Developing Component-Based E-Commerce Applications for Learning Organizations: An Inter-Enterprise Architectural Response to Organizational Transformation

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Abstract

This paper investigates the idea of enterprise component architecture (ECA) for e-Commerce, appropriate to the context of an enterprise electronic transformation (e-transformation) into a click-and-mortar organization. Specifically, we discuss how the ECA facilitates architected applications development for electronic business (e-business) applications, through its constituent architectures: the business architecture, and the technology architecture. The paper focuses on the architectural development and requirements management of the enterprise e-Commerce initiative. This initiative comprises the development of numerous information systems (IS) for different functionality, collectively supporting respective e-business work involving various organizational business models and processes. The paper also emphasizes the cooperation of an emerging new figure we call organizational architect for the IS sector. Such architects, alongside with the existing IS personnel have to design structures across organizational boundaries, engineer processes into strategic capabilities, align information technology with business strategy, and integrate the disparate pieces that constitute the organization. More, to put our ideas into perspectives for organizations to leverage on their intellectual assets, we consider the idea of learning organization in the enterprise's e-transformation effort. The paper concludes by outlining our actionable research framework to sustainable e-Commerce initiatives, which helps express the blueprint of our architectural IS solutions.

1 Introduction

Today, the Internet has broken the bonds of both time and distance and set the stage for profound, global change in trade and commerce. Though the signs of this technology-enabled business transformation are not always clear at first, many have already recognized the start of a new business era, the digital era, and have taken decisive action to change their business models. In response to this Internet-enabled era of commerce, electronic commerce (e-Commerce), the

industry consortium, CommerceNet, has proffered the following working definition: “e-Commerce is the use of inter-networked computers to create and transform business relationships. It is most commonly associated with buying and selling information, products, and services via the Internet, but it is also used to transfer and share information within organizations through intranets to improve decision making and eliminate duplication of effort. The new paradigm of e-Commerce is built not just on transactions but on building, sustaining and improving relationships, both existing and potential.” According to (Fingar et al 2000), e-Commerce has come to imply an infrastructure for extending a company’s inward-focused, unique business processes to customers, trade partners, suppliers and distributors with new, outward-facing applications. These new applications are greater than the sum of a company’s internal computer applications added to the applications of its partners. The interconnections make it possible to do things in ways not previously possible by eliminating time and distance. Opportunities and challenges permeate the enterprise affecting such aspects from research and development to production to supply chain to marketing to customer care. Since e-Commerce reaches directly into these core business processes that are the lifeblood of the enterprise, it is a mission-critical business issue. It is clear that e-Commerce is not something a corporation can just go out and buy. Rather, it is based on the experience of companies using the Internet to streamline their business processes, and create new wealth. For some forward thinking corporations, presently a third wave of e-commerce has begun. This is quite different from the first and the second waves appearing in the nineties of the last century characterized by HTML-based brochureware, and transactions using home grown or packaged software as point solutions for procurement and online catalog selling. It has been criticized that the simplistic procurement and catalog selling scenarios in those early waves could hardly match the complexity of real world commerce. With experience as their teacher, many companies have come to realize that e-Commerce is neither just a buy nor a sell-side package. These third wave companies have learned that if they extend their business processes across company boundaries and integrate them with their suppliers’ and customers’ business processes, something totally new starts to happen, such as eradicating duplicate processes, ineffective hand-offs and disconnects between and among enterprises. In fact, these companies are redesigning their business processes to create virtual organizations to share their business goals, common planning, and performance management tools. In such virtual corporations, inter-enterprise process development is their competitive weapon for designing and implementing efficient business processes that are integrated in real-time and jointly owned by suppliers and customers. Essentially, inter-enterprise process development is an ongoing endeavor that enables virtual corporations to evolve in a continually changing business ecosystem.

And it is supported by a new software construction paradigm commonly called component-based development (CBD).

2 CBD Overview for e-Commerce

The philosophy underlying the CBD approach is cost-effective software manufacturing in a repeatable way using components (Due 2000; Herzum and Sims 2000). It is a vision to envisage a world of software as components that are easy to swap, mix and match, plug and play at the enterprise level. Components are thereby considered as standardized building blocks that can be used to assemble, rather than develop information systems. And software components are generally interpreted as individually self-contained pieces of software with a well-defined interface or set of interfaces accessible at run-time. These interfaces enable separate component to be combined with other components to provide useful functionality (Cheesman and Daniels 2001). Essentially, to support component-based deployment for collaboration, components need an environment to be plugged into. The software sockets into which compatible components fit when they are deployed, ask of us the idea of an architecture for component-based development of e-Commerce applications. According to Ivar Jacobson, the role of architecture is many-faceted (Jacobson 1998). These include: to conceptualize the design in a form that developers and stakeholders can understand; to guide construction during the first development cycle, and in the future evolution of the system; and to enable management to structure the project and the organization itself around the architectural elements. Indeed, CBD (Herzum and Sims 96, 97, 98) is emerging as a software development approach where all aspects and phases of the development lifecycle, including requirements analysis, architecture, design, construction, testing, deployment, the supporting technical infrastructure, and also the project management, are based on components. This definition explicitly declares CBD to consist of building software using component-based thinking to the extent that the whole software development is component-centered. In practice, thinking of an information system in component terms, even if the components do not already exist, is found to be a useful way to mastering the complexities of e-Commerce applications development.

