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'Do It Yourself (DIY)' E-Business Solutions for Small and Medium Enterprises

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Abstract

The potential benefits and cost of adopting and implementing e-business solutions are both high. They are major attraction and concern for Small and Medium sized Enterprises (SMEs) respectively. If a right tradeoff point is not balanced between the two, a breakthrough progress is unlikely to become true. This paper addresses this very issue by proposing and developing a new approach based on the concept of “portalets” that are used as building blocks to develop e-business solutions with no or varying degree of customization efforts. Portalets are designed following the platform for deriving the software product lines. This “Do It Yourself (DI)” approach significantly reduces the time and effort to an affordable level while capturing the unique business logics into the solutions. In this paper, the necessity, feasibility, and the challenging issues of the proposed DIY e-business approach will be discussed. Case studies will be presented to demonstrate the approach and directions for further work.

Keywords: Enterprise portal, e-business, Do It Yourself (DIY), Digital enterprises, Small Medium Enterprise (SME).

1. Introduction

In recent years, the importance of Internet and World Wide Web (WWW) technologies in manufacturing industries has been rising very rapidly in a global context, the impact of which is deemed most profound ever since the Industrial Revolution (Manufacturing Foresight 2020). The waving interests in the electronic commerce and electronic business (e-commerce / e-business) have spread, from the heartland (product development) to the battlefield (shop floor), of manufacturing enterprises. The technology gradually transforms traditional manufacturing to what can be referred to as Digital Manufacturing (or e-Manufacturing), with more companies using the Internet to get into new markets, increase supply chain efficiency, create new value chains, and increase the efficiency of internal planning and operations.

The number of web applications is ever on the rise, and many practitioners are keen on trying these remote systems through web browsers to support their decision-making activities. Indeed, product design and manufacture professionals will soon be able to benefit from such remote services and supports commercially available on the Internet. The practice and performance of product development and realization are expected to make immense progress. Web applications in product design and manufacture signals the beginning of a new era of the digital manufacturing enterprise.

Although the Internet technology has the potential of enhancing a company’s competitiveness, it has also created a new challenge for the manufacturing industry. Manufacturing companies have just been persuaded to invest in Information Technology (IT) and Information Systems (IS), and have made appropriate changes to accommodate and adapt to these technologies. Now these information systems are becoming legacies even before their capabilities have been fully exploited. Now their roles have to be performed under the Internet and web environment. Hence, manufacturing companies have difficulties in formulating the most appropriate investment strategy in IT and IS under such rapidly changing environment.

In addition, the adoption of the web-based manufacturing approach is not only the decision of the manufacturers. If the customers, suppliers, and the commercial and financial sectors prefer to adopt the web approach, the IT industry will provide various web applications to meet their requirements. Eventually, most decision-support systems (DDS) for the manufacturing industry will also become web-based. They will then have to incorporate some or many of their business activities, decisions, and operations into web applications.

The potential benefits and cost of adopting and implementing e-business solutions are both high. They are major attraction and concern for Small and Medium sized Enterprises (SMEs) respectively. However, SMEs are generally unclear about which approach should be adopted to introducing the e-business solutions (EBS). This paper is in favour of the so-called DIY (Do It Yourself) approach, meaning that SMEs designing, developing, deploying and maintaining their own EBS. The rationale behind this DIY approach is only valid on the assumed emergence of the concept of “portalets” which are ready made constructs to facilitate the EBS design, development, deployment and maintenance. This paper will discusses the necessity and feasibility of the portalet-based DIY approach to EBS.

The remainder of the paper is arranged as follows. Section 2 presents a typical scenario that motivates this research, highlighting the major issues. Section 3 articulates the concept of Digital Enterprises in general and Digital Manufacturing (Enterprises) in particular. Typical approaches to EBS are discussed in Section 4 to highlight the necessity of the proposed approach. Section 5 demonstrates the feasibility of the proposed approach from a number of aspects. The concept of “portalets” is briefly introduced in Section 6. Section 7 focuses on the case study on the “TreeTable” portalets which have been widely in a variety of EBS.

2. Motivating Scenario

Let us first imagine a typical manufacturing enterprise that has enjoyed a rapid business expansion from a much smaller scale two decades ago to the present medium-sized scale. The company was created in Hong Kong as a family business in early 1960s and enjoyed a steady development by serving the US and European markets during 1970s. The company took advantage of the Mainland China' open door policy since early 1980s and moved most of its manufacturing facilities to the Peal River Delta while keeping its headquarter in Hong Kong to accommodate production-related logistic activities such as purchasing, marketing, product development. Because of much cheaper labour and raw materials in Mainland China, relatively fewer competitors and growing US and European markets, the business had enjoyed a rapid development during 1980s and 1990s.

Like most of the other manufacturing enterprises, the company invested in Information Technology and Information Systems (IT/IS) mainly to support operations of routine business processes. The Computer Aided Design and Manufacturing systems have been routinely applied. The company also invested in MRP (Materials Requirements Planning) and a number of hiccups occurred during the implementation and introduction process. Eventually, the company was able to manage a partial success.

