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Adaptive Learning Systems Technology Advisor:

A model for business entrepreneurs to implement IT

by

DESSA J. V. DAVID

A dissertation submitted to the Graduate faculty in Computer Science
in partial fulfillment of the requirements for the degree
of
Doctor of Philosophy,

The City University of New York

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INFORMATION TO USERS

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ABSTRACT

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by

Dessa J. V. David

Advisor: Dr. Linda W. Friedman

Software agents are the new paradigm shift in the quest to develop intelligent software systems. Their roots can be found in Artificial Intelligence (AI) and Human Computer Interaction (HCI), but differs from traditional AI techniques, which use symbolic knowledge representation to emulate human thinking in computer systems. Agent-based systems are simply programs designed to simulate "intelligence" in software. The idea is to create personalized software that knows the users' interests, habits and goals. Although this type of software holds great promise for HCI and Information technology (IT), this infant field lacks theoretical foundations and wide-scale acceptance practical for real world problems [Bradshaw 1997; Hook 1996; Jennings et al., 1998; Maes 1994; Nwana 1996]. IT has been credited as the key to unlock benefits otherwise inaccessible to businesses. This compels a diverse population of business entrepreneurs to make IT implementation decisions. The process of IT adoption and use is critical to deriving its benefits. Yet, very few studies are focused on the pre-adoption phase of IT implementation. Software agents possess the characteristics that can assist decision-makers during this phase.

This dissertation studies a software agent, ALSTA (Adaptive Learning System Technology Advisor) in a theoretical framework to examine its effectiveness as a DSS during the IT adoption process. The model clearly defines ALSTA, proposes characteristics for ALSTA and describes a method for evaluation. It supports the works of earlier researchers who suggested that there is a need to include mediating entities as part of the technology acceptance model (TAM). These entities can serve to augment the decision-maker's perceptions during the pre-adoption phase of IT implementation [Agarwal et al., 1998, Gefan et al., 1998, Iacovou 1995, Igbaria et al., 1997, and Karahanna et al., 1999].

Beyond the framework, this research empirically validates the effectiveness of ALSTA in a laboratory experiment. The experiment compares support rendered by ALSTA, a non-adaptive DSS (NADSS) and a human consultant (HDSS) during the decision-making phase of IT implementation. One hundred and ninety subjects participated in the experiment. The effectiveness of the systems was measured along several dimensions. The results strongly suggest that utility of ALSTA during IT implementation decision-making process is effective. ALSTA outperformed or performed comparatively to NADSS and HDSS on several measures observed. This role as a DSS that positively assist decision-makers should not be overlooked. These results, although preliminary steps, are significant contributions to theory and practice of software agents, IT implementation, Human Computer Interaction and decision support systems.

DEDICATED
To
My Grandmother, Dorris
and
my Mom, Jerlyn
whose love, support and confidence has made this possible

ACKNOWLEDGEMENTS

On the title of this dissertation, only one name appears, but credit must be given to many extraordinary individuals who made significant contributions. Without them, this dissertation would not have been complete. The road to completion was much longer than anticipated; there were numerous bumps and curves, even unexpected ditches along the way, but with unwavering support of many, and a determination to succeed, I have reached this milestone.

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CHAPTER 1: INTRODUCTION

> *So, to a writer happily engaged on his work and excited by it, there may come a curious extension of his ordinary faculties; he will find portions of knowledge floating back into his brain, available for use, which he had supposed to be thrown away long ago on the rubbish heap outside the back door of his mind; relevant passage will quote themselves in his mind from books he scarcely remembers to have ever read; and he suddenly sees germane connections where in his ordinary state of mind he would see nothing.*
> -C.E. Montague, A Writer's Notes On His Trade

Adaptive Learning Systems (ALS) have garnered tremendous attention in recent years from academia, practitioners and trade press [Bradshaw et al., 1999; Luck et al., 1997; Murch, 1999; Nwana et al., 1997; Soltysiak et al., 1998]. The numerous agent conferences, agents' interest groups and World Wide Web agent pages [Murch, 1999; Appendix K] that have been developed lately further evidence this prevailing trend. The list of participants is quite impressive and continues to grow. A partial list of major players includes universities: MIT, Stanford, Carnegie Melon, University of London, and University of Maryland; along with corporations: Apple, AT&T, HP, IBM, Lotus, Microsoft, Oracle, and British Telecom (BT). The concept of ALS is not new. It is part of the agent-based systems seeking to emulate "intelligence" in computer systems with origins in AI, HCI and related disciplines. These systems can be traced to research labs decades ago dealing with robot-like creatures. Today, ALS provide users with new foundations for interacting with computers. This is a different paradigm than traditional software systems, which are passive, and will only function when directly instructed by

users. These agent systems are characterized by behaviors that are adaptable (*by self-automation of actions*), flexible (*by learning the users' preferences, styles, cognitive levels)* and proactive. These system's characteristics if incorporated in applications promise to revolutionize and optimize the way we interact with the technology that has become an integral part of our daily lives.

In this era, computer systems have become a permanent staple in our daily conversational diets; hence, it is not surprising that Information technology (IT) is becoming ubiquitous to our lives. IT has been heralded as the single paradigm that can positively change the way we live. IT promises to dramatically reshape the way chores are conducted and is frequently cited in the research literature for its positive effects on productivity. IT is a vehicle that facilitates changes. The result of this is the hallmark of an era with an increased pool of diverse users (technocrats and naïve) interacting with technology. As IT becomes more integrated into our society, this pool will only increase. Simultaneously, software complexities are expected to continue to rise [Bradshaw, 1997; Brachman, 2002] and information overloads, as well as, interpretation of the information and the ability to monitor the vast amount of unstructured information present new challenges and prominent problems for us.

As this growing body of heterogeneous users seeks to take advantage of the benefits that technology promises, effectively exploiting IT remains a primary challenge to many users. As technology continues to become increasingly omnipresent in our lives the gap between the technocrats and non-technocrats will naturally expand. Utilizing the current

method of human computer interaction, direct manipulation, only limits effective access to technology for certain users. "The whole metaphor of direct manipulation, of viewing software as a tool that the user manipulates, was invented about 25 years ago when the personal computer was first emerging and when the situation for the user was completely different. Back then the computer was being used for a very small number of tasks. It was being used by one person, who knew exactly where all the information was on the computer because he or she put it there. Nothing would happen unless that person made it happen. This was a controlled, static, structured kind of environment" [Maes, 1997]. Times have obviously changed, as more users are reliant on computer systems to complete their jobs. To effectively take advantage of IT there is a need for us to change our perspective on computer systems. Traditional means of human computer interaction represents a conflict to the current computer environment. There is a need for a more active type of computer interaction, one that enables all users to take advantage of the volumes of unstructured information that exists. According to the Intelligent Agents Group [Green et al., 1997], the computer is merely a passive entity waiting to execute specific, highly detailed instructions; it provides little help for complex tasks or for carrying out actions that may consume a large proportion of the user's time. In 1993, Benyon et al., acknowledged the difficulty of human computer interaction (HCI) by stating "one of the things which makes successful Human Computer Interaction difficult is the large range of tasks which a computer can perform and the variety of systems users."

To facilitate a solution to this problem, users need software with features that will assist them in performing their tasks without the additional cost of frustration and time. Software must be user-centered, that is, flexible in supporting the user's interaction with the computer and maximizing the benefits of goal realization. This means personalized support. Software that can adapt (i) to a variety of users (ii) to the changing needs of an individual user (iii) to the dynamic environment of the interaction and (iv) to the task. Traditional systems lack the flexibility and adaptability to meet these needs. ALS offer a powerful repertoire of tools and techniques to overcome these challenges [Jennings et al., 1998; Maes, 1997]. According to the Green et al., [1997], we need software agents because: -

- more and more everyday tasks are computer-based
- the world is in a midst of an information revolution, resulting in vast amounts of dynamic and unstructured information
- increasingly more users are untrained and therefore users require agents to assist them in order to understand the technically complex world we are in the process of creating.

In 1994, the computer industry stimulated new waves of interest in agent technology. This focus was frontier by Pattie Maes [1994] with her groundbreaking paper "*Agents that reduce work and information overload*". In that paper she called for agents to be used in more general perspective ways than they had in the past. From that moment, a new crop of agents descended among us. Just as we have human agents to take care of complex and specialized tasks; software agents that perform delegated tasks on our behalf

are the need of the hour. Since then researchers have been actively developing prototypes and conducting research in this area [Benyon et al., 1993; Bradshaw, 1997; Bradshaw et al., 1999; Fazlollahi et al., 1997; Holsapple, 1993; Jennings, 1996; Luck et al., 2003; Maes, 1994; Menczer et al., 2002; Ndumu, 1998; Nwana, 1996; Wooldridge, 1996]. This dissertation intends to make significant contributions in this area.

Adaptive Learning Systems have the potential to be highly beneficial, assisting users with general purpose tasks. ALS lend themselves to the dynamic environment of IT and offer many advantages to users that are unattainable with traditional systems. Systems that are not personalized (adaptive) leave users without the proper mechanism to discover the full advantages of available technology that is becoming more and more complex and omnipresent in our daily lives.

ALS have the potential to enable

- the development of software system which will help and engage a heterogeneous body of users
- the solving of real world problems
- the simplification of complex task
- filter and gather volumes of information
- the presentation of information to the user in a level he/she can understand

This dissertation examines the literature on adaptive learning systems. The general research questions guiding this research are *(a) what are the attributes of an adaptive*

learning system? (b)What theories/framework have been used in the literature to explain adaptive learning systems? (c) What are the major uses of adaptive learning systems?

Although there is an explosion of agent-based research being conducted, a number of technical challenges can be extrapolated for research and development. There is still need for further research about

- general application of agent based systems in real world problems
- clear and generalized framework for developing agents
- development of industrial standard agent-based software
- development of methodology for detection of user's changing needs
- profile standards
- standardize tool kit for development
- development of evaluation methods
- user's trust and confidence in agents

More specific questions addressed in this research are:

- Can an adaptive learning system be of any help to business entrepreneurs during their decision making to implement IT?
- Can ALS be used to improve the decision-making process and if so how?

The roadmap for this dissertation is structured as follows: - Chapter 2 gives a comprehensive review of ALS- research and a proposed framework applicable to decision support during IT implementation decisions. Chapter 3 discusses the conceptual

model of ALS used during this study. In Chapter 4, the general theoretical model is given. In chapter 5, a description of the research methodology and hypotheses is given. Chapter 6, presents the results of the data analysis and Chapter 7, discusses the contributions and implementations of this research, as well as any future work.

CHAPTER 2: LITERATURE REVIEW

ADAPTIVE LEARNING SYSTEMS

A number of researchers are currently engaged in work surrounding adaptive learning systems (ALS). Jennings et al., [1996] suggest that this field of software agent is probably the fastest growing area of information technology. From a research perspective, we have witnessed the emergence of several agents' interest groups, research centers and conferences[1]. Within the framework of traditional conferences, such as DSI, AMCIS, AAAI we have seen a surge of agents' tracks or agent based systems studies dominating the emerging trends section of the program. Simultaneously, there has been the introduction of numerous software products on the market that are tagged with the name of agents.

In the research literature, you will find ALS under several creative labels. The names include: adaptive agents, learning agents, autonomous agents, smart agents, intelligent agents, software agents, softbots, interface agents, ADSS, intelligent decision support systems, intelligent support systems, ES-DSS, intelligent agents, knowledge-based DSS, active decision support systems or simply agents. But, what exactly is meant by adaptive learning systems? Within the varying environments that utilize agents, the term has been used in several different ways. Thus, to familiarize us with the subject, a sampling of definitions found throughout the research literature is highlighted.

[1] See http;//www.agentlink.org , Accessed April 2004

Definitions of Adaptive Learning Systems

Agentlink [2003], European based network of researchers and developers with common interest in agent technology. – defines ALS as a computer system capable of flexible autonomous action in a dynamic, unpredictable and open environment.

Chuang et al., [1998] defines ALS as a DSS that is able to automatically or manually modify some aspects of its structure, functionality or interface to meet the needs of different users."

Fazlollahi et al., [1997] describes ALS as DSS that support human decision-making judgments by adapting support to the high-level cognitive needs of the users, task, characteristics, and decision contexts.

FIPA [1997], an international consortium of academic and industry professional to develop public standards of agents, - It is a software agent that acts semi-autonomously for and on behalf of a user, modelling the interests of the user and providing services to the user or other people and PAs as and when required.

Holsapple et al.,[1993] states that ALS utilizes unsupervised inductive learning, perhaps in addition to other forms of learning, to acquire some of the necessary problem processing knowledge [PPK].

Jennings & Wooldridge [1996] a self-contained program capable of controlling its own decision-making and acting based on its perception of its environment, in pursuit of one or more objectives.

An intelligent agent is a computer system that is capable of flexible autonomous action in order to meet its design objectives. By flexible, we mean that the system must be:

- responsive: agents should perceive their environment (which may be the physical world, a user, a collection of agents, the Internet, etc.) and respond in a timely fashion to changes that occur in it,
- proactive: agents should not simply act in response to their environment, they should be able to exhibit opportunistic, goal-directed behavior and take the initiative where appropriate, and
- social agents should be able to interact, when they deem appropriate, with other artificial agents and humans in order to complete their own problem solving and to help others with their activities.

Pattie Maes, [1994] - An agent should also be robust and adaptive, capable of learning from experience and responding to unforeseen situations with a repertoire of different methods. Finally it should be autonomous so that it can sense the current state of its environment and act independently to make progress toward its goal."

Pattie Maes is in charge of at MIT labs where she founded and directs the Software Agent Group

Murch et al., [1999] ALS are software agents that basically learn from their user or owner. Learning we define as the modification of behavior through experience or judgment. Once tasks are learned, the agent can then instruct or suggest ways to improve. The learning process is gradual and interactive.

Murch is the author of Intelligent Software agents.

Object Management Group - Agent Working Group [1999] is an autonomous software entity that can interact with its environment.

This group was formed to provide a forum for identifying and building consensus and convergence in the industry around agent technology development.

Nwana [1996] a component of software and/or hardware which is capable of acting exactingly in order to accomplish tasks on behalf of its user

Nwana is a principal research scientist/engineer and technical group leader in the Advanced Communications Research (ACR) department at BT. He also ran the agents research program within ART's Intelligent Systems Research (ISR) group which he left in May 1998

M. Shaw [1993] capable of self-improvement in a changing environment.

Selker [1994] - computer programs that simulate a human relationship by doing something that another person could do for you.

Selker is an IBM fellow and Stanford university consulting professor. Dr. Selker is known for the design of the TrackPoint in-keyboard pointing device with performance advantages derived from a special behavioral/motor-match algorithm, for creating the "COACH" adaptive agent that improves user and for the design of a notebook computer that doubles as a LCD monitor.

A generic definition for an agent, from the American Heritage dictionary [cited in Bradshaw, 1997], is "one that acts or has the power of authority to act or ... represent another" or "the means by which something is done or caused; instrument." This terminology covers a wide magnitude including real estate agents.

Unfortunately, after an exhaustive examination of the research literature, it is apparent that there is no firm standard definition for the word agents [Brenner et al., 1998; Green et al., 1999; Jennings et al., 1996; Jennings, 1998; Laufmann, 1998; Luck et al., 1995; Luck, 1999; Murch et al., 1999; Ndumu et al., 1996; Nwana, 1996; Nwana et al., 1997; Raisinghani et al., 2000; Schut, 1999]. This previous statement as often as it has been used can almost be considered a cliché and controversial. A number of researchers have exploited the lack of a standardize definition, as the basis for several debates. On the other extreme, several researchers have refrained from defining "agents" completely, in this respect any interpretation of the essence of their research is left solely up to the reader.

Post analysis of the definitions cited above, reveals that agents are described by a number of broad characteristics. These characteristics are highlighted in more details in subsections that follow. In an attempt to identify the major characteristics of agents as inferred from the definitions, a Venn diagram model is constructed. The figure 2-1 illustrates the key attributes of the agents' universe. The rectangle represents all agents, one circle represents adaptive agents, this includes agents that can adapt but from predefined programming- this will cover agents like expert systems, traditional DSS etc. The next circle represents learning agents. The intersection of the two circles indicates that adaptive learning systems are agents that are *autonomous and learning agents*. The agents under study in this project fall within the intersection.

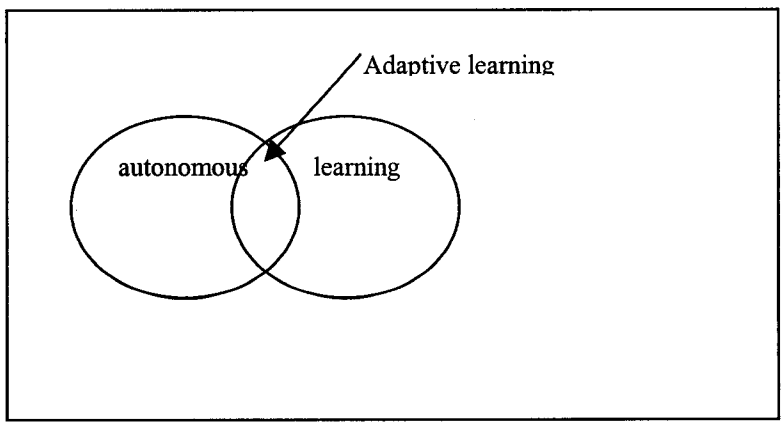


Figure 2-1 Adaptive Learning Systems

With such widespread vicissitude in the definitions of agents, it is not difficult to comprehend why a study of agent-based systems can present many inconsistencies in terminologies. The various abstractions from the definitions found within the literature cover a magnitude of areas, diverging in several directions. This research is not designed

to argue or discuss the appropriateness of the preceding definitions, but instead a solid attempt has been made to synthesize the essence of the word agents as used within the research framework.

All agents[2] are software that are distinguished by key features that enable them to learn their user's preferences and self-adaptive to any changes that may occur while proactively pursuing their goal on behalf of the user. For this study, the only inclusion of this discussion is to introduce the concept of adaptive learning systems and aid readers in understanding the core reasons why researchers bestow the name of agents on their research projects. For interested readers a general overview of agents can be found in works by Bradshaw [1997], Brachman [2002], Brenner et al., [1998]; Green et al., [1997], Luck et al., [2003], Maes [1997], Nwana [1996] and Wooldridge et al., [1998].

It is this researcher's clear belief that further study is needed in this sub area. On a preliminary evaluation of each of the listed studies, it can be argued, that the various definitions used by authors in their respective research, bear relevance to the environments they were created. But the lack of universal consensus on the word: agents, hinders any given interpretation within a specific study to be generalized across all domains. As such, to effectively study and significantly contribute to the field of agent-based technology, it is imperative that this research adopt a working definition for the word: agents. The formalizing of a definition for agents is a pioneer effort to provide

[2] For simplicity, this researcher will use the words ALS and agent(s) interchangeable from here on

clarity and standardize the misnomers of agent based research. To synthesize a working definition from the existing literature, agents can be characterizes as follows:

An agent is a computational entity situated within an environment interacting with that environment to achieve a goal on behalf of the user by sensing and communicating with the environment autonomously, proactively and adapting to any changes to produce an optimal output. Agents work on behalf of users autonomously, proactively, learning any changes of the user/environment and adapting while working towards a goal.

The above definition states in essence what an agent is. Figure 2-2 models a black box illustration of an agent interacting with an environment.

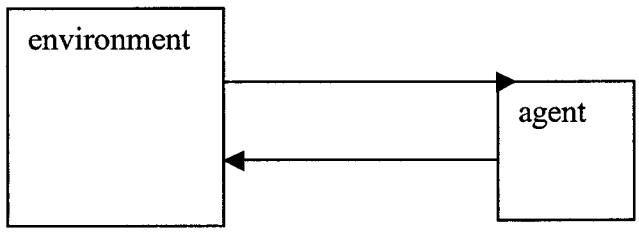


Figure 2-2 Adaptive Learning Systems interacting with its environment

The environment can comprise of the user and/or any other interfaces: databases, other agents. The agent receives stimulus from the environment and communicates with that environment towards fulfilling its goal.

What can an Adaptive Learning System do?

Traditionally, adaptive learning systems were mainly associated with robot technology designed to simulate human like behaviors in computer systems in their quest to build intelligent systems. This idea was later used in small programs to allow for a more intelligent human computer interaction [Maes, 1997]. This use of agents as a metaphor for designs of systems provided the initial impetus for emergent of new development in this field [Maes, 1994; Negroponte, 1995; Luck et al., 2003].

The 90's saw the dawn of a new paradigm in computing: software agents; software with smarts. They are used and touted in several applications with the promise to assist with many real world tasks. To manifest this ability, ALS are moving from the research laboratories and can be found as the basis for several applications. A partial list of these systems' uses are guidance [e.g. Lieberman, 1995], monitors of events/ procedures assistants [e.g. Hayes-Roth, 1997], accountants, memory aids [e.g. Rhodes, 1996], buyers/sellers [e.g. Chavez & Maes, 1996], filters/critics [e.g. Sheth & Maes, 1993], match maker/referral giver [e.g. Foner, 1996], training tool [e.g. Benyon, 1993], e-commerce [e.g. Maes, 1996], decision-making [e.g. Fazlollahi, 1997], and workflow management [e.g. Jennings et al., 1998].

This has sparked great interest for researchers and many are visionaries of their future success. For example, Nwana et al., [1997] predict *" by early in the next millennium, we expect software agents to play numerous roles, including managing and controlling networks as the WWW, managing the information explosion problem, mining vast*

databases, assisting in the control of air traffic, facilitating command and control in military systems, and providing many other 'value added' services."

Despite this proliferation, as earlier indicated, agent technology is diverse and widely labeled. There is no fixed typology for agents. This presents several challenges for the field. From a researcher's perspective, this makes a review of the agent literature a down right impossible or an infinite task. It also validates the argument for further research on the classifications of agents. In previous attempts to bring clarity to this area, some researchers have created various categories for agents' identification. The result is a non-mutually exclusive typology of agent systems; this classification consists of several gray areas. Franklin and Graesser [1996] note that agents can be characterized in a variety of ways in terms of their properties, the task they perform, the domain they inhabit, the technology they use and their control architectures.

On the basis of the literature, some of the agent categories include but are not limited to: static or mobile agents, deliberative or reactive agents; social agent, recommender agent, Internet agents, filtering agents, autonomous agents and multi-agent system [Nwana, 1999; PAAM]. This author chooses adopt PAAMs model and categorize agents into two camps: autonomous and multi-agent for the purpose of this dissertation.

The focus on autonomous agents is mainly concerned with the agent interaction with the user whereas those of multi-agents are concerned with agent-to-agent interactions. Among autonomous agents there are several subdivisions. There are autonomous agents

that are Internet agents, email agents, personal assistant and filtering agents. For this dissertation, the author limits her focus to personal assistant agents, which is a dominant class of autonomous agents. In particularly, personal assistant agents that can assist/embody decision support systems.