3 The Importance of Enterprise Component Architecture

In order to achieve coherence and manage the complexity and change inherent in multiple e-Commerce applications, an overarching structure is needed to guide the construction and assembly of e-commerce initiatives into the growing clicks-and-mortar superstructure called a *digital enterprise*. This structure, called the *enterprise component architecture* (ECA) provides

the blueprints, the structural abstractions, and style that rationalize, arrange and connect business and technology components to achieve a corporation's purpose – be it now or in the future. Indeed, the task of transitioning to a digital enterprise from its bricks-and-mortar form is not a single event. Nonetheless, companies are not changing their information systems, they are changing the very way they conduct business, which is the way they operate. The nature, size, and sheer complexity of building the ultimate digital enterprise demands that companies develop an overall ECA, and implement the architecture's components in a step-wise fashion. Because of the absolute need for quality in each component in these mission-critical systems, business and software engineering disciplines are essential. Understandably, development of software systems involves many different tasks, ranging from the collection and specification of business requirements, to the actual software development process, to deploying and maintaining the systems in an operational environment. Each of these activities involves a different set of concerns, people and solutions, and all these represent aspects of a true enterprise-class architectural solution.

Principally, the architectural precepts communicated in an ECA include the following: separation of concerns, accommodation of change, independence from technology, and a phased approach to implementation. Separating concerns means that the architecture problem space is divided into a set of related sub-architectures, each of which addresses one or a few related concerns. The main benefit of this separation lies in the simpler artifacts created and communicated in a format and style that is meaningful to the intended audience. We call such a separation of architectural concerns a viewpoint because it addresses the architecture from a particular point of view. The ability to accommodate change is another fundamental characteristic of a good architecture. Typical architectural analysis often identifies what is likely to change in the system, so that any developed solution insulates the rest of the system from changes in those areas. An example is the use of an abstraction layer, say a database abstraction layer to present an unchanging interface to the system components that use a database so that this layer takes care of communicating with the specific database, rather than having applications writing directly to the database. The same principle can be applied to the development of architecture independent of implementation technology. This is done by using an abstraction layer which presents an unchanging model to the rest of the system, and then by mapping that model to a specific technology. More importantly, we cannot make business stop and wait while the architecture is being completed. Instead, we must continually release new applications. This fact of life requires that we have a phased implementation process, where pieces of the infrastructure are implemented as part of specific projects and subsequent projects continue to both build on and enhance the architecture over time.

The ECA underlying a digital enterprise is generally designed to include two important viewpoints, including the business architecture, and the technology architecture. The former mainly includes the business models, the process models and the applications models of the enterprise, whereas the latter comprises the technical aspects, the implementation aspects, and the operations aspects, which allow an iterative implementation and deployment of the business architecture.

3.1 Business Architecture. The business architecture comprises components of the ECA that are related to modeling the business functionality of the organization. Its design should be guided by the overall re-engineered vision of the digital enterprise, and must be grounded in the realities of the organization's current execution. The business architecture is generally divided into three distinct areas of development: business models, process models, and applications models. The business models provide a high-level perspective of the enterprise's business initiatives, of which an example is to determine the organization's target market and primary audience for its goods and services. Another example is to work out a careful analysis of the organization's resources for reusability and valuation. The process models are aimed to describe the internal and external processes representing the organization's daily behavior. They often reflect the organization's information strategy and the individual business models chosen for implementation. The application models are aimed to represent the electronic applications to be developed to streamline business processes from the end-user perspective. Specifically, they outline the overall application functionalities from the end-user perspective, in the form of a user-interface mock-up, which allows users to step through the process via the application's navigation aids. Often, such functionalities are supported by some data and object models, which describe the underlying data structure and usage for a target application.

3.2 Technology Architecture. The technology architecture is aimed to translate the organization's business vision into effective electronic applications that support the re-engineered intra- and inter-enterprise business processes. It is typically composed of distinct stages of development of the technical, the implementation and the operations aspects. The technical aspect describes the overall design of the enterprise applications. It also describes the infrastructure to support software development, which the company intends to rely on as it constructs component-based applications. The implementation aspect derives from the requirements imposed by the specific standards and products used in a specific application. The operations aspect derives from the specific operational requirements of the applications. These important aspects are generic in

the sense that they apply to all of the component applications the enterprise will develop. Of particular interest in our discussion is the technical aspect, which describes the structure of software systems realizing the individual enterprise subsystems. Essentially this technical aspect consists of a conceptual model and a development infrastructure. The former provides a conceptual foundation of the software system through two basic ideas: functional layers and distribution tiers into which an application can be divided. The latter provides the facility to reuse software artifacts in support of software development, including the reuse of business components.