These IT solutions were able to support the company to cope with the busy routine business activities until the company recently encountered enormous challenges. Firstly, more competitors have entered even contracting markets. Some of these newcomers have even been better equipped with sophisticated IT solutions and are likely to take competitive advantage in terms of responsiveness. Secondly, the customers are becoming more demanding in terms of quality, price, delivery times, and after-sales supports. Finally, the costs of labour and raw materials are no longer a distinctive advantage because they have increased considerably and other competitors are equally enjoying the same benefits anyway.

The external pressure has changed the way in which the operations were internally managed. In the past, although the schedules were busy, operations were generally executed smoothly with very few major hiccups. However, the current situation can be described as "fire-fighting". Some of the problems become apparent. Firstly, the communications between the Mainland manufacturing plants, the Hong Kong headquarter, and customers/suppliers became a major source of a variety of problems. Although managers and engineers from the headquarter visited the manufacturing plants regularly, the effectiveness and efficiency were not impressive because of long journey. Telephone calls, faxes and email messages have been used to compensate the face-to-face communications. The problem of effectiveness and efficiency of these communication methods was even more serious. Very often, data sent through faxes and sometimes email messages have to be processed again before sensible analyses can be conducted.

Secondly, the new product designs developed at the Hong Kong headquarter tend to have more errors related to downstream business processes. For example, manufacturing difficulties and quality defects exist in many new designs and were not identified promptly. This was because the manufacturing expertise and test labs are located in Mainland China and not readily available and accessible by the Hong Kong development team.

Thirdly, it was evident that the Purchasing and Sales departments spend significantly more time and efforts in clarifying purchase and sales orders with the suppliers and customers respectively. This problem has significantly affected the new product development team because they have to modify their new designs too often to cope with order changes.

Fourthly, there have been increasing complaints from engineers about the increasing number of requests for making changes to the product designs and manufacturing plans. This has not only affected the lead time but also the total costs.

Finally, the product range has increased significantly from a limited few in 1960s to several hundreds at present. Every product is a different product but all the products look similar. The increased product variety has further stretched the increasingly more expensive resources.

The company was determined to solve the problem. During the tide of e-commerce around the turn of the century, the company was naturally advised to look into the potentials of the latest web and Internet solutions. The top management was very open-minded, supportive but skeptical/cautious. As long as IT/e-Business solutions truly deliver their promises in improving the competitive and efficiency significantly, they were prepared to invest in such solutions.

The company was seriously considering getting a suite of sophisticated e-business solutions from a reputable vendor. Consultants from this major vendor were invited to give an overview of its e-business solutions. During the talk, the aggressive promotion by the consultants actually scared the engineers involved in the project. Firstly, the consultants talked about the evolving history of their e-business solutions over one and half decade. This period may be long enough to the IT vendor but short to an IT user. Their systems evolved from early standalone system through networked client-server to fat-client web-based systems. They also indicated that they will launch a fully web-based thin-client system shortly.

Secondly, the consultants pledged that their e-business solutions would contribute to the reengineering and rationalization of the business processes and operations if they were fully implemented. This was in fact imposed by their solutions: whether willing or unwilling, changes must be made to suit the methodologies embedded in the solutions.

Thirdly, the consultants offered intensive training for the company staff members of the project team. The basic training was included in the initial acquisition price of the

suite. However, extra charges would be made to advanced training for features such as customization after the installation and implementation.

Fourthly, the consultants mentioned their joint venture with a service provider for an opportunity for the company to subscribe to their EBS with the Application Service Provider without purchasing the solutions to reduce the acquisition and maintenance costs.

Finally, the consultants proudly announce that they provide a suite of solutions encompass the entire business operations and these solutions can be introduced in different phases according to individual needs.

After the consultants' promotion talk, the company decided not to continue along this direction for the following reasons:

- The solutions themselves have been evolving too fast to follow as an IT user. The fundamental question is can we keep up with the changes made by this vendor? A free upgrading would be attractive. But any fundamental major changes to the user interfaces and underlying methodologies might cause significant problems.
- The business and operation models incorporated in the solutions were not readily compatible with the existing ones of the company and significant changes must be made in order to implement the solutions. This may potentially lead to more fundamental traps, operational chaos, and significant resistance from the engineers and workers.
- The customization of the solutions to suit the company's unique features might take too long and too much specialist skills may be required to customize and maintain the customized systems. Chaos might occur in case of personnel turnovers.
- Training and maintenance costs might be unpredictable and thus unmanageable after a few years with uncertain commitment and benefits.
- The opportunity of subscribing to an Application Service Provider was attractive in some sense. But the above concerns were basically addressed. In addition, this approach introduces a third-party whose commitment is yet a major concern.

