viders, there will be no way of billing visitors to your homepage. In this game, free speech advocates and big businesses have become strange bed fellows arguing against micropayments. Contrary to common belief, however, efficient intermediaries and micropayments may very well be the savior of the free speech and free information in the digital age.

CONCLUDING REMARKS

Although it is well understood that the Internet presents an exciting opportunities to reduce transaction costs, its future may depend on how non-technological but fundamentally economic issues such as the lemons problem are solved. A market where buyers and sellers trade goods electronically lacks many of the conventional ways to assess the quality of a product. We have explored how intermediaries using short-term contracts and microtransactions can reduce transaction costs for verifying quality. Organizing and managing such an information intermediary is being experimented in a project by the CREC (http://cism.bus.utexas.edu). Furthermore, any little bit of information should find a market to trade in if electronic commerce were to ferment a truly informational age. Micropayments and intermediaries in electronic commerce will play an important role toward that goal.

AGENTS AS MEDIATORS IN ELECTRONIC COMMERCE

BY ROBERT H. GUTTMAN, ALEXANDROS G. MOUKAS AND PATTIE MAES, MIT MEDIA LABORATORY, USA*

ABSTRACT

Software agents help automate a variety of tasks including those involved in buying and selling products over the Internet. This paper surveys several of these agent-mediated electronic commerce systems by describing their roles in the context of a Consumer Buying Behavior (CBB) model. The CBB model we present augments traditional marketing models with concepts from Software Agents research to accommodate electronic markets.

INTRODUCTION

Software agents are programs to which one can delegate (aspects of) a task. They differ from "traditional" software in that they are personalized, continuously running and semi-autonomous. These qualities make agents useful for a wide variety of information and process management tasks [1]. It should come as no surprise that these same qualities are particularly useful for the information-rich and process-rich environment of electronic commerce.

Electronic commerce encompasses a broad range of issues including security, trust, reputation, law, payment mechanisms, advertising, ontologies, electronic product catalogs (EPCs), intermediaries, multimedia shopping experiences, and back-office management. Agent technologies can be applied to any of these areas where a personalized, continuously running semi-autonomous behavior is desirable. However, certain characteristics will determine to what extent agent technologies are appropriate.

For example, how much time or money could be saved if a certain process was partially automated (e.g., comparing products from multiple merchants)? How easy is it to express your preferences for the task (e.g., shopping for a gift)? What are the risks of an agent making a sub-optimal transaction decision (e.g., making stock market buying and selling decisions or buying a car)? What are the consequences for missed opportunities (e.g., not being able to effectively monitor new job postings)?

Generally, the more time and money that can be saved through automation, the easier it is to express preferences, the lesser the risks of making sub-optimal transaction decisions, and the greater the loss for missed opportunities, the more appropriate it is to employ agent technologies in electronic commerce.

ROLES OF AGENTS AS MEDIATORS IN ELECTRONIC COMMERCE

It is useful to explore the roles of agents as mediators in electronic commerce in the context of a common model. The model we present stems from traditional marketing Consumer Buying Behavior (CBB) research and comprises the actions and decisions involved in buying and using goods and services. However, we augment traditional CBB models with concepts from Software Agents research to accommodate electronic markets.

Although CBB research covers many areas, it is important to recognize its limitations up-front. For example, CBB research focuses primarily on retail markets (although many CBB concepts pertain to business-to-business and consumer-to-consumer markets as well) [2, 3]. Even within retail, not all shopping behaviors are captured (e.g., impulse purchasing). Also, as mentioned earlier, electronic commerce covers a broad range of issues, some of which are beyond the scope of a CBB model (e.g., back-office management and other merchant issues). Nevertheless, the CBB model is a powerful tool to help us understand the roles of agents as mediators in electronic commerce.

CONSUMER BUYING BEHAVIOR MODEL

There are several descriptive theories and models that attempt to capture consumer buying behavior – e.g., the Nicosia model [4], the Howard-Sheth model [5], the Engel-Blackwell model [6], the Bettman information-processing model [7], and the Andreasen model [8]. Although different. these models all share a similar list of six fundamental stages guiding consumer buying behavior. These six stages also elucidate where agent technologies apply to the consumer shopping experience and allow us to more formally categorize existing agent-mediated electronic commerce systems [9]:

1. Need Identification
   This stage characterizes the consumer becoming aware of some unmet need. Within this stage, the consumer can be stimulated through product information. This stage is called Problem Recognition in the Engel-Blackwell model [6].