3.2.1 Functional Layers and Distribution Tiers. The functional layers and the distribution tiers address three important issues of applications development: distribution, scalability, and enhancement. If we consider the functional layers as rows, and the distribution tiers as columns, different functional layers typically occupy different rows, and residing in different tiers. Meanwhile, resources can be applied to each functional layer independently as required by mapping to corresponding distribution tiers. These possibilities along with techniques such as load balancing between tiers allow an application to scale up. Also, functional layers may be replaced or split into finer-grained layers in an enhancement of the architecture. Separation of concerns from the development infrastructure allows designers to replace or enhance parts of the architecture with minimum impact to the rest of the system. Besides, distribution tiers are generally divided into logical areas of concerns from the viewpoint of applications designer in distributed systems: namely, presentation, application logic, and resources management. The presentation tier is responsible for managing user interface details, such as presentation of information, data input and output, and navigation within the application. The application logic tier is responsible for managing the integrity of enterprise resources, enforcing system-level business rules, and providing services to requestors. This tier implements the business objects; that is, the entities and processes that have been identified by the business analysis and modeling activities. The resources management tier is responsible for providing shared access to the resources and services of the system, particularly the enterprise databases, as well as access to legacy and packaged applications.

3.2.2 The Development Infrastructure. The infrastructure viewpoint of the technical aspect focuses on making the application developers more productive by providing guidelines to reuse software artifacts through a service-based idea for CBD. Essentially, we employ the concept of service packages to facilitate a business-oriented modeling process. A service package provides a set of services belonging to a single service category. Each service from a service

package is realized by an individual component, which is also a container of different objects. This provides a business-oriented basis for modeling deployment of components using service packages, which are implementation packages of objects, providing services through their interfaces. That way, components provide a means of packaging related objects together into pre-fabricated piece of software. And service packages provide a mechanism for grouping those objects into units (in the form of components) that are cohesive to the needs of a particular set of services from which business solutions can be constructed. It is important to notice that the promise of component-based development is that software solutions can be composed from reusable components, in analogous fashion to hardware (Allen and Frost 1998; Cox 1986; Eeles 2000; Repenning et al. 2001). Nevertheless, the service packages must be modeled in a way that makes the resulting components useful building blocks, simple to activate and inexpensive to administer. The level of granularity of a component can vary from large and complex to small and simple. In practice, large components have the greatest potential for reuse but are often not cohesive and may be difficult to assemble into solutions with other components. Small components are usually more cohesive but often need to be coupled with many other components to achieve significant reuse, resulting in excessive inter-component coupling. Clearly, settling on a good and useful level of granularity is a trade-off between these two extremes.

4 Program Management for e-Commerce Applications

In order to successfully deploy enterprise-wide e-Commerce solutions and increase collaboration between enterprises and their partners, two major challenges must be addressed. The first is the redefinition of company tasks in holistic or process-oriented terms that result in innovative process-integrated business solutions. The second is the deployment of a sophisticated middleware infrastructure that supports company-wide and cross-company distributed information-processing activities. In addressing the first challenge, corporate structures must be shaped around business processes. And entire process chains that cross the functional or organizational boundaries should be engineered and modeled in such a way that enterprises can integrate all their critical business activities and respond to changes in the market more effectively. In the second challenge, we should design the middleware infrastructure to promote interoperation between Web-enabled applications and a large number of interconnected legacy information systems, and satisfy a request, irrespectively whether the business logic lies in the legacy system or in an Internet-enabled business transaction. Accordingly, the combination of business process definitions with an advanced middleware infrastructure has the potential to make

possible a real acceleration of productivity improvement for inter-networked organizations and will enable new forms of business and work.

To remain competitive in a global market, the increasing growth in inter-enterprise exchange of information requires of the physical enterprise an objective program management methodology to transform itself into its digital counterpart. Obviously, this methodology of electronic transformation (e-transformation) must be instrumental to creating a productive and efficient digital enterprise. In particular, it should enable the digital enterprise to launch and learn, and then incorporate those lessons and launch again. Actually, this can be accomplished only if we have an agile operation based on a reusable business and technology architectures (as described in the preceding section), and supported by a repository of reusable business and technology assets. We try to characterize this methodology as follows: First, we need to define an electronic vision for the enterprise, to bring all of its real-world and virtual-world strengths together in a re-configurable constellation. Second is to define the enterprise's business architecture, encompassing its associated business models, processes, and applications which will let us move from vision to reality. Third, we have to entail a corresponding technology architecture that allows an iterative realization of the business architecture. Fourth is to create a reusable infrastructure of both business models and technology applications, which allow us to recycle every piece of learning, time after time, and in as little time as possible.