For the above reasons, the company decided to abandon the previous approach. Instead, they decided to conduct an exercise of business process reengineering (BPR) for the sake of improving the business operational performance, instead of jumping into EBS directly. Following this "IE (Industrial Engineering) before IT (Information Technology)" approach, Key business processes were identified and then analysed one after another. Problems with each business process were examined and then determined what IT solutions were appropriate. Suitable IT solutions would then be acquired and implemented. The company, however, experienced the following dilemma:

- Very few IT solutions that suit the company's requirements were readily available in the commercial market. Most such vendors were small IT firms. Long-term customer services become a major concern.
- Those suitable IT solutions were from completely different third-parties. Their interfaces were completely different. They had different user management. After all, they were separate systems.
- If the company really wanted a solution that best suits its requirements, the best approach was to develop it on its own. Several questions arise immediately: Do we have the necessary IT expertise and skills? Can we afford the time and efforts? Is this a commercially viable approach?

Te above company and its story is purposefully created to illustrate concerns that typically represent those of many SMEs. The long-term implication is however significant. The DIY approach seems to be most appropriate for SMEs and EBS vendors may have to transform themselves from total EBS vendors to the so-called "Portalets" vendors in the future. The rest of this paper is to explain and justify the belief that the Portalets-based DIY approach is not only a suitable approach to SMEs, but also a commercially viable and technically sound approach.

3. Vision towards Digital Enterprises

3.1. EBS: Electronic Business Solutions

A web application is defined as any software application that depends on the World Wide Web, or simply web, for its correct execution (Gellersen and Gaedke, 1999). Hence, software systems that are explicitly designed for delivery over the web, for example web sites, and that use the web infrastructure for their execution, are web applications. For example, many information systems that were designed and built prior to the web are now wrapped and made available as web applications through the use of web browsers.

Electronic Business Solutions (EBS) are web and Internet applications or solutions that are used to facilitate the business decision making and executing activities. The imaginary company in the motivating story is interested in gradually introducing a spectrum of web applications throughout the product development and realization process, focusing on topics ranging from market research to the supplies of tools/equipment and raw materials. In other words, one or more EBS are needed for each of its business processes.

3.2. Enterprise Portals

If a manufacturing enterprise uses only one web application for the purpose of product design, the users access the relevant web pages and components after the successful login session. Because they belong to the same web application, all the web pages are arranged in such a way that they are efficiently and effectively used.

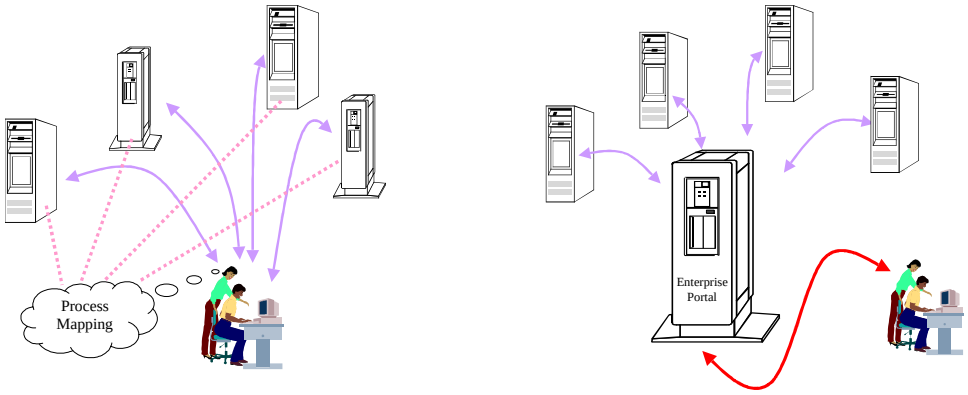
If the enterprise uses multiple web applications, the above method of accessing them can still be used on an

individual basis. That is, the access to each web application is controlled by itself separately. If the number of the multiple web applications is limited to the manageable level, say 7±2, the users are able to work effectively and efficiently with these web applications. However, if this number increases dramatically and these web applications are left scattered on the Internet without a central hub, it will be very difficult for the designers and team members to locate the appropriate web applications at the right time for the right tasks. This situation is shown in Figure 1(a). The engineers should have an overall picture of the organization's business processes and functions. At the same time, they should also be conscious in the relevant documents, information flow and applications over the Internet. However, the situation will quickly become problematic when the number of information sources increases and the complexity of the business changes dynamically. The situation will be worse by the adoption of standalone and isolated applications, each with different working procedures, different interfaces which are non-self explanatory, and different installation and maintenance requirements.

The concept of enterprise portals is introduced as a central hub for accessing web applications to overcome the above problems, as shown in Figure 1(b). Enterprise portals gather and organise the huge amounts of unconnected data scattered across the enterprise, and then present the information in the forms of window areas, where each containing a view of the enterprise. Enterprise Portals provide a secure, personalized view of the enterprise for each individual user or class of users, based on job functions, roles or other relevant criteria. An Enterprise Portal integrates disparate sources of information and business logic, and provides a single point of access to the knowledge and processes of the organisation through a simple and intuitive interface to users of the extended enterprise, including customers, employees, suppliers, and business partners alike, with a single point of access to the knowledge and processes of the organization through a simple, intuitive interface. The technicalities of the back-end applications, documents or databases remain in the background and are invisible to users. Using an enterprise portal, these constituencies (customers, partners, employees) can conduct business via the Intranet, Extranet or Internet from wherever and whenever convenient for them.

