MODULARIZATION OF WEB-BASED COLLABORATION SYSTEMS FOR MANUFACTURING INNOVATION

Kwangyeol Ryu*, Seokwoo Lee** and Honzong Choi**
* *Department of Industrial Engineering, Pusan National University, San30, Geumjeong-gu, Busan 609-735, Korea*

** *i-Manufacturing Center, KITECH, 7-47 Songdo-dong, Yeonsu-gu, Incheon 406-840, Korea*

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Abstract: Unpredictable customer needs strongly require for manufacturing enterprises to produce quality products satisfying cost and time constraints. To cope with such dynamically changing manufacturing environment and to get higher competitiveness, the manufacturing industry needs to be equipped with advanced technologies including IT as well as substantial infrastructure. On the one hand "*i*-Manufacturing" is the name of the project funded by the Korea government, but on the other it is the strategy for achieving manufacturing innovation in Korea. The most basic but important concept of the *i*-Manufacturing is "collaboration". As a part of the *i*-Manufacturing project, we are developing various kinds of web-based collaboration systems, referred to as hub systems. Along with increase in the number of collaboration systems and users every year, we have to modularize function modules for easy and synthetic application of systems to other conglomerates or industries. Here, collaboration systems we developed are currently being used by more than 300 companies in Korea. In this paper, therefore, we first introduce the *i*-Manufacturing project and collaboration systems we have developed. The system architecture and composition of function modules which has multi-level framework will be described in detail before concluding the paper.

1 INTRODUCTION

The manufacturing industry has been facing with unpredictable challenges brought on mostly by dynamically changing customer demands. To cope with competitive market environment, the manufacturing enterprises of today should equip advanced technologies as well as corresponding infrastructure. Due to widespread availability of the Internet and over the past decade, business of the enterprise has been evolving into e-business, which innovates in business processes and systems such as Enterprise Resource Planning(ERP), Supply Chain Management(SCM), Product Lifecycle Management (PLM), Customer Relationship Management(CRM), and so forth. It has aided the acceleration of rapid and smart production in manufacturing systems to fulfill requirements of customer such as short delivery, low cost, and quality products(Lee, 2003). Because of sudden growth of IT, aforementioned business areas or concepts are implemented in on-line or web-based ones such as e-SCM, e-PLM, e-CRM, etc., which is so called "e-" version of concepts. On the other hand, recent fashion of naming technologies or tools seems to add "u-" because ubiquitous technologies are in the spotlight. Even though any prefix is fine, but we have to note that such technologies should be supported within synthetic strategies in order to achieving innovation.

Enterprises must capture, manage, and leverage their intellectual assets to differentiate themselves. The best way is to use the right application which supports collaboration. Collaboration is the most important factor to increase a company's flexibility and agility to respond swiftly to changing market pressures and competitors. Collaboration is being viewed as the next big wave after e-Commerce, digital commerce and several other variants that have emerged over the last decade. According to the outcomes of the *i*-Manufacturing project that we are conducting, as illustrated from the following section, collaboration systems can function as a good extranet as well as an intranet especially for small and medium sized companies who do not have sufficient IT resources and infrastructure including hardware, software, and experts.

For facilitating collaboration of manufacturing companies in Korea, we develop various kinds of

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collaboration systems every year. We first applied them into injection-mold industry as it is considered to deal with the root and core parts for making products. From the statistics in 2006, five different collaboration systems were developed and 239 companies used them as illustrated in Figure 1.

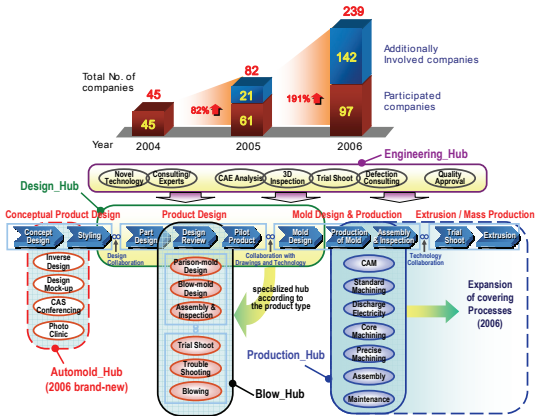

Figure 1: Composition of collaboration systems and users.

Users got really beneficial influences by using collaboration systems in terms of productivity, profit, and product quality. Based on such results, we decided to extend the usage of our systems to other injection-mold companies or other industrial sections such as press-mold(even though it is still in mold industry), automobile, machinery, and electronics as depicted in Figure 2. To cover all industrial divisions, however, we need to develop and deploy novel technologies because of several limitations as illustrated in Figure 2.

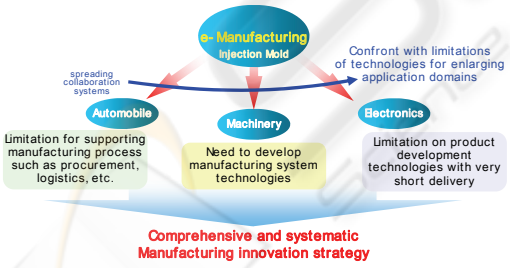

Figure 2: Limitations in propagating collaboration system.