In other words, we recognize that becoming a digital enterprise is not simply a technology issue to be managed by an information technology (IT) department. Instead, the e-transformation itself involves business process engineering and re-engineering, and it is a core strategic issue, requiring meticulous planning before construction. It is about molding selected aspects of the running enterprise into whatever the re-engineered vision of the business process and the market (global and local) demand that they be. And it is about setting long-term goals to refocus the business of the enterprise. In practice, it is about business as much as it is about technology, and as such it must be managed directly by a team of integration specialists (executives, administrators, technologists) who can walk the line between corporate strategy and IT issues. Oftentimes, this requires IT leaders to learn business, and business leaders to learn technology. In today's complex business-to-business (b-b) and business-to-customers (b-c) environments, it is believed that the core of a digital enterprise is a backbone of inter-organizational business processes which cross the organizational boundaries to include external stakeholders. Thus, a successful platform for the electronic commerce applications provided by the digital enterprise,

must involve not just customers and suppliers, but also internal processes, employees, and back-office functions as well as external partners.

5 Inter-Enterprise Work Teams for e-Commerce

E-Commerce is currently turning industries upside down and forcing enterprises to refocus their information systems (IS) from inside out. With the focus on an architecture-centric approach to systems development, the tasks, knowledge and skills inherent in e-Commerce environments can be packaged into new roles and organizations for handling the work responsibilities. Among the numerous roles to be highlighted is that of the organizational architects. They define, align and refine the overall inter-enterprise architecture. They carry out many of the tasks of program management and provide guidance so individual projects can make optimum use of infrastructure resources for e-Commerce. They do the balancing act between business requirements and technological capabilities. On individual projects, organizational architects help identify the requirements, goals and constraints of the project. They allocate responsibilities for each of the architectural elements and coordinate the modeling and design activities for the overall enterprise architecture. They are the chief architects of the e-Commerce initiatives and coordinate the work among the business, the infrastructure, and the application architects.

- *Business Architects*. These architects are steeped in business domain knowledge including business processes and logical information structures. They coordinate the work of business and technology analysts and modelers who develop abstract representations (business object models) of the business domain. Such models, typically application-neutral, should enable the reuse of business analysis and design artifacts in the process of realizing the e-Commerce initiatives.
- *Infrastructure Architects*. These architects identify the technical services required of the technology architecture to empower and support the logical business architecture. They evaluate existing infrastructure services, select those appropriate to a given project and acquire (via build or buy) new components needed in the infrastructure. They oversee the work of technical specialists in modeling the services of the technical infrastructure. They also maintain the technical components of the development repository.
- *Applications Architects*. These architects coordinate the business process modeling activities across multiple projects and business domains. They coordinate the work of domain modelers and maintain the repository of business and component models. They evaluate against business component services, select those appropriate to a given project and acquire (via build or buy) new components needed in the evolving business model. They maintain the business application components of the development repository. Most importantly, they guide solution and component

developers in blending the business object model with the infrastructure services needed to implement the models in an e-Commerce platform. Typically, solution developers develop the use cases for the specific application at hand, compose solutions through extensive use of business object models and use case repositories. They assemble application components to implement e-Commerce applications. Yet, they do not build or program components. These are the jobs of the component developers, who are masters of the component technology and know the intricacies of composition, delegation, and object-oriented systems analysis and design. They should be proficient in component development languages (such as Java and C++), modeling standards (such as UML and XMI), and distributed computing platforms (such as CORBA, DCOM, and EJB).

6 Inter-Enterprise Process Development for e-Commerce

With an overall function of program management established, multiple e-Commerce projects may be undertaken concurrently. Companies that are taking the path toward becoming a fully digital and customer-driven business design enterprise and inter-enterprise framework whose centerpiece is e-Commerce integration. This process of integration begins with identifying the business services with respect to application domain requirements and standards to meet the unique requirements of the domain as well as application interoperability. Those services are then translated into specifications for core e-Commerce application components often stratified in a hierarchy where higher layers, in object-oriented terms, inherit and specialize attributes and behavior from the lower-layer(s). Oftentimes, it is convenient to view the business support facilities of this framework as comprising three layers of functionality: the workflow layer, the business processes layer, and the business objects layer.

6.1 Business Objects

Business objects play a central role in capturing the semantics of actual business entities and operations, in a way that is understandable by the business (Brodie 1998; Manola et al. 1998). They provide a method for describing application-independent concepts such as product, order, customer, and payment. They are often used in business models to represent the business resources, people, goals, policies and constraints within an enterprise. Specifically, business objects communicate with one another at a semantic level and encapsulate the meta-data and business rules associated with the specific business entity they describe. Such business rules are related to the way the organizational objectives are modeled. By defining applications in terms of business objects, enterprise-wide definitions and behaviors can be enforced for all applications.

Obtaining agreements between enterprises on business object definitions is necessary to enable networked e-Commerce applications, such as the connection of one enterprise's ordering to another enterprise's delivery of goods and services processes. Usually, appropriate names and descriptions of products in a particular market are generated by means of a standard ontology (Papazoglou and Milliner 1998). The semantic definition of the meaning of each trade element or product is then stored in a concept dictionary.