2. Product Brokering
   This stage comprises the retrieval of information to help determine what to buy. This encompasses the evaluation of product alternatives based on consumer-provided criteria. The result of this stage is the "consideration set" of products.

3. Merchant Brokering
   This stage combines the "consideration set" from the previous stage with merchant-specific information to help determine who to buy from. This includes the evaluation of merchant alternatives based on consumer-provided criteria (e.g., price, warranty. availability, delivery time, reputation. etc.). The Nicosia model merges both brokering stages into one Search Evaluation stage [4]. The Engel-Blackwell model dissects these two stages orthogonally into Information Search and Evaluation of Alternatives stages [6].

*Pattie Maes
(pattie@media.mit.edu)
is an Associate Professor at MIT's Media Laboratory, where she founded and directs the Software Agents Group. She currently holds the Sony Corporation Career Development Chair. Her areas of expertise are Artificial Intelligence, Artificial Life, Human Computer Interaction, Computer Supported Collaborative Work, Information Filtering and Electronic Commerce.

Alexandros G. Moukas
(moux@media.mit.edu) is a currently a doctoral candidate at the Agents Group of MIT Media Lab focusing on Agent-mediated Electronic Commerce of intangible goods and services. Alexandros worked as an IT consultant at IBM Greece/Economic Data S.A. and a research associate on clinical decision making at Athens Children's Hospital.

Robert H. Guttman
(guttman@media.mit.edu)
is continuing his studies in AI related technologies as an S.M. candidate and a Telecom Italia Fellow in Pattie Maes' Software Agents group at MIT's Media Laboratory. He is now focusing on a variety of issues in Agent-mediated Electronic Commerce including semi-automated integrative negotiation techniques for online retail markets.

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4. Negotiation
   This stage is about how to determine the terms of the transaction. Negotiation varies in duration and complexity depending on the market. In traditional retail markets, prices and other aspects of the transaction are often fixed leaving no room for negotiation. In other markets (e.g., stocks, automobile, fine art, local markets, etc.), the negotiation of price or other aspects of the deal are integral to product and merchant brokering. Traditional CBB models do not identify this stage explicitly, but the conclusion of the Negotiation stage is comparable to the Choice or Decision stage found in other models [4, 6].

5. Purchase and Delivery
   The purchase and delivery of a product can either signal the termination of the negotiation stage or occur sometime afterwards (in either order). In some cases, the available payment (e.g., cash only) or delivery options can influence product and merchant brokering.

6. Product Service and Evaluation
   This post-purchase stage involves product service, customer service, and an evaluation of the satisfaction of the overall buying experience and decision. The nature of this stage (and others) depends upon for whom the product was purchased.

As with most models, these stages represent an approximation and simplification of complex behaviors. As noted, CBB stages often overlap and migration from one to another can be non-linear and iterative.

From this CBB perspective, we can identify the roles of agents as mediators in electronic commerce. The personalized, continuously-running autonomous nature of agents make them well-suited for mediating those consumer behaviors involving information filtering and retrieval, personalized evaluations, complex coordinations, and time-based interactions. Specifically,

	Persona Logic	Firefly	Bargain Finder	Jango	Kasbah	Auction Bot	Tete-a-Tete
1. Need Identification	*Only a few primitive event-alerting tools (e.g., gift shops that track birthdays) help anticipate consumer needs and provide paths into the subsequent CBB stages. However, systems like Firefly can alert a consumer and provide product recommendations when consumers with similar interests purchase a specific product.*						
2. Product Brokering	◆	◆		◆			◆
3. Merchant Brokering			◆	◆	◆		◆
4. Negotiation					◆	◆	◆
5. Purchase and Delivery	*Post-purchase evaluation usually includes feedback about two distinct elements of the shopping process: product brokering and merchant brokering. Traditionally, customer remarks are accessible (and used) by either the marketing staff of manufacturers or the customer satisfaction staff of merchants. However, agent-based distributed trust and reputation mechanisms (like Kasbah's Better Business Bureau) enable customers to share and combine their experiences and use merchant and product reputations as additional aspects of brokering and negotiation.*						
6. Product Service & Eval.							

Table 1 Roles and Examples of Agents as Mediators in Electronic Commerce

these roles correspond most notably to the Product Brokering, Merchant Brokering, and Negotiation stages of the Consumer Buying Behavior model. Table 1 lists the six CBB stages and shows where several representative agent systems fall within this space. The rest of this section expounds the three agent-centric stages of the CBB model with examples.