Like several areas within IT, many researchers agree that agent research is not fully matured. Despite its infancy, ALS definitely hold great promises for businesses [Bradshaw et al., 1997; Bradshaw et al., 1999; Brenner et al., 1998; Luck et al., 2003; Maes et al, 1994; Norman, 1994; Nwana et al., 1997]. In 1992, Dent et al. stated that construction of personal assistants as learning apprentices -- interactive assistants that learn continuously from their users -- is one approach that could dramatically reduce the cost of knowledge-based advisors. Personal knowledge-based assistants have the potential to assist with many daily tasks. Maes et al., [1994] describe humans as largely responsible for collecting, interpreting information and making business decisions. She points out that software agents can be used to automate several of the most time-consuming tasks. The personalized feature of a software agent makes them apt to assisting a variety of individuals. The motivating concept behind Maes' agents is to free the user of several mundane tasks that can be delegated to an agent. In the MIT lab several prototypes inspired by Maes have been built: filtering emails, filtering news, scheduling meeting [see Appendix K for a comprehensive list]. Crabtree et al., [1998] consequently supported that idea by stating, "presently nearly everyone can benefit from personal agents that organize and present information specially tailored to the individual both in form and content". Realization of the full potential of agents involves agent

integration in a variety of applications. Agent-based systems have been proposed as a new means of making human computer interaction more beneficial to a wider body of users. These scenarios clearly present a case for the building of software agents.

Today, several tools are available to design agent-based software e.g. [Brenner et al., 1998; see http://www.agentbuilder.com/AgentTools/index.html; OMG, 1999]. However, there is no commonly accepted language or toolkit for developing these systems. This presents another problem for many developers who are seeking guidance in selecting an appropriate toolkit for agent building. Bradshaw et al., [1999] cites this gap as a potential research area to be further developed.

Despite this lack of blueprints, several prototypes of personal assistant agents have been built in individual labs to demonstrate the usefulness of agents. The research labs are swarmed with these prototypes [BT, CMU, IBM,MIT, QMW, Stanford]. A representation but by no means an exhaustive listing of these agents include:

Fazlollahi [1997] - investment planner;

FIPA [1997] - management of his personal meeting schedule;

Ndumu [1998] - personal travel planner;

Maes [1993] - Calendar Agent and

Maes et al., [1996] – market system

Segal et al., [1999] – email filter

Selker [1994] - coach

Sycara [1994] - visitor hosting

To view a more comprehensive and updated list of agent based prototypes see the tables in Appendix K or visit the URL http://www.umbc.edu/agents.

Of the numerous agents that have been built, very few can be found in real-world applications. Höök [1996] and Maes [1997] delineated that for agents to gain further acceptance, real world applications that actually do work must be developed. They explain that this can lead to further acceptance of the usefulness of software agents and the positive impacts agent-based systems can have on our daily lives. The adoption of agent technology for use in fielded applications is an important milestone in the development of the field [Luck, 1999]. Nwana [1996] proposes that to really realize the benefits of agents, experiments with real users in real work settings must be performed and ways found to compare different approaches with criteria such as helpfulness and usefulness. This dissertation hopes to directly contribute in filling this gap. As an active agent researcher, Ndumu et al., [1998] believe that despite the infancy of this area of research, the field has matured enough to be utilized in systems as the bases of all real industrial applications.

What are the attributes of Adaptive Learning Systems - personal assistant?

Abstracting from the works of agent-based researchers [Bradshaw, 1997; Brenner et al., 1998; Negroponte, 1997; Nwana et al., 1997; Wooldridge & Jennings, 1996], it is logical to conclude that agents might make competent personal assistant to business

entrepreneurs. Since the research literature is swarmed with inconsistencies in terminologies this dissertation must clearly define what distinguishes a personal assistant agent. To be bestowed the title: competent personal assistant agent; at minimum that agent should embody the following characteristics:

- User centered - concentrating on the user's needs and preferences. The agent should be able to make user specific and context specific choices for presentation styles based on the user's needs, expertise, and abilities. It should be given in the vocabulary of the user. It should work on behalf of a user with their interest in mind
- Proactive - actively works towards a goal, even when not initiated
- Adaptable - changes its behavior based on inputs
- Communicative - interacts with the user
- Autonomous - exercises control of its actions without user's intervention
- Flexible - actions not hard-coded
- Responsive - reacts in a timely fashion

What persona should agents take?

This question highlights yet another debatable issue of agent-based systems: an agent's persona. Here the focus is on the visible presence of an agent e.g. Microsoft Office paper clip, avatars etc. There are advocates for highly antromorphised agents and strong

opponents such as Shneiderman [1997]. There are also many researchers who are neutral on the issue or believe that a balance is between both.

For this study, the issue is not considered explicitly, but merits further discussion since it relates to the designs of agents. To gain a deeper appreciation of some of the issues surrounding this question see Shneiderman and Mae's debate [1997].

What are the main theories/frameworks driving the design of Adaptive Learning Systems?

Areas of Influence

From the above discussion on definitions and attributes of agents, it can be inferred that personal assistant agent research has been influenced by many disciplines. This growing research area has attracted significant attention from a cross discipline of scholars within: AI, HCI, cognitive science, philosophy, and decision sciences, As such, agent-based software can be truly considered interdisciplinary [Brenner et al., 1998]. The various characteristics of personal assistant agents: emulation of human behaviors, autonomous adaptation can be best understood with the different influencing fields. Most noteworthy among these fields are AI and HCI. The following section describes the influences of AI and HCI in the development of software agents.

AI

Typically, ALS seek to model "intelligent" human behaviors when executing tasks. Therefore, they make good surrogates for task that involve human beings. Jennings et al. [1998] alleged that any situation where human agents can be used, that situation is also suited for agent-based systems. Other researchers have used many human metaphors to describe agent behaviors. A sampling of these metaphors found in the literature is listed below:

- metaphor of personal assistant [Maes, 1994]
- metaphor of football coach [Selker, 1994]
- human staff assistants and staff advisors [Fazlollahi et al., 1997]
- intelligent, dedicated and competent assistant (e.g. a secretary of a busy executive, or a medical assistant of an engaged physician) [Bui et al., 1999]
- well trained English butler [Negroponte, 1997]
- personal secretary [Kozierck et al., 1993]

Common among all these metaphors is the ability to mimic human behaviors. Many researchers have indicated that AI is the science that models intelligent behaviors. Durfee [1992] stated that the goal of AI is to endow computer science with capabilities approaches those of people. Russell et al., [1995] described agents as building intelligent artifacts. The main stimulus underlying AI is the ability to model "intelligent" behaviors. As such, agent developers seek to employ these influences from the AI discipline to provide stimulus for building agents.

To enable this ability the agent paradigm of software is viewed as an evolution to existing AI techniques currently used. It utilizes existing paradigms like pattern recognition, machine learning to achieve its task. It moves beyond the traditional software engineering techniques which were generally specific in focus to a broader scale since many of the decisions that an agent makes happens at run time and not design time.

- HCI

In addition to AI, HCI plays a pivotal role in the perceived benefits of ALS. Another function of ALS is to provide the heterogeneous body of users seeking to use technology the opportunities to overcome the limitations of current user interfaces. Jennings et al., [1997] stated despite the many motivations in human computer interface design over the past two decades, and the wide availability of powerful window-based user interfaces, computer-naïve users still find most software difficult to use. Direct manipulation as a governing form of computer interaction has its benefits but does not accommodate a vast number of users. To highlight some of the limitations of current HCI, Jennings et al., [1997] stated that computer users of software product typically has to describe each and every step that needs to be performed to solve a problem, down to the smallest detail. As further corroboration, Maes [1994] also stated that in order for untrained users to take advantage of the complexity of computers we need to change the way we interface with computers. ALS promise us an opportunity to overcome these current limitations. Bradshaw [1997] cites overcoming the current generation of user problems interface approaches

as one of the motivations for development of software agents. The development/use of ALS is expected to heavily impact the way users interact with computers. The advances of HCI especially with multimodal and perceptual interfaces shine new light on overcoming the limitations of current user interfaces. The direct effect would be enabling users to interact more naturally with computers rather than the users adapting to the computer/software.

Theoretical frameworks

In the quest to find a theoretical base for agent systems, it was discovered that no commonly agreed upon theories exist. In fact, many models discussed in the early research papers on agents have been generally elusive of any theoretical base. For agent-based systems, grounded theory is a foreign concept.

Of the few theories found in the literature to model agents' behaviors, the three most common theories are the deliberative thinking agents that reason their actions such as the Belief Desire and Intention (BDI) model; the reactive thinking that operate in a stimulus-response fashion, such as the subsumption architecture and a hybrid: deliberative-reactive theory, which aims for a compromise between the two. These theories have enabled our understanding of agents but possess several limitations [Brenner et al., 1998; Ndumu et al., 1996] in allowing us to actualize the full scope of agents.

BDI may be the best-known model for a practical reasoning agent [Georgeff et al., 1999]. It maintains a symbolic model of the environment and the capability of logical reasoning as a basis of its intelligent actions. However, its effectiveness is debated for dynamic environments especially with the new crop of proactive learning agents. Subsumption architecture traced to Brooks [1991] does not keep an internal model of the environment but instead defines behaviors by their interaction with the environment. This architecture is highly criticized for its inability to plan [Brenner et al., 1998] alternative possible actions and to evaluate them in advance of performing them. The hybrid architecture, which was created to overcome the shortcomings of its predecessors, has also been disputed lately.

To rectify this situation, ALS researchers have used theories from other disciplines to model their agents' behaviors and roles. These agents tend to be specific to that area rather than offering general solutions. D'Intervno et al., [1997] stated that basing agent research on grounded theory from other disciplines could lead to further acceptance. Maes et al., [1994], it is useful to use a common framework as a context for exploring the roles of agents. There is a need for development of further theoretical base for software agents in research. This research intends to help close that gap, and find a domain that can provide a solid foundation for this type of agents. This author believes like D'Intervno et al., [1997] that finding a solid theoretical foundation within a domain for agents can be helpful in proving the usefulness of adaptive learning systems.

Summary of ALS

To summarize the findings of agent-based research, the literature reveals a promising field of study with no widely accepted definition, architecture, theories or models. This in turn, makes comparison of earlier works extremely difficult if not impossible. Coupled with this disadvantage are many opportunities for a researcher to explore. Many experts are predicting and documenting that it will be the major area of focus for the next few years [Luck et al., 2003]. A look at the roadmap in figure 2-3 clearly outlines the vision of the field as seen by Agentlink.

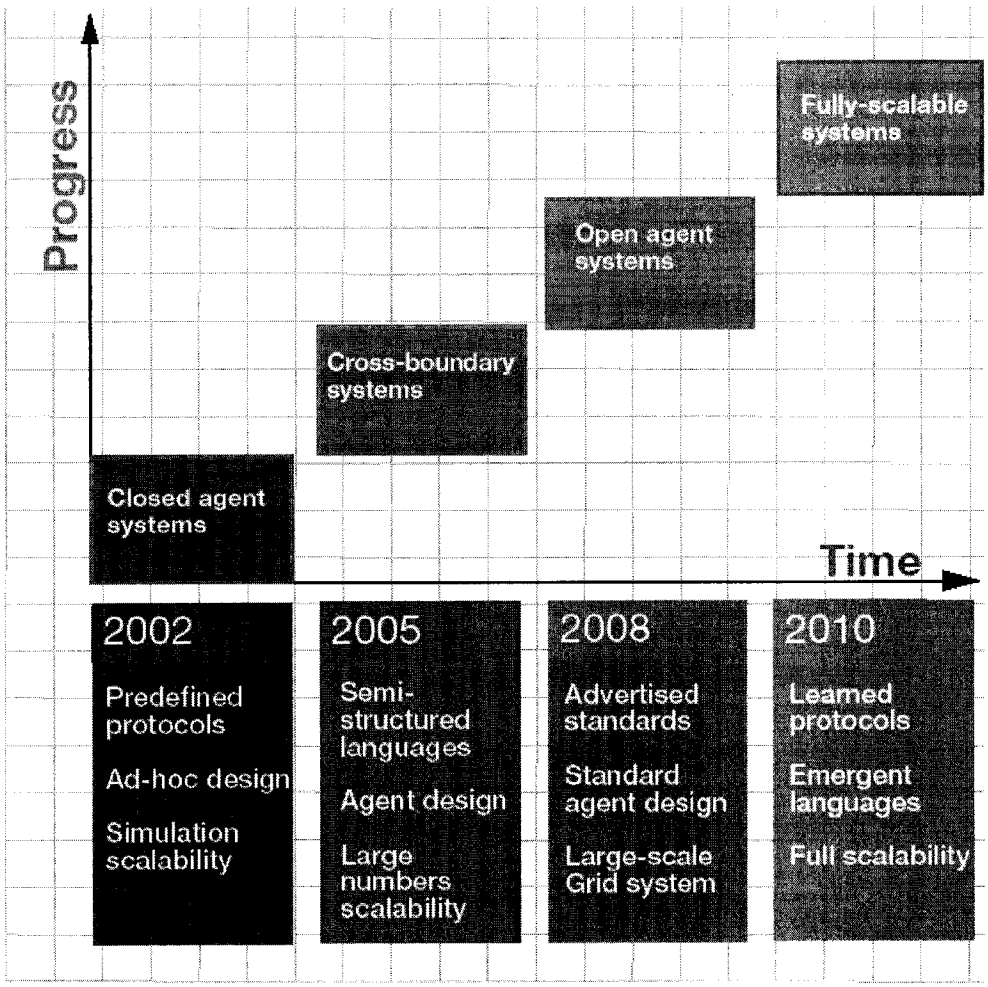


Figure 2-3 The roadmap timeline suggests how agent technology will progress over time if R&D is aimed at the challenges identified.[3]

Undoubtedly, more work is needed for the agent research. The field suffers more lack of in depth study in the following areas.

- ❖ personalization issues

[3] taken from Agentlink: The Roadmap -

- standards in building user profiles
- methodologies for extracting user's goals and preferences
- adaptation to user's changing objectives
- development issues
- lack of common theoretical framework for building adaptive learning systems
- lack of blueprints to assist developers in building agents and
- applications
- domains that can benefit from agents
- Validation issues
- lack of agent evaluation and validation methods.

In addition, researchers have been complaining about the lack of these systems' use as practical tools for real world problems [Bradshaw, 1997; Bradshaw et al., 1999; Höök 1996; Jennings et al., 1998; Maes, 1994; Ndumu et al., 1996; Nwana, 1996]. Few researchers have attempted to remedy this situation [FIPA, 1997; Ndumu, 1998]. One of the goals of this research is to discover a domain that can significantly benefit from this technology.

RELATED WORK

In spite of the apparent chaotic state of agent research, the field continues to spark interest and promises to revolutionize the way we view software. Software agents are often times perceived synonymous to Internet agents. Maybe this can be attributed to the

fact that the World Wide Web has been the benefactor of most of the available agent applications. This does not discount that other domains cannot realize similar benefits. On the premise that a software agent can be a good surrogate human agent, good agents for filtering information overload, and are adaptable there is room to use agents as tools for more general-purpose tasks. This dissertation proposes that an agent may be used as a tool to assist decision makers during their IT implementation process. At the point of writing, there is no other study in the literature that this author is aware of that has deployed ALS as a tool to assist decision-makers during the IT implementation. Following is a table of a sampling of agents built in recent years.

Table 2-1 Selected sampling of agents built

Agent	Ref	Filtering	Searching	Recommende	Adapts to user
Email					
Re: agent	Boone, 1998	✔	✔		✔
Remembrance	Rhodes, 1996		✔		✔
Web browsing					
Letizia	Lieberman, 1995				✔
Webmate	Chen et al., 1997	✔	✔		✔
E commerce					
Kabash	Chavez, 1996		✔		
Movieselector					
	Ghosh, 1998	✔	✔	✔	✔
Ringo	Shardanand et al, 1995	✔	✔	✔	✔
Remembrance	Rhodes, 1996	✔	✔	✔	✔
News filter					
Newt		✔	✔		✔
	Sheth, 1993	✔	✔		✔
News Dude	Billsus, 1994	✔	✔		✔
Schedule management					
Calendar agent			✔		✔
	FIPA		✔		✔
Visitor hosting	Sycara, 1994		✔		✔
	Kozierok, 1993		✔		✔
Travel agent					
	Ndumu, 1998		✔		✔
	FIPA		✔		✔
Matchmaker					
Yenta	Foner, 1996	✔	✔		✔
Chaung	Chaung, 1998	✔	✔		✔
Training					
Adele	Shaw, 1999				✔

	Benyon, 1993				✔
Monitors					
Patient Advocate	Hayes-Roth, 1997			✔	✔
Investment					
	Fazlollahi, 1997	✔	✔	✔	✔
	Parikh, 1997	✔	✔	✔	✔

What can be learnt?

After analyzing, the agent research that has been conducted, one can conclude that agent-based systems promise to be valued personal assistants. These systems are cited as beneficial for searching large amounts of information, filtering data and recommending selections based on inputs [Maes et al., 1994; Middleton, 2001]. These criteria are some of the necessary elements required for making IT implementation decisions [Agarwal et al., 1998].

IMPLEMENTATION OF INFORMATION TECHNOLOGY DOMAIN

Today businesses are integrating technology at a phenomenal increasing pace. However, the potential benefits of IT to several of these businesses have been unrealized. While there are multitudes of IT solution platforms to fit a given business task, incorporation of technology within business processes requires finding the right fit of the technology to the task. A business entrepreneur (human decision maker) is usually accountable for all stages of the IT decision-making process.

This research posits that ALS will be useful in assisting the business entrepreneur during the decision-making process to implement IT. This task involves evaluation of voluminous amount of information in the context of one's environment. This is a task of appraising changing information and analyzing the data in the context of one's business environment to ensure that the decision is a sound business investment. Unlike, traditional software, agent software are personalized, goal-oriented and autonomous. These qualities can assist in optimizing the IT decision-making process. The IT implementation decision environment has many interesting features including:

- enormous amount of continually changing information
- many sources of uncertainty and dynamic changes in the environment
- resource and cost constraint
- alignment to business goals

For such environments, an adaptive learning system, based on a model of a human personal consultant promises to be of enormous value.

A business entrepreneur embarking on Information Technology (IT) implementation faces many challenges. The benefits of IT as extolled daily are attractive. Adoption of new technology promises business entrepreneurs benefits that were only dreamt about yesterday. Frequently this decision is loaded with social and economic pressures. Alternatively, failure to adopt IT or incorrect decisions regarding IT implementation can be detrimental to their business. The IT implementation decision is risky. Generally, business entrepreneurs would like to minimize their risks and maximize their return on

investment. Many cannot withstand such risks. In short, the decision to adopt IT is weighted, complex, challenging and risky. What would be ideal, to help take advantage of technology is a trusted IT consultant. However, not finding the right consultant can also be devastating. This is where the idea of software agents as consultants on disk comes in. Researchers need to focus on methods that can reduce the risks experienced by business entrepreneurs during the IT implementation decision-making.

Technology Acceptance Model and related studies

To answer the research question, "can an adaptive learning system assist in the IT decision-making process?" it is useful to use a grounded framework as a context for exploring the role of ALS as a DSS (mediator) during the IT implementation process [Maes et al., 1994]. Thus, one needs to examine the literature concerning IT implementation/adoption. In recent research literature, adoption and use of IT have received a great deal of attention [Brancheau et al., 1990; Chau, 1996; Hu et al., 1999; Harrison et al., 1997; Lai et al., 1997]. Of the many models used within research and development to explain IT adoption, the technology acceptance model [TAM] developed by Davis et al., [1989] appears to be the most influential among the other technology acceptance research. TAM, grounded in the theory of reasoned action [TRA], explained and validated perceptions: perceived usefulness and perceived ease of use as major determinants to IT acceptance. Davis's TAM model has been used as the theoretical basis for many empirical studies of technology acceptance/adoption [Adams et al., 1992; Chau, 1996, Chau, 1997; Davis, 1989; Davis et al., 1989; Hu et al., 1999; Szajna, 1996] and has

accumulated ample empirical support. TAM has proven to be a robust model to be used in IT adoption/use research. As such, TAM was chosen to form the basis for this current research.

Building on the TAM model, a number of scholars have conducted considerable research on technology acceptance [Adams et al., 1992; Agarwal et al., 1998, Allen, 1997; Chau, 1996; Gefan et al., 1998; Hu et al., 1999; Iacovou et al., 1995; Igbaria et al., 1997; Karahanna et al., 1999]. Many of these modified technology acceptance models extend TAM to demonstrate the influence of certain factors on perceptions used in the decision-making process. The main impetus in most of these models is the antecedents to the perceptions listed by TAM. These researchers highlight influences of factors: environmental, organizational, and personal characteristics that can impact perceptions. However, these studies with the exception of Agarwal et al., [1998] fail to examine the effect of any mediating entity in the development of the decision-maker's perceptions. This research agrees with these researchers, that there are several factors that affect the decision-maker's perceptions that lead to the IT implementation decisions.

In general Davis [1989] and Davis et al., [1989] found that the more decision makers perceive an innovation will be useful as well as easy to use, the most likely that innovation will be adopted. In summary, he concluded that adoption of a technological innovation is a function of perceived usefulness and perceived ease of use.

Moore and Benbasat [1991], whose work is also grounded in Rogers [1983] diffusion of innovation theory, agree with Davis [1989] that perceptions influence the technology adoption process. However, Moore et al., [1991] argue that perceptions include many additional attributes than Davis [1989] presented in his TAM model. Their list of perceived characteristics includes attributes such as relative advantage (usefulness), ease of use, compatibility, trailability, observability, image and perceived voluntariness. Further studies on perceptions of innovation indicate that only three of these measures: relative advantage (usefulness), ease of use and compatibility have been consistent within the literature [Agarwal et al., 1998; Karahanna et al., 1999; Tornatzky et al., 1982].

Other variants on technology acceptance differentiate between TAM for adoption of new IT and TAM for continued use of IT [Karahanna et al., 1999]. While another by Chau [1996] and Thompson et al., [1994] postulate that perceptions measures of the technology acceptance model will differ dependent on whether the technology will be for short term or long term use.

Common among all the technology acceptance research is the role that perceptions highly influence the decision-making process. As such this dissertation will make the role of perceptions during the IT implementation decision-making process a focal point of this study. In particular, what leads to the development of perceptions of IT has been greatly overlooked in the research literature. The exception being, Agarwal et al., [1998] who examined the role of communication channels on development of perceptions. Clearly, this is an area to be researched. "*The pivotal role played by perceptions in technology*

acceptance models and theories clearly highlights the need for more work [Agarwal et al., 1998]."

This study extends existing research by attempting to demonstrate that between the antecedents and the perceptions of the decision-maker there can be a mediating entity that can positively affect the development of the decision-maker's perceptions. An intelligent agent of this kind might prove to be highly beneficial.

It should be noted that a potential decision-maker's perceptions of the characteristics of the usefulness and the ease of use of IT is what affects the rate of adoption and not the classification made by researchers. Hence it is the secondary attributes of innovation, not the primary attributes of an innovation that are of vital importance in the adoption decision. The primary attributes of an innovation are fixed [Allen, 1997; Rogers, 1983]. For example, a secured site on the Internet can allow us to submit confidential information securely between nodes. The security of the site is a primary attribute of that technology. On the other hand, individual perceptions of the technology can vary [Agarwal et al., 1998; Allen, 1997; Davis, 1989; Davis et al., 1989; Moore et al., 1991; Rogers, 1983]. If an individual perceives that private data such as credit card information is not secure, he/she will most likely not agree to adopt that technology for fear of the risks involved. A mediating entity can assist in augmenting the decision-makers perceptions.