6.2 Business Processes

A business process is the definition of a set of interrelated activities that collectively accomplish a specific business objective, possibly, according to a set of pre-specified policies. The layer of business processes is intended to provide generic business processes. They are a set of basic building blocks for an application in a specific business domain, say, procurement management. Such building blocks can be specialized and extended to capture domain or application specific processes, which are realized at the workflow layer. Typical examples of generic business processes common to multiple applications, include retail (shopping, order fulfillment, and shipping), and business-to-business (procurement, order entry, inventory and supply chain management, and logistics) functions. Business processes are initiated by events that trigger activities in the organization (Curran, Keller and Ladd 1998). These events can be internal (e.g., rules) or external (e.g., customer requests). Typically, on the basis of an incoming event (e.g., a customer request), some business processes are initiated, and they result in an outgoing event (e.g., the notification that a product is ordered). Business processes operate on business objects, i.e., they change their states. They are also conceptual in nature and usually comprise three elements: an activity, a transition and decisions (Eeles and Sims 1998). Every business process consists of one or more activities. Activities follow one another, therefore a transition occurs when one activity finishes and hands control over to another activity. A transition may depend on a decision that has associated conditions. Overall, there are three types of business processes: operational, resources, and management. Operational business processes are often the only kind of business processes that are related to the primary business value-added chains, e.g., to optimally manage merchandise flow and operating costs in order to improve customer service and profitability. The management business processes consist of controlling and planning activities, whereas the resources business processes support both the operational and the management business processes. These three types of business processes are often mixed to implement a certain business workflow.

6.3 Workflows

The workflow layer provides the means for developing inter-business, or networked, applications which interconnect and manage communication among disparate business applications and put the business processes in motion. For example, workflows provide the opportunity to automate business processes and provide continuity between a customer requiring service, and the production of these services. Workflow applications rely on an extensive foundation of reusable components, viz. the core business processes that form the basis for building new applications. Workflow-enabled business processes track transactions across, departments, company and enterprise boundaries. This type of distributed workflow layer provides the sequence of business activities. These include arrangement for the delivery of work to the appropriate inter-organizational resources, tracking of the status of business activities, coordination of the flow of information of (inter and intra-) organizational activities and the possibility to decide among alternative execution paths (Papazoglou et al. 1997). The workflow layer allows users to develop control scripts to manage the execution of sequences of operations that relate to particular business objects and processes. It allows a user request to weave multiple application programs, views of data, and interact with numerous business objects and services.

7 The Idea of a Learning Organization

Nowadays, enterprises are challenged to do things faster, better and more cost-effectively in order to remain competitive in an increasingly global economy. Consequently, there is a strong need to share knowledge in a way that makes it easier for individuals, teams, and enterprises to work together to effectively contribute to an organization's success. This idea of knowledge sharing has been well exemplified in the notion of a learning organization (LO) (Garvin 1993; Kim 1996; Levine 2001; Senge 1990). Basically, LO refers to an organization, which focuses on developing and using its information and knowledge capabilities in order to create higher-value information and knowledge, to modify behaviors to reflect new knowledge and insights, and to improve bottom-line results. Based on this characterization of LO, there are many information system (IS) instances that can be incorporated into a learning organization. The acronym "LOIS" (Learning Organization Information System) (Williamson and Lliopoulos 2001) as applied to an organization is often used as a collective term representing the conglomeration of various information systems, each of which is a functionally defined subsystem of the enterprise LOIS. Namely, it is defined through the services it renders. Such services could include the following. LOIS should support structured and unstructured dialogue and negotiation among organization's knowledge workers (organizational architects, business architects, infrastructure architects, and

applications architects). They need to support reflection and creative synthesis of information and knowledge and thus integrate working and learning. They should also help document information and knowledge as it builds up (e.g. by electronic journals). And they have to make recorded information and knowledge retrievable, and individuals with information and knowledge accessible. Collectively, LOIS can be considered as a scheme to improve the organization's chances for success and survival by continuously adapting to the external environment. Consequently, we stand a better chance of increasing social participation and shared understanding within the enterprise, and thus foster better learning. Although we believe that this positioning of LOIS represents a significant vision of a future generation of information systems, there are serious questions to be addressed in connection with knowledge capture and transformation, as well as knowledge asset management within the enterprise. They have consequences for enterprise positioning initiating transformation in such areas as strategies, structures, processes, systems, and people. The philosophy underlying the LOIS design should recognize that our knowledge is the amassed thought and experience of innumerable minds and LOIS helps capture and reuse those experiences and insights in the enterprise. The notion that emerges resembles strongly the classical history paradigm of learning from past events, necessitating the collection of data and repeated re-interpretation of its meaning, significance and impact for next generations. That is also the idea of organizational learning (Kim 1995), supported by an organizational memory. Organizational memory is considered as the means by which knowledge from the past is continuously brought to bear on present activities. It could possibly result in higher or lower levels of organizational effectiveness (Stein 1992) in terms of the decision-making, organizing, leading, designing, controlling, communicating, planning, and motivating functions of the management process. The cultivation of an electronic version of organizational memory is fundamental to enterprises that intend to establish, grow and nurture a digital learning organization (Hackbarth and Grover 1999), where individuals grow intellectually and expand their knowledge by unlearning inaccurate information and relearning new information. Oftentimes, there is the essential difference between doing it the way we always did it (single-loop learning) and arriving at an innovative solution that establishes new patterns and relationships (double-loop learning) (Argyris 1992; Kim 1995).

