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Enterprise Integration

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Abstract

Enterprise Integration (EI) is the re-engineering of business processes and information systems to improve teamwork and co-ordination across organizational boundaries, thereby increasing the effectiveness of the enterprise as a whole. Starting from the needs for EI, and some identification of the state of the art, the paper tries to define a base for building consensus on the research issues. Various models and infrastructure are presented to complement the need for EI requirements in Information Technologies (IT). The needs for acceptance and awareness on enterprise integration in the user community are then presented. Only if the user community is convinced of the benefits of enterprise integration will the IT vendors invest in such a market and will the efforts bear fruit. The vision for enterprise integration has to be a tool for the enterprise operation supporting day-to-day decision making across the entire operation from customer order acceptance and asset management to customer support. It must be a tool, which will link decision-makers on all organizational levels to relevant and real time information across organizational boundaries. This tool will enable new paradigms like extended and virtual enterprises to become a reality on a broad scale and with fast turn-around times and which, in the long run, will support operation control and monitoring.

Keywords: Enterprise Integration, Enterprise Modeling

1. Enterprise Integration: The Needs

Enterprise integration has been discussed since the early days of industrial computers and in the manufacturing industry in particular. Computer integrated manufacturing (CIM) was first introduced by Joseph Harrington in the '70s[3]. Processes, resources, organization, and information have been considered as major building blocks to achieve a cohesive CIM system to support the business goals of manufacturing enterprise. CIM is the operation integration and support of communication in manufacturing by means of information technology. In spite of the differences in understanding of the scope of CIM, it has always stood for integration through efficient communication and information sharing across enterprises. Although there are companies reporting dramatic improvements in cost, quality and schedules, there is also disappointment reported in many corporations due to unmet expectations. Nevertheless, global competition demands shorter life cycles and customer values. The concept of achieving integration among functional requirements, resources, organisation and information is still upheld as a critical element for the success of the enterprise. Integration is not only among machines, processes and information, but also most importantly, including the human aspect. In the past, CIM efforts in many enterprises often fell short of integrating the human aspects and concentrated most of the efforts on the hardware aspect [2]. One reason is that there are few established tools and methods to tackle the integration of the two aspects. Integration essentially consists of:

"Providing the right information, at the right time, at the right place."

Integration is a never-ending process. Over time, both the internal and the external environment will change, and the enterprise must react to these changes and adapt its operation accordingly. Providing the right information at the right time requires explicit knowledge of both the information's needed and created by the different activities in the enterprise operation. Providing the right information at the right place requires information sharing systems and integration platforms capable of handling information transactions across heterogeneous environments. However,

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current information technology does not yet provide a complete solution for enterprise modelling and it has limited use. To form and dissolve partnerships rapidly and to integrate business discourse internationally requires not only

intra but inter enterprise integration. This mostly short-term cooperation requires easy access and the use of information on enterprise operations by the partners in order to assess potential contributions and to integrate those into the operation of the virtual enterprise. Integration between suppliers and manufacturers : in order to reduce product lead times and share the risks in new product launches, manufacturers and suppliers must integrate and synchronize their processes. Integration of design and manufacturing: in order to reduce the time to market and minimize design errors, concurrent engineering practices must be adopted that enforce better integration of design and manufacturing activities. Figure 1 summarises these developments indicating the shift of emphasis from systems integration to enterprise integration with increasing focus on inter enterprise operations or networks.