Questions regarding methods to augment the decision-maker's perceptions of IT during IT implementation need to be studied. Agarwal et al., [1998] stated that empirical work in innovation diffusion research suggest that perceptions are directly instrumental to the adoption decision and does not acknowledge the existence of moderating influences. Researchers like Agarwal et al., [1998], and Karahanna et al., [1999] have stated that decision-makers need awareness from a more personal standpoint as to the benefits of technology for them. According to Agarwal et al., [1998], knowledge should be personalized for individuals. Personalization and the ability to obtain answers to questions such as "what will its advantages and disadvantages be in my situation" can be helpful in shaping perceptions needed for the IT decision-making process. Given this situation, the present study will attempt to extend TAM and modified TAM by proposing a mediating entity to personalize the decision-marker's knowledge that will develop his/her perceptions during IT implementation.

This mediating entity in this research is in the form of a software agent. It is expected to positively impact the IT decision-making process. Today, as businesses continue to invest in IT, user technology acceptance/adoption has become an increasingly critical technology implementation and management issue. Assisting business entrepreneurs in making successful IT decisions may be one method of boosting their productivity. On the other hand, unsuccessful implementation of IT can have adverse effects. Regardless of the potential technical superiority and promised merits an unused or underutilized technology cannot be effective [Chau, 1999]. Often times, the underutilized or unused

technology is as a result of an unsuccessful IT decisions [Delone, 1988]. An effective decision support tool can assist in eliminating such problem.

IT-decision process/Innovation-decision process

The functional parallel between IT and technology innovation has been suggested by several researchers [Agarwal et al., 1998; Brancheau et al., 1990; Kwon et al., 1987; Lai et al., 1997; Moore et al., 1991; Thong, 1999]. "*An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption. It matters little, so far as human behavior is concerned whether or not an idea is "objectively" new as measured by the lapse of time since is first use or discovery*" [Rogers, 1983]. The rapid changes affiliated with technology clearly present most changes as a major innovation over the next.

The innovation-decision process by Rogers [1983] describes how an individual gathers and synthesizes information for an innovation. This behavior consists of dealing with uncertainty that is inherently involved in deciding about a new alternative to those previously in existence. Rogers [1983] model (figure 2.4) includes five stages:

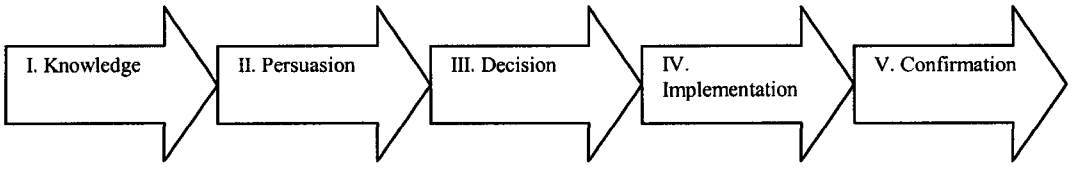


Figure 2-4 A model of the stages in the innovation-decision process [Rogers, 1983]

- ❖ knowledge - occurs when an individual is exposed to the innovation's existence and gains some understanding of how it functions.
- ❖ Persuasion - occurs when an individual forms a favorable or unfavorable Attitude toward the innovation
- ❖ Decision -occurs when an individual engages in activities that leads to a choice to adopt or reject the innovation
- ❖ Implementation - occurs when an individual puts an innovation into use
- ❖ Confirmation -occurs when an individual seeks reinforcement of an innovation -decision already made, but he or she may reverse this previous decision if exposed to conflicting messages about the innovation.

This research is focused on the initial stage of the decision-making process. Thus, the study will center on the knowledge-persuasion-decision stages. This is where an individual is exposed to the innovation and the individual forms a favorable or non-favorable opinion of the innovation. At this stage the individual is seeking answers as to how will the innovation benefit them. The first three stages involve information gathering and attitude formation and are antecedents to the adoption decision [Brancheau et al., 1990; Lai et al., 1999; Rogers, 1983; Thong, 1999].

What decision support tools are currently available?

Prior research shows that tools based on expert system, decision support system and executive information system paradigms have been developed to assist the business entrepreneur minimize his/her risks during the decision-making process. However, although these tools have been valuable, they are limited in scope. These tools lack the flexibility to adapt to a wide variety of users as well as the user's changing needs and patterns.

Past research also indicate that support tools for decision making should be adaptable to the user's changing needs and habits [Agarwal et al., 1994; Bui et al., 1999; Chaung, 1998; El-Najdawi et al., 1993; Shaw, 1993]. ALS have the characteristics needed to for a DSS tool to support the business entrepreneur during IT implementation decision-making process: flexible, self-adapting systems capable of accomplishing task on behalf of the user, filters of information, tutor, and monitors of processes. Consequently, ALS can be used as a support tool for business entrepreneurs during IT implementation decision-making.

What benefits can be expected from ALS?

As computers are integrated more and more into our daily lives, software agents are expected to assist us with a variety of tasks. ALS are also expected to revolutionize the way we interact with computers. Some of the benefits include:

- simplify the use of computers [Norman 1994]
- assist with dealing with the complexity and volume of information [Bradshaw 1997]
- assisting with interpreting the information
- aligning decisions with company's goals
- reduced cost of knowledge-based workers [Dent, 1992]
- enhancing intelligence

DEVELOPMENT OF AN ALS FOR BUSINESS ENTREPRENEURS

Although the literature does not report on ALS that assist business entrepreneurs during IT implementation decision-making process, there are several reasons why such a system deserve investigation:

- ❖ Business decisions are the prime responsibility of business entrepreneurs
- ❖ ALS are good agents for dealing with uncertain environments
- ❖ ALS are good agents for searching volumes of information
- ❖ ALS are good agents for personalization: adapting to changes in the user, environment and task.
- ❖ Many researchers have requested the need for a mediating entity to augment the TAM model.

CHAPTER 3: CONCEPTUAL MODEL OF ALSTA

The main function of ALS is as an intelligent decision support (DSS) tool: an Adaptive Learning System Technology Advisor (*henceforth referred to as ALSTA*). As such, ALSTA should meet all the objectives of traditional DSS (see Sprague and Carlston, 1980). What differentiates ALSTA from other DSS is its adaptation feature. The ability to learn or adapt is widely recognized as one of the most prominent abilities of any animate or inanimate intelligent system [Deng et al., 1992]. Fazlollahi et al., [1997] assert that adaptation is achieved by matching support needs with system needs. One of the underlying assumptions for adaptivity is to provide a fit between the knowledge required by the decision-maker and the decision-maker, by so doing, it is expected that to improve the quality of decisions and performance of the user [Chaung, 1998]. Consequently, ALSTA is expected to be a robust tool that has a mediating effect on the decision maker during the decision-making process.

A review of the literature suggests that there are few comprehensive frameworks for agents, these models however failed to receive widespread acceptance. Many of the recognized agents that are built were based on ad hoc, closed models. This chapter proposes a comprehensive model of an intelligent decision-making agent in the hopes that it will form a base for agent based DSS. This section is organized as follows first an identification of the behaviors of ALS. Next it outlines the various attributes of ALSTA followed by a conceptual model.

Adaptive behaviors of ALSTA

The concept of adaptivity enhancing functionality of software has sparked tremendous interest from the research community. There is a sea of research on adaptive interfaces and adaptive help systems. Each researcher attesting that by adding new adaptive components to software, it enhances its functionality. ALSTA promises to be one such tool.

ALSTA should be able to personalize it support for a specific decision-maker in a context that she/he can understand. In so doing ALSTA would be accommodating the heterogeneous body interacting with IT. ALSTA should be able to adapt its knowledge to suit the user's changing needs and skill levels [Chaung et al., 1998; Deng et al., 1992; Fazlollahi et al., 1997]. It should also be able to adjust to any changing needs of the current user. ALSTA should be user-centered, focusing on how to better enable the user. To ensure the functionality of ALSTA, ALSTA should possess the following adaptive behaviors:

- ✓ multimodal - multiple methods of presentation to users. This feature primarily caters to the heterogeneous body of users interacting with the system. By presenting the information in a form applicable to the user, is one method of fostering learning by the user.
- ✓ Multiple views -options to view the information in different forms
- ✓ Perceptive - any changes in the environment, should be incorporated

into the model in pursuant of goal

- ✓ multiple scenarios -this is the ability to conduct various what if analysis for various situations
- ✓ different problem situations – alert the user of any possible situations that may arise surrounding their decision – new IT. Basically, this is the part that explains all the inherent risk factors.
- ✓ self-moderating - To effectively, support a user, the DSS must possess the ability to learn autonomously of new needs which would be used to make better decisions in the future.
- ✓ proactive - the system must be able to intervene at various times with minimal interference from user.

These behaviors are characteristic of true adaptive systems. By implementing these behaviors, would be ensuring the functionality of ALSTA.

Attributes of Adaptive Learning Systems Technology Advisor

For ALSTA to be considered a true competent personal assistant, it must be able to learn and improve its problem-solving skills of time. By doing so, ALSTA would be adapting to the user's styles, preferences, as well as environmental and task changes while offering her/him personalized support. This level of support will foster learning of the problem domain by the decision-maker. To achieve this, ALSTA must have a knowledge base, which will provide the base knowledge of the decision and the decision context. ALSTA

must also be able to autonomously provide support for the user with minimal intervention from him/her. This process will involve some level of learning about the user, task and environmental changing needs.

Figure 3-1 below highlights the major qualities desired in an agent that will assist the business entrepreneur in his decision-making.

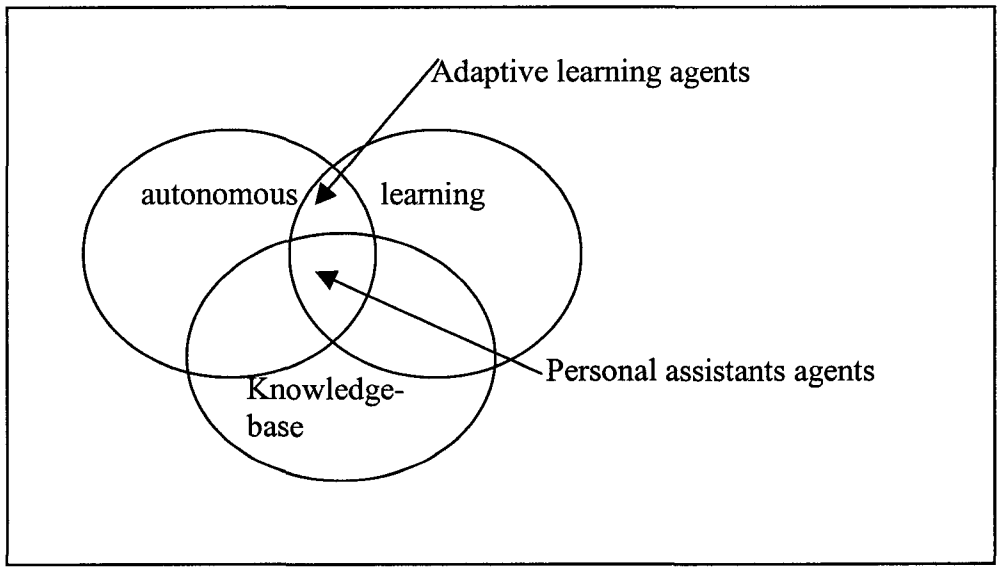


Figure 3-1 Adaptive learning systems personal assistant agents

An adaptive learning system that will assist the business entrepreneur in his decision-making regarding IT implementation should have the following attributes:

- User centered
- Proactive
- Adaptable
- Communicative

- Autonomous
- Flexible
- Responsive
- Learner-centered
- Knowledge base
- degrade gracefully

How will ALSTA work?

The model of ALSTA will be based on a competent personal assistant. As in a real work environment, the agent is expected to work on behalf of the user completing a delegated task. In fulfilling that role, the agent is expected to utilize knowledge of the user without being told to accomplish his job. Basically, this is analogous to what Negroponte [1995] call the "digital-sister-in-law:"

" When I want to go to the movies, rather than read reviews, I ask my sister in law. We all have equivalent that is both an expert on movies and an expert on us. What we need to build is a digital sister in law. In fact the concept of agents embodied in human helping humans is often one where expertise is indeed mixed with knowledge of you. A good travel agent blends knowledge about hotels and restaurants with knowledge about you... A real estate agent builds a model of you from a succession of houses that fit your taste with varying degrees of success. Now imagine a telephone answering agent, a new agent,

or an electronic mail managing agent. What they all have in common is the ability to model you."

Consistent with the above, Shelly and Cashman [2001] state a competent systems analyst must have strong technical skills and broad knowledge of information management concepts, tools and techniques. In addition, the systems analyst needs a solid understanding of the company's operations and business in general. Above all the systems analyst must be able to communicate effectively. ALSTA will be the type of personal consultant who will act proactively and autonomously to fulfill the user's requirements.

Once ALSTA is presented with a problem situation, to perform its task effectively it should evaluate the task within the context of its capabilities to determine its scope. Once the task is within the scope of ALSTA's problem-solving domain; it will then diagnose the support needs of the decision-maker. The focus in this study is to augment the decision maker's perception of the technology he/she is thinking of implementing. ALSTA will seek to teach the decision maker about the technology in the context of his/her world. Simultaneously it will attempt to find a solution to the problem on hand. If ALSTA cannot effectively do any of the aforementioned; it will try to learn by invoking various learning methodologies to produce a solution. Once a solution is found, ALSTA will utilize knowledge from the models to decide on the level of guidance and presentation that it must provide for the user. In the interim, if the user communicates any data to ALSTA, ALSTA will always evaluate that information in the context of the user's

situation. This entire process is dynamic. Any changes to the user, task and environment will be immediately incorporated in the solution. An agent in this environment is like a valued trusted personal assistant.

What type of knowledge is needed to enable such a system?

To enable the level of dynamic support that ALSTA is expected to supply for the decision-maker, some basic information must be captured. For such systems, there is a general consensus in the literature that the following models should be captured: user, domain. Due to the variety of explanations that exists to define the varying models, clarifications as to the meaning of these models in this context are warranted.

- User model - provides information about the user characteristics, preference, domain knowledge and history with using the system. It is a dynamic model. As the user needs changes, ALSTA should update its model with minimal user intervention to reflect the current needs.
- Domain model -It contains information about the problem domain- requirements, risks, models affiliated etc.,
- System model - this is a model of the capabilities of the system itself.
- Presentation model-contains all the elements and modes of presentation that is part of the system.
- Learning rules knowledge – this model has all the rules and relationship of the other models.

By capturing the above information, ALSTA will be able to customize the information in form most pleasing to the decision maker. By invoking all this information from its various knowledge bases, one can logically conclude that ALSTA would deliver any information needed to make an informed decision about your new IT.

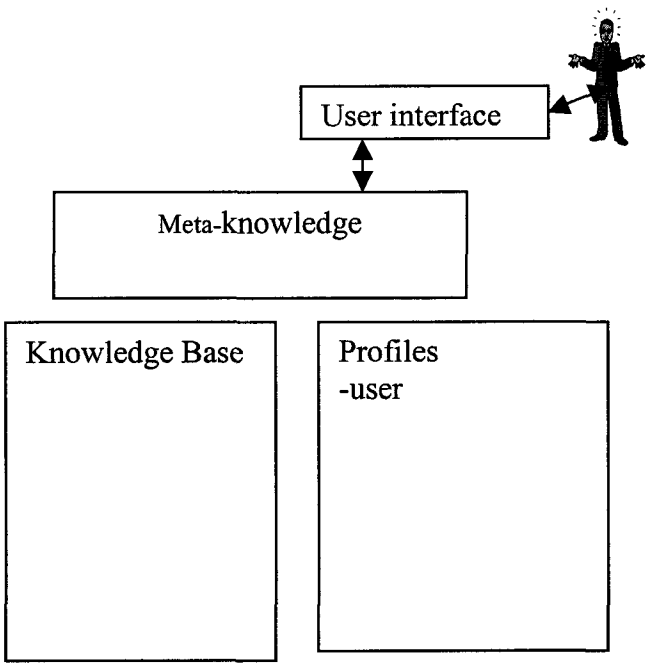


Figure 3-2 Conceptual model of ALSTA

CHAPTER 4: RESEARCH MODEL

[Do not] put too much confidence in experimental results until they are confirmed by theory.
-Sir Arthur Eddigton

INTRODUCTION

By consensus most researchers agree that agent based technology can be beneficial to a heterogeneous body of users interacting with technology. Visionary Negroponte [1995] pointed out that we can greatly benefit during this information era from human-like personal assistant agents aiding with the avalanche of information we are experiencing. Visionary Pattie Maes [1994], later reinforced this sentiment in her article "Agents that reduce work and information overload". Agent based technology offers promise to dramatically change the way that users interact with computers. This viewpoint may have given rise to the flood of agent-based research that is currently ongoing.

However, the development and acceptance of agent-based projects have been plagued with inconsistencies and lack of grounded theoretical framework. Although the reasons for this are uncertain, many attribute it to the infancy of this field. One means of realizing the full potential of this field is to nest this 'infant' research area within a grounded domain. According to Luck [1999] the adoption of agent technology for use in fielded applications is an important milestone in the development of the field. This research agrees and attempts to make progress towards this end.

Building on these notions, the author posits that ALS hold potential to facilitate the decision-making process regarding Information Technology (IT) implementation. Information technology investments have been heralded throughout the literature and general media, as one of the paradigms that can positively change a company's bottom-line. This has made IT implementation decisions one of the high priority issues facing managers today [Brancheau et al., 1990; Chau, 1996; Hu et al., 1999; Harrison et al., 1997; Karahanna et al., 1999; Lai et al., 1997, Venkatesh and Davis, 2000].

In spite of the fact that today's world offers an unprecedented amount of IT business solutions, business entrepreneurs are faced with the task of finding the right solution to fit their business needs. This task poses many challenges for the average business entrepreneur who may not be well versed in IT implementation issues. Simply acquiring technology is not sufficient in realizing returns on investment [Agarwal et al., 1988; 1997]. At least, acquisition with low and improper usage of technology by target users has been cited as key contributors to the "productivity paradox" [Agarwal et al., 1988; Venkatesh and Davis, 2000]. As a consequence, this can have many organizational impacts but on an individual level, many researchers have studied the determinants of successful IT adoption, however the activities that lead to an individual initial adoption decision have been largely ignored.

The promise of ALS

This research hopes to satisfy these concerns by evaluation of an agent based DSS to assist the business entrepreneur lower the risk of unsuccessful IT decisions. The IT

decision-making process involves information gathering, evaluation of alternatives, alignment to business goals and scope. The promise of agents to be valuable in this domain stem from the similarities in objectives of gathering information, aligning to business goals, autonomously adapting to various user's needs and preferences and in many cases tutoring the decision-maker about the technology and its implications.

Albeit there have been recent studies exploring the use of agents as decision support tools, none has explored the use in the IT implementation domain. Thus there are very little guidelines for developing such agents. To facilitate the understanding of the IT decision-making process, the author draws upon previous IT implementation research models to explain the usefulness of an agent during technology acceptance/implementation.

IT Research Models

Past IT research is replete with several models to explain technology acceptance. However, most of the research on IT tends to focus on post adoption issues of technology acceptance. The number of research centered on pre-adoption issues is very limited. It has been asserted that pre-adoption research can provide critical insights for the bases of IT implementation decisions [Karahanna et al., 1999; Tornatzky et al., 1982]. *"Research on prediction of innovation adoption would be much more valuable if the data regarding the perceived innovation characteristics were gathered to or at the same time as with the individual's decision to adopt or reject the innovation*" [Tornatzky et al., 1982]. More

research is needed on the pre-adoption phase of IT implementation. This research will focus on the IT implementation decision-making process, which is in the pre-adoption phase of IT implementation.

Specifically, this research study will reference the technology acceptance model and other technology acceptance research. Consistently recurring in that research stream is the key factor that IT decisions are a result of the decision-maker's perceptions of the usefulness and ease of use of the new technology. Yet there is a lack of extensive work on the development of the user's perceptions about the new technology. "What, for example explains how a user comes to believe that a system is useful in his or her job? [Karahanna et al., 1999]"

The noted exception studies were conducted by Agarwal et al., [1982] and Karahanna et al., [1999]. None of the prior studies have examined the use of agent-based system in that role. This study will examine the effect of ALSTA in the development of various decision-makers' perceptions regarding the new technology. It will extend existing work on technology acceptance, as Karahanna et al., [1999] suggested, incorporating aspects of the user's acceptance process.

The theoretical base for this study will come from technology acceptance and innovation diffusion research. The research will attempt to evaluate the effectiveness of ALSTA as an effective DSS during the IT implementation decision-making process by measuring a

number of the decision-maker's perceptions regarding (i) new technology prior to adoption as well as (ii) the decision support systems.

General Theoretical Model

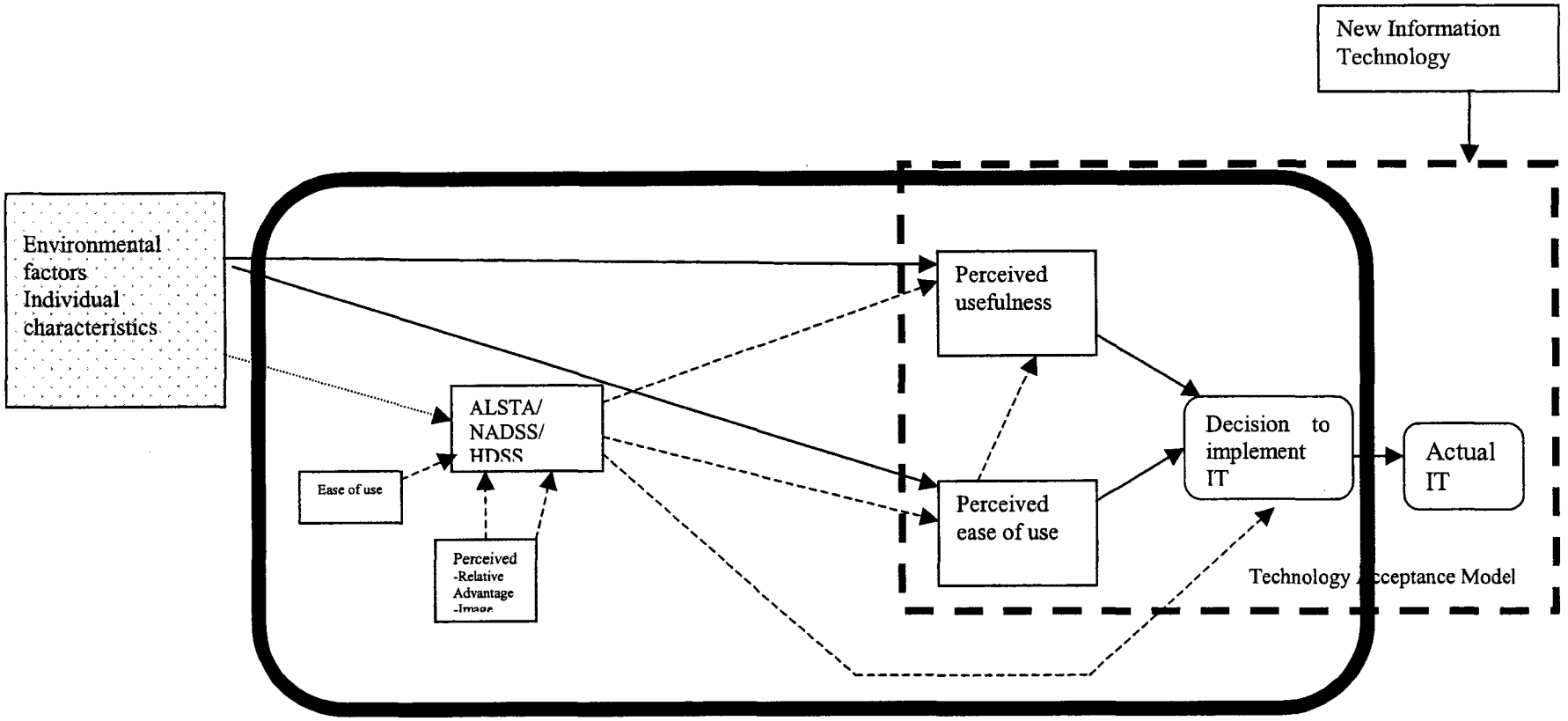


Figure 4-1 Theoretical Model (expanded framework for technology acceptance model)

Hypothesized effects

Previously empirically proven theoretical links

Influencing factors (outside realm of study)

Theoretical Base

Several theoretical frameworks in previous studies have influenced the development of this research model. The design for this study combines aspects of the Innovation diffusion framework [Rogers, 1983], Technology Acceptance Model (TAM) [Davis et al., 1989] and modified TAMs [Adams et al., 1992; Agarwal et al., 1998, Allen, 1997; Chau, 1996; Gefan et al., 1998; Hu et al., 1999; Iacovou et al., 1995; Igbaria et al., 1997; Karahanna et al., 1999] to propose an extension to TAM based on a mediating entity: an adaptive learning system.

