E-BUSINESS INTELLIGENT AGENTS: CONTROLLING ALL ASPECTS OF THE TRANSACTION FROM INVENTORY LOCATION TO OPTIMAL PAYMENT SELECTION

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ABSTRACT

An Internet-based intelligent agent process for small businesses and consumers was developed to facilitate the sale of excess inventory from business to consumer. An experiment building on previous work was completed to test this intelligent agent process. The research project described herein discusses the results of that experiment, which incorporated two sets of e-business intelligent agents that acted to 1) enable small businesses to obtain higher revenues for their excess inventory, and 2) enable consumers to access that excess inventory and also select a preferred method of payment, given varying parameters and values associated with those methods of payment.

INTRODUCTION

There were approximately 22.9 million small businesses with less than 500 employees, which comprised, in total number of firms, 99.7% of all employers and about 50% of all private sector employees [1]. They paid 44.3% of total private U.S. payroll and generated 60% to 80% of the net new jobs in the U.S. in the past decade [2]. When defined as independent commercial organizations with less than 10 employees, small business employed 78.8% of all U.S. businesses [2]. It is therefore clear that small businesses, regardless of which definition describes them, are vital to the U.S. economy.

The life of a small business may be short or long, depending on many factors, but in a general long-term equilibrium state, the total number of small businesses will not change considerably over time. Two of the factors that will keep that number relatively constant are the growth of some of those small businesses into larger businesses and the failure of others of those small businesses. Regardless of the specific firms that are classified as small businesses or how many there are, they will all be faced with decisions that impact their survival. At some point in the life of each of those small businesses, one of those decisions will be what to do with excess inventory. Considering the statistics presented above relating to the total number of small businesses and their impact on the U.S. economy, the overall effect of all small businesses dealing with excess inventory will carry a large national economic impact. This impact could be either positive or negative on each business and on consumers, depending on the ability of each small business to deal successfully with its excess inventory.

One way to measure the financial status of a firm is by examining the level of its excess inventory. A firm that has low levels of excess inventory does not have its own capital tied up in that inventory, thus freeing that capital to other more valuable uses in the firm. However, when negative changes occur in the economy in general or in the industry sector in which that firm participates, the firm may be left holding higher levels of inventory than it would prefer. This could come about through general trends in the economy, which the firm may be able to anticipate or at least react to in a financial viable way. However, economic impacts that drive up inventory may happen in a rapid enough fashion that the firm

is not able to react to reduce their inventory in a way that is financially best for the firm. This type of situation will lead to the firm holding more inventory than it would otherwise choose to do. In particular, excess inventory numbers for the U.S. economy in general, leading up to the year 2000, show U.S. firms holding <u>excess</u> inventory totaling \$400 billion [3].

Whereas one measure of the financial health of an individual firm is that firm's level of excess inventory, one measure of the financial health of the U.S. economy is the Inventory Ratio Index. The IRI shows, for any particular economic sector, the numeric relationship between the shipment of products (which indicates the demand for those products) and the inventory of products (which indicates the supply of products). In the U.S. economy over the past three years, there has been a slow but steady increase in the IRI, indicating that the sellers of inventory are falling behind the demand for that inventory.

While excess inventory is increasing, large organizations typically have formalized corporate mechanisms for managing that excess inventory. They have the resources available within their organizations to set up organizational structures and processes specifically tasked to dispose of excess inventory. Some such processes available to large organizations are: highly promoted sales campaigns (as occurs at the end of the model year in the new automobile industry), donations to charitable organizations (as might occur in industries that deal with highly perishable items such as admission to sporting or cultural events), or movement of items from one location to another (as might occur in national retail sales organizations). Small businesses, however, are much less likely to have the money, people, and time, to set up such mechanisms for reducing their excess inventory in a manner that is financially acceptable to the firm. In addition, even if they did have some of these capabilities, they are much less likely than large organizations to be able to absorb the costs of those mechanisms or to need the resulting value (such as tax write-offs for charitable contributions) that a larger organization might accept or want.

