

# Developing an Interoperable Data Exchange Architecture Centering on Design Integration Services

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**Abstract**—The Web-intermediary transaction platform can provide its users with needed products and services. Also, it can be used to collect, exchange and integrate knowledge. During an intermediary transaction, the product information involves design, production, marketing, as well as consumer feedback. However, it is rather difficult to integrate and share the knowledge coming from different stages of product development. In view of that, the researchers employ the service-oriented architecture (SOA) to configure a design-centric, Internet-mediated and knowledge-integrating platform. All the product samples belonging to different users are incorporated into the platform. Moreover, the intermediary mechanism for product samples serves as the underlying infrastructure which communicates and transmits information. With the help of XML technology, different fields of knowledge covering a wide variety of concepts and relevant features are integrated into the programmed procedure of an Internet-mediated transaction (IMT). Such knowledge is closely connected with the designing, manufacturing and marketing of the product. In consequence, the knowledge accumulated after an IMT will be structurally preserved; later, it will be transmitted between the heterogeneous systems of the users. As the files in the product specifications are used uniformly, the goal of integrating heterogeneous data is achieved.

**Index Terms** — Extensible Markup Language (XML), knowledge-sharing, Internet-mediated transaction (IMT), Web service, service-oriented architecture (SOA), heterogeneous data.\*

## I. INTRODUCTION

Thanks to the widespread popularity of the World Wide Web (WWW), electronic commerce (e-commerce) has flourished rapidly. As the Internet is put into more applications, a larger number of businesses have utilized it to carry out their operations (Amit, & Zott, 2001; Chen, & Liou, 2002). In addition to transcending geographic boundaries, the Internet easily increases intercorporate interactions. Consequently, no organization or individual is confined to the traditional mode, and nor is it necessary to operate only through the physical channel. Wherever one goes, one can effortlessly join the virtual community or market via the Internet (Iyer et al., 2005; Steve, & Amit, 2008). Thus, not only will the demander obtain the needed product and service but the business manager will collect

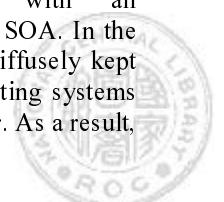
and integrate knowledge effectively (Bowman, 2002; Sugumaran, 2002; Carlsson, 2003; Jennex, & Olfman, 2004; Benbya, & Belbaly, 2005). However, there are two challenging problems waiting to be solved. One is how the demander can efficiently locate the needed product and service; the other is how the supplier can efficiently provide the demander with product information. To address the above problems, the infomediary services have sprung up with the advancement of the Internet, which is a high-capacity, interactive, and affordable medium. No wonder the consumer or business turns to the mode of E-commerce for more business opportunities (Ordanini, & Pol, 2003).

During an Internet-mediated transaction (IMT), the most difficult challenge concerned with knowledge-sharing is how to exchange, integrate, and search product information. To overcome that problem, XML presents itself as an excellent, Internet-oriented, fundamental, and information-integrating technique (W3C, 2006). With the structured data exchange format (SDEF) of XML, the users can effectively establish the format of the product information file during the IMT. Furthermore, with regard to data-searching, the structured XML can ensure the acquisition of precise data and quickly identify the relationship between the files (Robie et al., 1998; Schlieder, & Meuss, 2002; Andrew, 2004; Kamps et al., 2006; Marcos et al., 2009; Kim, & Yoo, 2009; Lampathaki et al., 2009; Lu et al., 2009). As for the practical use of XML in various fields, there are innumerable cases in existence. Choi, et al. (2010) proposed using the standard data format of XML to define the product, process, and resource (PPR) information. In addition, they developed the product lifecycle management (PLM) integrator, which supports PPR information exchanges between commercial heterogeneous PLM systems and other systems. Hu, et al. (2010) proposed a Web-based intelligent system architecture for collaborative product development (CPD). The system is built upon service-oriented architecture (SOA), which is a cost-effective infrastructure for handling the shared resources of the distributed heterogeneous systems. To cope with the problem of knowledge-sharing, the distributed computing platforms which are integrated by XML prove to be the most viable approach. Fang, et al. (2009) provided real estate agents with an information-integrating platform based on the SOA. In the past, the information about real estates was diffusely kept by different agents. What is worse, the operating systems used by the agents differed from one to another. As a result,

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the user wasted some time in searching for the needed information; likewise, the agent suffered a waste of capital investment. The abovementioned study utilized the standard XML format, integrated the heterogeneous databases of the different agents, combined the real-time real-estate information with Google Map, and transmitted the information to the interested buyers through Web services. In this way, the problem facing the communication between buyer and seller was solved. Gao, et al. (2009) also presented an agent-based intelligent system to support joint production and decision-making in the chemical industry. Besides using the aforesaid system to exchange and share information, agents will collaborate to make timely decisions in dealing with various scenarios. Suárez, et al. (2007) proposed the codification of lexical information in electronic dictionaries, in accordance with a generic and scalable XML scheme model, and its conjunction with linguistic tools for the processing of natural language. Lau, et al. (2002) proposed the design and implementation of an information infrastructure embracing the open standard of XML, together with an intelligent data mining technique which combined On-Line Analysis Process (OLAP) and rule-based reasoning approaches to support knowledge discovery.

The service-oriented architecture (SOA) is a novel concept for constructing the information system architecture. By publicizing the semantics of message passing, it provides a new solution to the integration of heterogeneous systems (Hirschheim et al., 2010; Li et al., 2010; Zhang et al., 2010). Based on Web services technology, the SOA service, as a business process, can be implemented independently or jointly with other services. The concept of Web services increases the reusability and flexibility of the component. Canales, et al. (2007) used an SOA to deploy reusable, accessible, durable and interoperable services. The above cases are also the reason for the researchers to implement our integrated system in the form of an SOA platform.

For the specific purpose, we have managed to construct the SOA and to integrate the design-centric, Internet-mediated, and knowledge-sharing environment, as is shown in figure 1. Through XML, the product

information documents coming from an IMT can be timely transmitted and shared, without being restricted by any heterogeneous system. What's better, the reusability and flexibility of the computer program will be enhanced. In this way, the internal information systems of the users, such as CRM, ERP, PDM and SCM, can incorporate the knowledge generated after the IMT. Later, such knowledge can be shared by means of Web Services; as a result, the goal of knowledge-sharing is achieved and the competitive edge is also improved.

