

AN EVALUATION OF INTELLIGENT AGENT BASED INNOVATION IN THE WHOLESALE FINANCIAL SERVICES INDUSTRY

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Abstract: It is now widely accepted that success in providing wholesale financial services will depend on the industry's ability to develop flexible ebusiness models and strategies, as well as its ability to develop innovative systems for knowledge management and customer relationship management that can communicate effectively with legacy systems. In this paper we describe the problems and challenges facing Australian corporations in the Wholesale Financial Services sector and describe a research model which seeks to assess the impact of emerging Intelligent Agent enabled e-business initiatives, particularly in the area of system architecture and mass customisation. The purpose is to assist these firms achieve a level of international competitiveness in this area through (a) the investigation and longitudinal monitoring of the current status of and further developments in intelligent agent technologies, and (b) the investigation of emergent applications and successful approaches for the adoption and implementation of these key technologies in the provision of improved value-added customer services. We argue that a multi-disciplinary integration of e-business strategy, finance, intelligent agent architectures and knowledge technologies offer a previously unexplored solution to the documented challenges confronting Australia's Wholesale Financial Services industry. Agent architectures transcend traditional information system designs for applications that require complex, highly customized transactions in an open exception rich environment where responsiveness is imperative. We show that agent architectures naturally support e-business innovation by providing a framework for genuine dynamic information system development, which in turn leads to the kind of system agility that is crucial in the current highly competitive global financial environment. Agents can evolve over time iteratively and independently, without impacting other agents. A key difference between agent architectures and more traditional architectures is that instead of building relationships between software components at design time, agent architectures allow relationships to be formed on the fly at run-time. This results in highly

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responsive systems that are sensitive to the dynamic financial services context and that may be opportunistic in any competitive complex business environment. The ability to be opportunistic is particularly important in the current highly competitive global wholesale financial services industry.

1. INTRODUCTION

In the current increasingly efficient business environment, customers and businesses enjoy instant access to information and a wide array of product choice, a situation leading to intensive comparison shopping [7, 25]. Electronic business facilitates conditions for *perfect competition* and forces a knowledge shift from sellers to buyers [15, 25]. This massive power shift occurs as buyers gain advantage through rapid access to high quality information [7,13]. Sustaining competitive advantage in this highly competitive complex business environment era of e-commerce is challenging.

In this paper we describe the problems and challenges facing Australian corporations in the Wholesale Financial Services sector and describe a multi-disciplinary research model that seeks to assess the impact of emerging Intelligent Agent enabled e-business initiatives, particularly in the area of system architecture and mass customisation. The purpose is to assist these firms achieve a level of international competitiveness in this area through (a) the investigation and longitudinal monitoring of the current status of and further developments in intelligent agent technologies, and (b) the investigation of emergent applications and successful approaches for the adoption and implementation of these key technologies in the provision of improved value-added customer services.

We focus on the wholesale financial services throughout, and suggest a multi-disciplinary approach [5, 6] to evaluate and monitor intelligent agent architectures and knowledge technologies within the financial services context that may offer significant benefits when applied to the recognised problems facing the industry.

Intelligent agents are software entities that are capable of independent action in open, unpredictable environments, and as such they have become a promising information management technology. Indeed, one could argue that they are emerging as a new way of thinking, and as a consequence they are dramatically changing the way we design and build information systems in a wide variety of fields.

Agent architectures transcend traditional information system designs for applications that require complex, highly customized transactions in an

open exception rich environment where responsiveness is imperative. Agent architectures support innovation by providing a framework for genuine dynamic information system development, which leads to the kind of system agility that is crucial in the current highly competitive global financial environment.

Agents are autonomous, and as such can evolve over time iteratively and independently, without impacting other agents. A key difference between agent architectures and more traditional ones is that instead of building relationships between software components at design time, agent architectures allow relationships to be established on the fly at run-time. This results in highly responsive systems that are context-sensitive and that can be opportunistic in a competitive complex business environment. The ability to be opportunistic is particularly pertinent and important in the current highly competitive global wholesale financial services industry.

