexing.
3. Authorization using XML techniques. The ASP platform is a service platform which is utilized by multi-users including administrators, unregistered users, registered users, users paying bills, and so on. Each kind of user authority is different. The platform adopts a user-management model based on logic separation between users and authority, which facilitates the authorization. In addition, by using the XML technique the authorization function based on roles is achieved.

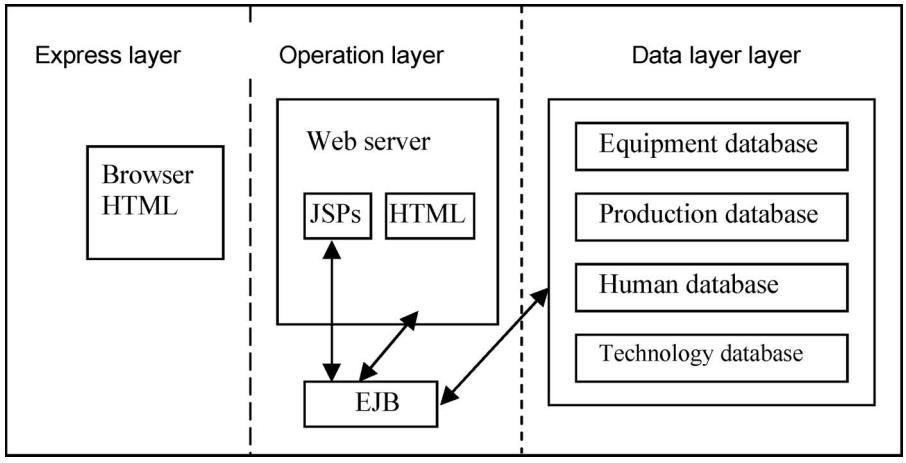

Figure 3. System architecture based on J2EE.

4. Application service provided by the platform

The application service is the professional service (Fladmoe-Lindquistk 1995, Liu *et al*. 2000, Montreuil *et al*. 2000, Rockwell automation e-manufacturing industry road map-making sense of e-manufacturing 2000, Yang *et al*. 2000, Xinjian *et al*. 2001) that the system offered to the manufacturing enterprises. Four types of services are described below.

4.1. Networked product cooperative design service

The system provides visual distributed cooperative design and manufacturing services between different enterprises. The functions provided include diagram document maintenance, diagram document online coordination, diagram document size measure, discrepancy comparison between images, diagram document online mark, diagram document browse, diagram document format conversion, and system management. The platform adopts cooperation, intelligence, visualization techniques, and J2EE architecture to realize the diagram document management, the diagram document video, the diagram document check, and the online coordinated design.

The system can deal directly with different CAD systems and work on over 200 different format documents, while the local host does not need the work environment of a CAD system. The original CAD editing software is not needed either, and the original document integrity is retained completely.

4.2. Network material arrangement service

The system releases all kinds of materials that need to be arranged and searches for the materials that need to be arranged according to material category, material name, specification, issuance industry, trademark, and manufacturer quickly. The material arrangement system achieves the arrangement of the materials among the industries and does the statistics and analysis for negotiation times, contract number, intent number, dealing resources number, waiting to deal resources number, dealt resources number, enterprise logon times, contract signing time, etc.

4.3. Group network deal and sale service

A networked marketing and material regulating system has been set up for tender invitation, bidding, discharge bidding, judge bidding, decide bidding, etc. The public service platform provides enterprises with the functions including online ordering, batch uploading, bulletin issuing, tender invitation/bidding template management, doubt handling, bidding examination and approval, negotiation, bidding result consultation and after service, etc.

4.4. Information service

Chinese equipment manufacturing network websites provide resource libraries such as product, equipment, technique, raw material, and personnel resource information for enterprises. It is the information releasing platform for the enterprise and provides 1000 different kinds of standard graphic libraries for member enterprises, a product library of more than 20 000 enterprises, and various technique standards.

5. Applications and benefits

The system has been applied to Anshan Magnetic Valve Company, Shenyang SISUN Robot Automation Co., Ltd, Anshan Hengtong valve Co., Ltd, Anshan steal and bearing group and Benxi Pump Co., Ltd separately to achieve cooperative design. Network purchase, sales, and material arrangement systems are used in Heilongjiang Sida Paper International Group, Heilongjiang Paper Co., Ltd and Jiamusi Paper Co., Ltd, etc.