## II. THE DEVELOPMENT STRATEGY AND ORIENTATION OF THE DESIGN INDUSTRY

Industrial design is a creative, process-oriented activity which covers product strategy, market & consumer research, appearance design, mechanism & engineering design, model design, production, and marketing, with all of them forming a comprehensive industrial design process (CEPD, 2004). Restricted by the small scale, insufficient manpower, and inadequate database, traditional industrial design companies can focus on only the middle stage, namely, product design ranging from appearance design to model design. Regrettably, such a practice fails to integrate the early stage (product strategy and market research) and the late stage (production and marketing), resulting in disparity between the finalized product design and the market demand. To cope with such a troubling trend, some businesses establish their own design department and design companies able to provide complete services are increasingly needed. Hence, nowadays more and more design companies are gradually expanding their services into both the early stage (market research and product analysis) and the late stage (mold development and component production) of product development. In this way, the formerly-ignored services combined with the existing ones (including appearance design, mechanism design, and model making) will form a complete network of design services and in turn increase the added value of the services. However, both the early and late stages of design services require a vast, supporting database which

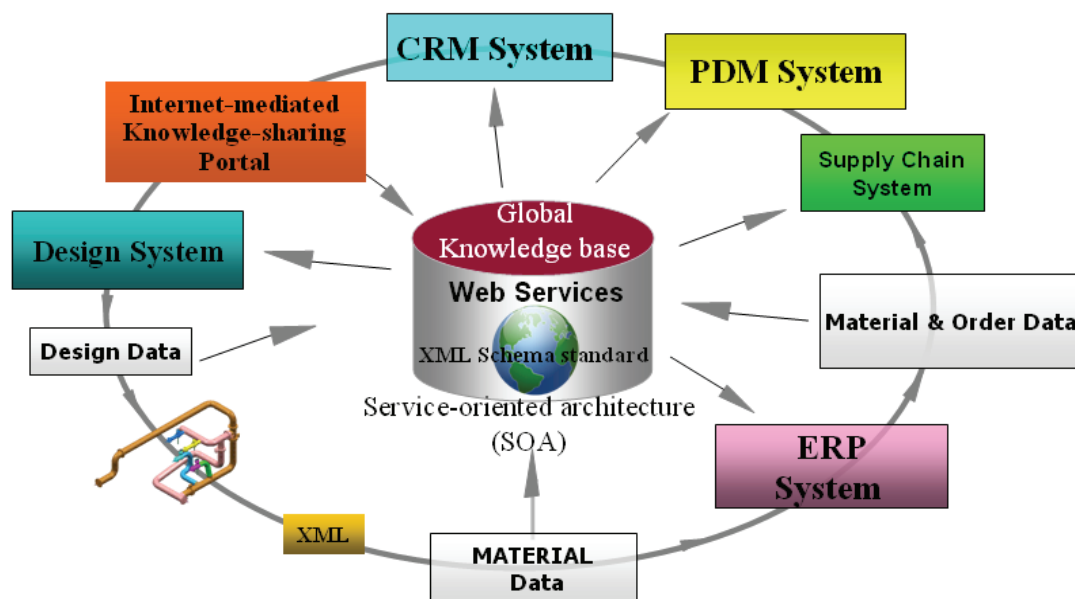


Figure 1. The SOA integrating the heterogeneous systems



is managed by experienced engineers to achieve the maximum profit. To be sure, this task poses a big challenge for many newly-started design companies. Evidently, industrial design is no longer limited to the opening or finishing stage of the development process, nor is it simply connected with art, technology, creativity, engineering, and solving technical problems. On the contrary, it should also involve the diversified and more professional combination. Both the front end (i.e., consumer demand, innovative research and development, and creative design) and the back end of industrial design (i.e., mechanism & engineering design, molding technology, optimum production technology, and R&D design, even together with the planning process, strategic aspects, and marketing aspects) should be taken into careful consideration. Taken as a whole, the R&D design of a product is by no means a simple or single technical service; instead, it involves supplying goods, innovation, service, technology, engineering, customer communication, optimum customer satisfaction, the brand image and, more importantly, shaping the overall corporate image. All these are closely related to industrial design services.

At present, confronted with global competition and challenges, businesses all over the world have slowly paid reasonable attention to the knowledge industry. Utilizing knowledge to create added value as well as providing hardware/software integration services has become the core project undertaken by all countries worldwide. Therefore, for current industrial design services to become highly competitive, a knowledge platform must be established to realize “knowledge management and knowledge sharing”, allowing the design industry and manufacturing industry to be blended into a complete supply chain (Luh, & Lin, 2007). Only by merging the concept, design, rapid prototyping, and molding tools into a consistent R&D process, will the competitive, service-oriented industrial design industry be materialized (Chen et al., 2004).

### III. ESTABLISHING THE DESIGN INTEGRATION SERVICES NETWORK

Industrial design covers a wide variety of products, which is illustrated in the process of product development. As a business engages itself in developing a new product, it follows a strategy aimed at adapting to both the environment and the market. An excellent process of product development enables the business to foresee the vision of the successful product (Sethi, 2000). Throughout the process, design plays a decisive role: first, the customer has a demand for a certain product, then the manufacturer and the design firm enter into close cooperation in the course of development and production, and finally the finished product is distributed by the retailer to the consumer, as is shown in figure 1.

The way in which traditional businesses collaborate with each other is linear. Under such circumstances, it is almost impossible for one role to jump over the intermediary role and to contact another role directly. On the other hand, the advantage of the Internet lies in the fact that it can flatten the value chain and convert the vertical relationship of the roles into the horizontal relationship. In other words, with the features of the Internet, the roles involved can conduct every kind of transaction imaginable. Therefore, Wu (2007) proposed employing the IMT to satisfy the service demands of different roles. His research is divided into two main parts. In the first part, interviews are conducted which are directed towards the central roles of the design services, i.e., design firms and manufacturers. The interviewed companies engage in two types of business: original equipment manufacturer (OEM) or original design manufacturer (ODM) and own brand manufacturer (OBM). Moreover, the companies focus on the industrial design, establish their own design/R&D department, have a general idea of the online services, and show some interest in the aforesaid services. It is concluded from the interviews that