Another important advantage intelligent agents offer business is the ability to forge and nurture relationships with their customers [27]. Intelligent agents offer mechanisms to fulfill and anticipate customer needs [2,3]. Intelligent agents can be used to increase the scale and efficiency of existing CRM strategies by employing mass customization techniques.

The challenge lies in the identification of relevant information to provide to the customer that will enable them to make good decisions and that will assist them to reach their goals.

A wide range of radically new business models is emerging that challenges existing business methods and IT architectures. New business models need new IT architectures and infrastructure to support them. Traditional solutions are too inflexible. Indeed it is this inflexibility that has lead to the phenomena of new businesses taking the lead in ebusiness and leaving the bricks and mortar businesses behind or putting them out of business. Businesses must interact with other businesses information systems i.e. customers, partners etc. A key capability of Amazon.com is its capacity to interact with DHL's to give customers specific information about book purchase deliveries. Agent solutions have an intrinsic capacity for establishing and managing the formation and evolution of business relationships. Early adopters of technological innovation typically immerse themselves in a learning environment where they can "play" and experiment with technology where they can develop novel approaches to problems quickly and effectively. This means that their systems must be flexible and extensible.

2. PROBLEMS IN INDUSTRY

A successful, robust, and vibrant wholesale financial services industry is crucial for Australia's future. The range of services provided by the industry includes bonds, cash management, deposit, equity, foreign currency exchange, investment, loan, settlement and other facilities for enterprises and government organisations in support of their commercial operations. It has become widely accepted that long term success in providing wholesale financial services will be dependent on the industry's ability to develop flexible ebusiness models and strategies, as well as its ability to develop innovative systems for knowledge management and customer relationship management that can communicate effectively with legacy systems [7, 28].

Unfortunately, this necessity to develop new strategies and systems represents a significant challenge for the Australian Wholesale Financial Services industry. The industry is not known for its early adoption of e-business innovation. The major benefit of e-business lies in its potential to transform traditional business practice. Substantial business risk is associated with structural transformation of organizations and industries and financial services firms are traditionally risk averse. Based on interviews with 23 senior executives with responsibility for ebusiness in 18 corporations in 2000 - 2001, a recent industry report suggests that a significant transformation needs to take place in order for the industry to be able to seize the opportunities presented by ebusiness. Furthermore, if it fails to do so then its future and Australia's hopes are in serious jeopardy [7].

The reasons for the current concerns stem from a number of systemic problems in the industry including the following [as identified in 7]:

1. The poor state of integration between a bank's internal systems. The range of services offered by firms (as listed above) is typically provided by separate, incompatible systems. Apart from challenges in establishing a degree of integration across systems that would enable the recognition and treatment of customers in a consistent manner, there are also serious issues surrounding the necessity to maintain and to extend existing legacy systems.
2. Difficulties in achieving Straight Through Processing (STP). STP is the concept that transactions should be able to be processed completely through both customer and service provider systems without the necessity for manual intervention. STP is significant as 'it represents huge potential cost savings and increased margins without exposure to competitive threat or market risk'. The greatest barrier to STP in any organization is its legacy systems. The nature of the products, and the

relationships with suppliers and customers are also important. ‘The potential gains from STP will drive industry-wide cooperation in developing common standards and systems for trading capture and settlement.’ [7].

3. Information on customers is held in silos and is not integrated. This lack of integration is often an organizational issue, not just a technological one. Traditional information system architectures tend to closely mirror organizational structure and constraints. The close coupling presents significant obstacles for change.
4. There are difficulties linking the businesses information systems with client information systems. “All banks will face the common necessities of linking their processing systems more closely with those of their clients” [7].
5. The wholesale banking industry is not uniform. For example, low-value, high-volume commoditisable markets such as foreign exchange, the focus is on improvements in process efficiency. For high-value, low volume markets such as funds management, the focus is on adding value to the products.
6. Some product types, such as those in the funds management sector, are not easily commoditisable and require human intervention.
7. High cost of conventional customized information systems.
8. Large volume of data in many applications.
9. Regulatory nature of the financial sector.

In the following sections we argue that agent technologies can be used to alleviate many of the problems above. For example, agent technology offers the ability to support alliances and to build collaborative advantage - an important capability for business in the future. It also supports new forms of collaboration, which will result in providing seamless experiences for customers.