PRODUCT BROKERING

The Product Brokering stage of the CBB model is where consumers determine what to buy. This occurs after a need has been identified (i.e., in the Need Identification stage) and is achieved through a critical evaluation of retrieved product information. Table 1 shows several agent systems that lower consumers' search costs [10] when deciding which products best meet their needs: PersonaLogic, Firefly, and Tete-a-Tete.

PersonaLogic [11] is a tool that enables consumers to narrow down the products that best meet their needs by guiding them through a large product feature space. The system filters out unwanted products within a given domain by allowing shoppers to specify constraints on a product's features. A constraint satisfaction problem (CSP) engine then returns an ordered list of only those products that satisfy all of the hard constraints. PersonaLogic is marketed as a service that merchants offer to their customers that enables them to select the best product from the merchant's catalog.

Like PersonaLogic, Firefly services [12, 13] help consumers find products. However, instead of filtering products based on features, Firefly recommends products via a "word of mouth" recommendation mechanism called automated collaborative filtering (ACF). ACF first compares a shopper's product ratings with those of other shoppers. After identifying the shopper's "nearest neighbors" (i.e., users with similar tastes), ACF recommends products that they rated highly but which the shopper may not yet have rated – potentially resulting in serendipitous finds. Essentially, Firefly uses the opinions of like-minded people to offer recommendations. The system is currently used to recommend commodity products such as music and books.

MERCHANT BROKERING

Whereas the Product Brokering stage compares product alternatives, the Merchant Brokering stage compares merchant alternatives.

Andersen Consulting's BargainFinder was the first shopping agent for on-line price comparisons [14]. Given a specific product, BargainFinder requests its price from each of nine different merchant web sites using the same requests as from a web

[4]
F. Nicosia. Consumer Decision Processes: Marketing and Advertising Implications. Prentice Hall, 1966.
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browser. Although a limited proof-of-concept system, BargainFinder offered valuable insights into the issues involved in price comparisons in the on-line world. For example, a third of the on-line CD merchants accessed by BargainFinder blocked all of its price requests. This was because merchants inherently do not want to compete on price alone. Value-added services that merchants offered on their web sites were being bypassed by BargainFinder and therefore not considered in the consumer's buying decision. However, it was also the case that Andersen Consulting received requests from an equal number of little-known merchants who wanted to be included in BargainFinder's price comparison. In short, companies competing on price and/or desiring more exposure wanted to be included, the others didn't.

Jango [15, 16] can be viewed as an advanced BargainFinder. The original Jango version "solved" the merchant blocking issue by having the product requests originate from each consumer's web browser instead of from a central site as in BargainFinder. This way, requests to merchants from a Jango-augmented web browser appeared as requests from "real" customers. This kind of "aggressive interoperability" makes it convenient for consumers to shop for commodity products but does not leave merchants with many options. If merchants provide public on-line catalogs, they can be accessed by agents whether merchants want this or not.

Jango's modus operandi is simple: once a shopper has identified a specific product, Jango can simultaneously query merchant sites (from a list now maintained by Excite, Inc.) for its price. These results allow a consumer to compare merchant offerings on price.

MIT Media Lab's Kasbah [17, 18] is an on-line, multi-agent classified ad system. A user wanting to buy or sell a good creates an agent, gives it some strategic direction, and sends it off into a centralized agent marketplace. Kasbah agents pro-actively seek out potential buyers or sellers and negotiate with them on behalf of their owners. Each agent's goal is to complete an acceptable deal subject to a set of user-specified constraints, such as a desired price, a highest (or lowest) acceptable price, and a date by which to complete the transaction. The latest version of Kasbah incorporates a distributed trust and reputation mechanism called the Better Business Bureau. Upon the completion of a transaction, both parties may rate how well the other party managed his/her half of the deal (e.g., accuracy of product condition, completion of transaction, etc.). Agents then use these ratings to determine if they should negotiate with agents whose owners fall below a user-specified reputation threshold.

[11]
PersonaLogic URL: <http://www.personalogic.com/>
[12]
Firefly URL: <http://www.firefly.com/>
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U. Shardanand and P. Maes. "Social Information Filtering: Algorithms for Automating ‚Word of Mouth'." Proceedings of the Computer-Human Interaction Conference (CHI'95), Denver, CO, May 1995.
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NEGOTIATION

From our CBB perspective, the Negotiation stage is where the price or other terms of the transaction are determined[1]. Examples of where we see negotiation used in commerce include stock markets (e.g., NYSE and NASDAQ), fine art auction houses (e.g., Sotheby's and Christie's), flower auctions (e.g., Aalsmeer, Holland), and various ad-hoc haggling (e.g., automobile dealerships and commission-based electronics stores).