One avenue that is becoming increasingly palatable for the small business to get rid of their excess inventory is the Internet. Some of the ways that a small business can use the Internet to reduce their excess inventory are: 1) by direct sales through an organization such as eBay, 2) by sales through industry-specific trade organizations such as AutoPartSearch.com, or 3) by sales through generic trade organizations such as TradeOut.com. Although these Internet-based organizations can help a small business place their excess inventory in a marketplace, they all rely on the end-customer being able to find the excess inventory that the small business has for sale. The end-customer must also personally do any comparison-shopping and then finally personally negotiate the final transaction. This means that the sale process, from the perspective of the small business, is passive. While this is better than merely scrapping excess inventory, it is clearly not as effective as the more complex and powerful mechanisms available to large businesses.

SURVEY

An experiment expanding on previous research [4] was run to test the viability of using intelligent agents to facilitate the process by which a small business would reduce its excess inventory. The experiment consisted of initially collecting data from retail businesses in a large U.S. city to form an appropriate group of small businesses in which to apply the intelligent agent processes. For the purposes of the experiment, "small business" was defined as a commercial organization that had been in business for at least 3 years and had 9 or fewer employees. Businesses less than 3 years old were

excluded to try to remove those organizations that did not have enough experience and were still on a "learning curve".

There are numerous industries in which small businesses participate, and there was limited time and resources available to complete this research project. Therefore, one industry was selected in which to propose and implement an excess inventory reduction process based on intelligent agents. The community of giftware/collectible small retail establishments was receptive to the concepts involved in the research project, and so was selected for inclusion in the experiment. Small businesses in this retail trade sector are highly susceptible to changes in the economy, and can quickly accumulate relatively large amounts of excess inventory. Ten business establishments were randomly selected of a total of 81 such businesses willing to participate in the experiment.

On average, the 10 giftware/collective stores had annual income of about \$290,000 and an average of 6 employees. The stores held an average of about \$127,000 in inventory, of which about \$63,000 represented items with no demand for 120 days (no calls or requests for items totaling that amount). This indicates that about 50% of the items in their inventory would reasonably be called excess inventory. One additional negative consequence of holding all of that excess inventory was a reduction in available shelf space for more popular and better-selling items. A second negative aspect of holding that excess inventory is that it reduced the capital available for each business to re-invest in more profitable parts of their business.

It turns out that, according to the 10 selected businesses, this general situation is normal for the giftware/collectibles retail trade. Financial success in a business of this type is closely tied to the health of the general economy. When the U.S. economy is doing well, businesses in this field do well; when the U.S. economy is doing poorly, businesses in this field do poorly as well. A closer look at the firms' inventory showed a distinctly poor inventory turnover ratio. This ratio shows the velocity at which inventory turns over. For example, an inventory ratio of 3.0 would indicate that the firm is selling its inventory 3 times per year. Therefore, the higher the value of the inventory ratio, the more rapidly the business is selling products and the less excess inventory it can choose to hold. For the 10 businesses involved in this experiment, the inventory ratio for the past 3 years was 2.1. For the same group of businesses the inventory ratio was about 5.5 in better economic times.

The typical response to excess inventory for the 10 businesses in the study was to gradually reduce the price of an item or items until they were sold. Using this passive approach, and perhaps actively and directly contacting some known and better customers, the businesses were able to reduce their inventory by about 37% on average. However, even after employing this process, the businesses were still left with significant excess inventory. One particularly interesting measure of this process, calculated via a financial analysis of past items sold, was that an item that had reached a sale price 40% below its original price would still require an average of 97 **more** days before that item was sold.

It may be possible to use Internet-based e-business intelligent agents to help facilitate the process by which small businesses reduce their excess inventory and customers are made aware of products in which they might be interested. Constructed appropriately, it may even be possible to apply intelligent agents in a manner that would be beneficial to both parties in the transaction. That is, it may be possible for the small business to sell its excess inventory for a price higher than they would otherwise be able to do, and for buyers to be made aware of otherwise unknown items they may wish to purchase, and to use financial payment methods that are to their best benefit.

In such a system, an intelligent agent acting on the behalf of the small business would, with knowledge of the inventory of the business, find customers who were looking for those particular inventory items. Conversely, an agent acting on the behalf of the buyer would, with knowledge of the buyer's product and financing choices, purchase an excess inventory item in a manner most beneficial to the buyer. Therefore, the system would require construction of at least two different types of agents, each with similar powers but differing goals and knowledge. The current sales transaction model used by eBay and other on-line auction firms requires iterative manual intervention by buyers to monitor items they are interested in buying. The intelligent agent system as described and used in this research project removes all manual monitoring of the buying process after initial data is entered about which items to purchase and about other parameters required for a purchase to be completed.