3. AGENT TECHNOLOGIES

Intelligent Software Agents are innovative technologies that have the potential to become one of the most important information management tools of this century. Intelligent agents are autonomous computational entities capable of making decisions independently and without the intervention of other entities, e.g. humans [31]. They can be proactive, purposeful and exhibit goal-directed behaviour, as well as reactive and responsive to changes in the environment. They can interact and modify their environments, and most importantly they can interact with other

agents. A key feature of an agent is autonomy [17]. Being autonomous distinguishes them from objects in the object-oriented paradigm [12]. Autonomy allows system development to be enhanced with the embedding of desired actions into modular units, which can operate individually and independently. As a consequence they lead to more flexible designs, and since the processing is distributed, better performance can be obtained in practice.

Agents are most suited to applications that involve communication between heterogeneous information systems. Electronic business transactions in a global economy typically involve interactions between numerous heterogeneous systems. Intelligent agents have the ability to reason and draw inferences and as a consequence they can perform sequences of complex operations based on their internal beliefs, goals and the information/messages they receive [20]. They can use explicit representation of their internal beliefs, the services they offer, and their overall goals, which can then be communicated and shared with other agents.

Traditional software systems are often unable to model rational behavior and experience a great deal of limitation in a real time environment where information is typically incomplete and susceptible to change [29, 30]. Agents, on the other hand, thrive on the need for applications to exhibit rational, human like decision making in their respective problem domains [11]. These properties give agents the edge in the information and process rich environment of e-commerce, which creates the need for agent based programming as the solution for current and future business needs [10]. Although still in the phase of development, agent-oriented programming has already shown much promise in a variety of real-time applications such as air traffic management, air simulation, and distributed business systems.

The kinds of agent architectures we have in mind for the Wholesale Financial Services Industry is illustrated in Figure 1 below. In essence each client will have an agent, or family of agents, that acts as the go-between. The *customer agent* possesses information about the customer including information gleaned from the customer's corporate databases. The *customer agent* interacts with the *business agent* by sharing information pertinent to the transaction being negotiated. The *business agent* obtains information from the corporate databases and also from other sources that might involve automatically generated user profiles.

4. APPLYING AGENT TECHNOLOGIES TO WHOLESALE FINANCIAL SERVICES

Agent architectures support innovation by providing the framework for genuine dynamic development, which leads to the kind of system agility that is crucial in the current highly competitive global financial environment. Traditional architectures force businesses to accept a trade-off between scalability and agility. Enterprise-wide systems are typically rigid, and they provide the classic example of how agility is sacrificed for scalability. Inevitably traditional system development solutions result in relatively inflexible systems that reduce an organisation's responsiveness to change in both the short and the long term. Agent architectures, on the other hand, can be developed and enhanced iteratively because each agent is completely autonomous. Therefore, one of the main benefits of agent architectures is their scope for incremental deployment, progressive refinement and experimental elaboration – components and processes can be added, removed or changed independently.

