A MODEL FOR E-COLLABORATION IN THE SUPPLY CHAIN

Hulya Julie Yazici, Lee Kirche, Walter Rodriguez, and Dahai Guo
Florida Gulf Coast University, The Lutgert College of Buisiness
Fort Myers, FL 33965
hyazici@fgcu.edu

ABSTRACT

Current supply-chain information technologies (IT) allow managers to track and gather intelligence about the customers purchasing habits. However, collaborative operating relationship with partners is difficult to manage and much more is needed to anticipate demand and reduce uncertainty throughout the complex supply chain networks. A system architecture is proposed for sensing, analyzing, and responding to supply-chain demands and making real-time decisions under risk and uncertainty. This e-collaboration model integrates real-time electronic communications, information-sharing, and materials-flow as well as monitors the supply /demand processes.

INTRODUCTION

The inability to accurately forecast demand, coupled with incomplete information sharing increases variability in the supply chain, best characterized as the bullwhip effect [22]. A key approach to mitigating supply chain uncertainty is an improved “end-to-end” visibility. Although the emerging technology RFID (Radio Frequency Identification) holds the promise of closing information gaps in the supply chain providing real-time visibility, there has not been a representational framework of inter organizational information sharing, and the lack of well-defined and integrated e-supply chains is noted by several researchers [17], [18],[19],[21]. Collaborative decision-making can help to reduce the induced variability associated with the bullwhip effect and lead to effective supply chain planning and execution [4]. E-sensors offer a more proactive solution to current ERP systems by giving them the ability to process in real time relevant constraints and simultaneously order the necessary material type and quantities from multiple sources. Furthermore, IT/operations managers can “embed decision-making capabilities in the normal flow of work” [5].

A system architecture is proposed for sensing, analyzing, and responding to supply-chain demands and making real-time decisions under risk and uncertainty. The data collection and availability provided by the e-sensing infrastructure/architecture allows for an effective collaborative environment, improves forecast accuracy and increases cross-enterprise integration among partners in the supply chain.

E-Collaboration

SCM is the art and science of creating and accentuating synergistic relationships among the trading partners in supply and distribution channels with the common shared objective of delivering products and services to the ‘right customer’ at the ‘right time.’ [22]. In the e-collaboration/e-business context, SCM is concerned with these synergistic communications, relationships, activities and operations among the e-trading partners (producers, manufacturers, services providers, suppliers, sellers, wholesalers, distributors, purchasing agents, logisticians, consultants, shipping agents, deliverers, retailers, traders and customers) as well as improving their operations throughout the products' or services. SCM involves studying the movement of physical materials and electronic information, including transportation, logistics and information-flow management to improve operational efficiencies, effectiveness and profitability.

Integrated SCM systems can enhance decision-making by collecting real-time data and information as well as assessing and analyzing information and knowledge that facilitate collaboration among trading partners in the supply chain. "To achieve joint optimization of key SCM decisions, it is preferable that there be a free flow of all relevant information across the entire chain leading to a comprehensive analysis" [22]. As shown in Figure 1, IT systems, such as, Enterprise Resource Planning (ERP), Point of Sale (POS), and Vendor Managed Inventory (VMI) systems permit and, to some extend, automate information sharing (.

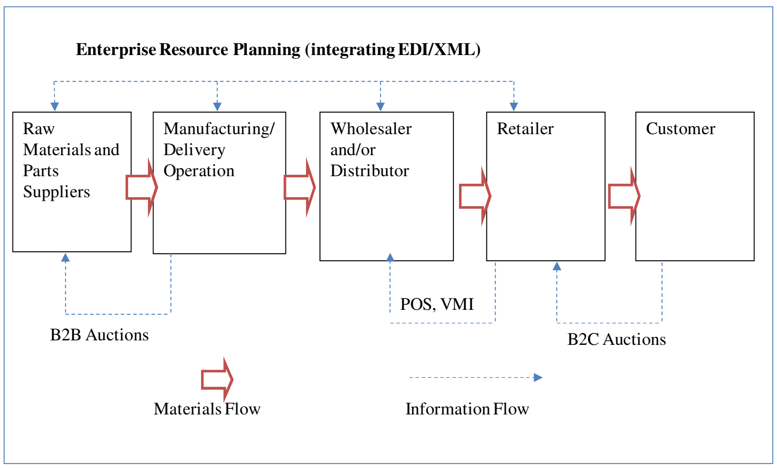

Figure 1. Information flow using electronic information technologies in the supply chain