5.1. Application of distributed and collaborative design

Based on SolidWork and with the help of the networked distributed coordinated design system, the three-dimensional model of a electromagnetism valve body part has been designed for Anshan Magnetic Valve Company separately in Shenyang and Anshan city according to the planar drawing of the company. Designers of the Shenyang Institute of Automation and Anshan Electromagnetism Valve Ltd take part in product design together. Figure 4 shows the main processes of coordinated design. The main processes of collaborative design are as follows.

5.1.1. Application service applying and design team. Due to its limitations of technique and circumstances, Anshan Magnetic Valve Company entrusts Shenyang Institute of Automation to complete the three-dimensional valve design task.

The design team comprising two organizations is set up. The tasks of designing, proving, examining, etc. are divided between the two organizations. Designers of the Shenyang Institute of Automation use SolidWork to design a three-dimensional entity model according to a general model provided by the enterprise. By using the model and document management menu, enterprise designers can join discussions and put forward modification advice online. The enterprise can check and accept the design result through the network after the design is completed.

5.1.2. Product design and online discussion (asynchronous). Once the team members find the drawing problem, they can mark on the graph, then negotiate with the user through

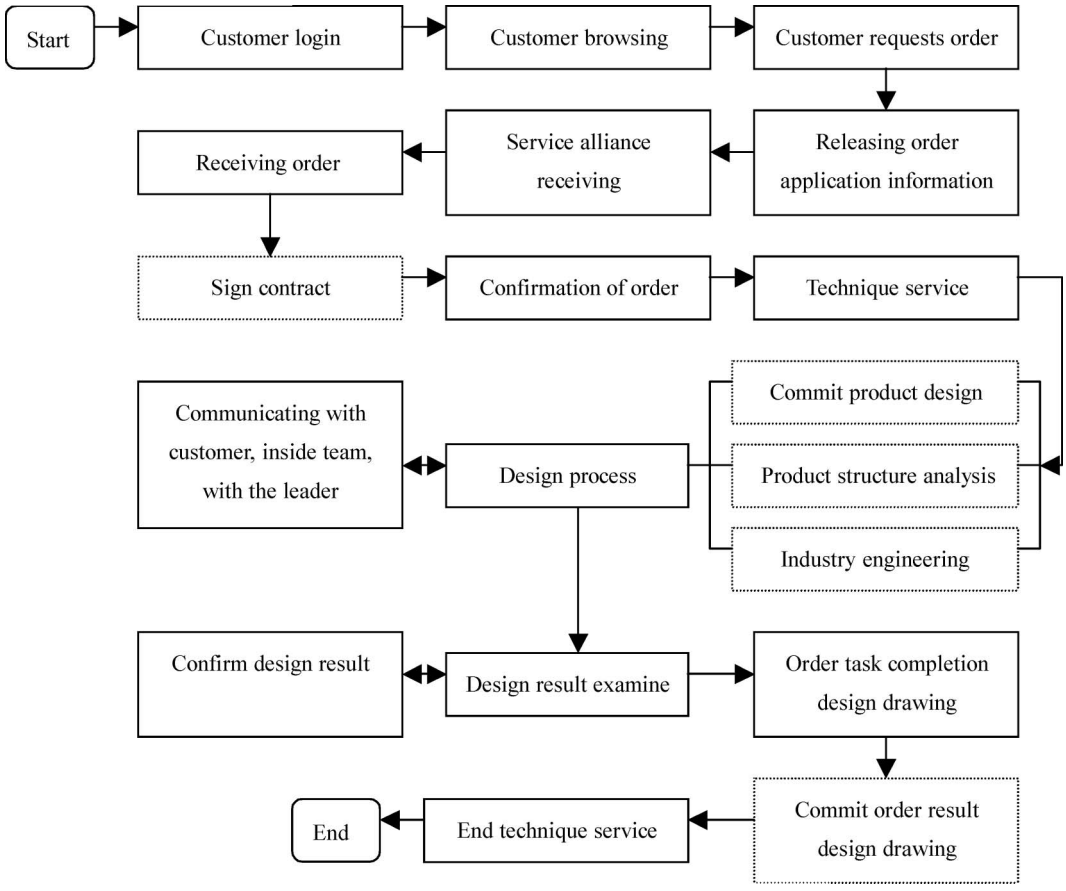

Figure 4. Coordinated design process.

the user message window, correct the original drawing provided by the user, do a three-dimensional design, and share the graph document information. Figure 5 shows the design discussion process interface.