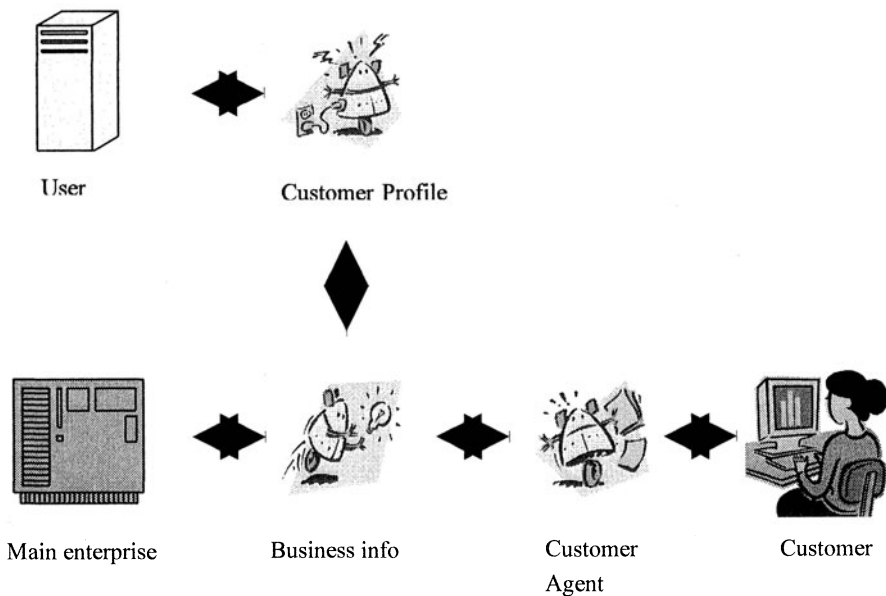


Figure 1. Agent Architecture for the Wholesale Financial Services Industry

Instead of building relationships between software components at design time, agent architectures allow relationships to be context-sensitive and to be formed at run-time. This results in highly responsive systems that can be opportunistic in a competitive business environment. The ability to be opportunistic is particularly important in the current highly competitive global wholesale financial services industry.

4.1 Agent based Business Process Management

Business process management in industry typically involves seamless end-to-end processing across multi-step business activities and multiple heterogeneous systems and people, in possibly one or more organizations. A major goal of business process management is to harness and enhance the value chain.

Many wholesale financial services enterprises have developed first generation process management systems, usually custom built combinations of workflow, document management, or systems automation with bubblegum-code “gluing” it all together.

Although Enterprise Application Integration and Enterprise Resource Planning systems attempt to provide a systematic end-to-end solution, there is no single system that has been capable of providing a complete solution. As a result the industry is left with overly complex monolithic and cumbersome legacy systems that are relatively inflexible when it comes to change.

As the industry tries to automate and enhance their customer-oriented operations and leverage Internet connectivity with suppliers, customers and partners, system complexity has increased dramatically and change has become even more difficult. In the current economic environment, industry is challenged to deliver bottom-line improvements through a combination of significant cost savings and increased responsiveness to customers. The industry is in desperate need of a pathway to sustained competitiveness and profitability. The answer to these problems lies in the adoption of innovations that will lead to significant improvements in the industry’s agility in an increasingly competitive global economy.

Agent technology offers a way to integrate large complex heterogeneous systems. They provide a mechanism for integrating legacy systems with newly developed information systems. Agents are well suited for middleware applications that translate information and implement information systems interfaces that meet a wide variety of requirements.

In many applications, system developers have legacy code that performs some unique function, which is needed in their new applications. An agent can be used to invoke and execute this legacy code. The capability to

enable execution of native software and legacy code is crucial for the financial services industry.

Agent architectures present tremendous possibilities for solving many industry problems. They can not only communicate with legacy systems, but even more importantly they alleviate many of the traditional design problems system developers face. In particular, the developers do not have to anticipate and explicitly design for all conceivable situations and potential scenarios. Developers using traditional means identify all possible execution paths during the design phase of the system development life cycle, which are later hard coded as links between the sub-processes. For large-scale applications, the number of interprocess links tends to grow exponentially. In practice this means that there are too many situations to code for and as a consequence, systems become sensitive to exceptions, i.e. they fail when something unexpected occurs. The problem of having to anticipate every conceivable situation at design time leads to the fundamental development dilemma: scalability or business agility.

Agent architectures differ with traditional solutions in fundamental ways. For example, how the various agents (and subprocess) come together and interact is determined at run time. The developer has only to specify properties and behaviours of the agent, does not need to dictate how it will respond in every possible situation.

Conventional software architectures do not handle the following financial services problems effectively:

1. The high volume of events or service requests: large online transaction and decision support systems such as foreign exchange and OTC services invoke many complex processes; many of those transactions requiring significant human intervention to be completed.
2. The high volume of configurations for example funds management: need a high level of process customization to handle all the possible scenarios; the number of permutations to code becomes rapidly too large.
3. The high volume of exceptions: those systems encounter many unplanned situations or exceptions, significantly reducing efficiency; self-service applications over the Internet, such as loan processing cannot be successfully automated due to numerous exceptions.