In the most simplistic sense, an enterprise portal can be simply a web page that has been created to collate the hyperlinks to all the web applications which are basically separate applications with differing functions and user interfaces. A user with multiple responsibilities, each of which requires the access to a web application, still needs to login and access a relevant web application for each responsibility.

Sophisticated enterprise portals are expected to accomplish much more than a web page hyperlinked to web applications. The accesses are usually highly personalized, depending on the roles and responsibilities of the users in the organization. Rapid deployment is achieved while high consistency is maintained. Searching within the portal is facilitated and better teamwork and collaboration is enabled.



(a) Web applications without enterprise portal

(b) Web applications with enterprise portal

Figure 1 An enterprise portal as a central hub for accessing web applications.

3.3. Digital Enterprises

An enterprise is called a "digital enterprise" if its web portal plays an important role in its business activities and decisions. Some digital enterprises conduct their businesses mainly by providing online contents (which are relatively simple form of web applications) and more sophisticated web applications. Their business processes are entirely accomplished on the Internet.

However, traditional businesses such as manufacturing and even software development extensively employ web applications (and consequently digital

enterprises) across the entire business processes to improve their operational efficiency and quality thus competitiveness. For example, a manufacturer becomes a digital manufacturing enterprise or simply an e-Manufacturing enterprise if it uses the web applications extensively in its business and engineering operations.

Indeed, a digital enterprise has the following characteristics. Firstly, the access to a digital enterprise is logically dimensionless in terms of time and geographical location, although it may be physically distributed (deployed) at different locations. To the user, it is a central web site. The geographical boundaries of the physical enterprise vanish with the emergence of the digital enterprise.

Secondly, a digital enterprise builds up the inter-connections between and among enterprises and intra-connections between and among units within a member enterprise via various levels of access control and authorities. The term "Virtual Enterprise" is often used to describe such a digital enterprise.

Thirdly, the lifecycle activities in the product development and realization processes are no longer arranged sequentially. The corresponding web applications are deployed in parallel across the entire the digital enterprise.

Finally, there is no longer difference between front- and back- offices in the digital enterprise.

4. Approaches to E-Business Solutions

The motivating story in Section 2 indicated three general approaches to the implementation and adoption of EBS. The first approach is for the enterprises to purchase/license, deploy and maintain the off-the-shelf e-business solutions commercially available in the market. Leading vendors have been developing comprehensive suite of sophisticated e-business solutions that are generally produced for large corporations because of the high costs, built-in business models, oriented towards the western culture, and level of customization and thus training. These are significant difficulties for SMEs (Small and Medium sized Enterprises) to take advantages of the recent developments in the technology.

In order to resolve these problems, efforts have been made by both application solution providers and application service providers to provide online services especially for SMEs. This second ASP approach reduces the cost and minimizes the technical skills required for implementing the technology to an affordable and acceptable level. However, other limitations still exist, prohibiting the widespread use of the technology in SMEs. For example, business models and business processes vary widely from one SME to another. It is extremely difficult to accommodate them into one e-business solution. This can only be achieved through customization which adds significant sophistication to the system and its operation. Advanced training is usually required. In addition to these limitations that are shared by the first approach as well, the ASP approach imposes serious dependency of the enterprises on the technical and business decisions of the service providers. If a service provider determines to terminate one service, the enterprise users who subscribed for the service will be unable to continue the service, leading to unacceptable interruptions.

The third approach is the "Do It Yourself (DIY)" approach. It is generally perceived that it takes significantly long time and enormous efforts to develop e-business solutions by enterprise users themselves because of technical sophistication and special programming skills even if they are fully familiar with their own business processes and operations. Therefore, it is not usually considered a viable approach to developing an e-business solution for a specific application by an SME.

The research discussed in this paper is mainly concerned with the fourth approach to deal with the above dilemma. This new approach is an extension to the third "Do It Yourself (DIY)" approach to e-business solutions. This DIY approach is however enhanced by the concept of "portalets" that emerge from the software product line management. This portalet-based DIY approach is expected to reduce the total adoption cost dramatically by at least 50~70% to a level affordable by SMEs. Such reduction is achieved by eliminating costs involved in the comparison and acquisition of the e-business solutions while keeping the development time and efforts to a level equivalent to those involved in the training and customization of commercial e-business solutions. In addition to the cost reductions, the DIY approach allows the SMEs to incorporate their own business models and business operations into the e-business solutions, instead of being rigidly imposed and prescribed by commercial systems. By so doing, SMEs are able to truly exploit the technology to support their daily decisions and operations thus really improve their competitiveness.

