Enterprise Integration in a Manufacturing Environment

Micheal Anderson

Western Kentucky University

Abstract

Enterprise integration in a manufacturing environment can give way to new possibilities that allow a company to prosper and stay current with what customers want. EA is a structured framework with each company moving through the 4 stages, which are business silos, technology standardization, core-business optimization, and business modularity. ERP, IERP, and SCM software has allowed manufacturing companies to successfully incorporated enterprise integration into the business processes. ERP when implemented in a manufacturing environment had limitation and IERP made up for and solved the limitations. Some of the limitations that ERP has are difficult configuration and no room for adaptability. Manufacturing has benefited from enterprise integration and the software that is used to provide this integration.

Enterprise Integration in a Manufacturing Environment

Technology has created the ability to overcome drastic hurdles in all aspects of business and manufacturing. The advancements in technology has paved the way for new and improved ways of handling whole manufacturing processes and allowed companies to improve, perfect, and integrate their manufacturing process to improve production and customer satisfaction. Enterprise architecture and integration has opened up the door to make these improvements possible, by integrating and controlling the whole supply chain process and offered businesses the tools to perfect their business processes. Kappelman & Zachman (2013) state, "We are blessed with and evolving abundance of wondrous new IT products for supporting just about and activity, function, process, or service, as well as for storing, virtualizing, switching, serving, powering, monitoring, trouble shooting and managing IT itself" (P. 87). This paper will introduce and explain the definition and purpose of enterprise architecture, the stages of enterprise architecture, the purpose and benefits of enterprise integration, the different categories of integration, and briefly discuss the tools used to manage integrated enterprises. Enterprise integration in a manufacturing environment has allowed businesses to continue to evolve and improve on the production processes in order to stay competitive and excel in the ever growing business market.

Enterprise Architecture

Enterprise architecture or EA is a broad term that is difficult to explain and is based on the concept of a shared infrastructure and language that allows for successful management of a corporation. It helps if you look at it, not as a whole, but as individual pieces. An enterprise is a company that provides a product or services and has a mission or goal that guides the company's overall business decisions. An enterprise can be large or small and is not categorized by its size,

but by its overall ambitions and goals. Architecture is the structure, which is efficient, adaptable, and allows a company to maintain its overall goals and keep up with the changing market. Enterprise architecture is not a permanent structure, it can be can shaped and molded to fit the needs of the business at any given time throughout the company's lifetime. Business needs and trends change rapidly and every successful company must keep up with this change to have continual success EA involves more than just the business processes and workflows, but it encompasses the people, services, and goods and how all these pieces fit together. How all of these pieces fit together determines how a company accomplishes its overall business goals and how theses goals support the overall business structure. EA also defines how a company can handle and adapt to change. EA is defined by Bijata and Piotrkowki as "… a formal description of the structure and functions of the components of an enterprise (including people, processes, information and technologies) the interrelations between these components and principles and the guidelines governing their creation and development over time" (p. 181). EA is an ever evolving concept and a company starts out at the bottom and progress through several stages, with some never reaching the top.

Stages of Enterprise Architecture

Enterprise architecture is modeled in a tier based format with different layers that represent where a company stands in overall cohesion and integration. There are four levels of enterprises architecture and a company is ranked and critiqued against each layer to see were they fall in terms of goals and functions. The four stages of enterprises architecture are business silos, technology standardization, core-business optimization, and business modularity. In each stage the company has certain characteristics, such as modularity, cohesion, integration, and automation, which can determine how dedicated and advanced a company's enterprise system is

and the company's maturity level. On average each stage takes around five years to complete depending on the overall dedication of the company and the amount of mistakes the company makes along the way. Gruman writes, "Each stage takes about five years to get through, says Ross, though that period could shorten as more companies go through the process and learn what missteps to avoid" (2006, Para. 7). A vast majority of businesses never make it to the final stages of enterprise architecture, but remain in the first two stages forever.