5.1.3. Design e-document examining and approving process. The menu of the examining and approving template is chosen to define the examining and approving process, and the complete design process, i.e. the product design, modification, and approval, is fulfilled with the help of such functions as graph document committing, proofreading, interior and exterior examination, correcting, approving, etc. Figure 6 shows a design-approval process interface.

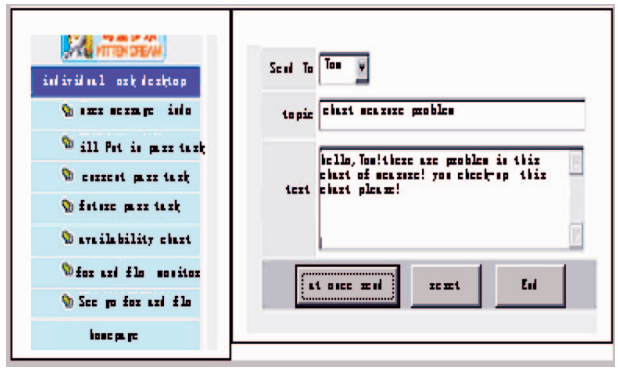

Figure 5. Design discussion process interface.

5.1.4. Design work fulfillment. The design team reports the work fulfillment instance to the alliance principal, and the customer checks the results.

5.2. *Network material arrangement system*

All kinds of information about the materials that need to be arranged can be announced through this platform. The information can be uploaded by batch method, and the enterprise can take part in the negotiation of the arrangement process, so the sharing of materials among enterprises can be realized. The detailed content includes:

1. Query about the material to be arranged. A quick and integrated search for the information about the material category, material name, specification,

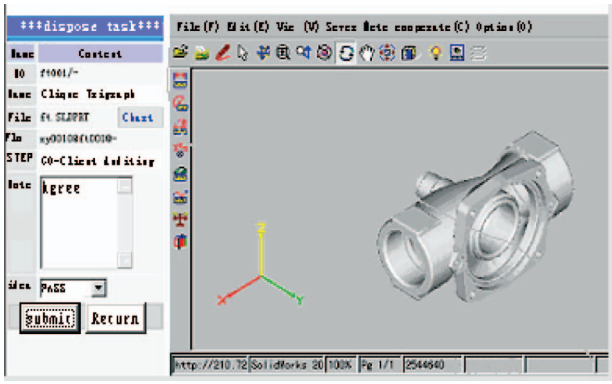

Figure 6. Design approving process interface.

issuance industry, trademark, manufacturer, and so on to find the materials that need to be arranged.

2. E-contract management. The online e-contract is signed using all kinds of templates provided by the system, including intent sending, returning, and affirming the contract.
3. Negotiation room management. This provides many kinds of negotiation methods such as video, sound, text, etc., and point-to-point or many-sides transmission style about various e-documents, and video files to complete the negotiation of two sides or many sides.
4. Material data conformity integrating management. This function provides the method for material data of all industries to integrate into this platform.
5. Statistic analysing and log management. This performs the statistics of each index value in system bargaining and exports each operation record and the data. The data include system total statistics and local data for each industry, negotiation degrees, the contract number, the order number, the number of materials to be dealt, the number of materials actually dealt, industry logon degrees and times, contract signing time, the order sending record in the process of signing the contract, and each data record transferred during negotiation.

5.3. *Application benefits*

The application of networked collaborative design system dealt with difficult problems such as three-dimensional design of the core product and engineering analysis. The application result shows that the product design cycle decreased from 35 to 12 days. The waste-product rate decreased by 8%. The ability of product design and innovation is improved, while the design cost decreased markedly.

The implementation of a material arrangement and sales system makes the redundant stock of materials alive. The cost of purchasing has decreased by 5%, and the cost of production 10%. This greatly speeds up the velocity of the fund cycle.

6. Conclusion

Networked manufacturing is a necessary trend for enterprise information development and is nearly the best approach for enterprises to meet the challenges of international competition. The networked platform architecture, application process management method, the regional networked manufacturing platform, and the content and style provided by the platform can provide an application service to satisfy various business needs. The platform is affirmed by demonstration and application in enterprises. The application results are favourable. The final research and development propelled information development and networked manufacturing techniques advancement in the north-eastern China industrial base. A theory model of networked manufacturing, technical and extending routes for different types of manufacturing industries is under way.

Acknowledgements

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