5. Portalets-Based DIY Approach

Let us now focus on examining its feasibility from the following aspects:

- Nature of the Internet and web technology
- Maturity of the Internet and web technology
- Readiness of technological developments
- Efforts of business process reengineering
- Awareness and enthusiasm of MIS
- Software product line / platform management

5.1. Nature of Internet and Web Applications

An EBS basically follows the so-called 3-tiered architecture. It normally includes three parts: the application client, server and database. One of the advantages of this architecture is its modularity for changing one component without or with little impacts on the other two. For example, the enterprise business logics are usually captured in the middleware server components. The client components can be added according to individual user requirements. The business data and the business logics are relatively independent of each other.

5.2. Technology Maturity

The Information Infrastructure Technology, both hardware and software, are evolving very rapidly. However, several aspects have reached a mature stage that justifies the DIY approach. For example, relational databases are now more or less standardized with a few limited dialects. SQL (Structured Query Language) is used in conjunction with JavaScript and/or VBScript on the server side to deal with the data between the database and the clients. These scripting methods are also relatively standard, widely taught with other standard web programming skills. Any graduates are expected to have reasonable understanding and skills in these aspects after completing courses like Information Technology, Information Systems, Computing and Programming, etc.

On the hardware and system side, setting up a web server and web site has been made as easy as creating a file for word processing by following simple instructions. This is expected to be improved even further in the near future.

5.3. Efforts of business process reengineering

Companies have been increasingly engaged in rationalizing and streamlining their business processes. Through these efforts, the workflow and information within the organizations are better structured to an extent that is difficult to change again to suit the requirement of a particular IT solution but ready for specifying a custom system that suits itself most.

- Simplify the business operations
- Streamline the business process
- Rationalize the flow of work
- Reveal the potential bottleneck issues
- Outline the fundamental logic and method

5.4. Software Product Line / Family

Advanced theories and methodologies for designing manufactured products have been a major area for research. One of such approaches is the so-called Platform Product Development (Robertson and Ulrich 1998). Similar approaches are emerging for designing, developing, deploying and maintaining software products. For example, Parnas (1976) and Meyer and Lehnerd (1997, Last few chapters) are dedicated to Software Product Line and Software Platform approaches respectively. The greater reusability and modularity will not only speed up the development process but also improve the interchangeability and exchangeability among EBS with the same enterprise.

5.5 Insights from Past Case Studies

Over the last 5 years, the first author has led a group of researchers at the University of Hong Kong on a variety of research projects involved in developing prototype web applications in product design and manufacturing with the financial supports from Hong Kong Government Research Grants Council and the University of Hong Kong Research Committee. Recent developments have been documented in Huang and Mak (2002). Some examples are listed:

- Engineering change management
- FMEA (Failure Mode and Effect Analysis)
- QFD (Quality Function Deployment)
- Design for X
- Collaborative Product Design Review
- Early supplier involvement in new product development
- Morphological chart analysis for concept generation and evaluation
- Market testing with conjoint analysis

Our direct experience from these projects shows that the Internet and web technology lend itself a strength of rapid development and deployment of applications components if certain templates are provided for key issues such as database connection, user interface formatting, etc. The time and efforts of developing a "new" application by this 'Do It Yourself' approach is no more than that involved in customizing a comprehensive commercial suite and participating in training courses. Customizing a system requires in-depth knowledge about the system, and therefore requiring intensive training. Our experience shows that 1-3 months of efforts are generally sufficient for two persons to develop one simple EBS, assuming that they have the necessary skills and background knowledge about the application. The "necessary programming skills" that we are referring here are not specialist skills, but common programming techniques such as SQL, Java scripts, and HTML scripts. These have been widely taught in undergraduate courses of not only computer and software engineering but also other engineering disciplines such as industrial engineering. If the source codes of some templates are available, this time and effort level can be further reduced below 2 months. This is the level that is usually required to learn how to use and customize a commercial e-business solution. By so doing, the high acquisition costs of the commercial systems are avoided, while company-specific business and operation models are easily accommodated.

6. DIY Portalets as Product Family Platform

"Applets" and "Servlets" are well-known Java constructs for building up client and server components of web applications, respectively. ActiveX components and Enterprise Java Beans (EJB) are two more recent concepts of competition. One of their main purposes is to standardize the techniques and constructs to facilitate the design, development and deployment of the web solution components at different levels (tiers).

6.1. Portalets

By following the similar conventions such as Applets and Servlets, the term "Portalets" is introduced to represent powerful constructs for developing enterprise portals. This introduction is necessary when more and more web applications are put into practice to support business operations, leading to the emergence of digital enterprise. The scope of this paper is limited to the manufacturing context, especially product design and manufacture.

There are at least three approaches to building enterprise portals and their features are summarized in Table 3. In a recent enterprise portal market study, Meta Group found that 75% of enterprise portal development efforts where still being accomplished using labor-intensive traditional web development environments. Their research concluded that companies should use portal frameworks or portalets, rather than conventional web tools to build their enterprise portals.

Portalets themselves are web applications for managing other domain-specific web applications. As a matter of fact, some utility web applications such as calendar, email, online chatting, bulletin board, whiteboard, etc. are delivered as constituent components of some commercial enterprise portalets.