Business Silos

The first stage, business silos is focused and implemented at the local level. Each business application, process, and department, functions independently and offer no or very little integration of the various business processes and functions throughout the different departments. Each location within the company is focused on improving its individual area and not the company as a whole. At this stage, the company's architecture is made up of independent platforms that don't have shared or a standardized technological infrastructure. The various systems throughout the company may or may not be similar technological platforms. The leaders of each department drive the IT goals and are focused on their individual departments instead of the company as a whole. According to Bijata and Pitrkowski, "People who drive IT investments are business leaders of each unit and investments are focused on fulfilling local requirements and automating local business process" (p. 185).

Standardization Technology

The next stage in the evolution of enterprise architecture is standardized technology. At this stage the company has adopted and implemented a standard technological platform in all areas of the company. Although there is a standard technological platform the department and individual areas are not connected and are not able to seamlessly share information. This can pose a

problem because there can be multiple files and programs that perform the same function, but in different departments. Since the departments don't have any form of shared information each file or program has to be recreated for each department. Data and applications are still implemented and controlled at the local level, instead of on a global or company wide basis. Company goals and strategies are based on improving all the individual departments throughout the company. "Investments into infrastructure are focused on fulfilling requirements of all units in the organization" (Bijata & Pitrkowski, p. 186).

Core Optimization

The third stage of enterprises architecture is the optimized core. At this stage to company moves to a more global infrastructure and works toward full business integration. Core optimization focuses on shared data and applications and integrated information systems. Feurer (2007) states, "…companies view data and applications from and enterprise perspective and so mainly focus on shared data and enterprise systems" (p. 5). At this stage, business strategy and goals are no longer dictated at the local or department level, but are planned and implemented with the entire business process in mind. At this stage business discussions are removed from the hands of local department leaders and mangers and handed to the executives and upper management. This allows the decisions to be made with the entire company in mind, so every department can benefit from the changes. Local managers and teams leaders may reject this stage; since the power is being taken from them.

Business Modularity

Business modularity is the fourth and final stage of enterprise architecture and it builds upon the previous stages. At this stage business processes are looked at as modular units that are well defined and efficient. These modular units can be implemented and formatted for different

objectives throughout the company. They offer a reusable framework to work from, which increases the speed and improves on the development of new business processes. Business modularity provides the best solution for the business from the global and local levels. Companies at this level can offer rapid deployment of new ideas to give the individual employers the ability to add and implement the suggestions of the people that work with the systems on a daily bases and know the faults, benefits and how to improve the business process. Being able to take and apply the suggestions of the people in control of the individual areas give them a feeling of power and the feeling that they are a part of the overall enterprises architecture. "In other words, Business modularity architectures decentralize decision-making by handing the tools to the line managers and thus creating a proactive, innovative climate", (Feurer, 2007, p.6).

Each stage of enterprise architecture defines how mature a company is and how a business defines its business processes and describes who and at what level decisions are made within the organization. See Table 1. Table 1 has four column one for each of the stages of EA and four rows for different parts of an EA. It then matches each part up with each stage in the evolution or EA. Local is when decisions and implementations happen at a department level, global is when they happen at the company or upper-management level, and modular can be used as both local and global.

	Business Silos	**Standardized Technology**	**Core Optimization**	**Business Modularity**
Infrastructure	Local	Global	Global	Global
Data	Local	Local	Global	Global
Application	Local	Local	Global	Modular (Both)
Decision Makers	Local Business Leaders	Local Business And IT Leaders	Top Management	IT Leaders, Business, and Specific area Leaders

Table 1

Enterprise Integrations

Enterprise integration or EI is closely linked to enterprise architecture and is a major yet challenging goal for many successful companies. “EI has now become a key issue for many enterprises and is considered to be a major challenge of these times” (Li Da Xu, 2014, p. 35). Enterprises integration is the method of tying the various enterprise systems, both intra and inter-organizational, applications together to incorporate and streamline all business processes to perfect and create the most efficient business model possible. EI is the process in which business and information technology are merged and forced to work together to provide the necessary tools to provide a high quality enterprise system. The purpose of EI is to integrate all parts of an enterprise system to perform a certain business goal. In order to achieve EI you must consider and implement physical integration, application integration and business integration. Physical integration is probably the easiest one to achieve, because it is the physical connection. Physical integration involves connecting all the various devices that are used in the enterprise environment. Application integrations is the process of integrating the various software application in the organizations enterprise, this could be database systems, inventory systems, or order entry systems. Enterprise integration can be achieved through a variety of frameworks, models, and specialized software. The needs of the overall company will determine how and why enterprise integration is needed.