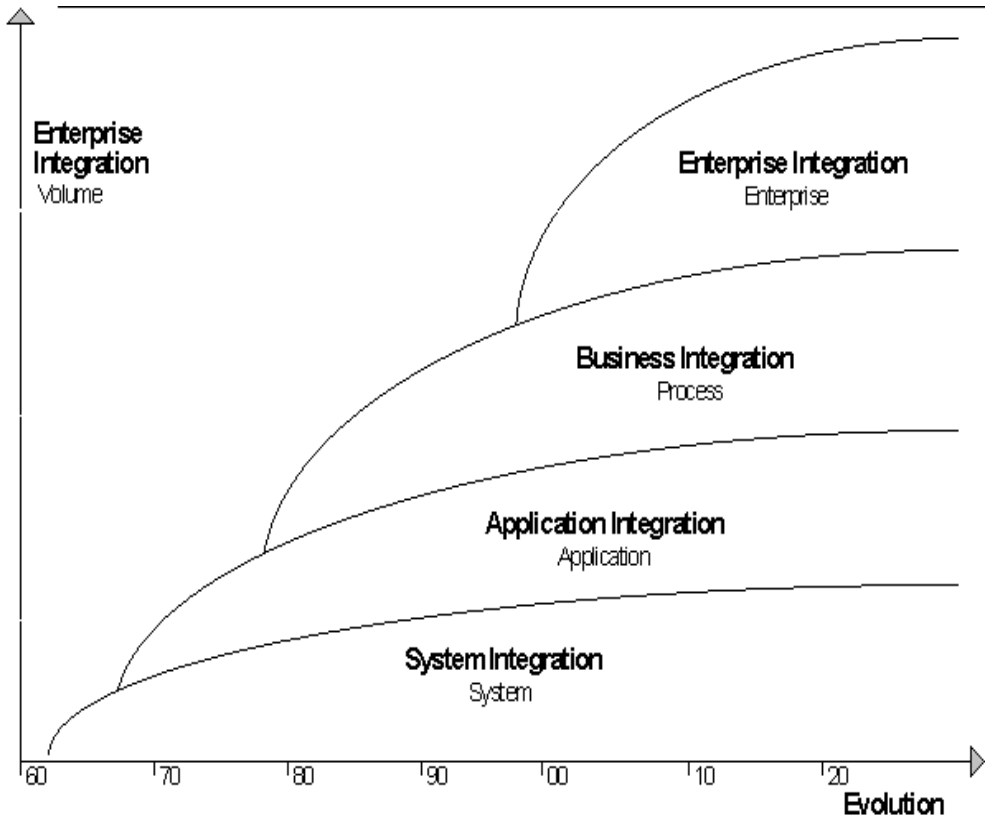

Figure 1 Evolution of Enterprise Integration [6]

1.1. What is an integrated enterprise?

Integration of an enterprise consists of putting components together to form a synergistic whole. It means integration on a grand scale, a scale that transcends traditional external and internal corporate boundaries. Enterprise inter-networking using electronic networking to form close ties with suppliers, distributors and customers. Problem solving and decision making are conducted by flexible teams cutting across the individual enterprises and distributed over time and space. It is a combination of horizontal integration for a better control of material and information flow and a vertical integration for efficient control of the decision flow. In essence EI is concerned with facilitating information, control and material flow across organisational boundaries. This is done by connecting all necessary functions and heterogeneous functional entities in order to improve communication, cooperation, and coordination within the enterprise so that the enterprise behaves as an integrated whole, therefore enhancing its overall productivity, flexibility and capacity for management of change.

2. Enterprise Integration: Strategic Issues

There are five issues that represent the future of manufacturing systems. So, enterprises should be aware of the following points when moving in the direction of coordinating and conducting distributed process business [8]:

2.1. Reduced product life cycles

Customer awareness of technological development on a global scale, electronic communications, close coupling of the customer to the manufacturing source have all led to reduced product life cycles. When moving in the direction of coordinating and conducting distributed process business, enterprises will have to be aware that the reduction in product life cycles will have to raise the flexibility in their enterprises to new levels. Advanced networks and closer connections to the customer will require much less inventory. Relatively expensive products will likely nearly all be made to order. Buyers will place most orders interactively through their own computers.

2.2. Time based-competition

The quicker a product can be placed on the market the higher price the product can demand. The generation, communication and application of ideas and their application in products is the core of fast time to market. When moving in the direction of coordinating and conducting distributed process business, enterprises must be open to the communication input increasing reliance on the cross border enterprise, including input from the customer. Not only are the basic computer processors becoming faster and cheaper, but communication high-speed links will soon allow true enterprise integration through inter workstation data transfers that are faster than today's mainframe. I/O channel speeds, making improved coordination and greater concurrency of activities possible through improved access to information from remote workstations. For manufacturing, this means that these powerful new workstations will allow feature-enriched solids modeling and simulation to replace prototyping. Concurrent design, not only in engineering and manufacturing, but also of the marketing program sales plan, will lead to short production runs and rapid product change with little or no physical prototyping.

2.3. Total product life cycle

Manufacturing enterprises are forced to take responsibility for the total life cycle of the product, including the environmental effects and the costs of disassembly, disposal or refurbishment. Networking enterprises can be seen to be responsible for and involved in the integration of the whole product life cycle, from material procurement, to production, to customer service and finally to end-of-life product handling.