Enterprise portalets range from simple Intranet indexing and search tools to enterprise-level database-driven information storage and retrieval products. Table 3 summarizes, without prejudice or preference, some of the typical enterprise portalets commercially available on the market. Although they offer competing features and unique facilities, they serve the similar purpose of facilitating the deployment of web applications to form enterprise portals. Figure 5 shows the architecture of the appsolut Enterprise Portal Suite (http://www.appsolut.com).

An enterprise portalet differs from general-purpose website development environments such as Microsoft Frontpage while sharing numerous common functions. A website development environment is generally considered as an environment for developing and deploying individual web applications ranging from simple HTML contents to web pages with sophisticated computational components embedded or attached.

In contrast, an enterprise portalet provides an environment for deploying various individual web applications into a central website called an enterprise portal. There is no doubt that environments like MS Frontpage have been used for this purpose in practice. However, this approach is unlikely to meet the requirements set out for many commercial enterprise portalets (see for example White Papers of portalets listed in Table 2).

6.2. Portalet Architecture

Because portalets themselves are web applications, they also share the 3-tiered architecture, as shown in Figure 2. This point is the major difference between the portalets and applets/servlets (ActiveX components and Enterprise Java Beans as well). Therefore, a portalet may include an applet at the client tier, a servlet at the web server tier, and of course a database at the data tier. Some of the alternative combinations are given in Table 1.

Another point worth pointing out is that different portalets can be obtained through different configurations of the same set of components at the 3 tiers. For example, "TreeTable portalet 1" is formed by combining the "HTML Table" client with the Server-side scripting and SQL recordset. "TreeTable portalet 2" is formed by combining the "TreeTable Java Applet" client with the Server-side scripting and XML data.

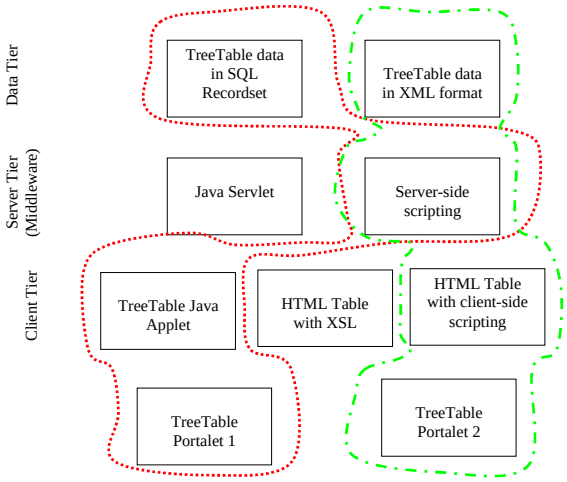


Figure 2 3-Tiered Portalet architecture.

Table 1 Alternative combinations of portalets

	Client Tier	Server Tier	Data Tier
1	Applet	Servlet	RDBM SQL
2	Applet	Server-side scripts	
3	HTML with scripts	Servlet	
4	HTML with scripts	Server-side scripts	

6.3. Portalets-Based EBS

The concepts of ActiveX components and Java Applets/Servlets/Beans have been devised by various IT vendors as basic constructs for building up web applications. The aim is to improve the reusability and rapid development/deployment. However, the technical complexity is still high and often not suitable for the DIY approach because the level of technical skills required is high. For this reason, these components should usually be designed and developed by highly skilled IT professionals and programmers. After they are purposefully configured into portalets, it becomes straightforward to design (configure) and develop a new EBS. For example, Figure 3 shows how to use the same set of portalets (general-purpose) to develop two completely different web application, one for presenting the Bills of Materials (BOM) in product development in Figure 3 (a), and the other for archiving Design Objects (usually documents) submitted for review. Because they are based on the same portalets, the configuration and customization are extremely easy to accomplish.

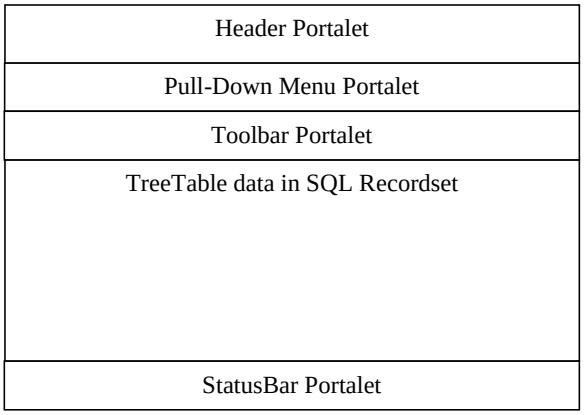


Figure 3 (a) Web solution for managing the Bills of Materials (BOM) in product development.