This proposed model concentrates on the process of IT implementation decision-making, which is a pre-adoption issue. Using Rogers's [1983] innovation-decision model as guide, the primary focus during this study would be on the persuasion stage of the decision-making process (see chapter 2). "*It is during that stage the secondary attributes about an innovation is formed. At the persuasion stage the individual becomes more psychological involved with the innovation; he or she actively seeks information about the new idea. Here the important behaviors are where he seeks the information, what messages he or she receives and how he or she interprets the information that is received. – it is at the persuasion stage that a general perception of the innovation is developed*" [Rogers, 1983].

Using TAM as the starting point in the proposed model, TAM and other technology acceptance research concede that decisions regarding the target IT are a function of the

decision-maker's perceptions of the new IT [Davis et al., 1989; Karahanna et al., 1999; Moore et al., 1991; Rogers, 1983; Venkatesh et al., 2000]. The more favorable an opinion that a decision-maker has regarding an innovation the most likely he/she will make a decision to adopt and ultimately implement that IT.

New IT is treated as innovation. All innovations carry a degree of uncertainty for decision-makers that are unsure of the results. In the case of IT this is especially true due to the dynamic nature of the field. A decision-maker seeking to implement IT usually requires support/ reinforcement that his/her thinking regarding IT is correct. It is during this stage that the decision-maker tries to amass the required knowledge to reduce the uncertainty of the new technology. Rogers [1983] reported on the use of mass media and interpersonal channels for technological innovation diffusion. Reliance on the general media for information is too general to define the advantages for the decision-maker [Rogers, 1983]. A more personalized channel of diffusion of IT is warranted.

With this in mind, it appears that the decision-making process can benefit from the use of mediating influences on the decision-maker's perceptions. As such, placing this research within this framework, it is the author's belief that an agent-based DSS can provide personalized decision support to the decision-maker is one such solution. After all, a DSS is designed with the aim of extending the capabilities and overcoming the limitations of the decision-maker [Todd et al., 1999].

The resulting theoretical model [figure 4-1] presents the logic of the research model as:

- The decision to adopt IT is a function of perceptions: perceived usefulness and perceived ease of use.
- Perceptions needed in the decision-making process to implement IT are a function of the decision support system that interacts with Individual characteristics and environmental factors.

The information in this chapter presents the theoretical model. The next chapter discusses the research hypothesis, methodology and testing the model.

CHAPTER 5: RESEARCH METHODOLOGY AND HYPOTHESES

One goal of this research was to empirically validate ALSTA within the framework of the theoretical research model. The research model used in this study was constructed to answer the research questions raised earlier and derived from theories described in the previous chapter. To authenticate the model, this researcher conducted a laboratory experiment. This methodology provides a controlled environment for the researcher to evaluate hypotheses addressing the effects of the independent variables on the dependent variables. Laboratory experiments have been used in several research studies [Changchit at al., 1999; Davis et al., 1989; Gefan et al., 1998; Parikh, 1997; Singh, 1998; Ye et al., 1995], most noteworthy Davis et al., [1989] TAM, one of the foundation pillars of the theoretical model used in this research (see Chapter 4).

This chapter will discuss the research methodology used in the study. It is roadmap as follows: discussion of construction of measures and hypotheses addressing the dependent variables, experimental design and procedures used during the experiment, independent, dependent and mediating variables, measurement of the dependent variables, subjects and sampling plan as well as reliability and validity measures to be computed during the investigation.

The experiment was conducted to examine the primary goal of ALSTA as an effective decision support advisor to business entrepreneurs during the IT implementation decision-making process. As a secondary goal, ALSTA was evaluated as a surrogate human decision support advisor. Towards that end, the researcher compared ALSTA's

performance with that of a non-adaptive DSS (NADSS) and that of a human consultant (HDSS).

To demonstrate the usefulness of a system it is important to evaluate the system within the boundaries of its limitation [Vinze, Vogel and Nunamaker, 1991]. Evaluating a model is by no means a simple task [Höök, 1996; Agarwal et al., 1997]. Therefore, in order to explore the usefulness of ALSTA, it is essential to distinguish these unique features of the ALS:

1. ALSTA as an effective decision support systems (DSS)
2. ALSTA as a personal assistant agent, that is as a surrogate for a human consultant.

CONSTRUCTION OF MEASURES

In this experiment, the main objective was to validate ALSTA as an effective decision support system to business entrepreneurs during the IT implementation decision-making process. As a secondary objective, ALSTA was evaluated as a surrogate human decision support advisor. ALSTA was compared to two control treatment systems: non-adaptive decision support system and a human consultant decision support advisor. This software agent is expected to outperform the non-adaptive decision support system and perform comparatively to a human agent for business entrepreneurs during IT decision-making.

Measuring the effectiveness of ALSTA as an adjunct decision support to the IT implementation decision-making process is difficult. In selecting appropriate measures for the evaluation of ALSTA previously used measures were examined. Previous literature has utilized a multiplicity of methods that measure the effectiveness of DSS [Sprague et al., 1982; Parikh, 1997; Udo et al., 1992]. There has been no strong evidence of a unified approach for evaluation of DSS; it has been assessed in numerous ways. Sprague et al., [1982], one of the most cited pieces of literature on DSS, proposed categories for the measurement of DSS into the following classes: perception, process, product, and productivity. Perception measures the impact of the ALS on the decision-maker; Process measures evaluate the impact of the ALS on the decision-making process; Product measures are used to evaluate technical merit of DSS; and Productivity measures are used to evaluate the impact of DSS on decisions.

Parikh [1997] and Sprague [1982] suggest that since the effect of a DSS depends on several factors, utilizing a combination of measures will probably result in the best evaluation of a DSS. This study conforms to these scholars approach and utilizes a combination of measures to evaluate the effectiveness of ALSTA as a useful DSS.

How to Measure

Sprague et al., [1982], suggest that evaluation of a DSS can be done in terms of two systems:

(1) the initiating system (DSS) itself whose impact is to be evaluated and

(2) the target (IT decision) on which impact it is to be measured.

As such, the success of the decision support system in this research will be measured in two phases:

(1) Phase 1 focuses on the evaluation of the usefulness of ALSTA and

(2) Phase 2 focuses on the degree to which ALSTA influenced the decision-maker's perceptions about the target.

The constructs for measurement used during the experiment was developed from prior empirically validated research measures. Subscribing to the "smorgasbord" approach this study employs a combination of process, productivity and perception measures to validate the goals of this research. Product measures were not used in this study. The main reason for not using any product measures at this point is the product is a prototype whose primary benefits are to further research in this field and thus costs are of secondary concerns.

What to measure?

The goal is to measure the effectiveness of ALSTA. As prescribed by Sprague et al., [1982] this research plans realize this goal by evaluating the DSS in terms of two systems:

(1) the initiating system (DSS) itself whose impact is to be evaluated and

(2) the target (IT decision) on which impact it is to be measured.

For Phase 1 in measuring the effectiveness of the DSS (ALSTA/NADSS/HDSS), this research also utilizes a myriad of process, productivity and perception measures. All the measures have been selected from relevant previous studies. The productivity, process and perception measures are consistent with Sprague and Davis. The perception measures selected to evaluate the ALSTA/NADSS/HDSS are also consistent with TAM and include measures of perceived ease of use and relative advantage. The term relative advantage as discussed by other researchers can be substituted for perceived usefulness [Moore et. al., 1991]. One of the criticisms that both the constructs: relative advantage and perceived usefulness suffer from is the scope of their definition is too wide. In any event, to evaluate the effectiveness of the decision support system, this author chooses to use the term relative advantage since it connotes a meaning "the degree in which using the innovation is perceived as better than its precursor" [Moore et. al., 1991]. This is consistent with prior innovation diffusion research and in this study a comparison of DSS is undertaken. Additionally, image is listed as a separate measure. In Moore et al.'s study, they included image as part of the relative advantage construct, however in recent

studies like Karahanna et al., [1999] and Allen [1997] image was listed separately. It is this author's belief that many adopters are persuaded to adopt a technology due to social pressure. Basically, if an adopter believes that by using an innovation will gain him/her social status, he/she will more likely be predisposed to adopting that technology. Therein lay the basis for the inclusion of image as a separate construct measure. Additionally, Parikh [1997] suggested that the "influence of a decision support system on the decision making effectiveness of the decision-maker can be measured by how effective the system has been in providing stimulus and tools that extend the 'bounded rationality' and capabilities of the DM."

At this point, it may be worthy to mention that two instances of the decision support system is technology based: a software agent as in the case of ALSTA and a non-adaptive software program in the case of NADSS and the third instance, HDSS, is a human agent.

For Phase 2 where the goal is to evaluate the effects of ALSTA's on outcome: the decision to implement IT (target), perception measures will be used. Since ALSTA is used by the decision makers (independent variables) to reach decision (dependent variables), it is expected to have a strong effect, it is considered a moderating variable. The perception measures for evaluating the influence of ALSTA on the decision-maker's perceptions of the new technology were adopted primarily from TAM. The measures of perceived usefulness and perceived ease of use were selected due to their inclusion in the TAM model and other technology acceptance research.

The following table summarizes the list of measures to be used during the study.

Table 5-1 Table of measures used during the experiment

Table of Measures used during the experiment		
Class of Measure	**Measure**	**Previous study**
Phase 1 – *evaluation of DSS*		
Productivity	Time to reach a decision	Sprague, 1982
Process	Number of alternatives examined	Sprague,1982; Todd et al., 1992
Perception	Perceived Usefulness	Adams et al., 1992; Chau, 1996; Davis, 1989; Doll et al., 1988; Gefan et al., 1998; Igbaria et al, 1997; Heilman et al., 1999; Hung, 2003; Moore and Benbasat, 1991; Parikh, 1997; Sanders, 1984
	Perceived Ease Of Use	Adams et al., 1992; Chau, 1996; Davis, 1989; Doll et al., 1988; Gefan et al., 1998; Igbaria et al, 1997; Heilman et al., 1999; Moore and Benbasat, 1991; Parikh, 1997; Sanders, 1984
	Relative Advantage	Agarwal et al., 1998; Moore and Benbasat, 1991
	Explanation	Ye, 1995; Hook, 1996

	Image/ Social Influence	Moore and Benbasat, 1991; Karahanna et al., 1999
	User satisfaction	Doll et al., 1988; Gefan et al., 1998; Moore and Benbasat, 1991; Sanders, 1984
Phase 2- ***evaluation of DSS outcome: (decision to implement IT)***		
Perception	Perceived Usefulness	Adams et al., 1992; Chau, 1996; Davis, 1989; Doll et al., 1988; Gefan et al., 1998; Igbaria et al, 1997; Heilman et al., 1999; Hung, 2003; Moore and Benbasat, 1991; Parikh, 1997; Sanders, 1984
	Perceived Ease Of Use	Adams et al., 1992; Chau, 1996; Davis, 1989; Doll et al., 1988; Gefan et al., 1998; Igbaria et al, 1997; Heilman et al., 1999; Moore and Benbasat, 1991; Parikh, 1997; Sanders, 1984

The constructs to be used in this evaluation were chosen in relevance to the context and on the basis that they have been previously used in empirical studies of this kind.

RESEARCH HYPOTHESES

Based on the outlined objectives of this study it is important to test ALSTA as an effective DSS for business entrepreneurs during IT implementation by comparing it with other control forms of decision support system: human agent and non-adaptive DSS. As such the following hypotheses

addressing the dependent variables were developed. The hypotheses are organized based on the two phases.

General Theoretical Model

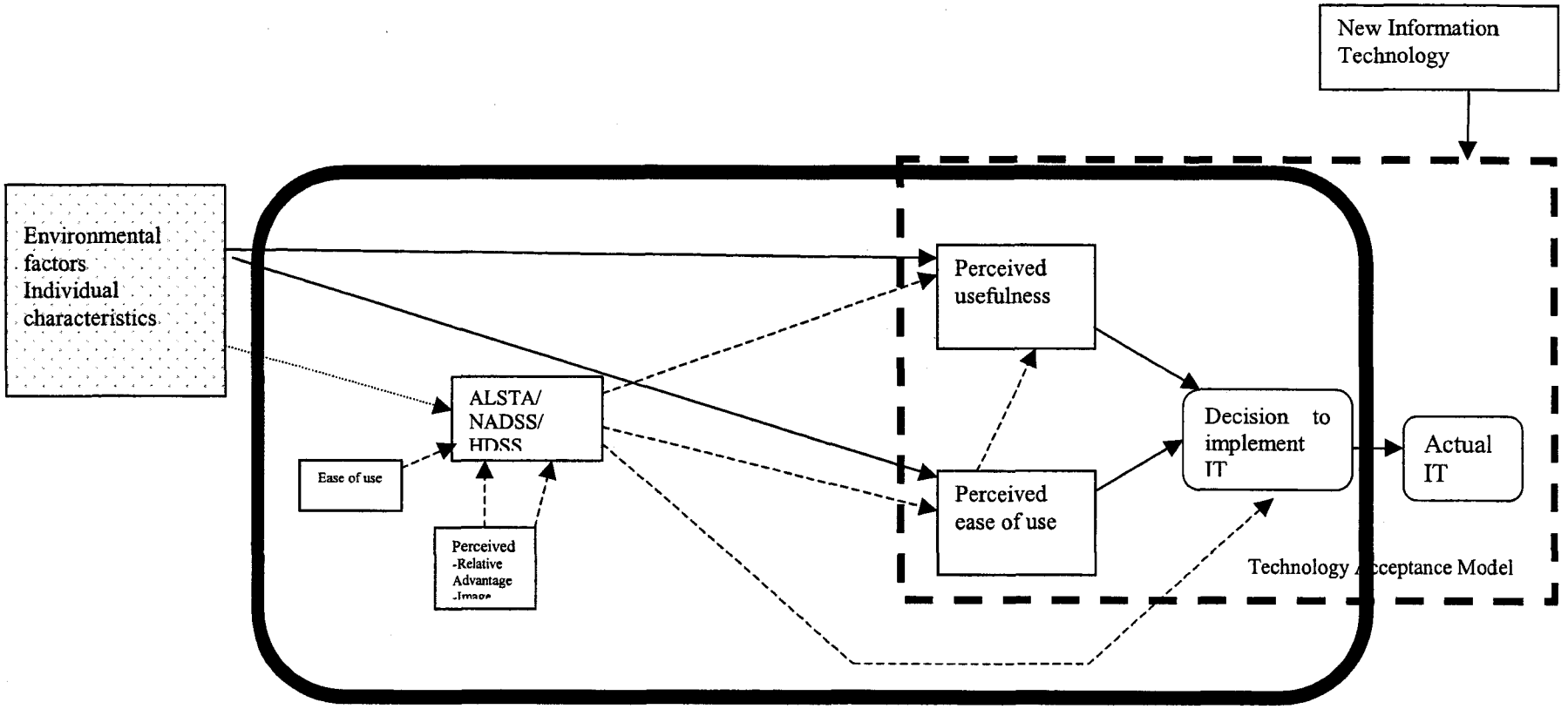


Figure 5-1 Theoretical Model (expanded framework for technology acceptance model)

Hypothesized effects

Previously empirically proven theoretical links

Influencing factors (outside realm of study)

Phase 1- Hypothesis based on evaluation of DSS whose impact is to be measured:

Productivity based Hypothesis

Hypothesis 1

This hypothesis evaluates the quality of the decision made by the user. In this study, it refers to the quality of the platform selected by the user. If the platform selected is consistent with a platform selected by an independent human domain expert then it is deemed efficient (see Appendix G). ALSTA is designed to provide more stimulus, education and overall guidance than NADSS. ALSTA was designed to be a surrogate human and thus provide guidance that would parallel that of a good consultant.

H1a: *The platform selected by ALSTA user will be rated more efficient than the platform selected by NADSS user*

H1b: *The platform selected by ALSTA user will be rated at least as efficient as the platform selected by HDSS user*

Process based hypothesis

Hypothesis 2

ALSTA is designed to encourage the user to examine the alternatives given to them. This means that the user will spend more time evaluating the various options available than the NADSS user. It is also expected that the HDSS will spend a considerable amount of time exploring the various options to the decision maker.

H2a: *An ALSTA supported user spends more time on the decision-making process than a NADSS supported user*

H2b: *The ALSTA supported user spends at least as much time on the decision making Process than the HDSS supported user*

Hypothesis 3

This hypothesis measures how many alternatives a user of DSS examines before making a final decision. It can be hypothesized that the computer based DSS will examine more alternatives than the human advisor. Additionally, the agent based DSS user will examine more alternatives than the traditional DSS user. The agent based DSS user is expected to provide more stimulus for the decision-maker, prompting them into evaluation of several alternatives.

H3: *The ALSTA supported user examines more platforms than a NADSS supported user.*

Hypothesis 4

The hypothesis relates to the tutoring effects of a DSS. The tutoring effects can be measured by analyzing each user's scores on two identical pre-test and post-test along with the decision made. If the DSS educates the user about the problem domain and the

decision making process, the user makes a more informed decision and thus a more effective decision-making process.

H4a: *An ALSTA supported user learns more of the problem domain than the NADSS supported user. This effect is greater for novice user than knowledgeable users.*

H4b: *An ALSTA supported user learns as much about the problem domain than the NADSS supported user. This effect is greater for novice user than knowledgeable users.*

Perception based hypothesis

Hypothesis 5

ALSTA users are expected to have a better mental model of the problem domain and thus make more informed decisions than NADSS users. Making more informed decisions leads to greater confidence in their decision-making and subsequently with their perception of their DSS. ALSTA was designed to mimic a human consultant during a consultant session. There were numerous interactive customizable modules built into ALSTA. As such the following hypothesis was developed.

H5: *ALSTA-supported solution will lead to greater confidence in decision-making than NADSS-supported solution and at least as confident as HDSS-supported solution. The above effect will be even stronger for novice users*

Hypothesis 6

ALSTA users are expected to have a better mental model of the problem domain and thus make more informed decisions than NADSS users. Making more informed decisions leads to greater satisfaction with their DSS and also confidence in decision-making. ALSTA was designed to give customizable support to its users, the way a good consultant should. NADSS was not designed to be customizable. ALSTA was designed to be a tutor where deficiency of knowledge was detected. As such the following hypothesis was developed.

H6a: *ALSTA user is more satisfied with the decision made than a NADSS supported user. This effect is greater for the novice users than the knowledgeable users*

H6b: *The ALSTA supported user is at least as satisfied with the decision made than a HDSS supported user. This effect is greater for the novice users than the knowledgeable users*

Hypothesis 7

ALSTA and HDSS are intended to be more supportive DSS than NADSS. For the novice user about to make a decision regarding IT implementation, customized explanations will improve his learning of the problem domain. ALSTA and HDSS will tailor its explanations to the level of the user.

ALSTA will autonomously adapt to the level of the user. It will determine the user's level of knowledge regarding the problem domain and increasingly act as a tutor regarding the domain thereby increasing the user's knowledge of the problem domain. Thus,

H7a: The *ALSTA user is more satisfied with the explanations given by their DSS than a NADSS supported user. This effect is greater for the novice users than the knowledgeable users*

H7b: *The ALSTA supported user is at least as satisfied with the explanations given by their DSS than a HDSS supported user. This effect is greater for the novice users than the knowledgeable users*

Hypothesis 8

In this era, understanding and utilizing technology is envisioned as enhancing one's image. Image is defined as "the degree to which use of the innovation is perceived to enhance one image or status in one's social setting "[Moore et al., 1991]. This measurement has been validated by Moore et al., [1991] as a distinct benefit to IT implementation. Today many decision-makers are perceived to be of greater value to an organization when they can effectively utilize IT to further their business functions. This discussion suggests the following hypothesis:

H8: *Use of the ALSTA will lead to an improved perceived image of the user than use of NADSS and at least as the same improved perceived image as use of HDSS. The above effect will be even stronger for novice users.*

Hypothesis 9

Relative Advantage (usefulness) the degree in which using the innovation is perceived as better than its precursor [Moore et al., 1991]. Even though this measurement can be relabeled usefulness, the term defined by Moore et al., [1991] will be used, since it connotes a sustainable advantage over other methods of decision support systems. ADSS is expected to be a better teacher than NADSS or HDSS. Thus it will empower a user about the problem domain more than NADSS or HDSS would. Therefore, this study hypothesizes

H9: Use of *ALSTA will lead to more perceived relative advantage than use of NADSS and at least the same perceived relative advantage as use of HDSS. The above effect will be even stronger for novice users.*

Hypothesis 10

ALSTA is designed with the complexities that an agent based system is characterized with. However, despite the complexity, which was needed to provide the personalized support (maintenance of user models and business profile); ALSTA remained very easy

to use. The interfaces of ALSTA, NADSS and HDSS were kept identical. Therefore the following hypotheses were developed:

H10a: The *ALSTA-supported user will perceive that his system is at least as easy to use as NADSS-supported user.*

H10b: The *ALSTA-supported user will perceive that his system is at least as easy to use as HDSS-supported user.*

Phase 2 – Hypotheses based upon evaluation of DM perceptions of IT to be implemented:

Hypothesis 11

ALSTA is intended to also be a teacher of the problem domain and the benefits of the technology to the business. It is expected to give guidance to its users. As a teacher ALSTA and HDSS will deliver customizable information to the users. Thong [1999] states that many CEOs reject the notion that IS could be of any use to their businesses, as they have no idea of the potential benefits IS offer. This seems to imply that if the CEOs could be more educated about the benefits of IS, they would be more willing to adopt such technology. Although NADSS can provide a tutorial to the user, if it cannot adapt its explanations to the level of the user then it will be perceived to have given less insight on the technology. For my research, this author will adopt Davis et al. [1989] definition

of Perceived usefulness- to which a person believes that use of a system would improve his or her performance. These arguments lead to the following hypothesis:

H11: The *ALSTA-supported solution will be perceived at least as perceived useful as the NADSS-supported solutions and HDSS-supported solution respectfully. The above effect will be even stronger for novice users.*

Hypothesis 12

Teaching the decision-maker about the benefits of IT eliminates the uncertainty of the problem domain. Also by adapting to the decision-maker's needs one can expect the recommendations of ALSTA will be tailored particularly for the business. Therefore the following hypotheses were developed:

H12: The *ALSTA-supported solution will be perceived easier to use than NADSS-supported solution and at least as easy as the HDSS-supported solution. The above effect will be even stronger for non-knowledgeable users.*

EXPERIMENTAL DESIGN

EVALUATION OF ALSTA AS AN EFFECTIVE DSS FOR IT IMPLEMENTATION

Assumptions

Despite the expected advantages of using ALSTA as a decision support tool during IT implementation, some important assumptions and preconditions should be noted. For example, the types of decisions supported by ALSTA are decisions that require a degree of forethought. These IT decisions under focus should involve some form of deliberation. It does not include trivial decisions such as replacement of a mouse but rather IT that can improve the business competitive edge and/or productivity. Examples include decisions such as implementation of new or upgraded LAN, improved access to information, new or upgraded software.