2.4. Creating effective organizations

The cross border enterprise focuses on the horizontal communication chain in order to form effective organisations. Teams of people will co-operate across the value chain. Therefore each member (link) in the chain understands how its activities add value to the customer. It is stated that the hierarchical authority systems prevalent in vertically integrated industrial firms are slow to identify rapidly changing customer requirements and to react quickly with creative product offerings. Now, vertical businesses and organisations, are quickly becoming things of the past. Businesses are now becoming flatter (horizontal as opposed to vertical)Horizontal integration concerns physical and logical integration of business processes from product demand to product shipment, regardless of the organizational boundaries.

2.5. Adopting an appropriate manufacturing strategy

The determination and implementation of good manufacturing strategic decisions in any enterprise has and will be recognised as one of the sources of advantage in today's competitive market. The greater the cooperation across the value chain, the greater the satisfaction of customer needs. Many manufacturing industries have already been carrying out their business to allow for this new concept. For example, Just in Time, Manufacturing Resource Planning, World Class Manufacturing and Benchmarking have all helped in the understanding of this concept. This concept requires that in order to conduct and coordinate distributed business processes the enterprise should be a knowledge-based organisation that uses the distributed intellectual strengths of its members, suppliers and customers.

3. Enterprise Integration: Models

In order to enable consistent modeling of the enterprise operation the modeling process has to be guided and supported by reference architecture, a methodology and IT based tools. Enterprise Integration also known as "Customer oriented manufacturing management system" and has evolved from a number of preceding information systems. Enterprise integration is the most recent approach to information systems design. Here the goal is to address the information needs of the entire organization as well as the customer and supplier interface. In simple

terms, EI attempts to create a complete information processing system to serve both functional requirements and the corporate business objective of companies in real time. This leads to the emergence of a number of reference architecture, which proposes a conceptual framework and associated methodology to support the life-cycle stages of an integrated manufacturing enterprise

3.1. CIMOSA

Computer integrated manufacturing open system architecture (CIMOSA) is aimed at the development of open reference architecture for the definition, specification and implementation of CIM systems. The intention is that the manufacturing system is to be designed, modified and run under the control and motivation of the business enterprise. This way, the technology is logically separated from the business but responds to and serves the business objective. The CIMOSA framework has 3 levels of architectural genererericity. These levels contain all the constructs required to gather the user requirements for this system operation and to translate these requirements into a consistent system description and implementation. The particular level is identical with the particular architecture. As such it contains specific requirements for the specific enterprise operations and all the specified, selected and implemented system components which satisfy these requirements. The 3 modeling levels of CIMOSA consist of 'definition' (the requirements modeling definition level), 'design' (the design specification modeling level) and 'implementation' (the implementation description modeling level)

Finally, CIMOSA provides four different types of views: Function view, Information view, Resource view and Organization view.

The function view is the representation of the enterprise operation in terms of a set of hierarchically structured business processes. Each business process is defined by its triggering events, the results it produces and by its explicit control flow description.

The information view, on the other hand, gathers all the information defined and contained in the enterprise. This information is structured through a hierarchically defined set of information classes and through a set of schemata based on a 3-schema approach. [6]

3.2. PERA

PERA (Purdue Enterprise Reference Architecture) developed at Purdue University recognizes the fact that many human functions (especially innovative) cannot be implemented on computer. Therefore, the main focus of PERA is to separate human based functions in an enterprise from those with a manufacturing or information perspective [1], [6], and. PERA takes an enterprise task and puts it into one of the 3 categories:

a) Information system tasks b) Manufacturing system tasks c) Human based (organisational) tasks

PERA takes two views of the enterprise, a functional view and an implementation view. Both information and manufacturing streams flow throughout the two views. The functional view consists of an information functional model and a manufacturing functional model. The information stream consists of planning, scheduling, control, and data management functions whereas the manufacturing stream consists of physical production functions. The implementation view consists of the information architecture and the manufacturing architecture. The information and manufacturing architecture is broken down into information systems architecture and a human and organisational architecture. The manufacturing architecture on the other hand is divided into manufacturing equipment architecture and a human and organisational architecture. In fact, the human and organisational architecture bridges the gap between the information and manufacturing architecture.