The benefit of dynamically negotiating a price for a product instead of fixing it is that it relieves the merchant from needing to determine the value of the good a priori. Rather, this burden is pushed into the marketplace itself. A result of this is that limited resources are allocated fairly – i.e., to those who value them most.

However, there are impediments to using negotiation. In the physical world, certain types of auctions require that all parties be geographically co-located, for example, in auction houses. Also, negotiating may be too complicated or frustrating for the average consumer. For instance, this sentiment inspired Saturn automobile dealerships to switch from price negotiation to fixed-price in order to appease its customers. Finally, some negotiation protocols occur over an extended period of time which does not cater to impatient or time-constrained consumers. In general, real-world negotiations accrue transaction costs that may be too high for either consumers or merchants [19].

Fortunately, many of these impediments disappear in the digital world. For example, OnSale [20] and eBay's AuctionWeb

[1] It is beyond the scope of this paper to discuss "winner's curse" or free-market alternatives.

[21] are two popular web sites that sell refurbished and second-hand products using a choice of auction protocols. Unlike auction houses, these sites do not require that participants be geographically co-located. However, these sites still require that consumers manage their own negotiation strategies over an extended period of time. This is where agent technologies come in.

Table 1 shows several agent systems that assist the customer in negotiating the terms of a transaction: AuctionBot, Kasbah, and Tete-a-Tete.

AuctionBot [22] is a general purpose Internet auction server at the University of Michigan. AuctionBot users create new auctions to sell products by choosing from a selection of auction types and then specifying its parameters (e.g., clearing times, method for resolving bidding ties, the number of sellers permitted, etc.). Buyers and sellers can then bid according to the multilateral distributive negotiation protocols of the created auction. In a typical scenario, a seller would bid a reservation price after creating the auction and let AuctionBot manage and enforce buyer bidding according to the auction protocols and parameters.

What makes AuctionBot different from most other auction sites, however, is that it provides an application programmable interface (API) for users to create their own software agents to autonomously compete in the AuctionBot marketplace. Such an API provides a semantically sound interface to the marketplace[2]. However, as with the Fishmarket Project [24], it is left to the users to encode their own bidding strategies. Fishmarket is not currently being used as a real-world system, but it has hosted tournaments to compare opponents' handcrafted bidding strategies along the lines of Axelrod's prisoner's dilemma tournaments [25].

Kasbah, as described earlier, is a web-based multiagent classified ad system where users create buying agents and selling agents to help transact products. These agents automate much of the Merchant Brokering and Negotiation CBB stages for both buyers and sellers.

Negotiation in Kasbah is straightforward. After buying agents and selling agents are matched, the only valid action in the negotiation protocol is for buying agents to offer a bid to selling agents with no restrictions on time or price. Selling agents respond with either a binding "yes" or "no". Given this protocol, Kasbah provides buyers with one of three negotiation "strategies": anxious, cool-headed, and frugal – corresponding to a linear, quadratic, or exponential function respectively for increasing its bid for a product over time. The simplicity of these negotiation heuristics makes it intuitive for users to understand what their agents are doing in the marketplace[3]. This was important for user acceptance as observed in a recent Media Lab experiment [17]. A larger Kasbah experiment is now underway at MIT allowing students to transact books and music [18].

Tete-a-Tete [27, 28] provides a unique negotiation approach to retail sales. Unlike most other on-line negotiation systems which competitively negotiate over price, Tete-a-Tete agents cooperatively negotiate across multiple terms of a transaction – e.g., warranties, delivery times, service contracts, return policies, loan options, gift services, and other merchant value-added services. Like Kasbah, this negotiation takes the form of multi-agent, bilateral bargaining but not using simple raise or decay functions as in Kasbah. Instead, Tete-a-Tete's shopping agents "argumentatively" negotiate with sales agents (see [29]) and use the evaluation constraints captured during the Product Brokering and Merchant Brokering stages as dimensions of a multi-attribute utility. This utility is used by the shopping agent to negotiate towards a pareto-optimal deal with sales agents. In essence, Tete-a-Tete integrates all three of the Product Brokering, Merchant Brokering, and Negotiation CBB stages.

[20]
OnSale URL: <http://www.onsale.com/>
[21]
AuctionWeb URL: <http://www.ebay.com/aw>
[22]
AuctionBot URL: <http:auction.eecs.umich.edu>
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S. Parsons, C. Sierra, and N. Jennings. "Agents that Reason and Negotiate by Arguing." To appear, Journal of Logic and Computation.

