Analysis of Digital Enterprise under Digital Manufacturing*

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Abstract Being a new manufacturing technology and model, digital manufacturing has obtained an effective integration of digital management, digital design and digital control along with better equipment networking and intellectualization. In this context, the paper probed into a framework model which can meet digital enterprise's requirement of being real-time, agile, and network. It also explored key technology concerning digital enterprises, providing reference for their development.
Key words Digital manufacturing; Digital enterprise; Digital enterprise technology; Framework model

1 Introduction

In the current times, enterprises witnessed profound changes in technological environment, market environment and social environment, mainly manifested in the overlapping, penetration and merging of various disciplines, for instance, manufacturing industry has been an interdisciplinary subject integrating machinery, material, controlling, information and management, etc; Enterprises are able to deploy, utilize and reorganize resources in a larger environment beyond the limitations brought about by region difference and resource ownership; Knowledge, including experience and skill, has become an important basic resource for enterprises, which not only manufactured products, but also created and accumulated abundant knowledge. How to obtain, manage, integrate and utilize these knowledge has become a key factor for enterprise innovation(technological innovation and management innovation); The boom of Internet technology, an open and changeable society, and more heated competition as well, led to many adaptations like manufacturing models and technologies, among which digital manufacturing represents one of the crucial trends.

Supported by virtual reality, computer networks, rapid prototyping, data base, and multimedia, digital manufacturing refers to the whole manufacturing process involving collecting resource and information based on customer's requirement; analyzing, planning and restructuring the product information, process information and resource information; simulating and prototyping the product's design and function; and finally producing the product whose performance will meet the customer's requirement.

Equipments, the basis of digital manufacturing, has developed itself from a simple manufacturing entity into a comprehensive information processing device, which can record the state parameter and environmental variable during the processing, and operate on line compensation, on line measurement, and remote fault diagnosis, etc. In this sense, digital manufacturing has effectively integrated digital management, design, and controlling.

Modern enterprises, on one hand, by adopting digital manufacturing equipments in hardware, succeeded in digital control and digital management. On the other hand, in software, digital modeling, simulation and management are implemented by applying tool software in product design, process planning, enterprise resource management, and marketing. In this way, enterprise become real "digital enterprise" since all aspects in the production process have been digitalized.

In terms of the implementation of digital enterprise, bibliography defines "digital enterprise technology", and explored five technical areas of digital enterprise. Bibliography proposed an adaptive, distributed conceptual framework model for manufacturing system, and studied on collaborative manufacturing platform.

2 Framework Model of Digital Enterprise

Since manufacturing is a complex process, enterprise, to be responsive to changes, should have reasonable organizational framework. Bibliography put forward an adaptive, distributed conceptual framework for manufacturing system, based on which, this paper here presents the framework model shown as chart 1.

The shown framework model can be divided into three levels, strategic level, collaborative level,

* Supported by the Fundamental Research Funds for the Central Universities

and executive level.

Strategic level refers to factors concerning the enterprise's overall strategy like market environment and social environment, among which the latter includes various policies, norms, and specifications, and financial services. These factors are resources for common use instead of being owned exclusively by certain enterprise. Nonetheless, enterprise of better reputation and benefit may get more social resources, particularly in financial service.

Also the enterprise needs to consider the market and competition environment. Besides, introducing and adopting new technology and management will help increasing its competitiveness. Strategic level mainly has its affect on the enterprise's operation from the strategy-making level rather than directly participate in specific producing and operation. However, to make reasonable and prompt decisions, it needs to understand the enterprise's current status from the collaborative level.

Collaborative level mainly includes application collaboration within the enterprise, and business collaboration among enterprises.

Feedbacks of the status of different systems in the enterprise should be given to the collaborative level, where information thus can be integrated and shared. Should there be any change in any executive level system or in the external environment, the collaborative level needs to respond promptly, adjust the original deploying plan, and submit a new plan to sub-systems in the executive level for implementation.

The collaborative level needs to conduct business collaboration with other enterprises if necessary. An enterprise can collaborate with multiple enterprises at the same time. Being order-driven and dynamic, this collaboration ends with the completion of orders until new order comes. Stable collaborative relations will gradually exist between enterprise alliances in long term cooperation.

Executive level consists of a group of autonomous system, including all links during the manufacturing process as product design, product processing, storage and transportation, which can be further grouped physically or logically into independent autonomous systems according to different functions. Each autonomous system respectively represents one link in the manufacturing process, which means the output of one system may be the input of the next system.

Autonomous system needs to complete tasks assigned by collaborative level, and then provide feedbacks of the progress to the collaborative level for reference. Each autonomous system may not only serve for the enterprise itself, but also for enterprise alliances.

Each autonomous system has its own input and output, and needs to measure the input quality parameter and output quality parameter. Only qualified output of each system can guarantee the final product's quality. Moreover, they need to evaluate the index in terms of time, cost, and environment needed to finish the task to meet TQCE requirement.

An automatic system can complete a specific task (a task or a team of tasks) at least. Generally speaking, when an automatic system is conducting the tasks, it need task planning and dispatching first and then monitoring the whole process, hence the self-managing ability. But while the environment is changing, the automatic system will dispatch internally, but only the overweight of the change can cause the new assignment of collaborative level by reducing the overall system impact of environmental change.