Also implied in this study is that the decision will be an individualized one. The decision-maker will be the sole person responsible for making the decision. This means that organizational factors will not be considered within the scope of this study. Another pre-condition that constrains this model is that the adoption of the new IT is voluntary. IT is not compulsory that decision-makers implement the new technology in order to continue their business.

Additionally, a major assumption during this research is that environmental factors will have equal effects on all subjects. The subjects will be given a task within the IT

implementation domain. Essentially since this experiment is conducted in a laboratory, the environmental factors will be a controlled variable and thus affect all participants equally.

Individual characteristics of the decision-maker (exception knowledge of the problem domain) will be collected but will not be focused on in this study. The subjects will be randomly assigned to the various treatments and thus will be expected to have equal effects for the various treatments. Overall, the goal is to test the effectiveness of ALSTA as a DSS. The only characteristic that we have isolated in studying is the effect on knowledge of the problem domain versus no knowledge of the problem domain decision-makers.

Experiment Setup

A 3X2 completely randomized laboratory experiment was conducted. There are three variables with two-levels each: subjects will have equal probability of being provided with ALSTA support, NADSS support or HDSS support [see Appendix C for detailed description of systems]. The procedure used is outlined below.

All subjects were given the same introduction to the experiment by the same principal investigator. Equal distribution of subjects among the three treatments: ALSTA, NADSS, and HDSS of decision-makers were controlled. All subjects were screened to assess their knowledge level of the problem domain. They were then asked a few questions that were

used to form a user's profile. Both their knowledge level and user's profile were captured on the computer.

Following that all subjects were presented with the task at hand. For the subjects utilizing the computer based decision support treatment, they continued with their task by interacting with their software DSS at a workstation. Each individual worked at their own pace in completing their task. No interaction was required between subjects. The decision-making in our experiment was completely an individualized one. The subjects that utilized the human decision support advisor, sat at a table with the advisor. The advisor had complete access to the knowledge and user's profile collected earlier. A tape recorder was placed in the center of the table to capture the communication for later transcription and coding.

DSS / Users	ALSTA	NADSS	HDSS	Total
Knowledgeable users	30	30	30	90
Novice users	30	30	30	90
Total	60	60	60	180

Table 5-2 Experimental design

Subjects:

Undergraduate junior, senior and graduate level students at a large urban business college within a university were the subjects of this experiment. Their participation was voluntary. According to university regulations guiding the use of human subjects in experiments, at the beginning of the experimental session each participant was asked to sign a consent form [Appendix G]. Students have been used in similar experiments of this type by several researchers [Davis et al., 1989; Henderickson et al., 1993; Klein, 1996; Parikh, 1997; Vinze et al., 1991]. These participants were asked to role-play as business entrepreneur decision-makers [see appendix A]. A stratified random sampling is suggested to include all subgroups under study. According to Sekaran [2000] stratified random sampling is a good choice when differentiated information is needed regarding various strata within the population. Baroudi et al., [1989] suggest that MIS research with a statistical power of 0.8 is acceptable. For this study, the author would like to obtain a statistical power of no less than 0.9. To achieve that level of confidence for this experiment the actual is sample size will be determined later.

Experimental Procedure

Subjects reported to the lab in groups of about four (depending on subject's availability). The subjects were first briefed about the experiment [Appendix H]. The same person briefed all participants to ensure non-bias. Pilot test showed that it took approximately

five minutes to read experimental material. In this study participants were assigned randomly to one of three experimental systems within a lab. In the first treatment, the subjects will be given to NADSS. The subjects in the second experimental treatment will be given ALSTA: An adaptive DSS tool and the subjects in the third treatment will be given to HDSS: the human consultant agents.

First demographics data were collected. Next, the system interactively acquired a profile of the user. Then, they were then presented with a pre-test on the problem domain. This enabled the prototype system as well as the researcher will be able to determine their appropriate level: novice or knowledgeable.

After the pre-test, the subjects assigned to the HDSS, consulted with their consultant, the others continued the process on the computer, since their support systems were software. The HDSS retrieved the user's profiles from the computer and proceeded with their consultation. The subjects were asked to envision themselves as the manager/decision-maker faced with the given task (Appendix A). In each case the subjects were reminded that they are not responsible for the actual implementation of IT but rather they were responsible for making the decision regarding whether or not they would adopt IT. The subjects then utilized their respective system (NADSS/ALSTA) to make a decision regarding implementation of technology within their organization. A post-test with questions identical to the pretest but randomized was administered to the subjects. For the subjects that utilized HDSS, they will return to their workstation to answer the perception question and take the post-test. Finally subjects were thanked and debriefed.

Measurement of variables

Independent Variables

The independent variables that were measured are the type of decision support system and the individual characteristic of the decision-maker: knowledge of the problem domain or lack of knowledge of the problem domain.

For each hypothesis the type of decision support system is an independent variable. There are three treatment groups: one treatment group using ALSTA, two control groups: one using HDSS and the other using NADSS.

Since the main goal of this study is to evaluate the effectiveness of ALSTA as a decision support system, other factors that might affect decision-making needed to be isolated. Though differences among the subjects can positively or negatively impact on the quality of a subject's decision, the literature remains unclear of this effect. Knowledge or expertise of the problem domain can be isolated as a feature that can affect decision outcome and thus the reason for knowledge as another independent variable. Very few studies have examined this effect, a notable exception being Hung [2003]. The individual characteristic of the user is also another independent variable. There are two: the knowledge of the problem domain and non-knowledge of the problem domain decision makers. Knowledge of the problem domain will be measured by pre-testing.

Random assignments of the various strata of decision-makers were to the various treatments ensures equal distribution of individual demographic factors among the groups.

Dependent variable

The dependent variable for this research is the effectiveness of the decision support system. This was defined in terms of two systems: For phase 1 it will be the usefulness of the decision support system and phase 2 the target system: the decision-maker's perceptions of the IT, pre-adopting the IT.

The decision-maker's perceptions are part of the IT implementation decision-making process. This involves the decision- maker's perceptions regarding the IT to be adopted. The constructs was measured using two scales: relative advantage, perceived ease of use. In using this approach the researcher remains consistent with technology acceptance studies primarily TAM that utilizes perception measures.

For Phase 2, there would be a mediating variable.

Mediating variable

The mediating variable for this research is the three different types of decision support systems. The effects of the various systems on the independent variable: Knowledge vs. treatment should have an impact on the decision.

The decision support system is the tool that will be used to assist in the development of the decision-maker's perception. The constructs were measured using three scales: relative advantage, perceived ease of use and perceived image.

The measurement and measures for each hypothesis was constructed from previous studies [Adams et al., 1992; Agarwal, 1994; Chau, 1996; Davis et al., 1989; Doll et al., 1998; Gefan, 1998; Heilman, 1999; Igbaria et al., 1997; Moore et al., 1991; Parikh, 1997; Raymond et al., 1992; Sprague et al., 1982].

Table 5-3 Summary of hypotheses and related measures

Hypothesis	Measure	Measurement
H1	Efficiency	Appendix G
H2	Improved understanding	Analysis of the post-test using the pre-test as a covariate
H3	Number of platforms examined	System recorded- each time an alternative was reviewed
H4	Time taken to reach a decision	System recorded – elapsed time from start of decision to recording the decision
H5	-confidence in decision making	Appendix D
H6	-explanation	Appendix D
H7	-image	Appendix D
H8	Decision-making satisfaction	Appendix D
H9	Relative advantage	Appendix D
H10	Perceived ease of use	Appendix D
H11	Perceived usefulness	Appendix D
H12	Perceived ease of use	Appendix D

EXPERIMENT RELIABILITY & VALIDATION

Appendix D shows the questions that were used to measure the constructs. The instrument validation process followed Straub [1989] guidelines for validation of MIS research with the aim of achieving a reliable and robust DSS tool. The measures used in this study have either been formally validated in previous methodological studies or have been used previously in empirical studies. There are thirty-two questions measuring eight variables in the instrument. Each question requires the subjects to agree or disagree with the given statements. The subjects were asked to select one number on a Likert-type scale ranging from 1 to 7. The responses on each question was summarized and analyzed.

Pilot Study

To further validate a pilot study was conducted to pre-test the procedures and instruments used in this study. Straub [1989] stated that a major purpose of a pilot study is to test the reliability and validity of constructs technically, in addition to the questionnaire administration procedure. Additional rationale for the pilot is to solicit feedback as to the length of instrument, format of scales, construct validity, ambiguous questions and software design issues. If necessary modifications will be made after the study is conducted to instrument, design and prototype.

Reliability and Validity

The importance of reliable and valid instrumentation in MIS research is critical [Harrison et al., 1997]. Validation may be defined as a process undertaken to ensure that the problem being addresses is solved correctly and that the solution is useful [Vinze et al., 1991]. The validity of ALSTA will instill confidence in its recommendations. A laboratory experiment will be conducted. Experiments are often used for testing causal relationships [Cooper et al., 2000; Davis, 1999; Parikh, 1997; Sekaran, 2000].

External validity

External validity refers to the validity to which this study's results can be generalized across population, settings and other similar conditions [Davis, 1999]. Maximum external validity can be obtained by ensuring that the lab experimental conditions are as close and compatible to the real-world situation [Sekaran, 2000]. The following measures were taken to ensure external validity.

- ✓ Pilot study
- ✓ Randomization of subjects to treatment
- ✓ Construction of cases from consultant's experiences

Content validity

Content validity refers to "the degree to which instrument items represent the domain universe of the concept under study [Harrison et al., 1997; Davis, 1999; Sekaran, 2000]. Content validity implies that the instrument contains a representative sample of the universe of subject matter of interest. To ensure content validity the following measures were taken.

- ✓ An exhaustive literature review was conducted
- ✓ Variables and their dimensions were carefully selected
- ✓ Expert opinion was solicited for developing and validating instrument
- ✓ Presentation of study in various professional conferences
- ✓ A pilot study will be conducted to validate instrument.

Construct validity

Construct validity addresses the question of whether the degree to which the scale represents and acts like the concept being measured [Davis, 1999]. Construct validity involves examining the convergent and discriminant validity of the research instrument, which indicates the strength of the constructs used to test the research model.

Convergent validity measures the degree of association between two maximally different measures that propose to measure essentially the same concepts. According to Thong et

al., [1996] three tests are suggested: first test reliability, second test that convergent validity is composite reliability of each construct and third is the average variance constructed by each construct.

Discriminant validity is the degree to which items differentiate between constructs, or measure different constructs. Discriminant validity can be assessed using two tests. The first test involves verifying that each item loads more highly on its associated construct than on any other construct. The second is that each item should correlate more highly with other items of the same constructs.

According to Davis et al., [1993] the use of well-established and accepted scales provides high convergent and discriminant validity. All measures in this study have been developed from previous studies.

Internal validity

Internal validity can be defined as the degree to which the results of the study can be relied upon as correct [Davis, 1999]. In other words, to what extent does the research design permit us to say that the variable A causes a change in the variable B? [Sekaran, 2000].

Subjects will be randomly assigned to avoid selection bias

Blind review by experts to prevent bias

Careful supervision of subjects

Procedural reliability

To foster procedural reliability during the experiment, the following steps were/will be followed:

- ✓ Measures were derived from prior studies. This ensures the use of well-established and accepted measures for variables.
- ✓ The researcher and advisor will closely monitor the process. This will allow for consistent mediating of all subjects.
- ✓ During each session, complete care will be given to the consistency of information delivery and treatments by using the same set of instructions on how to use the system

Statistical Conclusion Validity

Statistical Conclusion validity is an assessment of the mathematical relationship between variables and the likelihood that this mathematical assessment provides a correct picture of the true covariation [Straub, 1989].

To test the hypotheses 1, logit analysis is used to highlight differences between two of the systems: which system will predict with accuracy the dependent variable. For the other

hypotheses, two-way ANOVA will be used to determine differences among the various cells of data.

By following all these validity guides, the researcher is establishing the validity and reliability of this experiment.

CHAPTER 6: DATA ANALYSIS

This chapter presents the results after data analysis of the empirical investigation that was done for this research project. An outline of different statistical techniques utilized to test the hypotheses is presented. The SPSS statistical package version 11.5 for windows was used to perform the statistical analysis.

For this research one hundred and ninety two students participated in a laboratory experiment. There were missing items from two participants. These participants were excluded from the analysis to ensure equal treatment of subjects. Both participants were partaking in the study when the Blackout, 2003 happened in NYC. This prevented them from finishing the experiment.

The chapter is presented in the following order: demographics data, reliability and validity of instrument, hypothesis testing, and summary.

Research Study Demographics

The tables following 6.1-6.3 show the summary of the demographic characteristics of the participants in this study. The purpose is to examine the homogeneity of the experimental groups. There were three experimental groups: ALSTA, NADSS and HDSS. The analysis shows that there were no significant differences among the three groups. The Demographic data collected included two types of factors:

Ratio and Interval factors: Birth year, work experience, Number of CIS courses taken, computer experience, confidence in computer abilities, DSS experience, DSS confidence

Nominal factors: Gender, Major, Degree Program, and GPA

To evaluate the similarity of subjects among the groups the following statistical tests were used.

For the data type that was ratio and interval

ANOVA was conducted to find similarity of variance

Kruskal-Wallis H conducted to find the equality of mean rank.

The Kruskal-Wallis H is computed as follows:

$H=12/(N(N+1))*SUM(r^2/n)-3(N+1)$ df: k=1

H is distributed approximately as chi-squared

For The nominal data type

Chi-squared tests were used for differences among the groups on nominal factors.

Statistical analysis is summarized by the following hypothesis.

The null hypotheses are defined as follows:

Ratio and Interval scale factors: Equality of Mean Rank.

Ho: There are no significant differences among the three group mean rank

Ratio and interval scale factors Equality of variance

Ho: There are no significant differences among the three group variances.

Nominal Scale factors

Ho: There are no significant differences in the size of the three groups.

Table 6-1 Results of nominal value demographics across treatments

Demographics	Categories	TREATMENT		
		ALSTA	**NADSS**	**HDSS**
GPA	< =2.50	13	8	7
	2.51 - 2.99	13	18	18
	3.00 - 3.50	30	23	28
	3.51 - 4.00	8	15	9
	Frequency	64	64	62
		33.7%	33.7%	32.6%
	Chi-Square	**6.80**	**p-value**	**0.339**
MAJOR	Business	26	20	19
	CIS	13	12	11
	Other	25	32	32
		64	64	32
	Chi-Square	**2.54**	**p-value**	**0.637**
Gender	F	33	30	32
	M	31	34	30
		64	64	32
	Chi-Square	**0.377**	**p-value**	**.828**
Degree	G	14	17	21
	U	50	47	41
	Chi-Square	**2.311**	**p-value**	**0.314**

Table 6-2 ANOVA results of Demographics ratio and interval scale data

			MEAN			
	F	Sig.	ALSTA	NADSS	HDSS	OVERALL
AGE	1.655	.194	24.97	24.17	26.1	25.07
Work Experience	.405	.667	4.27	3.92	4.56	4.25
Computer courses	.446	.641	2.67	2.42	2.89	2.66
Computer experience	470	.626	4.45	4.66	4.65	4.58
Computer confidence	2.137	.121	4.41	4.88	4.52	4.60
DSS Experience	1.450	.237	1.78	2.05	2.15	1.99
DSS confidence	.403	.669	2.86	3.11	3.00	2.99

Table 6-3 Kruskal Wallis test results of Demographics ratio and interval scale data

	WorkExp	compcourses	compexp	Compconf	expDSS	confDSS	AGE
Chi-Square	.207	2.062	.830	4.926	3.668	1.269	3.858
Degrees of Freedom	2	2	2	2	2	2	2
p-value.	.902	.357	.660	.085	.160	.530	.145

The results show on all factors the p-values in tables 6.1-3 for the equality of variance, and in the chi-square tests are above the normally accepted 0.05. As a result, statistically, we can conclude that the groups are homogeneous.

Reliability and Validity

A questionnaire was administered to the participants to measure their perceptions of the system. Using the results of the questionnaire, reliability and validity of the instrument was appraised. The instrument was developed from previous studies. However, to further validate the instrument two additional tests were performed. First, reliability was assessed

using Cronbach's alphas and secondly, factor analysis was performed to evaluate construct validity.

Inter-Item Reliability

For inter-reliability, it was found that the items were very reliable. These results were not a major surprise since the items utilized for each measure were constructed from previous experiments. In evaluation of the Cronbach's alphas, Nunnally [referenced by Chau, 1996] suggested a minimum reliability of 0.80. As observed from the results, in all cases, the items' alphas as seen in the following table 6.4 surpassed that measure. Statistically, we can conclude that the instrument is very reliable.

Table 6-4 Cronbach's Alpha of Measures

Measure	Cronbach's Alpha
RAV	.9172
PUS	.9573
PEU	.9400
IMG	.8550
EXP	.9065
EOU	.9025
DMS	.9312
CID	.8495

Construct Validity

This refers to the degree that the scale used for measurement behaves like the concept being measured. One of the most used techniques for assessing construct validity is factor analysis. There is an underlying assumption that variables that significantly correlate, are measuring the same thing. The aim is to reduce multiple factors to a reduced number.

Factor analysis was first performed without rotation but this did not produce any meaningful factors. Thus, factor analysis with the Equamax rotation method was used. The results suggest five distinct factors as highlighted in the table 6.6 which accounted for 75 % of the overall variance. In other words, the original thirty-two items on the perceptions scales correlated into five factors.

A closer examination of factor 5 showed that items originally labeled CID, DMS, IMG and EXP correlated highly with each other. These factors dealt with confidence, explanations and overall satisfaction with the performance of the system. Generally, one can surmise that the factors dealt with how comfortable the users felt regarding the way their respective systems made decisions. For clarity this measure will be relabeled as decision-making satisfaction.

The cut off point factor loading was arbitrarily set to .475. The factors shown in the following table are all the factors loaded above .475, which was done primarily for clarity.

For Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, if the variables are measuring a common factor, they approximate to 1.0. The results from analysis of the factors resulted in a KMO of .948. Thus the degree of common variance among the variables can be characterized as "marvelous" [Friel, 2001]. Another measure, The Bartlett's test of sphericity has a chi-square value of 6019.712 and a significance of .000. This outcome suggests that there is a significant correlation among variables and factor analysis is appropriate.

As such factors were developed from this table, and given a name that indicative to item measured. These factors are later used in testing hypothesis 5-9.

Table 6-5 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.948
Bartlett's Test of Sphericity	Approx. Chi-Square	6019.712
	Degrees of freedom	496
	Sig.	.000

Table 6-6 Results from Factor Analysis

	Factors				
	1 perceived usefulness	**2 relative advantage**	**3 perceived ease of use**	**4 ease of use**	**5 decision-making**
CID1					
CID2					.560
DMS1					.498
DMS2					.540
DMS3					.611
DMS4					.520
EOU1				.754	
EOU2				.758	
EOU3				.751	
EOU4				.721	
EOU5				.729	
EXP1					.644
EXP2					.572
EXP3					.536
IMG1		.494			.526
IMG2					.567
PEU1			.871		
PEU2			.828		
PEU3			.794		
PEU4			.792		
PEU5			.708		
PUS1	.778				
PUS2	.776				
PUS3	.844				
PUS4	.815				
PUS5	.806				
RAV1		.785			
RAV2		.719			
RAV3		.813			
RAV4		.708			
RAV5		.589			
RAV6		.617			

Factor 1 - PUS

Factor 2 – RAV, IMG

Factor 3 – PEU

Factor 4 - EOU

Factor 5 –CID, DMS, IMG, EXP

These results strongly suggest that there is high construct validity for the instrument.

HYPOTHESIS TESTING

In this section, the statistical tests to validate the goals of this research are performed and the results are interpreted and discussed. To reiterate, the goal of this study is to evaluate the effectiveness of ALSTA, a software agent as:

1. ALSTA as an effective decision support systems (DSS)
2. ALSTA as a personal assistant agent, that is as a surrogate for a human consultant.

The objective of each hypothesis is broken down as follows:

Evaluation as an effective DSS

Compares ALSTA with NADSS

Evaluation of a surrogate Human consultant

Compares ALSTA with HDSS

As mentioned in the previous chapter, past research has outlined a "smorgasbord" method [Keen et al., 1978, Sprague Jr., et al., 1982] to evaluate DSS. This study has adopted the same approach utilizing multitude criteria to evaluate a DSS. The many measures used for evaluation can be categorized as productivity, process; and/or perceptions measures.

Several tests were employed to evaluate ALSTA as an effective DSS. However, the primary test used to evaluate the various hypotheses is the two-way ANOVA (hypotheses 1 being an exception). Two-way ANOVA is a very appropriate test, since they provide a sound forum for comparing the effects of two independent variables on the dependent variable. For each two-way ANOVA test a null-hypothesis is developed. For hypothesis 2a-5a, where the concern was to show that ALSTA was greater than NADSS as a DSS, the null is rejected if alpha was less than .05 at 95 % confidence and the means of ALSTA was greater than the means of NADSS. This study adopted a value for alpha of .05, even though other studies for one-tailed test have adopted a less restricted value of 1. For hypotheses 1, logit analysis was used. For hypothesis 6a-9a, we want to accept the null if the p-value is greater than .05 and if the means of ALSTA is greater than the means of NADSS when p-value is less than .05.

For the two-way ANOVA used in this research, two types of statistical tests where performed to meet objective 1; and for objective 2, one type of statistical test was performed.

For objective 1: Comparison of ALSTA with NADSS: For hypothesis H2a, H3a H4a, H5a, the objective is to prove that ALSTA is a more effective DSS than NADSS. The hypothesis can be summarized as follows:

H_o μ_a μ_n

H_a: $\mu_a > \mu_n$

The tests used for this analysis were an upper tailed two-way ANOVA, where the expectation were that there was a significant p-value and the means of ALSTA would be greater than the means of NADSS for the appropriate for 128 degrees of freedom at alpha = .050. If this is true then we will reject the null thus prove statistically that ALSTA is more effective than NADSS.

For hypothesis H6a, H7a, H8a, and H9a the objective is to prove that ALSTA is at least equally effective a DSS as NADSS. The hypothesis can be summarized as follows:

H_o: μ_a μ_n ,

H_a: $\mu_a < \mu_n$

The test used for these hypothesis was a lower tailed two-way ANOVA test, where the expectation was that there was an insignificant p-value or if there was a significant p-value then the means of ALSTA has to be greater than the means of NADSS for the appropriate degrees of freedom at alpha = .050. If this proves true then we fail to reject the null and thus prove that ALSTA is at least as effective as NADSS.