The advent of reliable communication technologies has forced business partners throughout the supply chain to rethink their strategies as well as change the nature of the relationships with suppliers and customers. Companies that have made the shift have benefited from: "reduced operating expenses, increased revenue growth, and improved customers levels," according to IBM ERP/Supply Management Division. According to the same source, the companies that have implemented supply chain improvement projects have been able to increase forecast accuracy and inventory reduction (up to 50% in overall improvement!). Some of the newer activities being implemented include: supply-and-demand auctions, integrated collaborative product design (CAD/CAM), cross-enterprise workflow processes, demand management collaboration. In addition, some companies are even deploying SCM as an offensive tactic to gain a competitive edge [4].

Swaminathan and Tayur [19] have presented models for supply chains in e-business. They discuss the major issues in traditional supply chain management and supply chain issues of visibility, and real-time decision technologies arising from the increased prevalence of e-business. Others have noted the lack of well-defined and integrated e-supply chains [21]. The interest in the use of information technology in supply chains has been growing, especially with the trend towards e-business [20], [16], [18]. Computer agent based systems have been proposed to reflect real world human based systems. The focus is on how such systems can assist and supplant human-based interaction and decision-making.

E-collaboration and inter-organizational information sharing encompasses both the management of explicit and tacit knowledge. Explicit knowledge can be easily codified, such as facts, axiomatic propositions, and symbols that provide information on the size and growth of a market, production schedules, and inventory levels. Several researchers investigated inventory information flows in supply chains [17]; [11]. On the other hand, tacit knowledge is know-how that is rooted in action, is complex, and difficult to codify, and often requires experiential learning. More importantly, tacit knowledge is contextual, held informally, and gained through experience and interactions among individuals and processes. Tacit or informal internal knowledge is in the minds of people in the organization, such as insights, intuitions, and hunches [10]; [15]; [9].

Tacit knowledge, because is difficult to articulate, is more challenging to transfer than external or explicit knowledge, and is best transferred through rich communication media such as observation [14]; [23]. Challenges of managing tacit knowledge and influence of organizational factors are recently studied [1]. When knowledge is tacit and takes the form of collective know-how, or tasks that require reciprocal coordination, the transmission of knowledge is complex. This complexity affects the rate of performance, as coordinating tasks across disciplines vary [6]. Similarly, creation, retention, and transfer of tacit knowledge among diverse supply chain partners is complex, and performance is likely to be difficult to predict and vary. As the approach proposed is based on explicit knowledge such as quality, cost and delivery schedule of the potential vendors, research is needed to explore how tacit knowledge can be best transferred. Although, inter-organizational learning practices has been tackled recently by several researchers, more research is needed in the effective collaboration and transfer of know how.

E-Sensoring

Artificial intelligent agents (or e-bots) can be deployed throughout the supply chain to seek data and information about competitive pricing; for instance, e-bots can search for the cheapest supplier for a given product and even compare characteristics and functionality. For this reason, the concept of an agent is important in both the Artificial Intelligence (AI) and the Supply Chain Management fields.

The term "intelligent agent" or "e-bot" denotes a software system that enjoys at least one of the following properties: (1) Autonomy; (2) "Social" ability; and (3) Reactivity. Normally, agents are thought to be autonomous because they are capable of operating without direct intervention of people and have some level of control over their own actions [3]. In addition, agents may have the functionality to interact with other agents and automated systems via an agent-communication language [8]. In this proposal, this agent attribute is termed *e-sociability* for its ability to interact with either people, or systems (software).

The researchers understand that the next evolution of the intelligent agent concept is the development of integrated hardware-software systems that may be specifically designed to sense (perceive) and respond (act) within certain pre-defined operational constrains and factors, and respond in a real-timely fashion to changes (not a just-in-time fashion) occurring throughout the supply chain. These integrated hardware-software systems are termed e-sensors, in this architecture, will be the collectors of data for the system. E-sensors bring a real opportunity for process innovation, although organizations will need to create new business applications to put e-sensors at the centre of a process (if they want to be competitive in this new supply chain environment.) Aside from data and asset tracking, each industry will have specialized applications of e-sensors that cannot be generalized.