Integrating wholesale financial services will be a time-consuming and expensive exercise. Automating large-scale business processes has essentially been limited to back-end operations such as financial reporting systems. Such systems are typically custom-coded and therefore very rigid. However, they generated adequate returns on investment because of the stable and predictable nature of the processes and configurations. As companies began to automate their customer-oriented operations, they

searched for flexibility to personalize handling of each customer and adapt to changing business policies and processes. Opening the environment of the enterprise resulted in increased complexity, rapid change and more unpredictable situations. New computing approaches such as workflow systems, e-process servers or rules engines have been used as the basis for Enterprise Application Integration solutions and other platforms and applications. However, customization resulted in significant custom coding and consulting support, close to back-end systems. With the extension of these applications to Internet-based connectivity, corporations are faced with unprecedented unpredictability that made it impossible to achieve high-performance, large-scale, yet agile business process management. A fundamentally new computing infrastructure is necessary to deliver in a single solution performance and agility and, at the same time, dramatically reduce the cost of developing and maintaining business automation systems.

Agent technologies have significant potential to address the industry's technology-based systemic problems and to improve its efficiency and competitiveness. Many systemic problems arise from incompatible legacy systems. Agent technologies present a possible cost-effective solution to systems integration. The promises of tight coupling between bank and client systems and adding value through customization of products and services in a high volume market may also be realised by the potential of agents to:

1. Support technology-based customized services to mass markets.
2. Enable integrated service provision to specific customers.
3. Eliminate margins based on customers' limited capability for price discovery.
4. Increase the rate of providers' responsiveness to market changes.
5. Reduce the time and cost of product and service provision.
6. Assist customers to migrate to online channels
7. Link disparate systems, eg financial service provider' and client's systems.
8. Enable collaborative advantage between providers.

4.2 Mass Customization

One advantage intelligent agents offer the industry is the ability to forge and nurture relationships with their customers. Intelligent agents offer mechanisms to fulfill and anticipate customer needs [2,3]. Intelligent agents can be used to increase the scale and efficiency of existing CRM strategies by employing mass customization techniques.

Data mining can be used to help build context sensitive customer profiles and models of customer behavior as they interact with a business system, see how customer profile building fits into our proposed architecture in Figure 1. Customization is nontrivial. First, different visitors carry different intentions and are attracted to the different elements and offerings of a business' website. Second, different visitors perceive the same site differently and may use it differently against the designer's expectations. Third, the same visitor may log in to the same site with new intentions.

The challenge lies in the identification of relevant information to provide to the customer that will enable them to make good decisions and assist them reach their goals. Many advanced solutions have come about in response to this challenge. All too often though these approaches are based on human interaction-input (user profile) such as Firefly [27]. These static inputs feed the system to produce the same non-dynamic personalized presentation, as the profile ages. Agent technology paired with web mining techniques will yield more favorable results because more meaningful exchanges of information can be achieved.

A number of approaches have been developed which focus on automatic personalization based on user-web site interaction. For instance Schechter et al [22] came up with the technique using user path profiles to predict further web usage, which can be used for network and proxy caching. Other researchers, Perkowitz and Etzioni [18] suggested the idea of optimizing on the Web site based co-occurrence page patterns. Clustering of user sessions to predict future user behavior were used by Shahabi et al [24] and Nasraoui et al [16]. Mobasher, Cooley and Srivastava [14] provided several techniques in which the user preferences are automatically learned from the web usage data to keep a constant rejuvenated user profile. Similarly, Spiliopoulou et al [26], Cooley et al [4], and Buchner and Mulvenna [3] have applied data mining techniques to extract usage pattern from web server logs [14, 16, 18]. Perkowitz and Etzioni [18] again, proposed a cluster based mining algorithm together with data mining algorithm to analyze log servers in attempt to synthesize the index page.

5. PROPOSED RESEARCH MODEL

This research seeks to assist Australian corporations in the Wholesale Financial Services sector to assess the impact of emerging Intelligent Agent enabled e-business initiatives, with particular attention to system architecture and mass customisation. The purpose is to assist these firms

achieve a level of international competitiveness through a multi-disciplinary research project for the:

- investigation and longitudinal monitoring of the current status of and further developments in intelligent agent technologies,
- investigation of emergent applications and successful approaches for the adoption and implementation of these key technologies in the provision of improved value-added customer services.
- determination of appropriate applications of these technologies to address identified problems confronting the Wholesale Financial Services industry, particularly in mass customisation.