Manufacturing Integration

Enterprise integration in a manufacturing environment in used to integrate all the components the manufacturing process. The theory of complete integration in the manufacturing community has only been around for a short time. As stated by Li Da Xu, “…complete

integration across the entire manufacturing process is a relatively new, as it was virtually nonexistent in early 2000" (2014, p.42). Manufacturing integration is the process of integrating and refining the complete manufacturing process. This evolves streamlining the complete manufacturing process from beginning to end or from raw material to finished goods. The whole manufacturing process is made up of research, design, manufacturing and fabrications, logistics, and the customer. The customer in one of the key components of the manufacturing process because the manufacturing process begins with costumer needs and then ends with the customer getting a final product. The process of taking care of the customer and making sure their expectations of the product or service are met is called customer integration. Another important element of manufacturing integration is the engineering integration, which is the process where all research and design is done. Enterprises integration in a manufacturing setting is made up of manufacturing integration, customer integration, and engineering integration.

Engineering Integration

Engineering Integrations is research and design that goes into every product before production starts. Research and design can be a onetime event or a continual cycle with constant improvement on the product or products produced by the business. A large portion of the cost of the product is tied up and determined during the initial design phase. This stage is where all the details are worked out and the product designs are produced before moving on to the manufacturing process. There are many design methods, but one that is extremely important and has grown in popularity is concurrent design. Concurrent design is the processes of working on multiple individual tasks simultaneously that are all integrated and tied together to create the final product. Concurrent design is important in complex processes and provides a better design when used in manufacturing enterprise systems. As stated by Li Da Xu (2014), "Concurrent

design has become increasingly important in designing complex products. When it is implemented in manufacturing ESs along with engineering integration, it is likely to generate better design" (p. 47). Computer Aided Design (CAD) / Computer Aided Manufacturing (CAM) have changed the way and efficiency that the engineering process is done. CAD allows for computerized drafting, design, and prototyping of products without the need to spend a lot of money on trial and error design. CAD allows for the design and planning while CAM links the plans and blueprint to the manufacturing side of the process. CAD/CAM uses advance technology along with special programs to plan, design, and create what the enterprises business goals set out to do. Mankute (2014) states, "Design, planning and manufacturing control functions must be fully integrated using special models, genetic algorithm-based approaches…" (p. 234).

Customer Integration

The one thing every business has in common is the need and importance of customers. Customer demand is what drives a business and create the opportunity for an enterprise to grow and be successful. "As customers play a critical role in the operations of an enterprise "customer integration" takes care of the activities involved in customer relations" (Li Da Xu, 2014, p. 40). Customer integration can create innovative openings by bringing the customer into enterprise integration. The customers can provide intelligent suggestions and they know what they need, so being able to collect data about customer behaviors, ideas, and needs can keep an enterprise ahead of the curve and competitive. "The term "customer integration" describes a wide array of methods to import intelligence about customers' values and behaviors" (Li Da Xu, 2014, p.50). Customer relationship management or CRM is the solutions to maintain quality customer relations both current and potential customers. CRM system is an efficient method of integrating

customers with the enterprises system. CRM can be implemented as a standalone software process or as a module of the existing enterprise architecture.