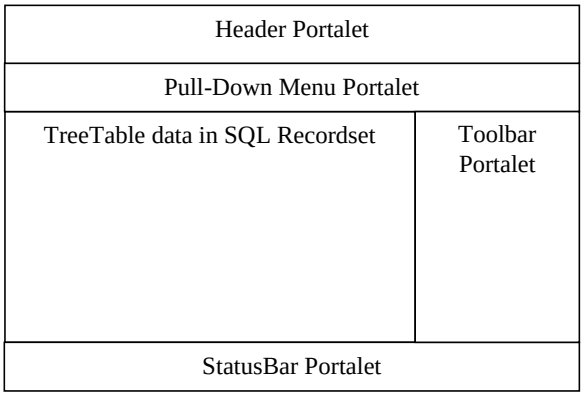


Figure 3 (b) Web solution for managing the Design Review in product development

6.4. Towards EBS Family Portalets Platform

Because of our primary interests in web-based collaborative product design and manufacturing, a set of portalets specialized in Collaborative Product Commerce (CPC) will be developed to demonstrate our proposed portalet-based DIY approach to EBS, in addition to some general-purpose portalets. These portalets become common features shared by all the resulting EBS. This will lead us to develop further along the direction of Software Product Line or Family management.

7. "TreeTable" Portalet Example

The lower part of Figure 4 shows an example of a TreeTable. The first column is an indented tree structure and the rest is actually a table. The tree branches can be extended to show and collapsed to hide details. Therefore, only the useful information is displayed at a time while giving the necessary overview. This combination of a tree and a table has been widely used in building the user interfaces of e-business solutions because many items of the enterprise information including engineering, business and market information are logically represented in this treetable format. It has also been widely used in most of our own prototype systems mentioned in the preceding section. As a result, TreeTable should be constructed as a "portalet" in our DIY e-business framework.

As shown in Figure 4, this TreeTable portalet includes three components that are ready for inclusion in the components corresponding to the 3 tiers of the web application. Source codes have been omitted from the paper because of limited space of 10 pages allowed for the proceedings of this conference.

7.1. Database Structure for "TreeTable"

The top of Figure 4 shows database tables used to construct a TreeTable for representing the Bills of Materials (BOM). The "Parts" Table is used to store the items of the BOM tree. The hierarchical relationship between the items is of the "many to many" type. The "BomStructure" Table is used to store these relationships. The "ParentID" and "ChildID" correspond to the two items in the "Parts" table, indicating the item with "ChildID" is a branch of the item with "ParentID". The 3rd table, actually a group of tables, provides additional information for describing the BOM items and their relationships.

The customization at the database level (tier) becomes very simple exercise of copying and then renaming the "Parts" and "BomStructure" tables to form new tables. There is even no need to change the naming scheme of the fields of the new tables for the "Tree" area. For the Table area of the TreeTable, additional data tables can be easily created to suit specific applications.

7.2. "TreeTable" Middleware Data Structure

The TreeTable portalet middleware that is used by the application server includes a few lines of scripts (either JavaScript or VBScript) to be embedded in the application server. First of all, the database must be connected. In Microsoft Active Server Pages, a few lines of short codes are needed to connect the application server to the database and then remember the connection as a session variable for future references. These connection codes are extremely simple and modular, independent of any other codes. Therefore, customization is straightforward.

The TreeTable data are retrieved using the SQL (Structured Query Language) together with the Java/VB scripts. The retrieved data can be represented in the native form of recordset or resultset of the particular Relational Database Management (RDBM) system.

Once again, the customization of the SQL string is straightforward. If the naming scheme for the fields are not changed, only the names of the tables need to be modified in the SQL string, and no other changes are necessary.

Alternatively, the retrieved data can be represented in the XML data structure, either directly from SQL if it support such conversion or through an XSL template to conver the SQL recordset into hierarchical XML data structure. XSL templates normally need not be changed for different applications.