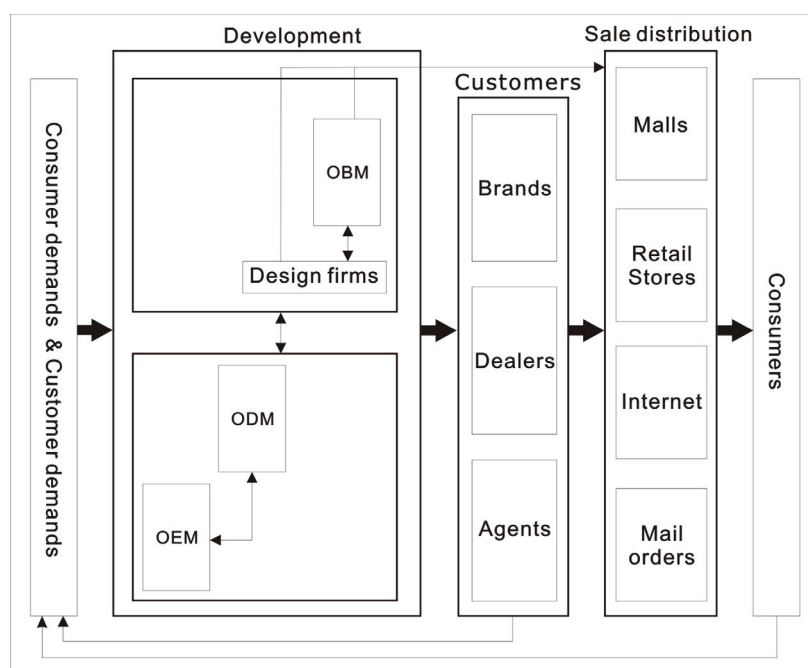


Figure 2. The workflow model of product development in industrial design



there are strong demands for five kinds of Internet-mediated services, namely, intermediary services for design projects, interactive communication services, design information services, advertisement or design exhibition services, and product/concept marketing services (Cheng et al., 2009). In the second part of Wu's research, the management modes of the online design mediators are analyzed. It is indicated that the websites focusing on the industrial design have developed various management modes up to now. For instance, the discussion group can be found whose main concern is to exchange design information. Likewise, the entry website dedicates itself to providing services for interested designers. At present, there are corporate intermediaries who supply some of their services or information through the Internet. Those websites are roughly classified into three groups engaging in the following jobs respectively: providing design information (i.e., Core 77 Design Magazine, <http://www.core77.com/blog/>, and Design Engine, <http://www.designenginearchitects.com/>), offering IMT services (i.e., K68 Network, <http://www.k68.cn/>, and Heyshow Network, <http://www.heyshow.com/>), or functioning as virtual communities (VCs) (i.e., Design Fascination, <http://twdesign.net/>, and Australian Infront Forums, <http://forums.australianinfront.com.au/>).

Integrating the findings presented in the above two parts, Wu (2007) proposed a model of the design-centric and Internet-mediated services, as is shown in figure 3. Wu's research model is adopted as the groundwork of our proposed system platform. It is discovered by the research model that the multilateral roles have a definite demand for the synchronization, share, integration, and exchange of

information. Therefore, while the system platform is being developed, the concept of knowledge-sharing must be incorporated in order to integrate the information resulting from the IMT. By doing so, the performance and value of the system platform will be enhanced.

*A. Knowledge-sharing in intermediary services*

Internet-mediated services are intended to satisfy the needs of the parties involved. The matched pairs in the e-commerce environment can be classified into the following types: business-to-business (B2B), business-to-consumer (B2C), consumer-to-consumer (C2C), and consumer-to-business (C2B). A large number of customers exist in the B2B type through the matching of business partners and also in the B2C type through the sale of products. Since most of the design companies and manufacturers are small and medium enterprises (SMEs), they can conduct B2B only, for the outlets are all controlled by the large-volume buyers. However, such limitations can be eliminated with the help of the Internet and it is possible for the SMEs to conduct more types of business. In addition to receiving B2B intermediary services, SMEs which previously had more difficulty in entering the market can reverse the trend by means of C2C, i.e., selling small quantities of products directly to consumers. Likewise, by means of C2B, customers can sell some ideas or innovations to SMEs so that the latter may enhance their competitive edge. Indeed, the unique Internet has broken through the barrier presented by the traditional mode of business, causing information to be shared by more distinct demanders (via B2B, B2C, C2C, C2B, etc.) By exchanging information, products and values, the participants obtain

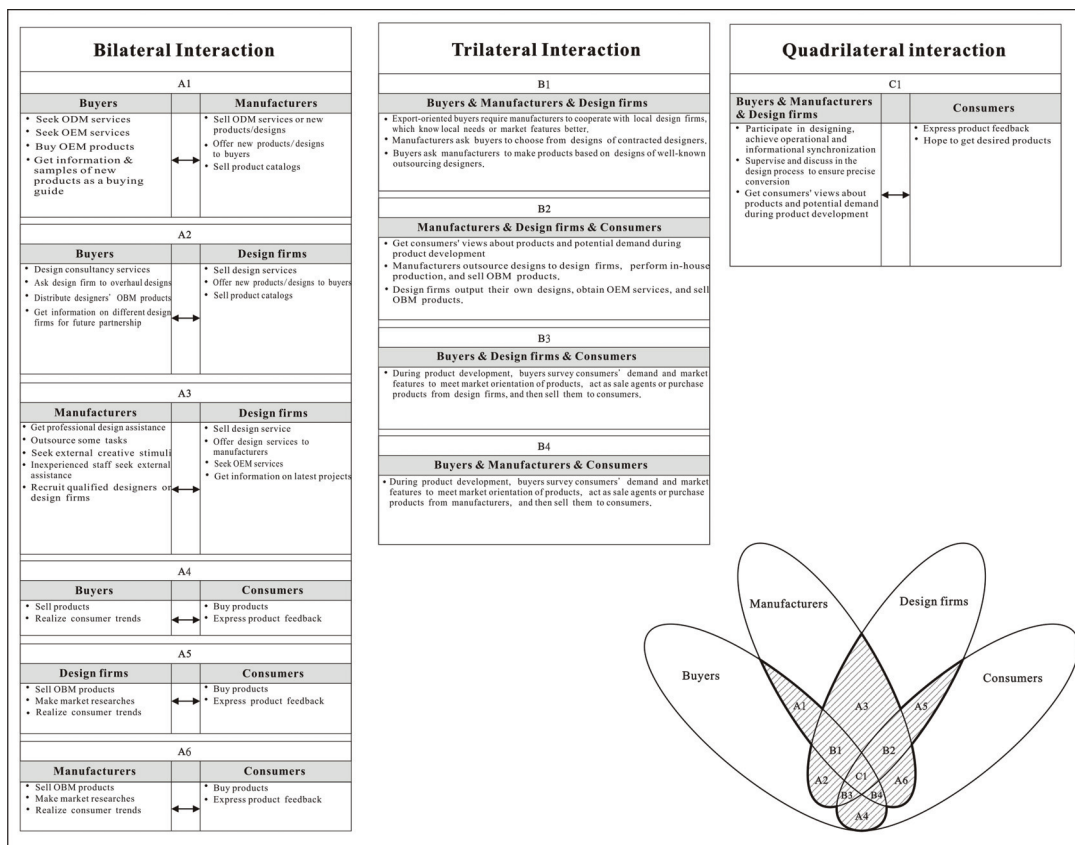


Figure 3. The demand model of design-centric and Internet-mediated services (Wu 2007)



the services needed. Above all, the foremost goal is to help them to better understand one another's specific knowledge and services. Afterwards, they can successfully conduct the transaction as a buyer or seller. By offering professional services, the Internet-based infomediary can provide the buyer/seller with the needed services and information as well as satisfy the consumer's demands. As a result, our knowledge-sharing and Internet-mediated platform is developed as the basic service framework.

Under close examination, it is discovered that all the users of the virtual platform are extremely eager to get their problems solved. Observed from such a viewpoint, an Internet-mediated transaction (IMT) is undoubtedly the source of accumulated knowledge, regardless of how the transaction is matched. The reason is that, once the transaction is successfully matched, both parties may obtain from each other some professional or innovative knowledge in addition to financial benefits. Consequently, the foregoing concept reasonably leads to the following conclusion: establishing a design-centric, Internet-mediated, knowledge-sharing, and accessible environment will surely satisfy and attract all the interested users as well as realize the ultimate goal of knowledge-sharing.