[2] This differs from Jango, for example, which employs a "wrapper" technology in an attempt to scrape meaningful content from Web pages. This is problematic because HTML is a data format language, not a data content language, and there currently are no standards for presenting and describing merchant offerings on the Internet.

[3] In the past week, there have been only two active, public auctions. There could be private auctions, however.

CONCLUSION AND FUTURE DIRECTIONS

This paper explored how Software Agents are helping consumers combat information overload and expedite specific stages of their on-line buying process. Today's first-generation agent-mediated electronic commerce systems are already creating new markets (e.g., low-cost consumer-to-consumer and refurbished goods) and beginning to reduce transaction costs in a variety of business tasks. However, we still have a long way to go before software agents transform how businesses conduct business. This change will occur as Software Agent technologies mature to better manage ambiguous content, personalized preferences, complex goals, changing environments, and disconnected parties. The greatest changes may occur, however, once standards are adopted and evolved to unambiguously and universally define goods and services, consumer and merchant profiles, value-added services, secure payment mechanisms, inter-business electronic forms, etc.

During this next-generation of agent-mediated electronic commerce, agents will enhance customer satisfaction and streamline business-to-business transactions, reducing transaction costs at every stage of the supply chain. At some critical threshold, new types of transactions will emerge in the form of dynamic relationships among previously unknown parties. At the speed of bits, agents will strategically form and reform coalitions to bid on contracts and leverage economies of scale – in essence, creating dynamic business partnerships that exist only as long as necessary. It is in this third-generation of agent-mediated electronic commerce where companies will be at their most agile and marketplaces will approach perfect efficiency.

SERVICES OF A BROKER IN ELECTRONIC COMMERCE TRANSACTIONS

BY MARTIN BICHLER, CARRIE BEAM AND ARIE SEGEV, UNIVERSITY OF CALIFORNIA AT BERKELEY, USA*

ABSTRACT

Current Web-based electronic commerce systems are lacking in efficient electronic brokerage. However, brokerage plays an important role in many electronic commerce transactions. Over the past few years significant research has been done in the area of electronic commerce, based on distributed object technology. Distributed object systems provide a key to building interoperable applications that can execute on a range of platforms. This new generation of electronic commerce systems is still in its early stages. This paper discusses the design and implementation of a CORBA-based electronic broker. The electronic broker is part of a research project called OFFER, which is trying to establish an object framework for business-to-business electronic commerce. The electronic broker supports search in underlying electronic catalogs and it provides a centralized marketplace with the possibility to use auction mechanisms to buy or sell goods.

INTRODUCTION

MOTIVATION

Electronic commerce on the Internet introduces a new marketspace, making it possible for large numbers of companies to participate. This addition to the electronic marketspace is a melee of smaller companies, each one relatively unknown and together offering a bewildering array of products. The vast amount of information available about products and services in electronic catalogs is difficult, if not impossible, to search. Electronic brokers are needed to provide secure means of exchanging information quickly and effectively between consumers and providers (Cunningham, et al 1997). These brokering agents will provide value-added services such as matchmaking, negotiating and monitoring transactions. This paper describes an electronic broker built on distributed object technology. The e-broker is part of a larger project developing an object framework for business-to-business commerce, called OFFER (Object Framework For Electronic Requisitioning). The e-broker in OFFER assists the user in two main ways during a market transaction. First, it helps search in many, often unknown e-catalogs of suppliers; second, it provides auction mechanisms to support price negotiation between buyers and sellers. The components of the framework are implemented in Java and use OMG's CORBA as a distribution infrastructure.

BROKERS IN ELECTRONIC COMMERCE

Electronic commerce offers several advantages over traditional ways of doing business. Organizations usually see electronic commerce as a way of reducing costs and offering better services. Cost reduction is gained through lowered transaction processing costs and the discovery of better offers than were previously found. Technology can be used in new ways to offer original and innovative services, which would not have been possible otherwise. It can be enhanced by electronic negotiation, contracting and ultimately collaborative specification work. In non-brokered commerce, customers contact suppliers directly, searching for offers and/or conducting one-to-one negotiations. Non-brokered commerce often happens in very small markets, transparent markets, or in markets with monopoly/monopsony structures.

A broker is a party, which mediates between buyers and sellers in a marketplace. Brokers typically provide services that may include searching for a suitable business partner, negotiating the terms of the deal providing letters of credit and/or