Chapter 3.5
Beyond Intelligent Agents:
E–Sensors for Supporting Supply Chain Collaboration and Preventing the Bullwhip Effect

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ABSTRACT

This article presents a new concept for supporting electronic collaboration, operations, and relationships among trading partners in the value chain without hindering human autonomy. Although autonomous intelligent agents, or electronic robots (e-bots), can be used to inform this endeavor, the article advocates the development of e-sensors, i.e., software based units with capabilities beyond intelligent agent's functionality. E-sensors are hardware-software capable of perceiving, reacting and learning from its interactive experience through the supply chain, rather than just searching for data and information through the network and reacting to it. E-sensors can help avoid the "bullwhip" effect. The article briefly reviews the related intelligent agent and supply chain literature and the technological gap between fields. It articulates a demand-driven, sense-and-response system for sustaining e-collaboration and e-business operations as well as monitoring products and processes. As a proof of concept, this research aimed a test solution at a single supply chain partner within one stage of the process.

INTRODUCTION: FROM E-BOTS TO E-SENSORS

As e-business and e-commerce has grown, so has the need to focus attention on the: (1) Elec-

tronic communications between e-partners; (2) operational transactions (e.g., sales, purchasing, communications, inventory, customer service, ordering, submitting, checking-status, and sourcing, among others); and (3) monitoring improvements in the supply (supply, demand, value) chain of products, systems, and services (Gaither & Fraizer, 2002).

Integrating continuous communication protocols and operational and supply chain management (SCM) considerations, early on in the enterprise design process, would greatly improve the successful implementation of the e-collaboration technologies in the enterprise. It is particularly important to examine the resources and systems that support the electronic communications, and relationships among partners, in the supply chain.

In addition, there is a need for obtaining (sensing) real time data for managing (anticipating, responding) throughout the supply chain. Typically companies need to synchronize orders considering type, quantity, location, and timing of the delivery in order to reduce waste in the production and delivery process. The data collection and availability provided by the e-sensing infrastructure/architecture discussed later in this article will allow for a collaborative environment, improve forecast accuracy, and increase cross-enterprise integration among partners in the supply chain.

Current supply chain information technologies (IT) allow managers to track and gather intelligence about the customers purchasing habits. In addition to point-of-sale Universal Product Code (UPC) barcode devices, the current IT infrastructure may include retail radio frequency identification (RFID) devices and electronic tagging to identify and track product flow. These technologies aid mainly in the marketing and resupply efforts. But, how about tracking partners' behaviors throughout the chain in real time?

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 e-operations 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 (Wooldridge & Jennings, 1995). Normally, agents are thought to be autonomous because they are capable to operate without direct intervention of people and have some level of control over their own actions (Castelfranchi, 1995). In addition, agents may have the functionality to interact with other agents and automated systems via an agent-communication language (Genesereth & Ketchpel, 1994). This agent attribute is termed here *e-sociability* for its ability to interact with either people, or systems (software).

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 time 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 article. Indeed, there is a real opportunity for process innovation and most likely 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 asset tracking, each industry will have specialized applications of e-sensors that cannot be generalized. Before getting into the e-sensors details, let us review some key supply chain management (SCM) issues relevant to this discussion.