*B. The knowledge-sharing mode of the SOA*

The Internet-mediated, and knowledge-sharing model proposed by this research can integrate the product information offered by all the users (design firms, manufacturers, buyers, and consumers) during an IMT. Additionally, it is hoped that the product information resulting from the IMT can be reused and that the heterogeneous information in the different systems can be effectively integrated. Employing the open standard to communicate, the SOA integrates the systems flexibly, is compatible with the development modes of all software languages, and functions as the solution to restructuring the

system and integrating the heterogeneous platforms. Therefore, on the basis of XML and Web Services, the SOA-based and knowledge-sharing mode is proposed to solve the problems concerning the communication protocol and data exchange between heterogeneous systems, as is shown in figure 4. With Web Services included as chief components, the SOA presents the functions needed by the users in the form of multiple services. By means of clearly-specified description of the services and the comprehensible definition of I/O (Input/Output), the SOA provides services for the users who just call or combine them into different services. With these Web Services, the users are enabled to integrate heterogeneous information and share knowledge with each other.

IV. TECHNICAL BASIS

In conventional knowledge-based systems, knowledge is represented in the form of if-then rules, which are reasoned by inference engines and applied to problem-solving. Most of such systems (e.g., expert systems) suffer from several problems, such as insufficient understanding of knowledge-based systems, expensive knowledge acquisition, and emphasis on complete but narrow solutions (Swartout, 1996). However, as the Internet connects the worldwide computing resources to each other, the need to capture various fields of knowledge becomes crystal-clear. For that reason, nowadays new encoding methods for such knowledge are actively researched and applied. This paper introduces the knowledge-sharing system based on the SOA technology as follows.

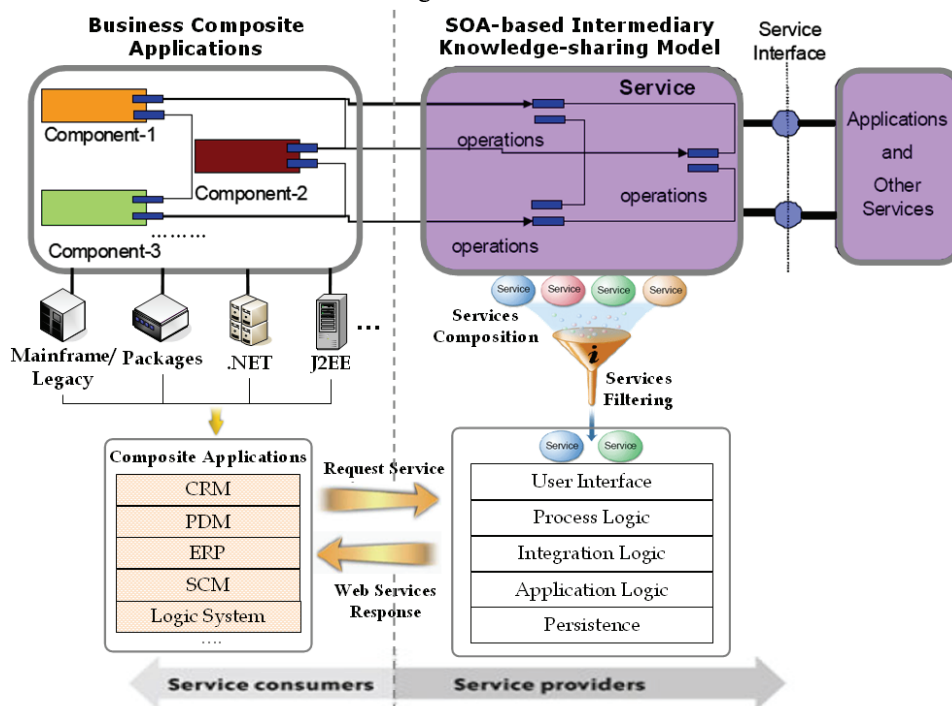


Figure 4. The knowledge-sharing mode of the service-oriented architecture



### A. XML

In the broadest sense, interoperability can be defined in the broadest sense as the ability of software and hardware on different machines from different vendors to share data (webopedia, 2006) and the ability of two or more systems or components to exchange information and to use the information that has been exchanged (IEEE, 1991). Interoperability is typically ensured by adherence to a set of common standards. Several interrelated types of standards, such as communication, request, data format and content, must be followed to guarantee interoperability between systems.

The term information interoperability indicates that the data generated by one system can be used by another, without regard to the request or communication mechanism (Benthall et al., 2002, 2003). It may be a direct connection, if both systems use the same data format and content. Alternatively, the systems may be connected through a mediator, which transforms the data format and content. XML has emerged as the extensible, flexible data format standard (Tong et al., 2006). XML stands for Extensible Mark-up Language, often mentioned together with Web technology and HTML. Yet, it is important to remember that XML is basically a way to describe and structure data. It can be used in a great variety of applications, not only in Web applications. Establishing the standard XML schemas should improve data-exchanging to protect earlier investments in the in-house information systems. Its standard is intended to serialize (or persistently store) the objects of an object-oriented database into a neutral format that may be communicated between applications. There is a great advantage in using XML as the information syntax; namely, there have been many tools of parsing, querying, transformation, validation, and presentation for the support of XML all over the IT industry. Applying the XML standard to the online knowledge-sharing mechanism leads to a data-centric and Internet-mediated environment. Such an environment makes it possible to facilitate some applications, translate the product data, and provide reasonable, XML-based model configurations (W3C, 2006).

### B. Web services

Regardless of compatibility and security problems, Web services bypass firewalls and proxy servers; moreover, Web service interfaces encourage the loose coupling between applications. Therefore, Web services technology promises to make it significantly easier and cheaper than before to integrate applications both within a company and between different companies (Chen et al., 2010). Loose coupling means that applications can be implemented on different platforms and operating systems, and that the implementations can readily be changed without affecting the interfaces. SOAP is a simple XML-based protocol to let applications exchange information with XML Web Services over HTTP. Supported by all Internet browsers and servers, SOAP provides a way to communicate between applications running on different operating systems, with different technologies and programming languages (Chester, 2001; Vinoski, 2002; Lee, & Park, 2003; Ibach, & Horbank, 2005; Zhang, 2005; Qiao et al.,

2006; Phaithoonbuathong et al., 2010). To ensure an organization's swift response to design requirements, the information flow between the IT systems responsible for these informational operations must be streamlined. This includes the organization's own IT systems as well as those of its partners. It is the task of information-integrating to automate this information flow optimally so as to modernize operations.

### C. Web services description language

The Web services description language (WSDL) is an XML format for describing network services as a set of endpoints which operate on messages containing either document-oriented or procedure-oriented information. Described abstractly, the operations and messages strictly follow a concrete network protocol and message format to define an endpoint. Related concrete endpoints are combined into abstract endpoints (services). Defined by W3C, the WSDL describes the standard interface format. WSDL is often used in combination with SOAP and XML Schema to provide Web services over the Internet.

### D. Simplified object access protocol

Simplified object access protocol (SOAP) is in the XML-based format to exchange the information in dispersal condition. The birth of SOAP helps to simplify the web server, for the latter can acquire the material from the XML schema without wasting time in formatting the webpage.