According to the analysis of the above model, we can see that the strategic level and collaborative level are sensitive to the change of environment and demands of users, and insure the systems’ quick and accurate response to the market. Meanwhile, executive level’s sensation of input and output data qualifies products. The model satisfies the enterprises with real-time, agility and networking, as well decreases the difficulty of system management.

3 Key Technologies in Digital Enterprise

The key technologies in digital enterprise are all the systems and methods to develop and realize the production and technologies in a product’s lifecycle, including five areas of technologies: Distributed design, Distributed and collaborative design, Process modeling and process planning, factory equipment and layout design and modeling, Physical-to-digital environment integrators, Enterprise integration technologies. To achieve the digitalization of enterprise, there are amounts of work to do in these five areas.

According to this paper, the key technologies in current time include these following sections.

(1) Distributed and collaborative design for the product’s lifecycle

The complete design of the product’s lifecycle should be considered from the very beginning of product’s concept to the specific designs in all the processes which include requirement identification, product design, production, transportation, application and recovery processing and so on. The complete design is for all the links and aspects supported by the specialized knowledge and technologies; therefore, it is not a simple DFX, but an amalgamation of multiple disciplines and technologies. Hence, the complete design needs a distributed and collaborative design environment based on the internet to realize the participations of different people from different disciplines and different departments and different areas. The rapid development of internet makes the participations of the users of internet possible.

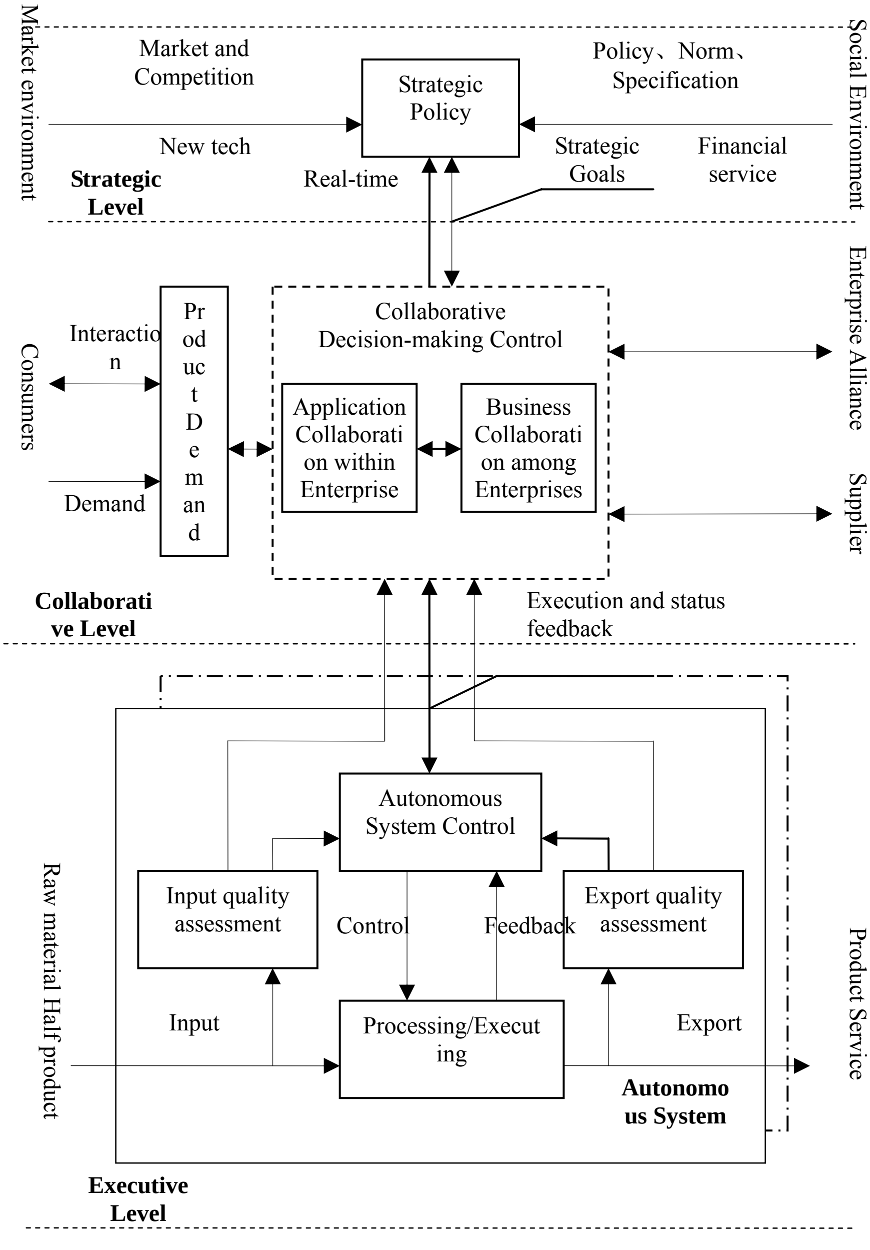

Figure 1 Framework Model of Digital Enterprise

80% of the cost is decided in the process of designing, as a result, time, cost, quality and environmental protection index demand consideration in the distributed and collaborative design to evaluate and optimize.