We also need to define and implement common platforms in order to extend systems previously developed to other users. Specifically speaking, we have to modularize basic function modules for common usage and to leave some parts as customizing areas for satisfying new users, thereby rapid and easy development of a collaboration system is possible. For this, we define 3-layer architecture including presentation, business, and data layers, and develop collaboration systems.

2 i-MANUFACTURING

i-Manufacturing is a government-led project that combines IT to conventional manufacturing and design to production, where *i* in *i*-Manufacturing contains meanings of *i*nformation, *i*ntelligence, and *i*nnovation. The project offers support to manufacturing companies by strengthening the competitiveness of the Korean manufacturing industry and nurturing new innovation. Before launching the *i*-Manufacturing project in 2007, there was a pilot project referred to as e-Manufacturing. It was started from 2004 by both central and regional governments to build up infrastructure promoting collaboration and technology development among companies. For realization of the manufacturing innovation, we reorganize the pilot project to more comprehensive one by adding other innovation categories. That is *i*-Manufacturing project. The core strategy of the project is referred to as a *middle-updown innovation*. It means both bottom-up and top-down innovations occur together by intensifying competitiveness of middle sized companies. By doing so, they lead improvement of technical power of small sized companies by spreading out high-level technologies and knowledge. They also have a role to strengthen the relations between small and big sized companies as a mediator between them.

Four main categories are included in the *i*-Manufacturing project such as the development of collaborative infrastructure, innovation in both manufacturing process and system, and innovation for developing brand-new products as illustrated in Figure 3. Each category will be conducted as sub-projects of the *i*-Manufacturing step by step, and the project will be continued to 2015.

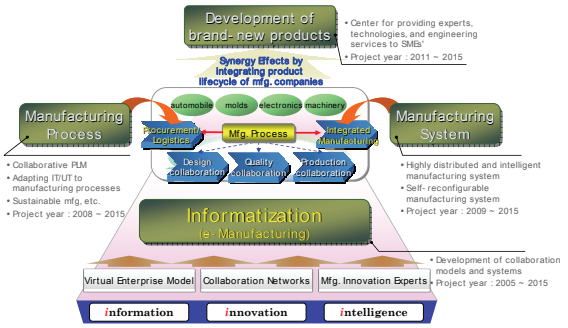

Figure 3: Innovation categories in *i*-Manufacturing.

3 COLLABORATION SYSTEMS

3.1 System Architecture

The collaboration systems have been independently implemented according to their specific objectives. As illustrated in Figure 1, we have developed *Design_Hub*, *Production_Hub*, *Blow_Hub*, *Engineering_Hub* and *Automold_Hub* until 2006. All functions of the collaboration systems are provided as a type of ASP (application service provider) so that users can use them at anytime and anywhere. For more details about collaboration systems, refer to Ryu et al. 2007a and Ryu et al. 2007b.

The architecture of collaboration systems includes 3 layers – presentation, business, and data. Note that the business layer consists of function and service layers, and data layer includes OS, storage and developer layers as illustrated in Figure 4.

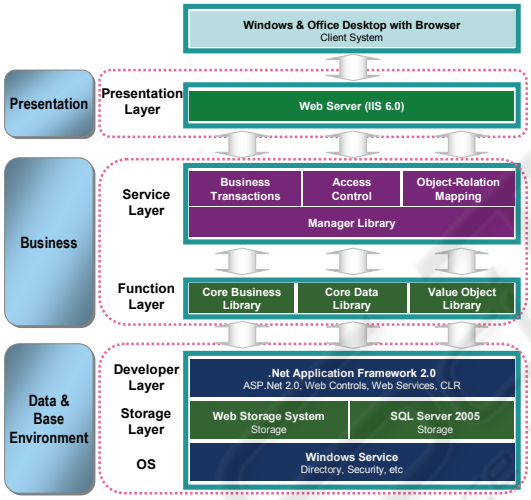

Figure 4: System architecture of collaboration systems.

3.2 Modularization of Function Modules

In order to apply collaboration systems already developed into other companies as well as industrial sections, it is very useful to implement main functions into modules. This is because several functions are essentially used by almost companies, but some of them are not necessary on the other hand. Following this idea, we now can develop a new system very quickly by assembling function modules previously developed like assembling LEGO blocks. Additional implementations are also needed if we cannot find the proper functions that customers want.

To define and implement basic function modules, we first gather customers needs (VoC; Voice of Customers) and define services they want after analyzing VoC as depicted in Figure 5. On the other hand, unit function libraries are developed by integrating unit classes and connecting API. In order to realize services, we find proper function libraries and merge them into a block, referred to as a unit technology library. Then we are now ready to develop a new collaboration system. After building up specific user interface, we just connect several technology libraries.