SOAP consists of three parts:

- The SOAP envelope construct defines an overall framework for expressing what is in a message, who should deal with it, and whether it is optional or mandatory.
- The SOAP encoding rules define a serialization mechanism that can be used to exchange instances of application-defined data types.
- The SOAP RPC representation defines a convention that can be used to represent remote procedure calls (RPC) and responses.

### E. Universal description, discovery, and integration

Universal description, discovery, and integration (UDDI) is established by W3C and IETF. It is an industrial specification to describe and probe website services. It enables the businesses around the world to publish their services on the Internet. Likewise, businesses can get to know one another and decide to enter into a business agreement. UDDI is founded on the SOAP, XML and HTTP/s protocol.

### F. Service-oriented architecture

Service-oriented architecture (SOA) is a flexible set of design principles used during systems development and integration. A deployed SOA-based architecture will provide a loosely-integrated suite of services that can be used within multiple business domains. SOA is based on the Web services. Different Web services could constitute a particular process for fulfilling the client's requirement.

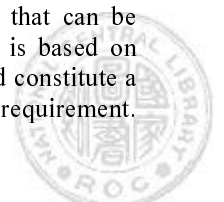


Figure 5 shows the service-oriented architecture (Baglietto et al., 2002; Stojanovic et al., 2004; Jiang, & Willey, 2005, Lee et al., 2005; Uyar et al., 2005).

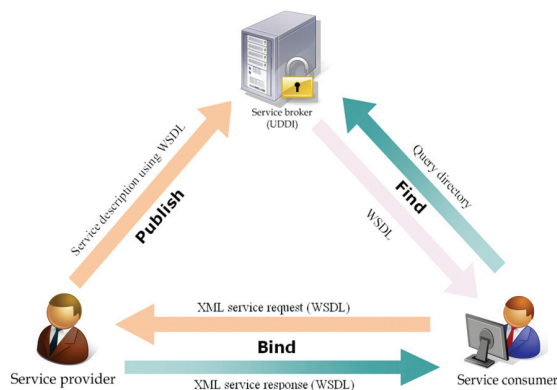


Figure 5. Service-oriented architecture (SOA)

### V. INTEGRATING SYSTEM ARCHITECTURE

The plan for this paper is to build the system that will enable the user to efficiently integrate product information. When employed to render the intermediary services involving any product sample, the platform will put together all the relevant information easily and rapidly. The services are aimed to help the user to manage, share, and integrate product information effectively. The proposed system is superior to other online counterparts in that the latter provide nothing more than primitive transaction-matching procedures, like outsourced projects and product procurement. Furthermore, the latter do not take into consideration the potential benefits of product information.

#### A. System architecture

The whole system configuration is mainly founded on an identical XML document which is transmitted throughout the different stages of product development. For instance, Rezayat's report (2000) proposed a knowledge-based system of product development founded on XML language. Relying on the detailed definition and Internet broadcast capability of XML technology, the system can timely deliver right data in the right format to right people. The same spirit can also be found in the knowledge-sharing platform suggested by Wong and Sriram (1993), which distributes professional expertise to interested people via the Web-based architecture. In addition, Yoo and Kim (2002) presented a similar Web-based knowledge management system, which would enable all virtual businesses, whether business-oriented or engineering-oriented, to share among themselves the product information generated by their application systems. Wu and Shaw (2004) suggested that product information management (PIM) should incorporate XML technology to develop a knowledge management system which would integrate the complete ship-designing process (Rando, 2001; Choi et al., 2003; Taa et al., 2004; Briggs et al., 2005; Shaw et al., 2006). Namely, during the ship-building process, XML technology should be used to integrate ship specifications, including outline specifications and full specifications, which will be applied to ship-designing. Therefore, this research will also adopt the XML-formatted structure to connect the contents of knowledge flow. Furthermore, the concept of XML data mapping is incorporated so that the process of file production can be connected smoothly and the repetitive data can be reused and shared (Collins et al., 2002; Stylus, 2004). Finally, the whole set of product information is rendered complete and accurate and thus a knowledge-sharing architecture for product specifications is established and applied to the IMT process. Based on the SOA and its standard, which are described in Section 4, the researchers have constructed a design-centric, Internet-mediated, and information-integrating platform. Figure 6 shows how to use the services of this platform and to design it.

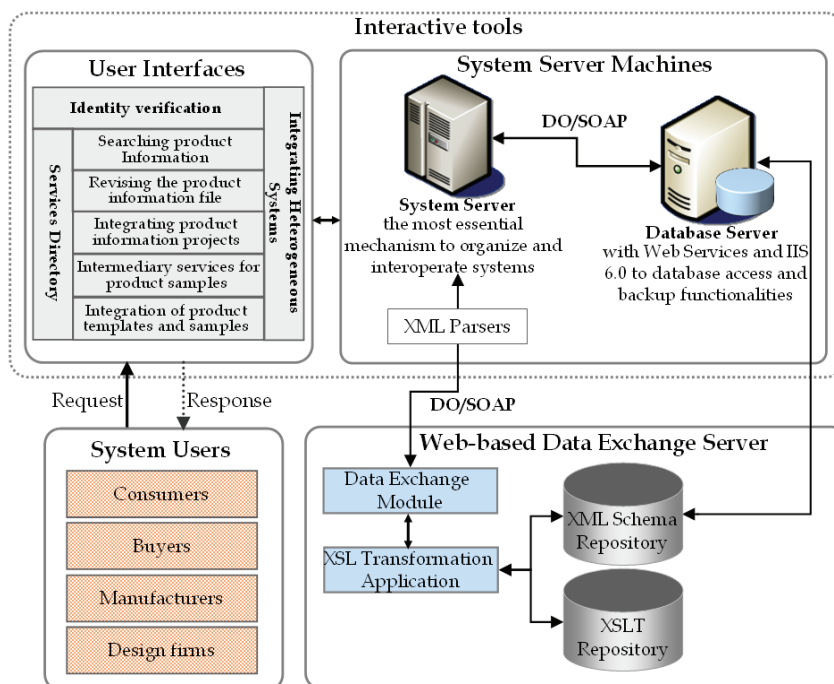


Figure 6. Architecture of the integrating system

### B. System functions

The services provided by the proposed system mainly focus on the management, search, share, exchange and integration of product information, as is explained below.