3.3. TOVE

TOVE (Toronto Virtual Enterprise), developed at the University of Toronto, takes note of the fact that currently, computer systems that support enterprise functions are created independently, and this leads to problems when integrating the enterprise [6], [10]. The problems are functions do not share the same representations of enterprise knowledge and therefore cannot share knowledge. The use of semantics in defining the above representations is

weak, and therefore the interpretations and uses of the knowledge are inconsistent. The goal of TOVE is to create a data model that will solve the above problems by providing a shared terminology for the enterprise that each agent can jointly understand and use. TOVE attempts to accomplish the goal by defining a generic level representation that includes the representations of time, causality, activity and constraints. This generic level is defined in terms of a conceptual level based on a certain terminology. TOVE approaches the second and third goals by defining a set of axioms (or rules) that define common sense meanings for the terminology.

3.4. GERAM

The GERAM (Generalised Enterprise Reference Architecture and Methodology) framework defined by the International federation of automatic control/International federation on information processing task force provides the necessary guidance of the modelling process and enables semantic unification of the model contents as well. The framework identifies the set of components necessary and helpful for enterprise modelling. The general concepts identified and defined in the reference architecture consist of life cycle, life history, and model views among others. These concepts help the user to create and maintain the process models of the operation and use them in her/his daily work. Operational models may cover both intra and inter organisation operation and thereby allow to model interactions with customers, suppliers or supporting organisations such as banks and distributors. With operational models providing interoperability, new paradigms like extended and virtual enterprise will be supported enabling faster and more efficient establishment of temporal cooperation [6].

4. Conclusion

Enterprises can no longer be seen in total isolation. Individual enterprises must work together across the value chain in order to fulfil customer needs. The challenge for the future of any enterprises is to consider the new concept of conducting business and to facilitate inter-enterprise networking across the value chain. In doing so, smaller firms will be able to gain the economies of scale of larger companies. On considering emerging enterprise modelling and integration theory and practice, the need to understand the nature of mapping between business, application and physical integration processes was highlighted as a definitive need to understand the nature of connections between various modelling perspectives, life-phases and levels of genericity. EI is a result of the natural propagation of MRPII and CIM to link together not only the entire organisation, but also its suppliers and customers; it is a complete integration of the activities along the value chain. Hence, it is not surprising that many vendors of MRPII and CIM system are scrambling to update and expand their systems so as to be able to offer an enterprise integration system. Finally EI can be envisioned as a complete redevelopment of the information system infrastructure. Not all technologies will apply to every business. Each business however will have to evaluate it for themselves. They can help in this evaluation if they understand the way their competitors and other leaders are using these technologies. Therefore, "bench- marking" is a very important practice that can help determine the practical value of specific technologies in certain types of industries and applications. You will need to benchmark both the effectiveness and the efficiency of producing the key deliverable, which may be a product ,service , or a document. It needs to be the eyes of the receiver , whether that is an external customer or internal customer to your organization.

5. Future Research

The business model is not a static model. The model, once designed, allows the information technology professional to develop the information system that will promote enterprise integration. However, the business model must be re-evaluated periodically. As the business environment changes, the model must be modified to incorporate these changes. It is management's responsibility to determine when to re-evaluate the business model and whose responsibility will it be. This re-evaluation is critical to the long-term success of EI and therefore more work must be done in this area. EI requires a fundamental re-thinking of how the organisation does business and therefore, a change in the mindset within the corporation. How this re-thinking will be instilled into all employees has not been discussed. Employees and managers will have to change the way they are working. With technology changing so rapidly, it is hard for companies to determine their current technology needs for EI, let alone predict future needs. EI represents the whole process chain from supplier to customer. This requires that the information systems that companies are using must be compatible with those of their customers and suppliers. This is a formidable task considering each company within the value chain could have different levels of computer automation, as well as information systems. Therefore, research must be conducted on how to determine the proper level of computer automation within an organisation as well as the system requirements in order for EI to be successful. Having the capability to share information easily within your organisation, as well as with customers and suppliers will

theoretically help the organisation. However, the costs of EI must be determined and will be beneficial in terms of the large sums of money being invested towards EI. Including monetary and non-monetary costs/benefits will allow organisations to determine if they should pursue EI. The current economic disorder on the international scene is forcing enterprises to slim their manufacturing and management operations to be more productive and efficient. The realisation of EI is successful only when true information exchange within the enterprise and even outside the enterprise in a vendor and IT solution independent environment is achieved.

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