The research also seeks to support a national priority to establish Australia as a regional financial services centre by ensuring that Australian financial services organisations have ready access to the latest developments in and applications of intelligent agent technologies in their provision of value-added customer services. In response to significant industry challenges identified in interviews with senior executives in 18 corporations in 2000-2001 [7], our research aims to:

- a) identify the current ‘best of breed’ levels of capability in intelligent agent technology and to determine the current capacity of these technologies to support value-added customer services in the financial services sector;
- b) identify emergent, relevant developments in intelligent agent technologies and their applications through a program of longitudinal monitoring of international activities;
- c) identify factors that drive and inhibit the potential for intelligent agent technologies to create and sustain value in value-added customer services;
- d) describe key elements of success in the understanding, planning, development and effective application of intelligent agent technologies;
- e) provide the basis for assessing progress, in understanding and use, of each successive wave of innovation in applications of intelligent agent technologies to value-added customer services; and
- f) incorporate a set of industry and national benchmarks for critical dimensions of intelligent agent effectiveness.

The research focus lies in the multi-disciplinary conjunction of information systems, knowledge representation, intelligent agent technologies, adoption of innovations, Australia’s Wholesale Financial Services sector and business-to-business e-commerce. Research questions include:

- a) What is the current level of applications of intelligent systems relevant to value-added customer services and mass customisation in the Wholesale Financial Services sector?
- b) How can the impact of intelligent agent technologies be reasonably and reliably measured by organisations, industries and nations?

- c) What are the likely impacts of developments in intelligent agent capabilities on organisations, industries and nations over the next 5 years?
- d) What factors drive or inhibit the strategic level adoption and diffusion of intelligent agent technologies for mass customisation?
- e) What factors, processes and practices influence the effective development and implementation of intelligent agent based value-added customer services?

The objectives are to proceed with parallel investigations into the technologies and their international applications in the Wholesale Financial Services industries. There will be regular reporting to Australian firms and other interested bodies of developments through industry-oriented publications, seminars, demonstrations and briefings. Suitable evaluation criteria will need to be developed for each research area.

A characteristic of this project is its multi-disciplinary approach with a single applied focus – determination of the potential of intelligent agent technologies to deliver internationally competitive, value-added, customised services. It will be implemented through integrated, parallel investigations into the technologies and their international applications relevant to the Wholesale Financial Services industries. The technologies investigation will be achieved through monitoring of and participation in internationally significant projects in intelligent agent technologies. The applications investigation will be achieved through a series of longitudinal case studies of organizations implementing relevant intelligent agent initiatives. In addition, through the establishment and collection of appropriate metrics, using interviews and surveys, the study will assess the on-going impact of intelligent agent initiatives on the financial services sector, the broader Australian economy and internationally.

6. DISCUSSION

Challenges confronting the Australian Wholesale Financial Services sector have been identified in a White Paper, launched by the Federal Minister for Financial Services in March 2001 [7]. Success in meeting these challenges will depend on the sector's ability to develop and to effectively implement flexible ebusiness models and strategies. A critical implementation challenge will be to develop innovative systems for knowledge management and customer relationship management that can communicate effectively with legacy systems.

Agent technologies offer a potential solution to specific industry problems. We have proposed a research model that seeks to assess the

impact of emerging Intelligent Agent enabled e-business initiatives, particularly in the area of system architecture and mass customisation.

Intelligent agent architectures and knowledge technologies offer the potential for significant benefits in the wholesale financial services industry.

Agent architectures transcend traditional information system designs for applications that require complex, highly customized transactions in an open exception rich environment where responsiveness is imperative. Furthermore, they naturally support innovation by providing a framework for genuine dynamic information system development, which in turn leads to the kind of system agility that is crucial in the current highly competitive global financial environment. This results in highly responsive systems that are context-sensitive and that can be opportunistic in a competitive complex business environment.

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