8 Remarks for Continuing Challenges

In this paper, we have presented an underlying structure to see through the challenges and strategies of contemporary e-Commerce initiatives faced by modern enterprises. The development of a strong architectural vision and the adoption of incremental development cycles,

supported by an agile operations management in launching enterprise e-transformation, are believed to be keys to sustainable e-Commerce success. In closing this paper, the following remarks for continuing challenges serve to contextualize our discussion:

8.1 The Situation of Concern. Currently the view that knowledge is a valuable organizational resource has become widely recognized and accepted in the business community (Spek and Spijkervet 1997). This is largely due to the emergency of the knowledge economy (OECD 1996) characterized by a highly competitive and turbulent business environment. One consequence is the increase in organizations' efforts to deliberately manage knowledge. Organizations are realizing that their competitive edge is mostly the intellectual capital -- brainpower (Stewart 1997) of their employees, and they are particularly interested in harnessing their human capital in order to stay ahead of the pack. The soaring attention on the application of knowledge management (KM) (Malhortra 2000) to e-Commerce, has propelled many enterprises to embark on their journeys of organizational transformation in order to tap the intellectual assets belonging inherently to their people. Meanwhile, with the rapid advances in networking technologies and the commercialization of the Internet, the connectivity and possible sharing of knowledge within and across organizations has greatly been facilitated (Conklin 1996). Many an organization is actively reflecting on their organizational design to transform their bricks-and-mortar (physical) entity into its clicks-and-mortar (digital) counterpart. We call such a transition effort the electronic transformation of the organization, or simply the e-transformation effort (Henderson and Venkatraman 1993; Hoque 2000). Preferably, the e-transformation effort should enable us to follow an iterative development sequence so that we could learn, plan and prepare for a launch based on a new business model within an estimated cycle time. Consequently, we consider an enterprise undergoing organizational transformation, as the learning organization (Senge 1990; Garvin 1993), implying its constant efforts to better itself for coming challenges, including those involved in its e-transformation into a digital learning organization.

8.2 The Problems. Organizational transformation in the direction of a learning organization (LO), including the e-transformation effort towards a digital counterpart of the LO, necessarily involves some organization modeling (Morabito et al 1999) comprising the e-organization models which are required for the subsequent architectural development of the underlying information systems. From the software architects' perspective, each information system (IS) has its own architecture, denoting the integrated structural design of the system, its elements and their relationships depending on given system requirements (Bernus and Schmidt 1998). We might

consider the architecture as an abstract plan including the corresponding design process of the system's structure appropriate to the goals of the system based on a methodological framework. Besides, the architecture has to represent all relevant aspects of a system, which are defined by models representing different system views. These models are often derived from the goals the system has to fulfill and the constraints defined by the system's environment. In our investigation, the acronym "LOIS" (*Learning Organization Information System*) as applied to an organization is used as a collective term representing the conglomeration of various information systems, each of which is a functionally defined subsystem of the enterprise LOIS, i.e., it is defined through the services it renders. On characterizing the requirements for the different LOIS services in support of our LO model for knowledge synthesis, we did arrive at some concerns to be seriously examined.

The first is the architectural paradigm shift (Malveau and Mowbray 2001) for constructing our e-organization models. The nature of information systems is changing from localized departmental application to large-scale global and dynamic systems. This trend is following the change in business environments toward globalization. The migration from relatively static and local environments to highly dynamic information technology (IT) environments presents substantial challenges to the software architects. Traditionally, software designers assumed homogeneous configurations, centralized systems, local communications, and infrequent failures. Today, highly distributed enterprises as characterized by e-transformation, reverse most of these traditional assumptions. We are often confronted with heterogeneous hardware/software, decentralized legacy configurations, and complex communications infrastructure. The resulting computing environments also have frequent partial system failures. The reason is that different elements of the system are often developed or purchased during different time frames by different organizational units and many of the decisions are made independently as a result of organizational turnovers in employees and the evolution of business processes. Consequently, the architecture of the organization impacts its IT architecture, and the software architects must accommodate the diverse evolving set of configurations.

The second is the contextualization of our e-organization models according to the learning organization concept. Most current discussions of learning organizations focus on high philosophy and grand themes. For example, Peter Senge, who popularized learning organizations in his book *The Fifth Discipline* (Senge 1990), described them as follows. These are places "where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where

people are continually learning how to learn together." To achieve these ends, Senge also suggested the use of five "component technologies": system thinking, personal mastery, mental models, shared vision, and team learning. Without question, these recommendations are absolutely desirable, but we still need a framework for action. As organizational architects, we need to know what policies and programs must be in place to get our organization from here to there. To initiate our LO-based organizational modeling efforts, we follow Harvard Business School professor, David Garvin's (Garvin 1993) suggestion to create our actionable framework for organizational transformation. First is the question of meaning. We need a plausible, well-grounded definition of e-learning organization; it must be actionable and easy to apply. Second is the question of management. We need clearer guidelines for practice, filled with operational advice rather than high aspirations. And third is the question of measurement (realization). We need better tools for assessing an organization's rate and level of learning to ensure that gains have in fact been made.