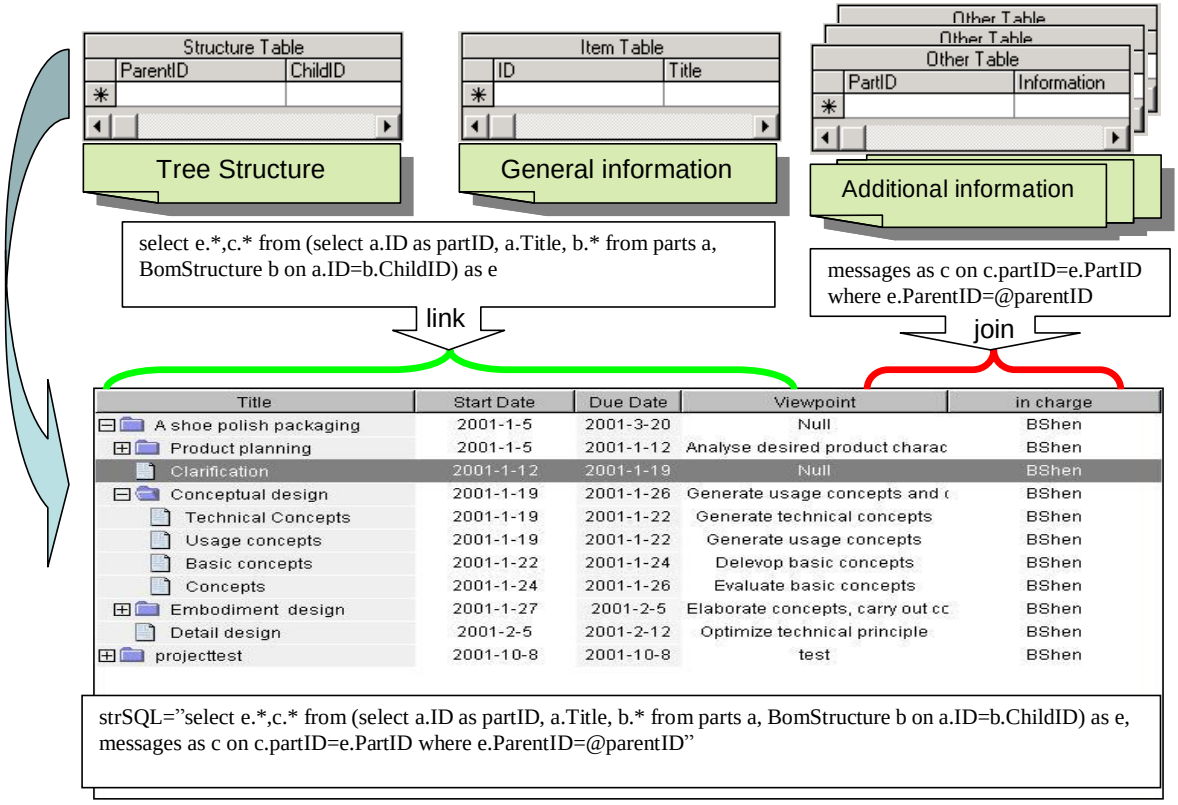


Figure 4 TreeTable Portalet and its components at the 3 tiers.

7.3. “TreeTable” Clients

Several methods exist for building TreeTable clients:

- Using a commercial Java Applet with SQL recordset
- Using standard HTML table with SQL recordset
- Using standard HTML table with XML without XSL
- Using standard HTML table with XML and XSL

7.3.1. “TreeTable” Java Applet with SQL Recordset

One method is to take advantage of ready-made TreeTable Java Applet, several versions of which are commercially available on the market. In MS Frontpage, server-side scripts are used to populate the data in the TreeTable Applet. The populating action takes place on the server side while the contents of the TreeTable are displayed on the client side.

The server-side codes include a few sections to greatly improve their modularity to facilitate the customization. For example, an independent procedure is prepared for populating the column headings of the TreeTable from the names of the columns of the recordset. Another independent procedure is prepared for populating the menu items for the right-click events of mouse buttons over the TreeTable items (rows). Finally, a procedure is developed for building up the tree branches and their associated information items.

The above three sub-procedures are used to form an overall procedure for building up the TreeTable. It takes an SQL as its input variable. Therefore, for different applications, it is only necessary to change the SQL string without changing the TreeTable procedure at all.

7.3.2. TreeTable with HTML Table from XML and XSL

If the retrieved data are represented in a nested XML format where nesting indicates the hierarchy in the TreeTable, then there are two ways of populating the XML formatted data into a HTML table. One is to use the script and the other is to use XSL. The latter is demonstrated here for its better modularity. The XSL template is designed and developed such that it converts any nested XML data into a TreeTable regardless of their contents. As a result, only the SQL string is needed for different applications and no further changes are necessary.

8. Conclusions

This paper has argued for the necessity and demonstrated the feasibility of developing e-business solutions by the SME manufacturing companies. This DIY approach is only practically viable with the support of the concept of “portalets”. Portalets are built upon standard web and Internet technologies. They are basic constructs commonly used in web applications. They are highly modular,

implying that no or little customization is required to adapt to a particular application. Portalets are logically configured to form what is called a "platform" of a software product lines/family. As a result, the portalet-based DIY approach to e-business solutions offers several advantages:

- The requirements for specialist IT skills are dramatically reduced to a level attainable by engineering graduates with certain on-site training.
- Developing and maintaining web applications (web pages) become as simple and easy as create, revise and maintain a word document.
- The time and efforts of developing e-business solutions are dramatically reduced to a level competitive to out-sourcing commercial e-business solutions.
- DIY e-business solutions are able to accommodate the unique business models and operation models of a particular company demanding minimum changes to the current good practice.
- The upgrading and extensions can be made freely without any external constraints at any time whenever necessary.

Further work will be conducted to substantiate the portalet-based DIY approach to e-business solutions in three directions. One is to create a number of widely used portalets such as TreeTable, Menu, Table, Charts, FillForm, etc. Another direction is to create a framework for configuring portalets within a web application according to certain requirements. Finally, case studies will be conducted to demonstrate how the proposed approach can be used to develop CPC (Collaborative Product Commerce solutions.

The impact of the portalet-based DIY e-business approach is enormous and fundamental. One has to change the traditional perception that e-business solutions require mythical specialist skills to develop and therefore have to be acquired (purchased or licensed) at high cost with intensive training. The technology has now evolved to a stage and provided an opportunity that one is now able to take full advantage to maximize one's competitiveness in one's own way and pace.

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