(2) The finding, managing and using of knowledge

The subsystems of digital enterprise contain not only all kinds of model data, but also the dynamic data from the practicing of production. Both kinds of data reflect the real production process of an enterprise in many aspects objectively. Conducting statistic analysis, data mining and other intelligent analysis in these data, we can achieve the following purposes.

①Examining and optimizing the relevant model: these data are produced in the real production process, so they can be used to analyze the model ones, and hence to optimize them, and make them closer to the real ones.

②The tacit, unknown, regular experience and knowledge can be found. For example, the mechanical course of working may be along with complicated physical change and even chemical change that people cannot know in the model changing process. However, through the controlling of state parameters and environment variables, plus the comparative analysis of the final working pieces, the best technologies of working piece and experiencing knowledge can be found.

The process of making productions is also the process of making an enterprise and accumulating experience and knowledge. Therefore, how to find, manage and use knowledge is also the important foundation of enterprise creativity improvement.

(3) The SOA structure based integration technology of application system

For the inner isomerous structural applications of the digital enterprise, how to realize the inner integration of all the application systems is another key technology to master. The fast development of IT provides the enterprise with choices of multiple techniques.

It is convenient to integrate the enterprise information system on the base of Web Service enterprises which have realized the independence of platform and language by integration technology. This Web Service based technology employs both incompact join and dynamic application integration, which are good to share and exchange the information and data in isomerous structural systems.

4 Conclusion

The development of digital manufacture technologies leads digital enterprises an inevitable trend of future enterprises. The foundation of digital enterprise is a complicated evaluation from specific part to the overall entirety. As a reference source, the paper provides a digital enterprise structure model which meets the demands of real-time, agility and networking,

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Integration of the Warehousing and Transportation Functions in the Supply Chain

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Abstract This paper examines the total cost benefits that can be achieved by suppliers and warehouses through the increased global visibility provided by an integrated system. A discrete event simulation model of a multi-product supply chain was developed to examine the potential benefits to be gained from global inventory visibility and trailer yard dispatching and sequencing techniques. Experimental results demonstrate the potential for this integrated paradigm to improve customer service through improved efficiencies, reduced costs, and reduced lead-time variability.
Key words Warehouse management systems; Transportation; Logistics; Supply chain management

1 Introduction

The Internet has provided a lower cost way of placing an order, and warehouses are experiencing more frequent, smaller quantity orders (Szgenda, 1999). This makes the task of consolidating orders to economic shipment quantities more challenging. It also forces companies to confront the trade-off between quick-response (more frequent shipments) and inventory carrying cost. Real-time information of the product flow becomes the tiebreaker for both sides of the business equation in terms of trading off transportation and inventory costs (Szgenda, 1999).

WMSs often contain information on operational efficiencies and cross-docking requirements, wherein a product is received in a facility, occasionally grouped with other products to the same destination, then shipped at the earliest opportunity without going into long-term storage. Most researchers have approached the management of inventory from an operational perspective. These include deployment strategies (push versus pull), control policies (determining optimal levels of order quantities and reorder points), and safety stock level setting at each stocking location. These safety stock levels are critical, since they are the primary determinants of customer service levels. From the WMS point of view, the only way to handle more shipments is by knowing items' characteristics a priori, such as item dimensions, location, and destination flexibility and visibility.

TMS are typically used as decision support tools in two areas: planning and optimization and transportation execution. In planning and optimization mode, TMSs determine the transportation mode(s), manage freight consolidation operations, and coordinate company shipments, including continuous freight moves (5–8% of the total freight payment). In execution or operations mode, TMSs are either directly or indirectly responsible for carrier load tendering, routing and scheduling, shipment tracking and tracing, and freight payment and auditing (Gilmore and Tompkins, 2000).

Today's supply chain management systems must provide real-time data and integrate data across the supply chain with real-time decision making. As the primary tools in supply chain execution, both WMSs and TMSs are the key factors to integrate the physical flow of goods along the extended supply chain, whose best management is achieved through integration between WMS and TMS (Gilmore and Tompkins, 2000).

Currently, most WMS and TMS systems are not fully integrated; however, the industry as a whole is moving quickly toward process-level synchronization (Gilmore and Tompkins, 2000). Through information exchange, inventory visibility, and intelligent decision support software, shipping firms are trying to reduce their operational costs to maintain current customer satisfaction levels. The integration of WMS and TMS should facilitate the reduction of suppliers' operational costs, thereby resulting in a decreased product cost for the end customer.

2 Integration of WMS and TMS

How WMS and TMS can integrate to reduce the overall costs within a supply chain and reduce lead times (LTs) with increasing reliability is the goal for today's systems to work like one unified and seamless application (Gilmore and Tompkins, 2000). Suppliers, retailers, and carriers need to share inventory levels, production schedules, demand (inbound/outbound orders), product characteristics (dimension, location, destination), available resources (transportation mode characteristics, warehouse