The third is the issue of knowledge characterizations that help structure and facilitate knowledge implementation and interconnectivity. The struggle to define knowledge is somewhat fuzzy as exemplified by the range of complexity and intellectual richness, from Plato's "justified true belief" (Nonaka and Takeuchi 1995) to a more mundane "the capacity to act" (Sveiby 1997). How it is characterized, used, and even created within an organization is very complicated. However, we believe that knowledge is subject to some level of modeling, and thus may be architected, integrated, and designed into an organization (Davenport and Prusak 1998; Levine 2001). We do so with some uncertainty, but with informed discretion just as human beings may manipulate and change the environment, in effect, changing the direction of our evolution and adaptation. Our working definition of knowledge is interpreted in terms of its potential for action and its ability to change context and goals – the rules of relevance and adaptation.

8.3 The Methods. The methods employed to execute our research include a combination of techniques. First, through literature reviews, we have come up with a practical scenario (Drucker 1988; Senge 1990; Garvin 1993; Gouillart and Kelly 1995) to initiate our investigation into the specifics of organizational development based on a working model of learning organization. Second, from the perspective of action research, we are to document the complexity of the technological challenges faced by software architects in realizing the e-transformation vision. Third, through organizational modeling, we are to introduce the important input from organizational architects in transforming the organization. Fourth, through business modeling, we are to describe how software architects (playing business modelers) construct the business

architecture, serving as the foundation for requirements' process. Fifth, through software modeling, we are to elaborate how the software architects achieve the transition from business architecture to software architecture, by managing the software requirements acquired. Briefly, the process of architecting organizational transformation involves constructing a number of essential viewpoints for modeling our system architectures on the part of the software architect. These include, following the suggestions of the Reference Model for Open Distributed Processing -- RM-ODP (ISO 1996): the enterprise viewpoint, the information viewpoint, the computational viewpoint, the engineering viewpoint, and the technology viewpoint. Each viewpoint is a perspective on an underlying information system, providing descriptions that address the questions and needs of particular stakeholders in the system. The set of viewpoints is also not closed so that additional viewpoints can be added as the needs arise. According to RM-ODP, these five viewpoints, presenting different stakeholder perspectives are sufficient for resolving both business functionality and distributed systems issues in the architecture and design of information systems. Briefly, the enterprise viewpoint takes the perspective of a business model. The enterprise models should be directly understandable by managers and end users in the business environment. It assures that business needs are satisfied through the architecture and provides a description, which enables validation of these assertions with the end users. The information viewpoint defines the universe of discourse in the information system. It is a logical representation of the data and processes on data in the information system. The computational viewpoint partitions the system into software components, which are capable of supporting distribution. This viewpoint defines the boundaries between the software elements in the information system. Typically, such boundaries are the architectural controls that assure that the system structure will embody the qualities of adaptability in management of complexity that are appropriate to meet changing business needs and incorporate the evolving commercial technology. The engineering viewpoint exposes the distributed nature of the system, defining the distributed processing solutions for the information system. The technology viewpoint defines the mappings between the engineering objects and other architected objects to specific standards and technologies including product selections. These five viewpoints are co-equal in the sense that they do not form levels of description; rather, each viewpoint provides a complete model of the information system that is object-oriented and complementarily independent of the others. Each viewpoint also defines various constraints on the design of the information system that provide various architectural benefits for each of the system's stakeholders. More importantly, those viewpoints enable the separation of concerns, which divide the business and logical functionality of the system from the distributed computing and commercial technology decisions of the architecture. Overall, RM-ODP is an elegant model, which identifies the top priorities for

architectural descriptions and provides a minimal set of traceability requirements that are adequate to assure system integrity. By applying the proven techniques of RM-ODP for what makes a good architecture, we are able to build our own tailored architectures, and clearly represent them in UML (Booch et al 1999) or some other tool, with an understanding of the underlying foundations for creating an architectural specification.