- Integration of product templates and samples: this service is intended to standardize and integrate the product information management (PIM) so that every product may have a standard structure, i.e., the product template. With the standard established, various types of information on product samples will be output rapidly in accordance with their different specifications and attributes. The designer, the manufacturer, or the buyer who uses this platform can put the service into diverse uses. For example, the designer can work out the sample of the product while the buyer can develop the marketing sample. Of course, the purpose of the platform will vary with the matched roles and their individual business.
- Intermediary services for product samples: based on the established product samples, the users can then engage in intermediary transactions. For instance, the supplier can instantly provide the demander with the compiled databases of the product samples. In the same way, the demander can search out different samples, following the proper procedures of the intermediary transaction. In other words, the system platform functions as the basic tool which exchanges and integrates information.
- Integrating product information projects: intermediary services for product samples are conducted on the basis of the same product templates. In consequence, all the information arising from an intermediary transaction can be integrated. This service is meant to manage the product information with the same project number after a successful Internet-mediated transaction. Certainly, the informational richness of a product project depends on the number of the matched roles. The participant roles will involve quadrilateral parties at most, namely, the designer, manufacturer, buyer and consumer.
- Revising the product information file: if product information is wrongly changed, the integrity of the product will be negatively affected. Therefore, the revision of the information must be professionally managed. This service is applied to two fields. First, it is concerned with the management of product samples. The user can define the tags necessary to the product samples. As the XML tags are highly definable, some of the fixed parameters concerning the specifications can be managed efficiently and uniformly. If necessary, only the values in the defined tag need to be changed and the overall information file will be revised accordingly. As the product information may contain the same defined values, uniform management will lower the risk of false revision. Secondly, the service can apply to the revision of the intermediary project. If the information in the matched project needs to be revised, the source of the information must be traced out; namely, the participant role who supplies the information must be identified. Compared with managing the user's own product sample, managing the intermediary project is of greater significance. If error should happen, the liability involving the intermediary

transaction would inevitably arise. However, with this service implemented, the values exclusively defined by XML tags must be adopted so that the consistency of the product information file may be secured.

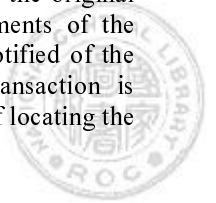
- Searching product information: the service can satisfy two needs. First, the user can rapidly locate the suitable partner by browsing the product samples. Second, the user can refer to the integrated product information after the intermediary transaction involving the sample is successfully concluded. For example, such information may be applied to the design, manufacture or marketing of the product.
- Integrating heterogeneous systems: this service is founded on the bottom-tier product files that are presented in the XML format. Consequently, it is really convenient for the user to communicate with the heterogeneous information systems and to integrate their information. Besides, if necessary, the user can integrate the services available on the Internet, such as the product material services offered by the proposed platform and the cost analysis provided by the ERP system. In other words, the user is not confined to a specific system or platform, and thus openness is truly achieved.

## VI. IMPLEMENTATION

This research aims to help the users exchange information and share knowledge during an Internet-mediated transaction (IMT). Therefore, we employ XML to exchange and integrate product information. In the meantime, the Web services function as the infrastructure which communicates and transmits information. Ultimately, based on the service-oriented architecture (SOA), the Internet-mediated and knowledge-sharing system is constructed. Drawing on the services provided by the system platform under discussion, the user can efficiently integrate the information originating from various heterogeneous systems.

The bicycle is taken as the experimental model to illustrate how the participant roles employ the services provided by the proposed platform and successfully accomplish the sharing and integrating of information.

- Integrating the information flow after the intermediary transaction of product samples: in order to integrate the product information flow of an Internet-mediated transaction (IMT), XML technology is adopted as the basic tool of informational exchange throughout the process. The exemplar case involves the detailed procedure of a quadrilateral intermediary transaction. In the beginning, the transaction between the buyer and the manufacturer takes place. As Figure 7 shows, the manufacturer finishes compiling the bicycle samples through the sample management service provided by the proposed platform. Then the buyer browses all the samples and discovers the capabilities of different manufacturers, which sets the guideline for the bulk buy in later days. After the buyer decides on the sample, he/she desires to add some extra design to the original product so that it may meet the requirements of the target market. Once the manufacturer is notified of the desirable design, another intermediary transaction is published on the platform for the purpose of locating the



competent designer. With the aid of the system platform, the chosen designer will acquire the information about the mediated bicycle sample originally approved by both the manufacturer and the buyer. After redesigning the product, the designer will transfer the revised information to the manufacturer. At this point, the manufacturer has to revise the production information about the bicycle sample in compliance with the designer's information. Eventually, the revised information and the redesigned sample will be given to the buyer. Based on the new sample, the buyer can

devise marketing strategy and start to sell the product to the consumer via the platform. In the quadrilateral transaction, the consumer is the last role that is responsible for product feedback. Figure 8 shows the final result of integrated information after the quadrilateral transaction is successfully conducted. Founded on the same product templates, the product information generated by the different stages of the intermediary transaction is integrated.

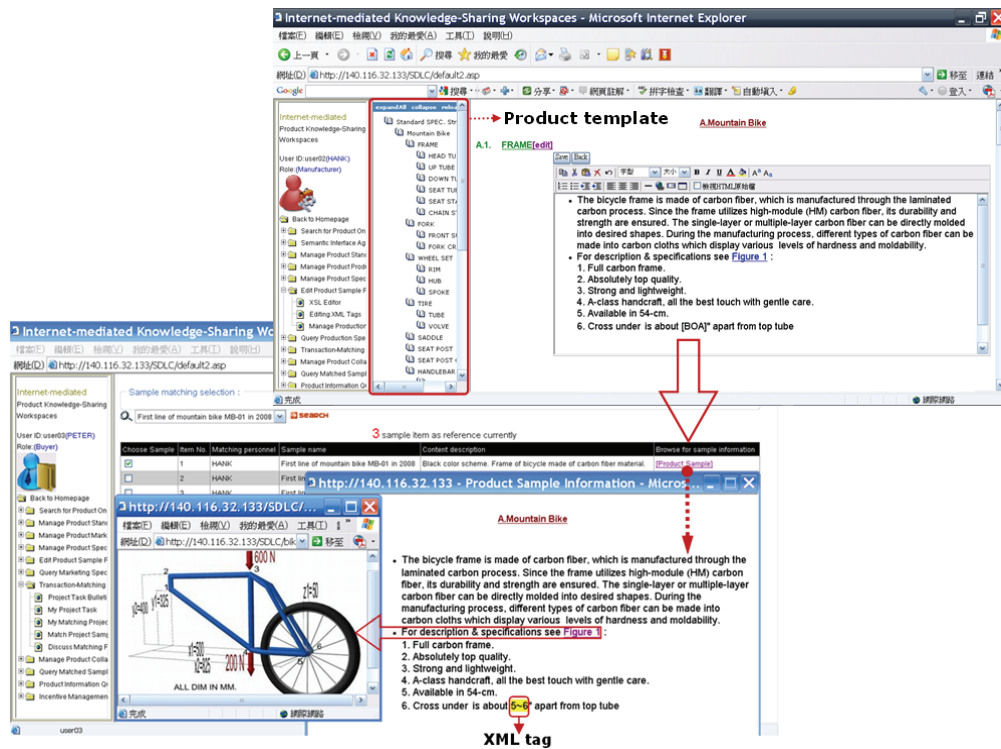


Figure 7. The intermediary transaction of a product sample between manufacturer and buyer