For objective 2: Comparison of ALSTA with HDSS, the hypothesis can be summarized as follows: All the hypotheses are summarizes as follows:

H_o: μ_a μ_h ,

H_a: $\mu_a < \mu_h$

For hypothesis 2b-9b the objective was to prove that ALSTA is at least equally effective a DSS as HDSS. The test was a lower tailed two-way ANOVA test, where the expectation are that the there is an insignificant p-value or if there is a significant p-value then the means of ALSTA has to be greater than the means of HDSS for the appropriate degrees of freedom at alpha = .050. If this is true then we fail to reject the null and thus prove that ALSTA is at least as effective as HDSS

Hypothesis testing

As indicated previously, the success of ALSTA is measured along several factors (multiple dependent variables). Thus, to evaluate ALSTA's success, it was appropriate to do a Multivariate Analysis of variance (MANOVA) test. MANOVA allows for a direct test of the null hypothesis with respect to ALL the dependent variables in an experiment. The results of the MANOVA are displayed in table 6-7.

Table 6-7 Results of MANOVA test

Effect		Value	F	Hypothesis df	Error df	Sig.
Rtreat	Pillai's Trace	.434	3.163	30.000	342.000	.000
	Wilks' Lambda	.589	3.437(a)	30.000	340.000	.000
	Hotelling's Trace	.659	3.714	30.000	338.000	.000
	Roy's Largest Root	.593	6.762(b)	15.000	171.000	.000
Rclass	Pillai's Trace	.450	9.278(a)	15.000	170.000	.000
	Wilks' Lambda	.550	9.278(a)	15.000	170.000	.000
	Hotelling's Trace	.819	9.278(a)	15.000	170.000	.000
	Roy's Largest Root	.819	9.278(a)	15.000	170.000	.000
rtreat * rclass	Pillai's Trace	.250	1.632	30.000	342.000	.022
	Wilks' Lambda	.760	1.666(a)	30.000	340.000	.018
	Hotelling's Trace	.302	1.700	30.000	338.000	.014
	Roy's Largest Root	.245	2.796(b)	15.000	171.000	.001

Since the multivariate results are significant (see sig. Column in table 6.7 above for Pillai's, Hotelling's, Wilks' and Roy's tests) for the main and interaction effects, we now have a reason to examine the univariate results as shown through the following hypothesis.

Hypothesis 1

H1a: The platform selected by the ALSTA-supported user will be more efficient than the platform selected by the NADSS-supported user.

For this hypothesis, the definition of efficiency is described as "performing a given task as well as possible in relation to a predefined performance criterion" [Keen et al., 1978]. The performance criteria used for this case is the correct selection of a network platform

for a small business. Thus, to evaluate the choice of the platforms selected by the users Logit analysis was selected as the most appropriate statistical method for analysis. Logit was primarily selected over ANOVA since the dependent variable was dichotomous. The accuracy of selection decision was measured by a dichotomous variable. The dependent variable was coded 1 if the subject made the correct selection and 0 if he/she gave the incorrect response. A "correct" selection was defined as the one corresponding to the expert panel decision for the case (see appendix F). This has been used in several research studies as an appropriate method (see appendix G).

Logit models extend the principles of general linear models to better treat the case of dichotomous variables. Here, the treatment variable is coded 1 for ALSTA and 0 for NADSS. One of the main purposes of using logit analysis is to understand the relative importance of independent variables (treatment) in predicting a depended variable. The logit model is set up as follows:

$$\text{Logit}(p) = a + b_1x_1+b_2x_2+b_3x_3..$$

The results of the model are summarized in the table 6-8:

Table 6-8 Hypothesis 1a: Results of Logit Analysis ALSTA vs. NADSS

		B	S.E.	Wald	Degrees of Freedom	Sig.	Exp(B)
Step 1	LOGTREAT	1.715	.408	17.684	1	.000	5.556
	RCLASS	.182	.402	.205	1	.651	1.200
	Constant	-.357	.345	1.074	1	.300	.700

The results of the overall model show that there is a strong relation between treatment (ALSTA) and predicting the correct platform (B positive). A high Wald statistic value of

17.684 with a p-value of .000 suggests that there are differences between the two groups: ALSTA vs. NADSS, and that difference is highly significant (p=.000). ALSTA being coded with a 1 value and NADSS 0, the positive B value indicates that ALSTA has more positive influence on decision outcome. Class was not statistically significant (p-value =.651) in predicting the outcome.

These results agree with previous studies on software personal assistant agents, and decision support systems, which found that DSS have positive effects on decision outcome [Cats-Baril et al., 1987; Sharda et al., 1988, Parikh, 1997]. Software agents study postulates that a software agent will realize any weakness of a decision maker and adapt to that user's level, educating the user about the benefits and weakness of a given situation [Negroponte, 1995; Maes, 1994]. A good decision support system should offer "decisional guidance", the objective being to influence the way a decision maker reaches a decision [Silver, 1990]. ALSTA is more effective than NADSS in terms of prediction of a positive outcome. ALSTA provided both system initiated help and user initiated help for the decision maker. In that sense, ALSTA provided several clues based on earlier collected profiles on the user. These clues provided greater insight and understanding of the task, which ultimately can only lead to greater analysis and more effective decision-making. ALSTA gave customized feedback to the user based on the task and situation and their user's profile. This feedback ultimately gave the users encouragement to examine several alternatives and thus make better decisions with a more complete bound of information. This might account for the high accuracy of platforms selected by the ALSTA user.

Alternatively, there were previous studies, which found that the use of a decision support system made decision makers over competent even though in performance, this was not a reality [Davis et al., 1994]. This meant that use of a DSS does not actually improve your odds of getting the correct outcome. The result of this research disagrees with this. Observations from this study show that ALSTA users significantly outperformed NADSS users in selection of an efficient portfolio. Again, this can be due to the fact that ALSTA provides customizable decisional guidance and education to its user greatly reducing the risks of making an incorrect decision. Unlike ALSTA, NADSS failed on those respects and confirms to results of earlier studies. As a result, the NADSS supported user significantly less efficient than the ALSTA supported user. Conclusively, ALSTA is more effective than NADSS in terms of selection of platform.

Hypothesis 1b

H1b: The platform selected by the ALSTA-supported user will be at least as efficient as the platform selected by the HDSS-supported user.

The accuracy of selection decision here was measured by a dichotomous variable. The variable was coded 1 if the subject made the correct selection and 0 if he/she gave the incorrect response. A "correct" selection is defines as the one corresponding to the expert panel decision for the case (see appendix F).

For the reasons stated above, Logit analysis was the test of choice. Here, the treatment variable is coded 1 for ALSTA and 0 for HDSS. One of the main purposes of using logit analysis is to understand the relative importance of independent variables (treatment) in predicting a depended variable.

The results of the model are summarized in the following table 6-9:

Table 6-9 Hypothesis 1b: Results of Logit Analysis ALSTA vs. HDSS

		B	S.E.	Wald	Degrees of freedom	Sig.	Exp(B)
Step 1	**LOGTREAT**	.918	.422	4.747	1	.029	2.505
	RCLASS	.472	.426	1.227	1	.268	1.603
	Constant	.277	.390	.504	1	.478	1.319

The results of the overall model, shows a strong relation between treatments (ALSTA) and predicting the correct platform (B positive). The p-value .029 suggests that there are differences between the two groups. The high Wald statistic value of 4.74 along with p-value < .05 suggests that ALSTA outperformed HDSS, as far as selection of platform. ALSTA being coded with a 1 value and HDSS 0, the positive B value indicates that ALSTA has more positive influence on decision outcome. Like the previous hypotheses class was not significant in predicting the outcome.

These results agree which previous studies on software personal assistant agents, and decision support systems. Software agents study postulates that a software agent will realize any weakness of a decision maker and adapt to that user's level, educating the user about the benefits and weakness of a given situation [Negroponte, 1995; Maes,

1994]. A good decision support system should offer "decisional guidance", the objective being to influence the way a decision maker reaches a decision [Silver, 1990]. ALSTA is at least as effective as HDSS in terms of prediction of a positive outcome. ALSTA provided both system initiated help and user initiated help for the decision maker. In that sense it provided several clues based on earlier profiles collected on the user. ALSTA gave customized feedback to the user based on the task and situation and their user's profile. This feedback ultimately gave the users encouragement to examine several alternatives and thus make better decisions with a more complete bound of information. This process increases the user's knowledge base about the task thereby allowing them to select an efficient portfolio for the business. This might account for the high accuracy of platforms selected by the ALSTA user.

The results show that ALSTA users outperformed HDSS users in selection of a portfolio. A possible explanation may be that with face to face help from a consultant; the user becomes overconfident in the consultant, thereby ignoring their ability to make a sound decision. Also the consultant may have certain biases, which may be transferred to the user without consideration for the overall good of the organization. Conclusively from our results, ALSTA supported user is at least as effective as HDSS supported user in terms of selection of platform.

Hypothesis 2

H2a. An ALSTA supported user learns more of the problem domain than the NADSS supported user. This effect is greater for novice users than knowledgeable users.

This hypothesis relates to the ability of how much the user learns about the problem domain while using the DSS. The learning effects of the user can be evaluated by measuring scores of the user's pre and post-test. A DSS is deemed more effective if it educates the user about the problem domain. The results of educating the user, indicates that the user is more knowledgeable, and thus can be a more effective decision-maker. For this study, if the ALSTA user learns more about the problem domain than the NADSS user, then ALSTA is deemed more effective than NADSS.

The hypothesis is tested in two ways (1) two-way ANOVA and (2) multiple regression analysis on with the post-test as the dependent variable, system as the independent variable and pre-test as covariate.

Two-way ANOVA

The hypotheses are summarized as follows:

H_0: μ_a μ_n

H_a: $\mu_a > \mu_n$

μ_a refers to the learning by from the ALSTA supported user, and μ_n refers to learning by the NADSS supported user. The results of the tests are summarized in table 6-10/11.

Table 6-10 Hypothesis 2: Diff. between Post and Pre-test Scores

TREATMENT	CLASS	Mean	Std. Deviation	N
ALSTA	*NOVICE*	3.72	2.319	25
	KNOWLEDGABLE	.41	1.517	39
	Total	1.70	2.467	64
NADSS	*NOVICE*	1.07	1.817	27
	KNOWLEDGABLE	-1.03	1.572	37
	Total	-.14	1.967	64
HDSS	*NOVICE*	1.42	2.434	19
	KNOWLEDGABLE	-.21	1.283	43
	Total	.29	1.859	62
Total	*NOVICE*	2.10	2.462	71
	KNOWLEDGABLE	-.26	1.554	119
	Total	.62	2.250	190
Effects	**F**	**P-value**	**DF**	
TREATMENT	21.943	.000	2	
CLASS	78.250	.000	1	
TREATMENT * CLASS	3.535	.031	2	

Table 6-11 Post Hoc tests for Test difference – Hypothesis 2

	(I) rtreat	(J) rtreat	Mean Difference (I-J)	Std. Error	Sig.
Games-Howell	ALSTA	NADSS	1.84(*)	.394	.000
		HDSS	1.41(*)	.388	.001

Based on observed means.

* The mean difference is significant at the .05 level.

From the ANOVA results of data analysis the overall model reveals that the p-value for main effects TREATMENT, CLASS and the interaction TREATMENT * CLASS are statistically significant $F(2,184)=21.943$, $p=.000$; $F(1,184)=78.250$, $p=.000$. F

(2,184)=3.535,p=. 031 which is less than α =. 05 at 95% confidence. To further evaluate the differences, a look at table 6-11 clearly indicates that there is a difference between ALSTA and NADSS users (p=.000). This means that treatment, class and the interaction of treatment and class had a pronounced effect on learning. To interpret these significant effects we need to examine the post hoc table 6-11 and consider the column of means in table 6-10. Inspection of the means of treatment, suggest that ALSTA users performed better than NADSS users and novice users outperformed knowledgeable users. However, part of the differences in the dependent variable is not accounted by those main effects but rather an interaction between the two independent variables (p=.031) at 95% confidence. Analysis of the results shows ALSTA users (novice, knowledgeable) showed positive learning but for the NADSS supported user the knowledgeable user should no learning. This can only be explained by the interaction effect. ALSTA was designed to support learning but NADSS was not. Knowledgeable users are less reliant on a support system, since they already possess the knowledge necessary for decision-making. With these results, we reject the null hypothesis and thus conclude that the ALSTA supported user showed greater learning than NADSS supported users respectively. These effects are amplified for novice users much more than knowledgeable users.

In further evaluation of the means reported, it was also found that in the overall model, NADSS did not support any learning as indicated by a negative mean value (-.14). This effective was enlarged for the knowledgeable users. Additionally, the results show a larger number for mean difference for novice users than knowledgeable users, thus in terms of learning the ALSTA user learns more of the problem domain than the NADSS

user and the effect is greater for novice than knowledgeable users. With these results, the null hypothesis is rejected and thus statistically speaking in the measure of learning there is support for the hypothesis that ALSTA is a more effective DSS than NADSS. This effect is greater for novice users than knowledgeable users.

Multiple Regression Analysis

For this test we try to account for the relationship between the use of the system and learning. The post-test is used as the dependent variable, system as the independent variable and pre-test as a covariate. The evaluation is based on predicting that ALSTA will positively affect the user learning about the problem domain. This type of analysis is frequently used in learning experiments [Moffit, 1994; Parikh, 1997]. With this method, we control for pre-test score so an increase in score from 7 to 10 is not as great as an increase from 4 to 7. The usefulness of the independent variable to the model can be determined by testing the significant difference between two R^2 value when that variable is added to the regression equation as well as the t and p values.

The multiple regression model is set up as follows:

$$\text{Post-test Score} = \text{Intercept} + (\beta_1 \times \text{system} + \beta_2 \times \text{Pre-test Score})$$

Pre-test and Post-test scores are actual values from observation and the system is coded with two values: 1 ALSTA and 0 for NADSS. Following are the results of the multiple regression analysis.

Table 6-12 Hypothesis 2a: Multiple Regression model – ALSTA vs. NADSS

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.695	.501		9.374	.000
	Regtreat	1.308	.277	.386	4.721	.000
	Rclass	.478	.503	.138	.952	.343
	Pretest	.167	.111	.221	1.505	.135

Table 6-13 R2 for regression

Model	R	Adjusted R Square	Std. Error of the Estimate
	rtreat ~= HDSS (Selected)		
1	.497(a)	.247	.229	1.496

The results of the overall model, shows that the system: ALSTA is significant with regard to the post-test score. System and pretest combine explain 24.7% of the variation in the post-test. High t value of 4.721 and p-value < .05 suggest ALSTA is highly significant (p=.000). ALSTA being coded with a 1 value and NADSS 0, the positive coefficient (β) indicates that ALSTA has more positive influence on post-test scores than NADSS. Conclusively, this states that the ALSTA supported user learns more about the problem domain than the NADSS supported user.

This high level of significance is expected based on software personal assistant agent theory, which posits that a software agent empowers a user by teaching the user about the task at hand. Some previous studies are mixed on their reports about DSS and learning effects on the decision maker. For this research, ALSTA was designed to support learning needs of various users, whereas NADSS was not. Learning in ALSTA was provided by continuous customized feedback, as well as system's initiated guidance and user initiated support. NADSS only provided user initiated support and standard feedback. ALSTA assisted the user whenever it detected any weakness about their knowledge of the problem domain. Past research is mixed on the issue, some studies report that DSS should support learning [Silver, 1990] but Keen et al., [1978] states that a DSS is not designed to support learning but, it can happen as a by product. The results showed that ALSTA positively influenced the post-test scores of all users, on the other hand, only NADSS novice users positive improvement in their post-test scores. Overall as a system, NADSS users did not show improvements in their post-test scores. Thus conclusively, ALSTA is more effective than NADSS in terms of the decision maker's learning about the problem domain. This effect is greater for novice users more than knowledgeable users.

Overall, the results of the two-way ANOVA and the regression model, suggests that ALSTA supported users learned more about the problem domain than the NADSS supported users.

H2b: The ALSTA supported user learns at least as much about the problem domain than the HDSS supported user. The effect is greater for novice users than knowledgeable users

This hypothesis relates to the ability of how much the user learns about the problem domain while using the DSS. The learning effects of the user can be evaluated by measuring scores of the user's pre and post-test. A DSS is deemed more effective if it educates the user about the problem domain. For this study, if the ALSTA user learns at least as much about the problem domain than the HDSS user, then ALSTA is deemed more effective than HDSS.

The hypothesis is tested in two ways (1) a two-way ANOVA on the with the dependent variable being the difference between the post test and pretest scores and independent variables being treatment and class; and (2) multiple regression analysis on with the post test as the dependent variable, system as the independent variable and pretest as covariate.

Two-way ANOVA

The hypotheses are summarized as follows:

H_0: μ_a μ_h

H_a: $\mu_a < \mu_h$

μ_a refers to the learning by from the ALSTA supported user, and μ_h refers to learning by the HDSS supported user.

From the results of data analysis the overall model reveals that the calculated p-value for main effects TREAMENT, CLASS and interaction effects are statistically significant (p value=000 which is less than α =.05 at 95% confidence). The post hoc test results displayed in table 6-11 reveals that there is a significant difference between the ALSTA supported users and the HDSS supported users in terms of their influence on the dependent variable (p=.001).

To interpret the effect of treatment we need to consider the means of different treatment averaged over class (novice, knowledgeable). Inspection of the means of treatment, suggest that ALSTA users performed better than HDSS users and novice users outperformed knowledgeable users. Since the interaction was significant, a more in depth analysis was warranted. The findings reveal that when evaluating ALSTA novice and knowledgeable users showed greater learning than HDSS novice and knowledgeable users respectively.

In further evaluation of the means reported, it is found that in the overall model, HDSS support very little learning as indicated by a mean value close to zero (.29). Novice users should some learning with a mean of 1.42 and knowledgeable users should no learning (-.21). This effective was amplified for the knowledgeable users. Additionally, the results show a larger number for mean difference for novice users than knowledgeable users.

From the results of the two-way ANOVA, the calculated p-value for the overall model is below the respected alpha. Therefore we fail to reject the null. This means that ALSTA users learnt at least as much of the problem domain than HDSS users. Further evaluation of the means reveal two additional factors. In the case of the HDSS supported knowledgeable users the mean was less than zero, which meant that no learning took place. This can possible be explained by the fact that once the consultant established that the user was knowledgeable, there was very little explanation, requested or dished out. Also the user themselves, may already think there is nothing to learn since they possess the knowledge to make an effective decision. In reviewing the means, there is also evidence that the novice users learnt much more than the knowledgeable users.

Multiple Regression Analysis

Like with hypothesis 2a a multiple regression analysis is set up to determine the relationship between the use of the system and learning. The usefulness of the independent variable will be determined by R^2 value when a variable is added to the regression equation as well as the t and p values.

The multiple regression model is set up as follows:

$$\text{Post-test Score} = \text{Intercept} + (\beta_1 \times \text{system} + \beta_2 \times \text{Pre-test Score})$$

Pre-test and Post-test scores are actual values from observation and the system is coded with two values: 1 ALSTA and 0 for HDSS. Following are the results of the multiple regression analysis.

Table 6-14 Hypothesis 2b Regression analysis results ALSTA vs. HDSS

Rsquared = .226

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.877	.493		9.889	.000
	Regtreat	.736	.286	.212	2.578	.011
	Rclass	.686	.544	.188	1.261	.210
	Pretest	.215	.112	.292	1.921	.057

a Dependent Variable: posttest

The results of the overall model, shows that the system: ALSTA is significant with regard to the post-test score. System and pretest combine explain 22.6% of the variation in the post-test. ALSTA being coded with a 1 value and HDSS 0, the positive coefficient (β) indicates that ALSTA has more positive influence on post-test scores than HDSS. The high t value of 2.578 and (p=.011) supports the hypothesis that ALSTA users learns at least as much of the problem domain as HDSS users.

This high level of significance is expected based on software personal assistant agent theory, which posits that a software agent empowers a user by teaching the user about the task at hand. Some previous studies are mixed on their reports about DSS and learning.

For this research, ALSTA was designed to support learning by the various users. This could be explained, because ALSTA provided system guided support whereas HDSS.

On further analysis, of novice users, learned more than knowledgeable, the difference of the mean as reported by the t-value is higher for novice than users than knowledgeable users. For all cases, as reported from the results of the regression model, the system with influence was ALSTA (positive coefficient).

Overall, the results of the two-way ANOVA and the regression model, suggests that ALSTA is at least as effective as HDSS in terms of learning about the problem domain.

Hypothesis 3

H3: The ALSTA supported user examines more platforms than a NADSS supported user.

This hypothesis relates to how many different platform options the users examine before making a decision. It is another measure that evaluates how complete an analysis was done before making a decision. A record of the examined platforms was stamped by the system and included choices of the different types of network such as peer to peer and server based as well as alternatives NOS. The research hypothesis is summarized as follows:

H_0: μ_a μ_n

H_a: $\mu_a > \mu_n$

μ_a refers to the mean of the number of alternatives examined by ALSTA and μ_n refers to the mean of the number of alternatives examined by NADSS. To test this hypothesis and independent two-way ANOVA was performed. The results are summarized in the following table.

Table 6-15 Hypothesis 3: Results of ALSTA/NADSS, num. of alt. examined

TREATMENTS	CLASS	Mean	Std. Deviation	N
ALSTA	NOVICE	11.96	6.003	25
	KNOWLEDGABLE	8.67	6.737	39
	Total	9.95	6.613	64
NADSS	NOVICE	7.48	7.698	27
	KNOWLEDGABLE	6.86	7.476	37
	Total	7.13	7.516	64
Total	NOVICE	9.63	7.230	52
	KNOWLEDGABLE	7.79	7.117	76
	Total	8.54	7.192	128
EFFECTS	**F-value**	**p-value**	Degrees of freedom	
TREATMENT	6.139	.015	1	
CLASS	2.379	.126	1	
TREATMENT*CLASS	1.115	.293	1	

The results of the ANOVA suggest that the main effect of treatment is statistically significant. There is no significant effect of class. The interaction between treatment and class is not significant either. Inspection of the means suggests that ALSTA users examined more alternatives before making a decision than NADSS users. As such, we

reject the null and conclude that ALSTA is a more effective DSS than NADSS in terms of the number of alternatives examined.

Past research showed mixed results for this measure, Todd [1992] did not find significant support for this measure while others such as Cats-Baril [1987], Parikh [1997], and Hung, [2003] did. Overall, ALSTA was designed to stimulate the decision-maker to evaluate several options before making a decision. Evaluation of more alternatives is a measure of completeness of information search before decision-making. This enabled the user to make a complete analysis of the option before reaching a decision. In the case of the knowledgeable user, it can mean that the explanation given by ALSTA once they selected their choice, confirmed their selection, and thus, it became less necessary to look at the other options.

Hypothesis 4

H4a: An ALSTA supported user spends more time on the decision-making process than a NADSS supported user. The effect is greater for novice users than knowledgeable users.

This hypothesis refers to the length of time that the user takes to reach a decision. It encompasses the time that the users explores and learns about the various options that are available to create an optimal solution for the business. If the user spends more time

analysis the various alternatives while using the DSS, the DSS is deemed more effective. The hypothesis is summarized as follows:

H_0: μ_a μ_n

H_a: $\mu_a > \mu_n$

μ_a is the mean of the time to reach taken to reach a decision by the ALSTA supported users and μ_n is the mean of the time taken to reach a decision by the NADSS supported users. An independent sample two-way ANOVA was performed to test this hypothesis. The findings are presented in the following table 6-16.