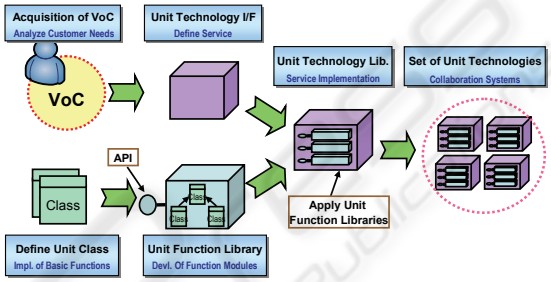

Figure 5: Unit function modules and technology libraries.

From the view of aforementioned 3 layers, we have integrated database and file repository in the data layer as illustrated in Figure 6. There are many kinds of function libraries in the function layers and technology libraries in the service layer. In the presentation layer, several UIs are implemented according to business models of collaboration systems. For example, if we have 10 collaboration systems, then we already have 10 different basic UIs. Every basic UI can be accommodated by each user if he or she wants to use some functions of the system. Most functions and services are implemented based on .Net application framework 2.0.

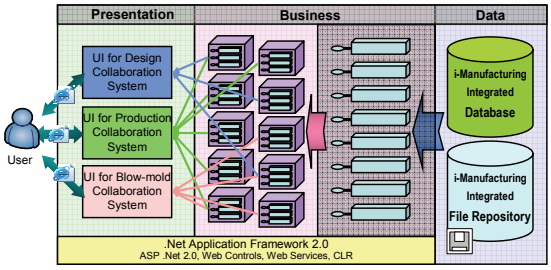

Figure 6: Conceptual framework of collaboration systems.

3.3 Illustration of Functions and Services in a Collaboration System

As described in Section 3.2, a collaboration system consists of many services containing multi-function modules. Among several collaboration systems,

Design_Hub is the system to support collaborative design of molds by providing useful tools including CAD conference, visualizer for 3D CAD drawings, collaborative project manager, etc. As illustrated in Figure 7, users of the *Design_Hub* wanted to use functions such as collaboration supports between customer and company, sales support, efficient data and schedule management, monitoring of production processes in real time, etc. Based on such VoC, we defined many services including customer support, sales support, data management, etc., and developed function modules as depicted in Figure 7.

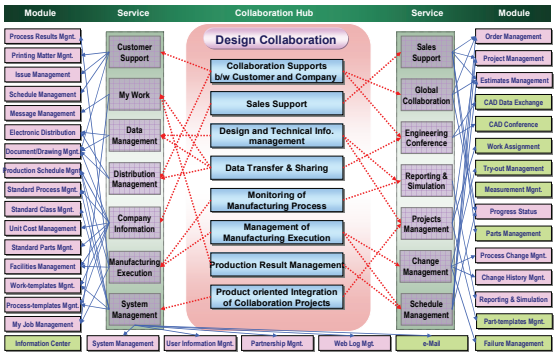

Figure 7: Composition of functions and services in the *Design_Hub*.

According to the user's purpose for using the system, function modules can be reorganized in each service by them. Furthermore, users can choose proper or modify services. Figure 8 shows the screen shot of the page that user can modify UI, services, and functions. By developing flexibly restructurable systems, users can use them with higher satisfaction.

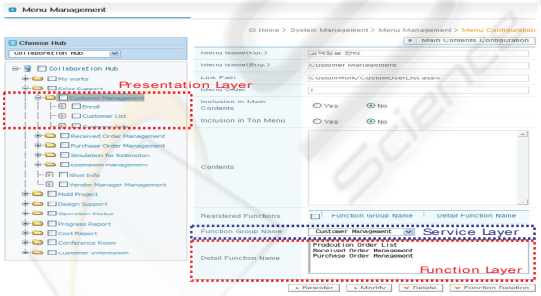

Figure 8: Menu management in collaboration systems.

4 CONCLUSIONS

Led by the Korean government, the *i*-Manufacturing project creates new value for the manufacturing industry through collaboration among companies. Through the project, Korean companies have overcome the limitations of time and space to carry out seamless production with overseas facilities and clients, and manage the entire production process in real-time. By using the system, they can reduce delivery time and enhance product quality. In the case of a conglomerate composed of nine small and medium sized companies using *Production_Hub*, average delivery time for molds has been reduced from 44.7 days in 2004 to 24.6 days in 2006. Their net profit has also increased 369.6% from 270 million won to 1.27 billion.

To widely enlarge the application areas of collaboration systems rapidly and easily, we define a common platform with pre-defined services containing basic function modules. With this system architecture and platform, we are developing two brand-new systems and restructuring *Production_Hub* for new conglomerates.

The easiest way to raise competitiveness and realize manufacturing innovation is to develop and to provide collaboration infrastructure especially for small and medium sized companies. However, lots of novel technologies regarding manufacturing processes and systems also have to be developed and combined with infrastructure to achieve innovation. The *i*-Manufacturing project, we hope, will be the answer of manufacturing innovation in Korea.

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