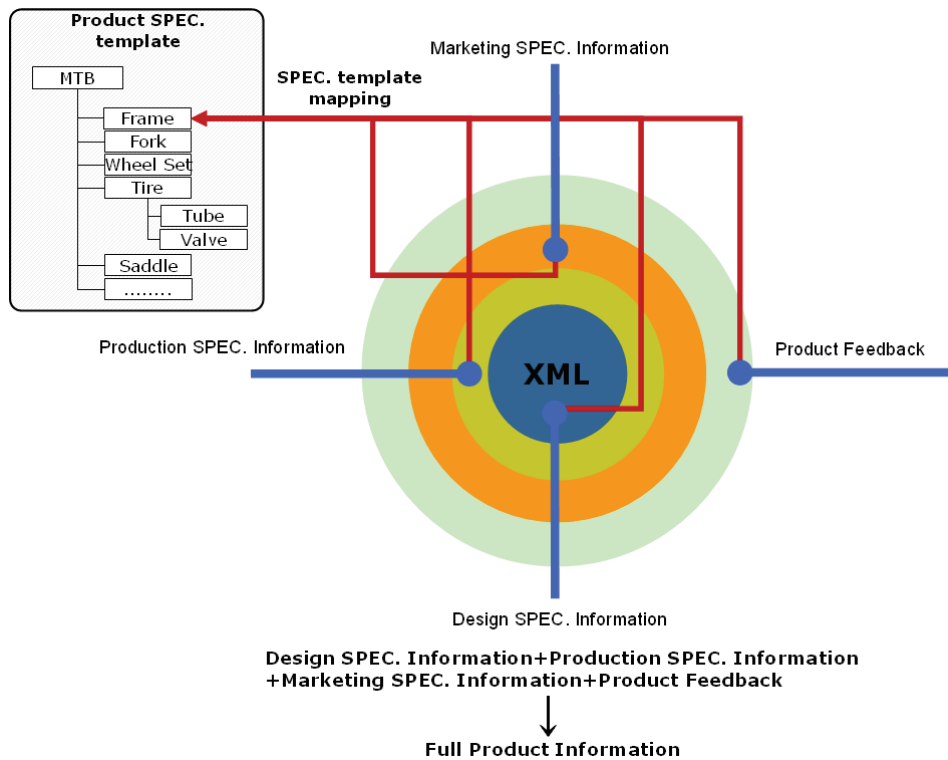


Figure 8. The structure of integrated product information



- Integrating the revision procedure of product information files: during an intermediary transaction, product information will often be revised. The quadrilateral transaction analyzed by this paper is conducted on the basis of the same sample. As a result, whichever of the participant roles revises the product information, the information file must be kept consistent. Since the XML tags are employed to manage the values, the revision procedure of the product information file is thoroughly integrated as the product sample is traded. Since the participant roles in the quadrilateral transaction jointly define all the XML tags, they must strictly follow the XML Schema specifications from beginning to end. If any of the roles modifies the information, each of the XML tags bearing the same definition will be revised simultaneously. Such a

standardized mode of management ensures the accuracy and consistency of product information throughout the intermediary transaction. Figure 9 shows how the revision procedure of product information is integrated. In addition, Figure 10 illustrates a case where the manufacturer and the designer exchange their ideas during the quadrilateral intermediary transaction. As the designer is asked to revise the parameters of the designed product, the values in the XML tags are directly adjusted. In this way, by the time when the manufacturer is informed of the revised information, the system platform will have already made corresponding changes automatically. When the product is about to be made, whatever information the manufacturer touches will derive from the latest version.

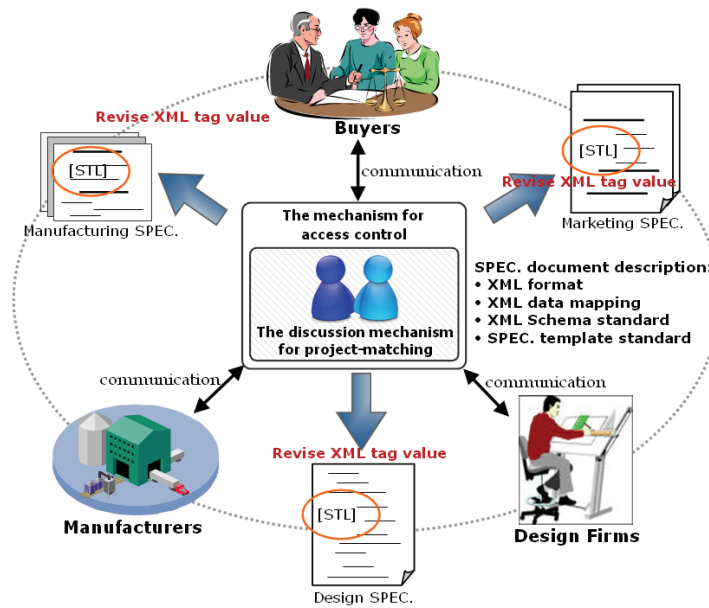


Figure 9. Integrating the revision procedure of product information

Figure 10. The query result of the changelog archive concerning the revised design



- Employing SOA to integrate the Information of heterogeneous systems: the users of the Internet-mediated and knowledge-sharing system come from different parts of the globe. Their operating systems (OS) and internal information systems are not necessarily compatible with one another. With the SOA proposed by this research, they have access to a mode of integrating product information that originates from an IMT. Besides, they can expand and integrate their internal information systems. What they need to do is call the Web services through HTTP, and then they can directly access and integrate the XML files stored in the system. Figure 11 illustrates the SOA information-integrating mode between the client terminal and the service terminal, which is

based on the Web services. Moreover, Figure 12 shows an exemplar case where the bicycle manufacturer employs the ERP system to integrate the material services provided by the Internet-mediated and knowledge-sharing system; as a result, a cost analysis system (CAS) is designed. After the manufacturer compiles the material list involving the product sample on the Internet-mediated platform, the system will output an XML file of the needed materials. The XML file will then be stored and used by the manufacturer’s ERP system. The ERP system will analyze the XML file through Data Mapping and, in accordance with the system fields, calculate the production cost that will be contemplated by the manufacturer.