8.4 The Contributions. There are a number of contributions our effort is expected to offer to the audience of interest involved in the related areas of research, such as organizational modeling, business modeling and software modeling, concerning the application of knowledge management to e-Commerce in today's learning organizations.

a) The formulation of 'virtual organizing' as a concept to emphasize the importance of knowledge and intellect in creating value in an organization (Venkatraman and Henderson 1998; Keinanen and Oinas-Kukkonen 2001). We propose a suitable conceptualization for the architecture of virtual organizing. Here, we present our views on the core architecture of the present-day organizational model. The term 'architecture' is chosen to represent an organization framework to align the organizational constructs that characterize the behavior of an organization: culture, people, process, information (data and knowledge), and learning (knowledge creation). The underlying organizational design should facilitate, guide, and provide a context for organizational transformation; it is not expected to be a rigid blueprint for merely conducting organizational activities.
b) The re-orientation of 'knowledge management' (Malhotra 2000, 2001) to account for human attention, innovation and creativity needed for renewal of archived knowledge, creation of new knowledge and innovative applications of knowledge in the e-transformation effort. In the context of enabling electronic business (e-business) strategy, knowledge management should cater to the critical issues of organizational adaptation, survival and competence in the face of increasingly discontinuous environmental change. Essentially, it embodies organizational processes that seek synergistic combination of data and information-processing capacity of information technologies, and the creative and innovative capacity of human beings.
c) The explication of 'information continuum' (Davenport 1997) as a concept to contextualize information in relation to data and knowledge as items of organizational resources. Typically captured in computer systems, data at one end represents easily structured states of the world. Information, on the continuum, is "data endowed with relevance and purpose" (a quote from Peter Drucker 1988). Information requires a unit of analysis and human intervention ("relevance and purpose" are provided by people). Knowledge, at the other end of the continuum, is information with most value, difficult to structure or implement in computers,

and usually requires some period of time for synthesis. There is the implication that the continuum reflects a dependency: information is some form of endowed data while knowledge is a synthesis of information. This increasing "richness" is a function of human intervention. In fact, human involvement increases as we move along the continuum from data to information to knowledge.

d) The introduction of a new role called 'organizational architect' (Morabito et al. 1999). This architect redefines the role of business analysts from being merely a communicator of business requirements to an information technology (IT) staff (say, the software architects), to being an integrator of organizational constructs, who is responsible for defining and building the organization's core architecture. Organizational architects must address many complex interactions, such as knowledge creation and learning, collaborative problem solving and team structures, business process innovation and many others like culture change and prevalence of knowledge workers.

e) The clarification of an architectural approach (Buffam 2000; Dikel et al 2001; Putman 2001) to building information systems (IS) solutions for e-business. An IS architecture for a specific enterprise provides a structure for selecting standards and for making decisions about the technologies and products needed to implement and maintain fully integrated information systems in response to business needs. Primary goals of an architectural approach include the following: to let business missions, strategies, and processes guide the use of information technology, and to allow the rapid adoption of new technology for competitive advantage.

f) The suggestion of five essential business imperatives (Fingar 2000) in securing success in e-Commerce initiatives. These five important arguments could serve as the organizational architects' blueprint in their latest enterprise e-Commerce endeavor: adopting the customer paradigm, optimizing the value-chain, achieving time-to-market, governance, and measuring progress and effectiveness.

- *Customer paradigm*. In the e-Commerce era, customer must be provided complete self-service access to a company's business processes and those of the company's value-chain. The customer-centric company of the 21st century changes the customer relationship by constructing customer-facing processes from the outside-in, creating the corporation where the customer initiates and conducts his or her own business using the open resources of the company.

- *Value-chain optimization*. With the customer in control, a business must realign its value-chain around the customer, customizing information, products and services. The company is extended to suppliers and trading partners so that when customers touch the resources of a corporation they also touch the resources of the value-chain. The customer will interact with

the whole ecosystem, not just the individual company, making general systems theory a core business competency. Companies must directly participate in building the new business ecosystem, providing the framework for customer-driven, value-chain optimization.

- Time-to-market. In the domain of e-Commerce, time-to-market is governed by time-to-software. Component-based development is the current best practice in software development because it combines strong architectural notions with rapid architected applications development.
- *Governance*. As companies transition to a fully digital business, the question of e-Commerce governance summons our answering. Principally, business users of information systems are the most accountable for business success, with IT playing a role of enablement and support. Yet, it is the CEO and the board of directors who will assume bottom-line responsibility for e-Commerce initiative. They are interestingly not very aware of the implications of the Internet, and often require hiring a technology coach to collectively educate them the competitive implications of IT (May 1999).
- *Measurement*. This is a critical element in any system of management. As a new platform for conducting business, e-Commerce is a long-term business proposition. Companies cannot go out and buy e-Commerce. They must make it a way of business and grow it. Measures of e-Commerce's value should include the long-term value of the business infrastructure it provides, plus the individual return-on-investment (ROI) of specific e-Commerce initiatives.

9 Conclusion

The emerging e-Commerce over the Internet, as a concept is changing the software applications, the everyday services landscape and the way we do things in almost every domain of our life. There is already a body of experience accumulated to demonstrate the difference between just having an online presence and using the Web as a strategic and functional medium in e-Commerce environment. The new and frequently invented technological solutions often fail to provide long-term benefits when facing an integration or growth scenario. Therefore, we have to make sure that the solutions should work with existing business processes, and enable us to integrate new processes without massive re-investments in changing the whole applications architectures. This paper has presented our perspectives, however fragmentary they are, in tackling the issues of electronic organizational transformation in relation to e-Commerce, through the viewpoints of both the software and the organizational architects in constructing component-based business solutions within and without the enterprise boundary.

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