Additionally, it is not simply gathering data, but interpreting incomplete and imprecise information and tacit (human) knowledge that provides the real advantage of developing the e-sensors. Companies like Cisco, Dell, IBM and Wal-Mart have led the development of responsive global supply chains. These companies and a few others have discovered the advantages of monitoring changes in near real-time. By doing so, they have been able to maintain low inventories, implement lean production and manufacturing operations, and even defer building and assembly resulting in lower costs and increase responsiveness to variable customer demands. This practice can be extended to incorporate e-sensors and human collaborators throughout the value chain and perceive and react to the demands.

SYSTEM ARCHITECTURE

The selected communication architecture is based on CORBA (Common Object Request Broker Architecture), a standard solution available from multiple vendors [2]. CORBA is an open system middleware with high scalability and potentially can serve an unlimited number of players and virtually any number of business processes and partners in the supply chain environment. As a communication infrastructure, it enables an integrated view of the production and distribution processes for an efficient demand management. Compared to other architectures in supply chain management, CORBA offers access to lower level facilities for product, sales and marketing information, and is more flexible and responsive to real-time changes. It allows combining hardware and software from different vendors, on a plug-in basis, thus increasing efficiency and improving timeliness in decision making.

The proposed architecture presented in Figure 2 enables important data sharing capability to partners illustrated in Figure 1. It allows the wholesaler/distributor direct access to the assembly lines of the manufacturers and their shipping/transportation data via the Operational Data Server. Full communication with the retailers is available. The wholesaler/distributor company has partial access and control over the Financial Data Server and Optimization Server of the manufacturers.

The goal of the proposed real-time system based on this architecture is to dynamically integrate end-to-end processes across the organization (key partners, manufacturers and retailers) to respond with speed to customer changes and market requirements. The real-time CORBA framework enables employees to view current process capability and load on the system and provide immediate information to customers, by enabling tuning of resources and balancing workloads to maximize production efficiency and adapt to dynamically changing environment.

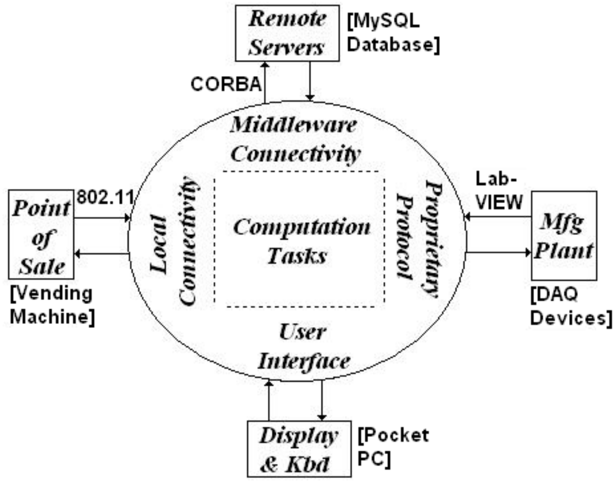

Figure 2. Context Diagram of the Distributed Information System
(DAQ: Data Acquisition and Control, 802.11: IEEE Std 802.11 for Wireless Networks, SQL: Standard Query Language)

CONCLUSION

This research proposes a real-time information system architecture for collaborative efforts (e-Collaboration) that, once fully developed, will increase the collective ability of supply chain partners to manage uncertainty. By bringing key operations and up-to-date information into visibility, the collaborative process can be sustained with less effort to maintain a competitive edge under adverse conditions. By employing e-sensors and open system middleware architecture, the collaborative decision-making process can help to reduce the induced variability associated with the bullwhip effect and lead to effective supply chain planning and execution. Consequently, the role of information sharing becomes increasingly important as more and more decision-makers collaborate with their upstream and downstream supply chain partners.

References

[1] Argote, L., McEvily, B., and Reagans, R. 2003. Managing Knowledge in Organizations: An Integrative Framework and Review of Emerging Themes, *Management Science*, 49(4), 571-582.