Table 6-16 Hypothesis 4:Timetaken to reach decision

RTREAT	RCLASS	Mean	Std. Deviation	N
ALSTA	NOVICE	1744.7600	544.80404	25
	KNOWLEDGEABLE	1127.7949	351.51807	39
	Total	1368.7969	528.81788	64
NADSS	NOVICE	1081.2593	423.53618	27
	KNOWLEDGEABLE	980.1622	381.58191	37
	Total	1022.8125	399.70751	64
HDSS	NOVICE	937.4737	288.21430	19
	KNOWLEDGEABLE	974.9767	375.73005	43
	Total	963.4839	349.30886	62
Total	NOVICE	1276.4085	560.32362	71
	KNOWLEDGEABLE	1026.6723	373.48866	119
	Total	1119.9947	466.95603	190
Effects	F	Sig	Degrees of Freedom	
TREATMENT	24.812	.000	2	
CLASS	14.221	.000	1	
TREATMENT * CLASS	10.985	.000	2	

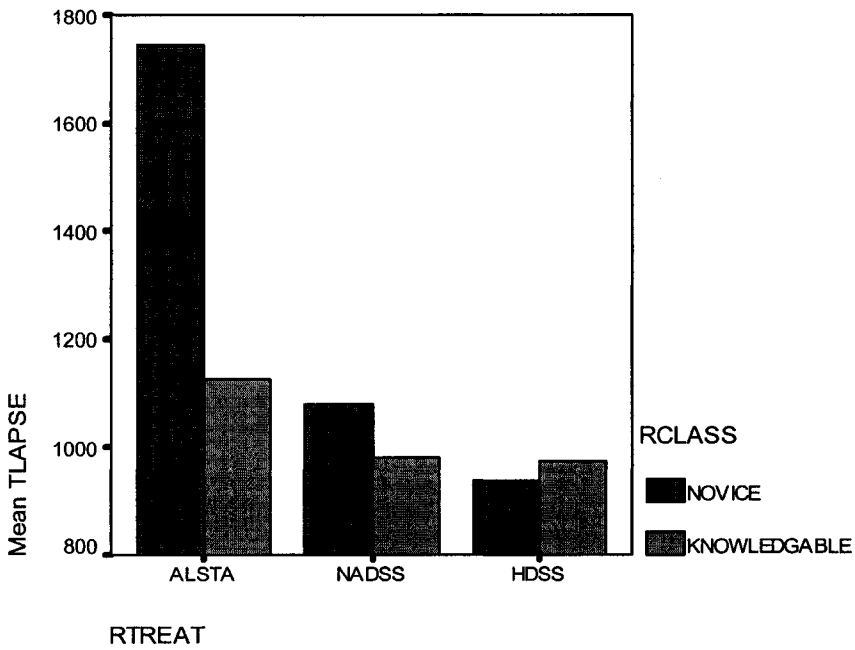
Table 6-17 Post Hoc tests for Hypothesis 4

	(I) RTREAT	(J) RTREAT	Mean Difference (I-J)	Sig.
Games-Howell	ALSTA	NADSS	345.9844(*)	.000
		HDSS	405.3130(*)	.000

Based on observed means.

* The mean difference is significant at the .05 level.

Table 6-18 Bar chart showing comparison of means Hypothesis 4



Overall the ANOVA results show that treatment, class and interaction had significant influence on the dependent variable. Post hoc test as displayed in table 6-17 reveal that there was a significant difference between ALSTA and NADSS users (p=.000). ALSTA users spent more time to reach a decision than the NADSS supported users. Analysis of

the column of means, in table 6-16, also reveals that novice users outperformed knowledgeable users in the time taken to reach a decision. The ANOVA also showed that there was statistically significant interaction, which warranted additional analysis. ALSTA novice users spent more time than NADSS novice users and ALSTA knowledgeable users spent more time than NADSS knowledgeable users. Thus we rejected the null hypothesis and conclude that the ALSTA supported user spends more time to reach a decision, than the NADSS supported user. The effect is greater for novice users than knowledgeable users.

H4b: The ALSTA supported user spends at least as much time on the decision making process than the HDSS supported user

This hypothesis refers to the length of time that the user takes to reach a decision. It encompasses the time that the users explores and learns about the various options that are available to create an optimal solution for the business. The hypothesis is summarized as follows:

H_0: μ_a μ_h,

H_a: $\mu_a < \mu_h$

μ_a is the mean of the time to reach taken to reach a decision by the ALSTA supported users and μ_h is the mean of the time taken to reach a decision by the HDSS supported

users. An independent sample two-way ANOVA was performed to test this hypothesis. The findings are presented in the tables 6-16/18 above.

The results of the ANOVA as displayed in table 6-16 show that the main effects: treatment, class, as well as the interaction effects are significant for this dependent measure. Overall we found that for main effects the ALSTA user took a significantly longer time to reach a decision than the HDSS user (table 6-17, p=.0000). From the general model, novice users take significantly longer time than knowledgeable users. In this experiment there was a significant interaction effect. To explain the significant interaction effect we conduct a deeper analysis of the column of means in table 6-16. A column graph of means is also shown in table 6-18. Here, we report that in the case HDSS knowledgeable users took and novice users took similar time reach a decision. From hypothesis 2, we concluded no learning took place during this encounter, and generally where there is learning one can expect a longer time to reach a decision. A possible explanation for this anomaly could be that the knowledgeable user when faced with a consultant was more engaging then without a consultant. This sub class of users, confident that their knowledge of the domain set is sufficient to make a decision will most likely be less apt to change their decision if different from the consultant. It is also possible that extra time was expended trying to impress the consultant of their knowledge level. All in all this translates to an unexpected increase in time spent by HDSS supported knowledgeable users before reaching a final decision. On the other hand, the human dynamics might have reverse effect on novice users who may be intimidated by their lack of knowledge of the problem domain, thus fearing that the consultant may perceive them

as ignorant. Thus, the novice user may also be less engaging and require less time with the consultant.

For this hypothesis, for the overall model, we fail to reject the null hypothesis. This is evident due to significant p-value. Thus we conclude that ALSTA users spend at least as much time as HDSS users to reach a decision.

Perception Measures

The following hypotheses refer to the users perceptions about their experiences using their respective decision support system. The hypotheses were examined by performing two-way ANOVA on the factor scores related for each measure.

Hypothesis 5

H5a: ALSTA user is more satisfied with the decision made than a NADSS supported user. This effect is greater for the novice users than the knowledgeable users

This hypothesis represents an aggregation of several questions (see results of factor analysis table 6-6) originally labeled decision-making satisfaction, confidence in decision-making, image, and explanation. Decision-making satisfaction deals with how the decision maker perceives about the systems. Confidence in decision-making refers to how much confidence the decision maker has in his decision. Image defined as the degree

to which adoption of an innovation is perceived to enhance one's image within the organization or profession [Rogers, 1983]. Explanation deals with justification, which is an explicit description of the causal argument or rationale behind each inferential step [Ye, 1995]. For all these measures, a DSS is deemed effective if the users are satisfied with their decision, has confidence in their decisions, think that the use of the tool enhances image and is happy with the explanations given by the system. Thus, if ALSTA users feel that ALSTA is more effective than NADSS on these counts, then ALSTA is a more effective than NADSS.

The hypothesis can be summarized as follows:

H_0: μ_a μ_n

H_a: $\mu_a > \mu_n$

The first analysis is done on the factor score 5: the correlated together (see above) which for clarity is henceforth referred to as DMS. The results are in the table 6-19 that follows. Here for the first analysis μ_a is the mean of the factor scores by ALSTA users and μ_n is the mean of the factor scores by NADSS users on questions related to DMS. For the second analysis, analysis μ_a is the average of responses of the ALSTA users and μ_n is the average of responses of the NADSS users on questions several questions related to: confidence in decision making (CID), Image (IMG), decision making satisfaction (DMS) and explanation (EXP). Two-way ANOVA tests performed on means of factor scores are shown in table 6-19. Two-way ANOVA as well as post hoc tests on average of responses are summarized in table 6-20, 6-21 and 6.22 respectively.

Table 6-19 Hypothesis 5: Decision making satisfaction- Factor scores - DMS

RTREAT	RCLASS	Mean	Std. Deviation	N
ALSTA	NOVICE	.2069941	.89266761	25
	KNOWLEDGABLE	-.0145117	.87306835	39
	Total	.0720140	.88045298	64
NADSS	NOVICE	-.2068813	1.25950799	27
	KNOWLEDGABLE	-.1171085	1.00590092	37
	Total	-.1549814	1.11125046	64
HDSS	NOVICE	.0226539	1.09292307	19
	KNOWLEDGABLE	.1134765	.95658150	43
	Total	.0856438	.99211131	62
Total	NOVICE	.0002744	1.09614299	71
	KNOWLEDGABLE	-.0001637	.94282720	119
	Total	.0000000	1.00000000	190
Effects	F-value	p-value	DF	
TREATMENT	1.211	.300	2	
CLASS	.008	.929	1	
TREATMENT* CLASS	.480	.620	2	

The ANOVA on the factor scores indicate for main and interaction effects as observed from the p-value are statistically insignificant (p .05). This means that we failed to reject the null hypothesis. It also means that ALSTA is equally effective as NADSS or less effective on this conjoined measure. The outcome was a bit surprising. To try to explain this anomaly, further evaluation of the individual average of responses of the four measures was undertaken. Earlier hypothesis implied that ALSTA users examine more alternatives, spent more time on decision-making and selected a more efficient platform. This indicates that ALSTA users were satisfied with their systems. However, the results from the ANOVA for this hypothesis suggest that both ALSTA and NADSS users are satisfied with their respective systems. This is consistent with previous studies that both ALSTA and NADSS users find their respective systems useful [Aldag & Power, 1986].

In this study a single decision maker used only one system, maybe if a comparisons were made where a user compared two systems the results might be different.

Table 6-20 Hypothesis 5a: Individual measures of Averages

	Rtreat	Rclass	Mean	Std. Deviation	N
Acid	ALSTA	NOVICE	5.6800	1.11692	25
		KNOWLEDGABLE	6.0897	1.05051	39
		Total	5.9297	1.08696	64
	NADSS	NOVICE	4.8889	1.76686	27
		KNOWLEDGABLE	5.6892	1.03650	37
		Total	5.3516	1.43560	64
	HDSS	NOVICE	5.5526	1.12909	19
		KNOWLEDGABLE	5.8837	1.08473	43
		Total	5.7823	1.10000	62
	Total	NOVICE	5.3451	1.43076	71
		KNOWLEDGABLE	5.8908	1.06198	119
		Total	5.6868	1.23789	190
Adms	ALSTA	NOVICE	5.2700	1.37674	25
		KNOWLEDGABLE	5.7949	.98487	39
		Total	5.5898	1.17207	64
	NADSS	NOVICE	5.0093	1.40138	27
		KNOWLEDGABLE	5.5608	1.11866	37
		Total	5.3281	1.26528	64
	HDSS	NOVICE	5.3421	1.20246	19
		KNOWLEDGABLE	5.7907	.97274	43
		Total	5.6532	1.05907	62
	Total	NOVICE	5.1901	1.33126	71
		KNOWLEDGABLE	5.7206	1.02106	119
		Total	5.5224	1.17197	190
Aexp	ALSTA	NOVICE	5.7467	1.31332	25
		KNOWLEDGABLE	6.1197	.93498	39
		Total	5.9740	1.10363	64
	NADSS	NOVICE	5.2593	1.36292	27
		KNOWLEDGABLE	5.7838	1.39048	37
		Total	5.5625	1.39269	64
	HDSS	NOVICE	5.6140	1.24852	19
		KNOWLEDGABLE	5.8760	1.00270	43
		Total	5.7957	1.08030	62
	Total	NOVICE	5.5258	1.31495	71
		KNOWLEDGABLE	5.9272	1.11754	119
		Total	5.7772	1.20749	190
Aimg	ALSTA	NOVICE	5.5400	.99917	25
		KNOWLEDGABLE	5.5385	1.09655	39

		Total	5.5391	1.05147	64
	NADSS	NOVICE	4.6111	1.52122	27
		KNOWLEDGABLE	5.2027	1.15145	37
		Total	4.9531	1.34140	64
	HDSS	NOVICE	5.0000	1.08012	19
		KNOWLEDGABLE	5.5349	1.26017	43
		Total	5.3710	1.22453	62
	Total	NOVICE	5.0423	1.28937	71
		KNOWLEDGABLE	5.4328	1.17517	119
		Total	5.2868	1.23038	190

Table 6-21 ANOVA table of univariate measures

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.
Rtreat	Acid	11.620	2	5.810	4.048	.019
	Adms	2.823	2	1.412	1.064	.347
	Aexp	5.241	2	2.620	1.835	.163
	Aimg	12.416	2	6.208	4.307	.015
Rclass	Acid	11.552	1	11.552	8.049	.005
	Adms	11.312	1	11.312	8.522	.004
	Aexp	6.539	1	6.539	4.578	.034
	Aimg	6.155	1	6.155	4.270	.040
rtreat * rclass	Acid	1.881	2	.940	.655	.521
	Adms	.080	2	.040	.030	.970
	Aexp	.502	2	.251	.176	.839
	Aimg	3.228	2	1.614	1.120	.329

Table 6-22 Post Hoc Test for Hypothesis 5

Dependent Variable		(I) rtreat	(J) rtreat	Std. Error	Sig.
Acid	Tukey HSD	ALSTA	NADSS	.21178	.019
			HDSS	.21348	.769
Aimg	Tukey HSD	ALSTA	NADSS	.21225	.017
			HDSS	.21395	.712

From the results on average of responses on questions measuring CID, IMG, DMS, EXP, it was found that the interaction effects were insignificant (p .05). These results were

unexpected. To try to evaluate the results a closer look at the main effects indicated that treatment was significant on measures of Image (IMG), and confidence in decision-making (CID) (p .05) but insignificant (p .05) on measures of explanations and decision making satisfaction. This indicates that on those measures: confidence in decision-making and image, ALSTA was rated more effective than NADSS. For the measure of Decision making Satisfaction (DMS), and EXP ALSTA is rated either equal of less effective than NADSS.

In terms of main effect: Class had slightly significant effect on the measure of confidence in decision making (p=.05) and significant for the other measures decision making satisfaction, image, and explanations (p .05). For those measures knowledgeable users rated their respective systems higher than novice users. This can be attributed to the fact that knowledgeable users were confident with the results from their system. Since both systems were robust DSS the results did not disappoint this group, which was less reliant on system support for decision-making. Their priori knowledge gave them a standard to judged the system accordingly. Novice users on the other hand were just rated the system without a standard of comparison.

Thus in terms of confidence in decision-making and image, it means the ALSTA is ranked more effective than NADSS and on the other measures decision making satisfaction and explanation, ALSTA is ranked equally or less effective than NADSS. Inspection of the table of means reveal on all measures that the average of the means was greater for ALSTA than NADSS. One might expect that measures of image, confidence

in decision-making, decision-making satisfaction and explanations would be judged as major factors for adoption.

Past studies have been split on the importance on several of these measures, this current study being no exception. For example, [Herbert, 1994; Tornatzky and Klein 1982] found image not to be a significant variable. Rogers on the other hand states the need to gain social status is undoubtedly, one of the key motivators for a person to adopt an innovation. On the question of image, utilizing the average of responses results, this research agrees with Rogers. ALSTA users outperformed NADSS users on several counts: more effective decisions, examining more alternatives, increased learning. All these measures assisted the user in making better decisions. As such, it would not be a stretch to imagine that one can visual the DSS as a tool that extends his/her "bounded rational". This can make a user feel more powerful and thus have an enhanced image of his/her value. NADSS performed considerable less effective on all mentioned counts and as such may not be seen as a tool that can significantly enhance one's image. In terms of confidence in decision-making, this study differs from previous studies, which did not show that the use of a DSS increased confidence in decisions. Our results show that ALSTA users were more confident in their decision-making than NADSS users. The customized tutorials and feedback could be credited for this confidence. ALSTA utilized weakness in the users' profiles and assisted the user in their decision-making. NADSS users on the other hand, as much as they were assisted, the feedback was standard, thus leaving several users unsure of their choice even when correct. This may account for some of the variance.

For the measure of explanations, the literature is relatively silent on that issue, the few exception being Ye [1995]. Ye [1995], states that explanation can have a positive impact as to whether users accept a system. There was no support found for Ye in this empirical study. With the customized feedback and tutorial from ALSTA one expected that there might be significant differences with the way users rated the system. This was not so, it can mean that both users were satisfied with the explanations given by their systems. Also the users, in their questions were not asked to compare systems but rather just give their perceptions of the system that they were using. The results indicate both users were satisfied. This also was consistent with the next measure of decision-making satisfaction. As much as with the process and productivity measures (H1-4) ALSTA outperformed NADSS. When asked about their perceptions of their respective systems, both users were satisfied. These results differ from Parikh [1997] who found adaptive DSS users more satisfied with their system than non-adaptive DSS users. Failure to ask the users to compare their DSS against a model "consultant" might anomaly in this hypothesis.

H5b: The ALSTA supported user is as least as satisfied with the decision made as the HDSS supported user. This effect is greater for the novice users than the knowledgeable users

This hypothesis represents an aggregation of decision-making satisfaction, confidence in decision-making, image, and explanation. Decision-making satisfaction deals with how

the decision maker perceives about the systems. Confidence in decision-making refers to how much confidence the decision maker has in his decision. Image defined as the degree to which adoption of an innovation is perceived to enhance one's image within the organization or profession [Rogers, 1983]. Explanation deals with how the decision maker perceives that the system. For all these measures, a DSS is deemed effective if the users are satisfied with their decision, has confidence in their decisions, think that the use of the tool enhances image and is happy with the explanations given by the system. Thus, if ALSTA users feel that ALSTA is more effective than HDSS on these counts, then ALSTA is a more effective than HDSS.

H_0: μ_a μ_h,

H_a: $\mu_a < \mu_h$

The first analysis is done on the factor scores on one measure, since all these measures correlated together (see above) and thus can be can be thought of as measuring the same measure. The results are in the table 6-19 that follows: Here for the first analysis μ_a is the mean of the factor scores by ALSTA users and μ_h is the mean of the factor scores by HDSS users on questions related to factor 5 labeled DMS. For the second analysis, analysis μ_a is the average of responses of the ALSTA users and μ_h is the average of responses of the HDSS users on questions several questions related to: confidence in decision making (CID), Image (IMG), decision making satisfaction (DMS) and explanation (EXP). Two-way ANOVA tests performed on means of factor scores are

shown in table 6-19. Two-way ANOVA as well as post hoc tests on average of responses are summarized in table 6-20, 6-21 and 6.22 respectively.

For all instances: confidence in decision-making, decision-making satisfaction, explanation and image as indicated in Post Hoc tests and ANOVA tables 6-20-22, we failed to reject the null hypothesis (p .05). This means statistically, that the ALSTA supported user is at least as satisfied with the decisions as the HDSS supported user.

Hypothesis 6

H6a: An ALSTA supported user perceives his system is as least as advantageous as the NADSS supported user.

This hypothesis deals with how the decision maker perceives the DSS as advantageous. Relative advantage is defined as the degree to which the innovation is perceived as better than its precursor [Harrison et al., 1997; Rogers, 1986]. The hypothesis is summarized as follows:

H_0: μ_a μ_n ,

H_a: $\mu_a < \mu_n$

Here for the first analysis μ_a is the mean of the factor scores by ALSTA users and μ_n is the mean of the factor scores by NADSS users on questions related to relative advantage.

For the second analysis, analysis μ_a is the average of responses of the ALSTA users and μ is the average of responses of the NADSS users on questions related to relative advantage. Two-way ANOVA tests performed on means of factor scores and average of responses are summarized in table 6-24 and 6.25 respectively.

Table 6-23 Hypothesis 6: Relative advantage Factor Scores (ALSTA/NADSS)

Dependent Variable: REGR factor score 2 for analysis 1 - RAV

RTREAT	RCLASS	Mean	Std. Deviation	N
ALSTA	NOVICE	-.0329061	1.17553357	25
	KNOWLEDGABLE	.0929413	.75213779	39
	Total	.0437822	.93353232	64
NADSS	NOVICE	-.1748990	1.45408076	27
	KNOWLEDGABLE	-.0118881	.88063737	37
	Total	-.0806583	1.14992548	64
HDSS	NOVICE	-.2061509	1.10481294	19
	KNOWLEDGABLE	.1459753	.79516533	43
	Total	.0380657	.90681398	62
Total	NOVICE	-.1332647	1.25646196	71
	KNOWLEDGABLE	.0795109	.80505814	119
	Total	.0000000	1.00000000	190
EFFECTS	F-VALUE	P-VALUE	DF	
TREATMENT	.232	.793	2	
CLASS	1.976	.161	1	
TREATMENT* CLASS	.202	.817	2	

Table 6-24 Hypothesis 6: Relative advantage Avg. of responses

RTREAT	RCLASS	Mean	Std. Deviation	N
ALSTA	NOVICE	5.5400	1.41444	25
	KNOWLEDGABLE	5.8632	.90230	39
	Total	5.7370	1.13070	64
NADSS	NOVICE	5.2654	1.18327	27
	KNOWLEDGABLE	5.6081	.97120	37
	Total	5.4635	1.07047	64
HDSS	NOVICE	5.4298	.87014	19
	KNOWLEDGABLE	5.7636	.77000	43
	Total	5.6613	.80976	62

Total	NOVICE	5.4061	1.18948	71
	KNOWLEDGABLE	5.7479	.87840	119
	Total	5.6202	1.01649	190
EFFECTS	F-VALUE	P-VALUE	DF	
TREATMENT	1.075	.343	2	
CLASS	4.761	.030	1	
TREATMENT* CLASS	.001	.999	2	

After analysis the results show that the insignificant p-values at 95% confidence for the main effect as well as the subclasses. As such we fail to reject the null hypothesis and conclude that the ALSTA Supported user feels that their system is just as useful as the NADSS supported user. These results are in agreement with past research on usefulness [Davis, 1999; Hu et al., 1999]. According to Chau [1996], if a user believes a technology is useful in accomplishing a current task, it predisposes that it will help him/her in the future and thus is most likely to adopt that technology.

H6b: An ALSTA supported user perceives his system is as least as advantageous as the HDSS supported user.

This hypothesis deals with how the decision maker perceives the DSS as advantageous. Relative advantage is defined as the degree to which the innovation is perceived as better than its precursor [Harrison et al., 1997; Rogers, 1986]. The hypothesis is summarized as follows:

H_0: $\mu_a \quad \mu_h$,

H_a: $\mu_a < \mu_h$

Here for the first analysis μ_a is the mean of the factor scores by ALSTA users and μ_h is the mean of the factor scores by HDSS users on questions related to relative advantage. For the second analysis, analysis μ_a is the average of responses of the ALSTA users and μ_h is the average of responses of the HDSS users on questions related to relative advantage. Two-way ANOVA tests performed on means of factor scores and average of responses are summarized in table 6-24 and 6.25 respectively.

After careful analysis of the results of factor scores, the outcome shows that for all cases the insignificant p-value. In terms of the averages of responses, there were insignificant p-values for interaction and treatment. This means that we fail to reject the null, and therefore conclude the ALSTA supported user feels that their systems was at least as equally advantageous as the use of HDSS.

Hypothesis 7

H7a: The ALSTA supported user feels that their system is as least as easy to use as the NADSS supported user.