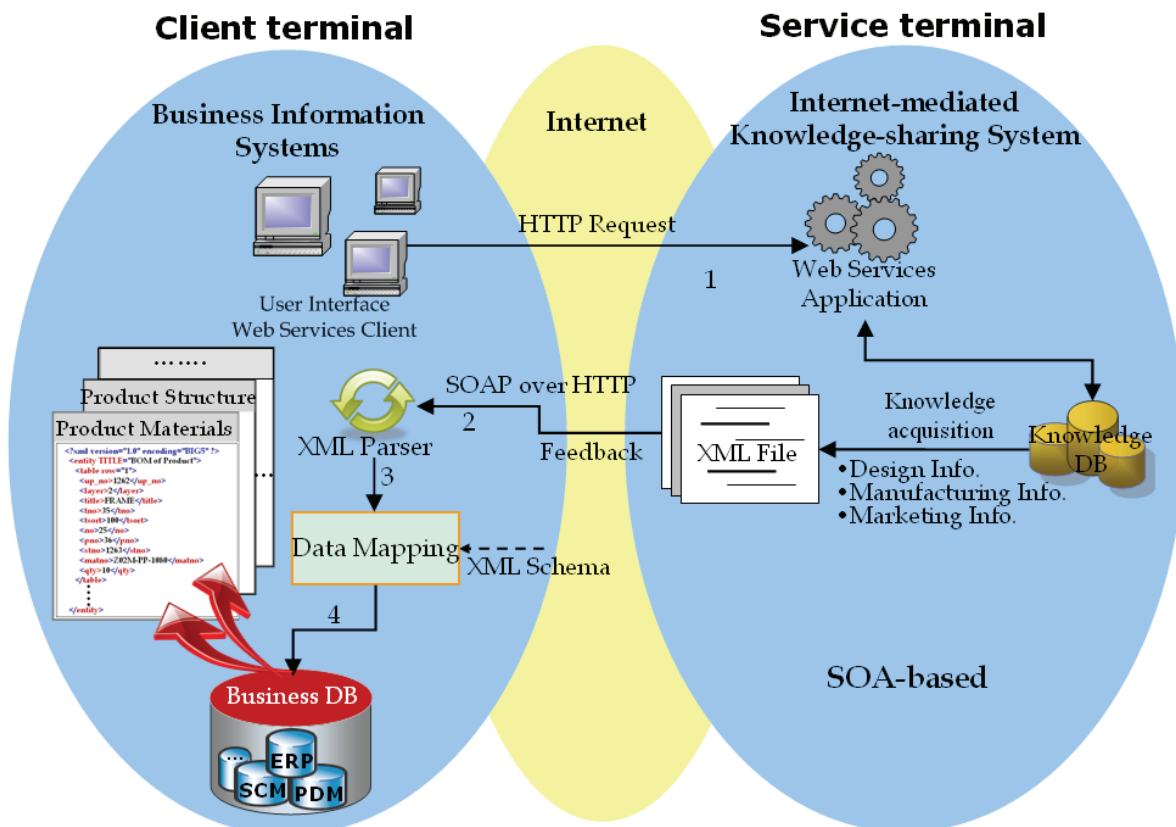


Figure 11. Client terminal calling Web Services to integrate the information at service terminal



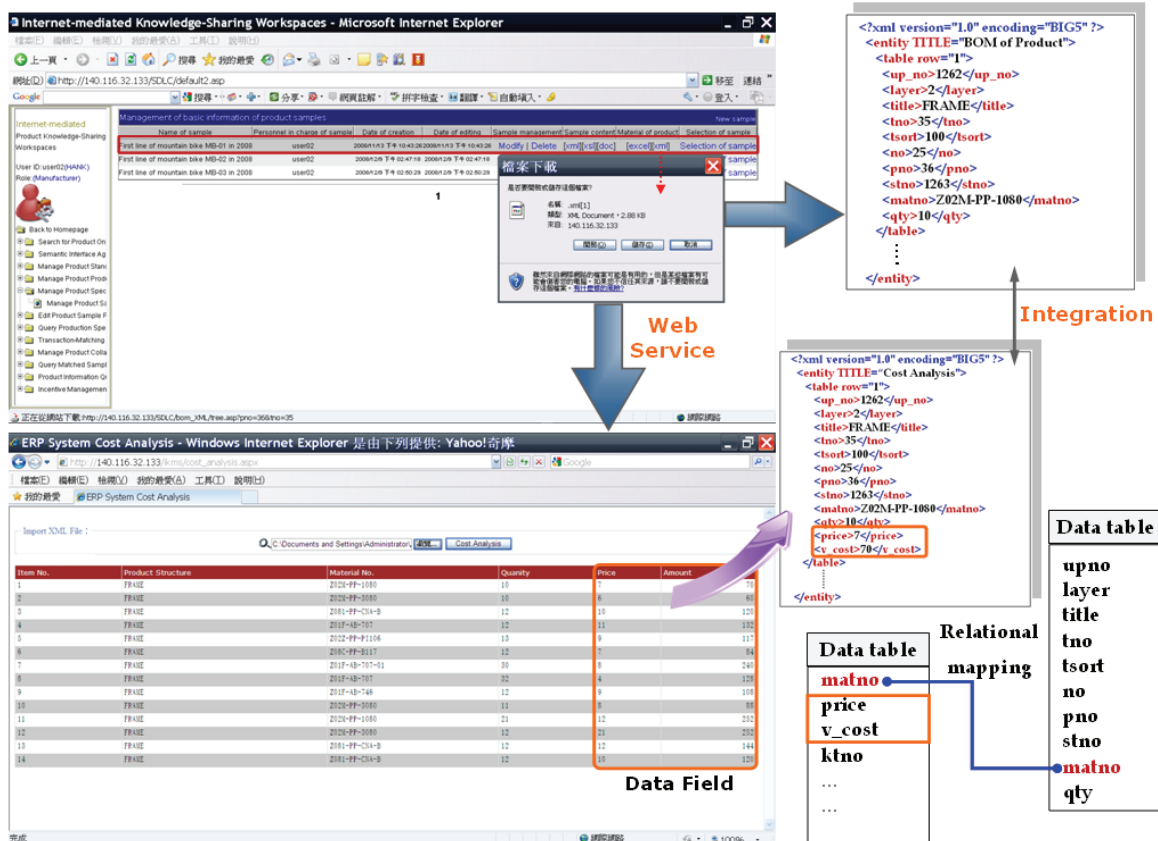


Figure 12. The ERP system making cost analysis and integrating the XML file of the needed materials

VII. CONCLUSION AND FUTURE WORKS

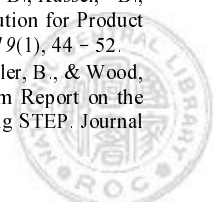
We have applied the concept of knowledge management (KM) and the XML-related technology to the design-oriented and Internet-mediated transaction. Furthermore, we have adopted the standardized XML to develop an SOA-based and information-integrating platform. Our target is to format the product specifications arising from the IMT so that the knowledge documents may be reused. Also, the various fields of knowledge provided by the users of the system platform will be integrated into the workflow of the IMT. Such knowledge includes different concepts and relevant features. In this way, the product database will become richer in a gradual manner. In the end, all the knowledge concerned with the IMT will be structurally preserved. Moreover, such knowledge will be transmitted between the heterogeneous systems of the users. With the SOA-based and knowledge-sharing system, the transmission of information and knowledge on the platform will be accelerated. In the meantime, the knowledge contained therein will be efficiently managed, employed, shared and reused. In brief, an integrated, Internet-mediated, and knowledge-sharing architecture is successfully constructed.

In recent years, the concept of the SOA has gradually attracted the attention of the whole business world. It is a concept built on the application program service architecture, capable of providing a more flexible, effective, and information-integrating environment. Beyond any doubt, with the help of SOA, more and more heterogeneous Internet services can be offered to the user and be used more effectively. Therefore, we propose the ontology-based and service-integrating method in which ontology is used as the model of the presented domain knowledge in the

future. Then the proposed system platform functions as the informediary. Namely, it is responsible for constructing the ontological architecture for domain services covering different fields of knowledge, describing the integrated relationships between the service categories, and defining the necessity or selectivity of the service category. This domain ontology architecture allows the service provider to examine the relationship between his/her registered service and other services. Consequently, drawing on the domain ontology architecture, the service provider can offer the professional and needed services. Similarly, at the request of the demander, the informediary can supply the required information which can be integrated. In this way, the information coming from different domains can be integrated and provided for the demander; ultimately, the system platform will be capable of integration and more applications.

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