[2] Bolton, F. 2002. *Pure CORBA, A Code-Intensive Premium Reference*, Sams Publishing, USA, 1st. Ed.

[3] Castelfranchi, C. 1995. Guarantees for autonomy in cognitive agent architecture. In Wooldrige, M. and Jennings, N. R. (Eds.), *Intelligent Agents: Theories, Architectures, and Languages*, 890, 56-70. Heidelberg, Germany: Springer-Verlag.

[4] Cross, G. J. 2000. How e-business is transforming supply chain management. *Journal of Business Strategy,* 21(2), 36-39.

[5] Davenport, T.H., and Harris, J.G. 2005. Automated decision making comes of age. *MIT Sloan Management Review*, 46(4), 83-89. [Also: Davenport, T.H., and Prusak, L. 2000, *Working Knowledge*, Harvard Business School Press, Boston, MA.]

[6] Edmondson, A.C., Winslow, A.B., Bohmer, R.M.J. and Pisano, G.P. 2003. "Learning How and Learning What: Effects of Tacit and Codified Knowledge on performance Improvement Following Technology Adoption", *Decision Sciences*, 34(2):197-223

[7] Gavirneni, S., 2002, "Information Flows in Capacitated Supply Chains with Fixed Ordering Costs", *Management Science*, 48(5), 644-651.

[8] Genesereth, M. R. and Ketchpel, S.P. 1994. Software agents. *Communications of the ACM*, 37(7):48-53.

[9] Grant, R. M. 1996. Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17:109-122.

[10] Koskinen, K.U. 2004. Knowledge Management to Improve Project Communication and Implementation, *Project Management Journal*, 35(2):13-19.

[11] Kulp, S.C., Lee, H.L., and Ofek, E. 2004. Manufacturer Benefits from Information Integration with Retail Customers, *Management Scienc*e, 50(4):431-444.

[12] Lee, H.L., 2002, Aligning Supply Chain Strategies with Product Uncertainties, California Management Review, 44(3):105-119.

[13] Lee, H., Padmanabhan, V., and Whang, S. 2004. Information Distortion in a Supply Chain: The Bullwhip Effect/Comments on "Information Distortion in a Supply Chain: The Bullwhip Effect". *Management Science*, 50(12): 1875 – 1894.

[14] Nadler, J.L., and Thompson, L. Van Boven, 2003, Learning Negotiation Skills: Four Models of Knowledge Creation and Transfer, *Management Science*, 49(4), 529-540.

[15] Nonaka, I. 1994. A Dynamic Theory of Organizational Knowledge Creation, *Organization Science*, 5(1), 14-37.

[16] Sauter, J.A., Van Dyke Parunak, H., Goic, J. 1999. ANTS in the Supply Chain, *Workshop on Agents for Electronic Commerce at Agents*, Seattle, WA May 1-5.

[17] Subramani, M.R., 2003. How Do Suppliers benefit From IT Use in Supply Chain Relationships, *MIS Research Center Working Paper # WP02-14*, Carlson School of Management, University of Minnesota.

[18] Swaminathan, J.S., Smith S.F., Sadeh, N.M. 1998 Modeling Supply Chain Dynamics: A Multiagent Approach, *Decision Sciences*, 29(3):607-632.

[19] Swaminathan, J.S., Tayur, S.R. 2003, Models for Supply Chains in E-Business, *Management Science*, 49(10):1387-1406.

[20] Subramani, M.R., 2003. How Do Suppliers benefit From IT Use in Supply Chain Relationships, *MIS Research Center Working Paper # WP02-14*, Carlson School of Management, University of Minnesota.

[21] Van Hoek, R., 2001, E-Supply Chains – Virtually Non-Existing, *Supply Chain Management: An International Journal*, 6(1):21-28.

[22] Vakharia, A.J. 2002. E-business and supply chain management. *Decision Sciences*, 33(4):495-504.

[23] Zarraga, C., and Garcia-Falcon, J.M., 2003, "Factors Favoring Knowledge Management in Work Teams", *Journal of Knowledge Management*, 7(2), 81-96.