The intelligent agent acting for the small business would have to be "loaded" with the knowledge of the excess inventory items for sale, and the associated selling parameters that would lead to an agreeable sale on the part of the small business. The intelligent agent acting for the buyer would be loaded with the knowledge of what items the buyer would like to purchase, including the financing options that the buyer would find most advantageous. This could include information associated with a variety of credit cards that the buyer could use, and might consist of factors such as interest rates, grace periods, frequent flier miles, and so forth. The small business owner or the item buyer could, at any time, intervene and over-rule the existing parameters controlling their part of the transaction, but without such intervention, the intelligent agent would have the power and ability to complete the transaction on behalf of its owner.

This type of Internet-based system is obviously very different from the traditional "person-to-person" purchase process where the buyer and seller must physically meet. It is also different from the standard on-line sale process wherein: 1) the seller issues an item for sale with static sale parameters and 2) the buyer must iteratively check items to see if they are now (or still) for sale and with what sale parameters.

It was hypothesized that such a system would be superior to either of the existing systems of in-store continual markdown until sale or on-line posting of sale items (which is essentially an extension of the standard approach to a larger buyer audience). The advantages to an intelligent agent system are that 1) no "live" person is required for the transaction to be completed, which releases both the buyer and seller for other activities, 2) inventory velocity increases due to faster sale of inventory, so the buyer gains the accompanying financial advantages, and 3) the buyer gains the financial advantages of their agent selecting the financially most valuable choice of financing, freeing the buyer from having to remember or calculate those advantages.

EXPERIMENT RESULTS

Inventory data for the 10 small collectible businesses were loaded on a web server and the store owners entered pricing information for each inventory item. Customers (drawn from volunteers solicited for the experiment) then entered purchase profile information, including what items they would like to purchase and for what price. They also entered the details of their credit card payment processes so their agents would be able to assess the most advantageous payment choice at that point in time. The details for the financial agent included billing cycle time, interest rates and any loyalty program their card/line of credit was linked to such as airline miles, hotel points, and car rental points.

When the system was turned on, 172 prospective transactions were found, financial payment choices for each transaction were selected, the purchases were completed, and the sales written up. Since the system was in a "static" mode for the experiment, no more transactions were found. However, in a real-

world "dynamic" system, businesses would be continually adding more inventory items and customers would be making more purchase choices.

As a further test to the system, after the initial 172 transactions were completed, the business owners made adjustments to their inventory item sale parameters. This would be very similar to the process in a normal retail environment wherein changes would be made to inventory prices based on other sales that have occurred. When those subsequent changes in inventory sale parameters were made, an additional 37 potential transactions were detected and completed.

The general effect of the system on both the seller and buyer were quite interesting. The sellers saw a very rapid increase in their inventory cycle as their inventory turned over more quickly. This was due the system enabling their products to find customers, rather than having to wait for customers to find their products. The intelligent agents for the buyers were able to complete the transactions for the products for which they were searching. Then using the payment methods that were most advantageous to them based on the rules established by the buyers with their intelligent agents, the agents went on to complete the transactions. In essence, the agents located the desired item and arranged for its payment and shipment without the need for the buyer to actually physically participating in the transaction.

Quantitatively, the sellers were able to sell their excess inventory for discounts ranging from 10% - 30%, with 82% of sales occurring at a discount of 20%. This is a sale discount level far below what had been required using a normal retail sale pricing policy. The outcome was that excess inventory sold much more quickly and for a greater profit to the small business. The buyers were able to purchase items that they would otherwise not know existed, and they were able to purchase those products for financial terms that were of greater benefit.

FUTURE RESEARCH

The next phase of this research project is to expand the realm of sellers and buyers to more closely represent the real-world e-business transaction process. A larger number of sellers and buyers would more closely resemble a real Internet-based economy, with the ultimate system being open to all sellers and buyers. Such a system would be of greatest benefit to both buyers and sellers, as it would open excess inventory products for sale to a larger number of buyers, and it would provide a larger number of items for sale to each buyer. As more financial institutions chose to participate in the financing of purchases, buyers would be able to get a larger financial benefit, as they would have a larger number of financing options to choose from. Ultimately, a completely open e-business system such as described in this document would produce better financial solutions for both buyers and sellers, while at the same time reducing the amount of "hands-on time" required for both parties to complete transactions.

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