Enterprise Resource Planning

In the early day of enterprises integration in manufacturing everything was accomplished by separate autonomous systems. These independent systems all ran on separate platforms and communication between systems was rare and difficult to accomplish. In the 1990 this was overcome by the development and release of ERP or Enterprise Resource Planning. ERP opened up the door to integrating all of the various business processes, such account receivable, finances, scheduling, and inventory. One to the greatest achievements of ERP was that it could manage large databases that are able to track and keep up with large amount of company resources. Aguirre, Carreno, Vega, Catellanos, and Hernandiz (2011) explains, "The most significant achievement of enterprise resource planning systems has been to provide an integrated and consistent database spanning large parts of an organization (Weske, 2010)" (p. 417). In 2009 Industry-oriented Enterprises Resource Planning was introduced and overcame some of the sort coming of ERP in the manufacturing environment. According to Li Da Xu (2014), "General-purpose ERP systems usually have problems such as complex configurations processes, a low ability to adapt to specific industrial sectors, and an extensive implementation time period" (p. 60). EIRP introduces a five layer design that allowed it to eliminate some of these problems with ERP. The five layers are: server layer, teamwork supporting layer, IERP construction and customization layer, reusable assets toolset layer, and the IERP system instance layer. IERP is designed and geared toward the industrial sector and with the layered design it offers a customizable framework that can be better implemented to fit the needs of multiple manufacturing environments.

Supply Chain Management

Supply chain management is another important concept in the manufacturing environment. Supply chains encompass the whole manufacturing process, from beginning to end. This doesn't just include the production of the goods, but the vendors, suppliers, warehousing, logistics and retail outlet are all involved and part of the supply chain. According to Kram, Tosanovic, and Hegedic (2015), "A supply chain consists of all stages involved, directly and indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer and suppliers, but also transport, warehouse, retailers, and customers themselves" (p. 161). Supply Chain Management software provides the tools and resources to successfully manage the whole manufacturing and supply chain process to better improve customer satisfaction. Radio frequency identification (RFID) tags have provided major advantages to supply chain management. RFID allows company to track their product throughout the whole manufacturing process.

Conclusion

Enterprises integration in a manufacturing environment can be a challenging drawn out process that never ends. Each company will start at the bottom of the enterprises architecture and work their way up as the company progressively matures through the process of reengineering business processes to become a more integrated and will organized corporation. Enterprise integration involves different parts of the business to become incorporated and managed. Research and design is a necessity and is taken care of with the process of engineering integration and customer satisfaction is taken care of with customer integration. The various tools and technological resources that provide the ability of enterprise integration have grown and improved over the past several years. Some of these technologies are ERP, IERP, and SCM

to name a few. These enterprise integration tools have allowed for manufacturing company to prosper and continually evolve in an ever changing market.

References

Aguirre, H., Carreno, J., Castellanos, J., Hernandez, Y. & Vega, C. (2011). Evaluation of Integration Approaches Between ERP and BPM Systems. *Ing. Univ. Bagato (Colombia)*, 16(2), 415-431.

Bijata, M. & Piotrkowski, K. (n.d.) Enterprise Architecture as a Tool to Support the Strategic Management Processes in an Organization. *Hyperion International Journal of Econophysics & New Economy,* 177-189.

Feurer, Sven. (2007). Enterprise Architecture – Maturity Stages. *SAP Seutshland AG & Co. KG.*

Gruman, Galen. (2006). *The Four Stages of Enterprise Architecture.* Retrieved from http://www.harbott.com/2011/12/15/the-four-stages-of -it-architecture-maturity/

Kram, M., Hegedic, M. & Tosanovic, N. (2015). Kaizen Approach to Supply Chain Management: First Step for Transforming Supply Chain into Lean Supply Chain. *Annals of Faculty Engineering Hunedoara – International Journal of Engineering,* Fascicule 1, 161-164.

Kappelman, L. & Zackman, J. (2013). The Enterprise and its Architecture: Ontology & Challenges. *Journal of Computer Information Systems, 8-95.*

Li Da Xu. (2014). *Enterprise Integration and Information Architecture: A System perspective on Industrial Information Integration.* Boca Raton, FL. Taylor & Francis Group.

Mankute, R. (2014). Integrated Structure of Manufacturing Data for Computer Aided Manufacturing Engineering. *Mechanika,* 20(2), 234-240.