A goal of this research is to develop a tool that will enable the growing body of heterogeneous users to effectively exploit IT. It is imperative that ALSTA is easy to use thus enabling novice users to take advantage of technology. Ease of Use as defined by

Davis et al., [1989] is the degree to which a person believes that using a particular system will be free of effort. A DSS is more effective if it is easy to use, thus allowing the decision making to concentrate at the task at hand. Therefore, the ALSTA user should feel that ALSTA is at least as easy to use as NADSS. These considerations lead to the following hypothesis, summarized below:

H_0: μ_a μ_n,

H_a: $\mu_a < \mu_n$

For the analysis based ease of use: μ_a refers to the average of responses of ALSTA supported users and μ_n refers to the average of responses of the NADSS supported users. For the analysis based on mean of factor scores μ_a refers to the mean of the factor scores of the ALSTA supported users and μ_n refers to the mean of the factor scores of the NADSS supported users. Two-way ANOVA tests were performed on the average of responses and the mean of factor scores and the results are summarized in the following tables 6-25 and 6-26 respectively.

Table 6-25: Hypothesis 7: Ease of use- averages

RTREAT	RCLASS	Mean	Std. Deviation	N
ALSTA	NOVICE	5.7680	1.09952	25
	KNOWLEDGABLE	6.2051	.83664	39
	Total	6.0344	.96382	64
NADSS	NOVICE	5.1556	1.23330	27
	KNOWLEDGABLE	6.0108	1.04238	37
	Total	5.6500	1.19576	64
HDSS	NOVICE	5.5263	1.09790	19
	KNOWLEDGABLE	5.9767	.97415	43
	Total	5.8387	1.02611	62
Total	NOVICE	5.4704	1.16624	71

	KNOWLEDGABLE	6.0622	.95127	119
	Total	5.8411	1.07290	190
EFFECTS	F	p-value	DF	
TREATMENT	2.374	.095	2	
CLASS	13.881	.000	1	
TREATMENT* CLASS	.804	.449	2	

Table 6-26 Hypothesis 7: Ease of use- factor scores

RTREAT	RCLASS	Mean	Std. Deviation	N
ALSTA	NOVICE	-.0151576	.87862388	25
	KNOWLEDGABLE	.2682980	.77287989	39
	Total	.1575731	.82086483	64
NADSS	NOVICE	-.5447584	1.08982585	27
	KNOWLEDGABLE	.2021070	.95862644	37
	Total	-.1129768	1.07401111	64
HDSS	NOVICE	-.3233121	1.05450601	19
	KNOWLEDGABLE	.0764830	1.08254154	43
	Total	-.0460349	1.08144985	62
Total	NOVICE	-.2990190	1.02176359	71
	KNOWLEDGABLE	.1784063	.94682358	119
	Total	.0000000	1.00000000	190
EFFECTS	F	p-value	DF	
TREATMENT	1.635	.198	2	
CLASS	10.494	.001	1	
TREATMENT* CLASS	.941	.392	2	

For both analysis of averages and factor scores, the interaction effects are statistically insignificant (p .05). Therefore, we failed to reject the null hypothesis and conclude that ALSTA is at least as equally effective as NADSS for the measure of ease of use.

Prior studies by Parikh [1997] and Burkhard [1984] state when two systems are well designed, ease of use is not significantly different. ALSTA and NADSS visually had the

same interface. The modules underlying ALSTA was more complex however the interfaced were consistent for both systems. Although ALSTA is a more complex system, it did not compromise ease of use to achieve that effect. Additionally, the interfaces, confirmed to Windows application standards which most of the subjects are familiar with. These results were not surprising.

H7b: The ALSTA supported user felt at least as equally at ease about their DSS, as the HDSS supported user.

This hypothesis refers to the users' perception on how easy it was to interact with their DSS. Ease of Use as defined by Davis et al., [1989] is the degree to which a person believes that using a particular system will be free of effort. A DSS is more effective if it is easy to use, thus allowing the decision making to concentrate at the task at hand. The stimulus of ALSTA was designed to model the interaction of a human consultant. Thus on the bases of the language of ALSTA, it should be very similar to those of a consultant. Therefore, the ALSTA user should feel that their system is at least as easy to use as HDSS supported user. These considerations lead to the following hypothesis, summarized below:

H_0: $\mu_a \quad \mu_h$,

H_a: $\mu_a < \mu_h$

For the analysis based on ease of use: μ_a refers to the average of responses of the ALSTA supported users and μ_h refers to the average of responses of the HDSS supported users. For the analysis based on mean of factor scores μ_a refers to the mean of the factor scores of the ALSTA supported users and μ_h refers to the mean of the factor scores of the HDSS supported users. Two-way ANOVA tests were performed and the results summarized in the following tables 6-25 and 6-26 above.

On all instances (tables 6.25/6) whether that analysis was done from the factor scores or the analysis of the averages, the interaction effect was insignificant (p .05). Statistically, for this hypothesis we fail to reject the null. This allows the researcher to conclude that the ALSTA supported user felt that using their system was at least as easy as the HDSS user felt about interacting with the consultant. Thus ALSTA as a DSS is at least as equally effective as HDSS with respect to ease of use.

This result can be classified as very exploratory, since past research tend to compare two computer systems, or computer systems and no systems. To my knowledge, no other system has made this comparison in the same experiment. It is a step in which validates the value of an agent- based system. ALSTA was designed to be interactive and engaging the way a valued consultant would [Negroponte, 1996]. ALSTA identified weaknesses of the user and providing customized assistance and tutorial. The nature of the interaction was designed to be analogous with one of a valued human consultant; therefore these findings certainly matched the expectations of this research.

Hypothesis 8

H8a: The ALSTA supported user perceives at least as much as the NADSS supported user that the network platform selection for the business when implemented will be useful.

This measure is recognized as an indicator for evaluating the success of the decision support system. An effective decision support system should enlighten the user about the outcome of the decision, in this case the network that will be implemented. If ALSTA is as or more effective than NADSS, the ALSTA supported users should fell at least as enlighten about the usefulness of the technology that will be implemented in their organization. The hypothesis is summarized as follows:

H_0: $\mu_a \quad \mu_n$,

H_a: $\mu_a < \mu_n$

For the analysis based on perceived usefulness of outcome: μ_a refers to the average of responses of ALSTA supported users and μ_n refers to the average of responses of the NADSS supported users. For the analysis based on mean of factor scores μ_a refers to the mean of the factor scores of the ALSTA supported users and μ_n refers to the mean of the factor scores of the NADSS supported users.

Independent two-way ANOVA on the averages of responses, as well as factor scores was used to evaluate this measure. The results are summarized in tables 6-27 and 6-28:

Table 6-27: Hypothesis 8a: Perceived usefulness –averages

RTREAT	RCLASS	Mean	Std. Deviation	N
ALSTA	NOVICE	5.6640	1.33257	25
	KNOWLEDGABLE	6.2974	.87283	39
	Total	6.0500	1.11041	64
NADSS	NOVICE	5.5037	1.24452	27
	KNOWLEDGABLE	5.8703	1.21034	37
	Total	5.7156	1.22866	64
HDSS	NOVICE	5.8737	1.02026	19
	KNOWLEDGABLE	6.1721	.75288	43
	Total	6.0806	.84656	62
Total	NOVICE	5.6592	1.21392	71
	KNOWLEDGABLE	6.1193	.96175	119
	Total	5.9474	1.08309	190
EFFECTS	F	P-VALUE	DF	
TREATMENT	1.779	.172	2	
CLASS	7.285	.008	1	
TREATMENT* CLASS	.408	.666	2	

Table 6-28 Hypothesis 8: Perceived usefulness – factor scores

RTREAT	RCLASS	Mean	Std. Deviation	N
ALSTA	NOVICE	-.3530189	1.05053315	25
	KNOWLEDGABLE	.1454083	.71943913	39
	Total	-.0492898	.89033674	64
NADSS	NOVICE	-.0732767	1.12426473	27
	KNOWLEDGABLE	-.1388076	1.10867459	37
	Total	-.1111618	1.10683317	64
HDSS	NOVICE	.0374797	1.36452337	19
	KNOWLEDGABLE	.2222509	.77564496	43
	Total	.1656275	.98540804	62
Total	NOVICE	-.1421384	1.16323163	71
	KNOWLEDGABLE	.0848053	.88294660	119
	Total	.0000000	1.00000000	190
EFFECTS	F	P-VALUE	DF	
TREATMENT	1.029	.359	2	
CLASS	1.876	.173	1	
TREATMENT* CLASS	1.243	.291	2	

The findings reveal that for all instances, both using the results of the factor loading scores and independent two-way ANOVA on the averages of responses, that the interaction effects are statistically insignificant (p .05). We thus fail to reject the null and conclude that ALSTA user perceives that the technology that will be implemented in the organization will be at least as useful as the NADSS user.

This is grounded in the technology acceptance model, and innovation diffusion theory, which states that a user will most likely adopt a technology if he/she perceives the technology, is useful. A good DSS will give support to the user to ensure that the user makes a correct decision. In this hypothesis the research did not disappoint expectations.

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Hypothesis 9

H9a: The ALSTA supported user perceives at least as much as the NADSS supported user that the network platform selected when implemented will be easy to use.

This measure is recognized as an indicator for evaluating the success of the decision support system. An effective decision support system should enlighten the user about the outcome of the decision, in this case the network that will be implemented. If ALSTA is as or more effective than NADSS, the ALSTA supported users should fell at least as

enlighten about the usefulness of the technology that will be implemented in their organization. The hypothesis is summarized as follows:

H_0: μ_a μ_n ,

H_a: $\mu_a < \mu_n$

For the analysis based on perceived ease of use of outcome: μ_a refers to the average of responses of ALSTA supported users and μ_n refers to the average of responses of the NADSS supported users. For the analysis based on mean of factor scores μ_a refers to the mean of the factor scores of the ALSTA supported users and μ_n refers to the mean of the factor scores of the NADSS supported users.

Independent two-way ANOVA on the averages of responses, as well as factor scores was used to evaluate this measure. The results are summarized in tables 6-29, 6-30:

Table 6-29 Hypothesis 9: Perceived ease of use of network –averages

RTREAT	RCLASS	Mean	Std. Deviation	N
ALSTA	NOVICE	5.3280	1.19007	25
	KNOWLEDGABLE	5.9538	.85528	39
	Total	5.7094	1.03705	64
NADSS	NOVICE	4.9630	1.15697	27
	KNOWLEDGABLE	5.5892	1.30294	37
	Total	5.3250	1.27267	64
HDSS	NOVICE	5.4421	1.04898	19
	KNOWLEDGABLE	5.4419	1.14106	43
	Total	5.4419	1.10506	62
Total	NOVICE	5.2197	1.14401	71
	KNOWLEDGABLE	5.6555	1.12444	119
	Total	5.4926	1.14838	190
Effects	F	p-value	DF	
TREATMENT	1.629	.199	2	

CLASS	6.040	.015	1	
TREATMENT* CLASS	1.435	.241	2	

Table 6-30 Hypothesis 9: Perceived ease of use of network –factor scores

RTREAT	RCLASS	Mean	Std. Deviation	N
ALSTA	NOVICE	-.1058106	.76292916	25
	KNOWLEDGABLE	.3352583	.67886907	39
	Total	.1629657	.73943335	64
NADSS	NOVICE	-.2966039	.84935326	27
	KNOWLEDGABLE	.1406408	1.30373685	37
	Total	-.0438218	1.14732915	64
HDSS	NOVICE	.0489425	1.02431693	19
	KNOWLEDGABLE	-.1989562	1.08196039	43
	Total	-.1229873	1.06249523	62
Total	NOVICE	-.1369530	.86998325	71
	KNOWLEDGABLE	.0817115	1.06521591	119
	Total	.0000000	1.00000000	190
Effects	F	p-value	DF	
TREATMENT	.748	.475	2	
CLASS	1.982	.161	1	
TREATMENT* CLASS	2.234	.110	2	

After analysis on the factor scores, the ANOVA indicate treatment* class has no significant effect on prediction of ease of use of the network F(2, 128)=.748, p .05. The main effects of class and treatment were also statistically insignificant. This means that statistically, ALSTA supported user perceives at least as much as the NADSS supported user that the network that will be implemented will be easy to use.

A good DSS will support the decision maker in selecting making good decisions. NADSS, although it is not adaptive it is a good DSS. Thus it is no surprise that statistically there was no difference between ALSTA and NADSS as in terms of educating the user on the ease of use of the technology to be implemented. Inspection of the means of factor scores reveals that the ALSTA users had a higher rating than NADSS users.

H9b: The ALSTA supported user perceives at least as much as the HDSS supported user that the network platform selected when implemented will be easy to use.

As discussed in 9a, this measure is recognized as an indicator for evaluating the success of the decision support system. An effective decision support system should enlighten the user about the outcome of the decision, in this case the network that will be implemented. If ALSTA is as or more effective than HDSS, the ALSTA supported users should fell at least as enlighten about the usefulness of the technology that will be implemented in their organization. The hypothesis is summarized as follows:

H_0: μ_a μ_n

H_a: $\mu_a < \mu_n$

For the analysis based on perceived ease of use of outcome: μ_a refers to the average of responses of ALSTA supported users and μ_h refers to the average of responses of the HDSS supported users. For the analysis based on mean of factor scores μ_a refers to the

mean of the factor scores of the ALSTA supported users and μ_h refers to the mean of the factor scores of the HDSS supported users.

On all instances (tables) whether that analysis was done from the factor scores or the analysis of the averages, the calculated p-values were insignificant (p-value>=.05). Statistically, for this hypothesis we fail to reject the null. This allows the researcher to conclude that the ALSTA supported user like the HDSS supported user did not have different feeling regarding the network to be implemented. A good DSS should educate the user of the benefits of a system. Ease of use as cited in several research articles has been used as a measure of success of a system. Thus ALSTA as a DSS is at least as equally effective as HDSS in respect to ease of use.

These results can be classified as very exploratory. ALSTA was designed to be interactive and engaging the way a valued consultant would [Negroponte, 1995]. ALSTA identified weaknesses of the user and providing customized assistance and tutorial. The nature of the interaction was designed to be analogous with one of a valued human consultant; therefore these findings certainly matched the expectations of this research.

Summary:

Nine hypotheses were examined to evaluate the effectiveness of ALSTA as a decision support system. For this we create two objectives (1) evaluation of ALSTA as compared to NADSS and (2) evaluation of ALSTA as compared to HDSS.

ALSTA was compared to NADSS using a "smorgasbord" of measures. From the results, one can conclude that ALSTA is more effective than NADSS on several measures (1-4) and at least as effective on perception measures (5-9). The use of agent-based technology as decision support systems in this domain proves beneficial. For years researchers have been complaining about the limitations of DSS, as observed from this research shows some of the benefits of agent based systems. Agent based DSS fills the gap that was created by traditional DSS. It is more functional as observed from the results. This is certainly a positive step for agent technology, DSS and IT implementation. In general, the results indicate that overall ALSTA is a more effective DSS than NADSS. In terms of the interaction effectives that were highlighted, this research brings to light that novices can be effective decision makers. Novice decision makers form a large section of decision makers who are placed in positions to make decisions about adopting various technologies. For this group of decision makers, it is important to empower them. An agent based decision support tool is certainly one way that this can happen. The results also show that knowledgeable users can also benefit from use of this DSS, even though the effects are less than novice users. Definitely, more research is needed in this area, but this can be considered a first giant step.

Table 6-31 Summary of Hypothesis Results

Hypotheses	Results
H1a	Supported
H1b	Supported
H2a	Supported
H2b	Supported
H3	Supported
H4a	Supported
H4b	Supported
H5a	Not supported
H5b	Supported
H6a	Supported
H6b	Supported
H7a	Supported
H7b	Supported
H8a	Supported
H8b	Supported
H9a	Supported
H9b	Supported

CHAPTER 7: DISCUSSION AND CONTRIBUTIONS

This research addresses open questions in software agent technology, IT implementation and decision support systems. In this chapter a review of the strengths and limitations of this study; the contributions to theory and practice; and suggestions for future research are presented.

As IT becomes the landscape of our being, in 2004 and beyond, more users are expected to utilize this technology for their daily business functions. Many practitioners believe that a larger and more diverse population will be responsible for making IT implementation decisions. However, this may lead to greater risk taking, which many companies cannot afford. Understanding, the factors that can help decision-makers increase the odds of a successful outcome are critical.

Simultaneously, research and development is actively promoting the utility of agent-based systems as an arsenal that appeal to the way we interact with computers. This technology utilizes existing AI techniques and the increased power of computing to make this paradigm a reality.

The process of identifying and addressing the critical factors that influence decision-makers intent to adopt technology is important.

Strengths of Study

The author believes that the strength of the study resides both in the theoretical conceptualization and in the way this research was executed. The model's foundation is rooted in strong theoretical bases provided by the innovation diffusion theory, the technology acceptance model, the decision support systems and software agent (chapter 2). Theory based research provides a structure for comparison to earlier work and the interpretation of results. Theory based research permits detection of unanswered questions and provides a structure for the creation of accurate and grounded models.

The internal validity of the experiment was increased, since the research was conducted in a laboratory. The study focused on the role of an agent based system: DSS during IT implementation. Hence, the evaluation of ALSTA as a DSS was important for the researcher and thus a controlled environment was needed. Consequently, any observed changes that occur with the dependent variable are a function of the independent variable.

Past studies on software agents provided very little theories to explain their usefulness. However, Maes' suggestion of using other theories as a context to explain the roles of agents was heeded with the intent to bring some validity to this field of software agency. This study contributes to agent research by contextualizing agents' roles in the grounded theories of IT implementation. Not only was this model conceptualized from prior research, but also it provides preliminary evidence of ALSTA as a useful DSS. These

results are undoubtedly demonstrates positive steps towards the acceptance of agent based systems and theories.

Prior studies in this field compared DSS to non-DSS e.g. pen and pencil. Other studies evaluated DSS against MIS software; one study compared an adaptive DSS to a traditional DSS; however, to the best of this author's knowledge no study has compared agent based DSS to traditional DSS and a human advisor (HDSS) in the same experiment. This allowed us to see for the first time how an agent based DSS compares with a traditional DSS and the agent based DSS compares with the support of a human consultant in the same experiment. The objective being to evaluate whether the agent based DSS is more effective than the traditional DSS and at least as effective as a human consultant. The methodology was developed from previous study and provides a basis for future research. Such results can also rekindle sparks in DSS research, which has seen several peaks and valleys.

There are numerous studies on IT implementation, but very few are set in the pre-adoption phase of decision- making. Hence, there is knowledge void concerning the factors that affect or modify the decision- maker's perceptions during the process of IT implementation. Karahanna et al. [1999] stated that absence of knowledge of technology could affect beliefs regarding adoption intentions. Agarwal et al.,[1998] urged IT implementation researchers to explore the role of mediating entity in formation of perceptions during the pre-adoption phase of IT implementation. This study explores the impact of DSS on a decision-maker's lack of knowledge about the technology to be

implemented. It also provides preliminary evidence that shows; given an agent based mediating entity, a decision-maker's perceptions can be affected and, consequently, there can be positive influences on decision outcome. Consequently, this study makes an important contribution to our theoretical understanding of the role of the mediating entity in the pre-adoption phase of IT implementation.

Limitations of Study

As with many studies, this current research has some limitations. First, the study was conducted in a laboratory. There were several compelling reasons for performing this research in a laboratory; however, a laboratory presents an artificial environment, which cannot depict the real world with 100% certainty.

The software used for the experiment was a prototype primarily developed for the purpose of the experiment. The prototype contains most of the key features but additional features, which may be of importance in a full-blown system, might not have been present.

The sample consisted of students and not actual business managers faced with a decision. They were role-players used as adjuncts for business decision makers. More research is needed to test this model with actual business decision-makers. While utilizing students may not be ideal, they have been used extensively in the past [Davis, 1989; Parikh, 1997] in similar research studies.

Some of the scales used to measure the users perceptions were two item scales. Past research have had mixed views on the use of two item scales. Some have argued that scales should be longer than two items. However, two item scales have been used extensively in previous studies. In this study the decision to use two item scales to measure image, and confidence in decision-making was due to: (1.) the success of these measures in previous studies, and (2.) the high results of their Cronbach's alphas (chapter 6).

This study examines the impact of ALSTA during the decision-making phase, but does not look at the post decision phase. A longitudinal study is necessary to examine the impact of ALSTA during the post decision period. In addition, there is a need to duplicate the study as a fielded experiment as well as replicate this study with improvements.

IMPORTANCE OF THE RESEARCH TO THEORY

The results of this study will have theoretical implications in several areas: For software agents; IT implementation and Decision support systems.

Contributions to Software Agent Theories

Throughout the literature, it is agreed that software agents are in their infancy. As a result, these agents are primarily found in research labs and several questions arise as to their role in the real world [Bradshaw, 1997; Bradshaw et al., 1999; Hook 1996; Jennings et al., 1998; Maes, 1994, Ndumu et al., 1996; Nwana, 1996]. Heralded by the visionaries to be beneficial to users, the verdict is still undecided. This research contributes to existing work this area. It also conceptualize validates that software agents can be effective DSS in the area of IT implementation.

The research proposes a structure that incorporates a definition of ALSTA, and specifies ALSTA's basic attributes. This aids in providing clarification to an otherwise ill-defined term. It also presents a methodology for evaluating software agents. The structure provides a general framework for software agents across domains that can be incorporated in other bodies of research.

This research provides an answer to an earlier call by researchers i.e., D'Intervno [1997], Maes [1994] who stated that providing a framework as a context to explore the roles of

agents can lead to further acceptance of agents. This research provides a theoretical foundation to model the role of ALSTA as a DSS in the IT implementation domain.

It provides empirical evidence showing that ALSTA supported decision makers out performed NADSS supported decision makers on several measures, and performed equally on others. It also provided results that ALSTA can be used as a surrogate human advisor, since it performed comparable or better than HDSS on all measures. Such findings give support to Dent et al., [1992] who stated that agent based systems could dramatically reduce the cost of knowledge-based advisors.

The research provides a methodology to evaluate agent-based system against a traditional system and a human advisor in a laboratory setting. Future studies will benefit from this methodology. .

Contribution to Information Technology implementation

Of the many models used to explain IT implementation, the technology acceptance and innovation diffusion models have been very influential in this field. This study utilized these two models as a theoretical basis for the empirical study. In effect, contributions to these models, as explained below are contributions to the IT implementation domain.

Contribution to Technology Acceptance Model

Noteworthy to this research is our contribution to the TAM. Hypotheses provide support consistent with Davis technology acceptance model antecedents of perceived usefulness and perceived ease of use as indicators for acceptance. In this research these measures are used to indicate acceptance of the DSS and also acceptance of the technology to be implemented.

Many scholars have extended the TAM model to include other factors, that influence a decision-maker's perceptions during the IT implementation decision-making process but there are still gaps that are unresolved. Agarwal [1998] argued that there was a need to examine the effect of a mediating entity on the decision-maker's perceptions. This research found evidence to support the fact, ALSTA as a mediating entity can affect the decision-maker's perceptions and ultimately the decision outcome – during the IT implementation process.

It is critically important to identify the effects of a mediating entity on perceptions as it relates to intention to adopt a technology. Although this idea has been rarely tested, the empirical results from this study suggest it is critically significant. These results also allows novice decision makers to be better decision makers by augmenting their initial perceptions on the technology they are about to adopt.

Many managers, who are responsible for making risky IT decisions, have limited knowledge of the problem domain. A utility that can assist these decision makers can reduce the risks of unfavorable decisions. Additionally, such tool can also lend support to knowledgeable users, confirming the correctness of their decision.

Contributions to Diffusion of Innovation

This research was set in the pre-adoption phase of IT implementation. It supports the idea as outlined by the IT innovation literature that a decision-maker goes through several stages before finally making a decision. Attention to the channel that assists the decision-maker in formation of perceptions about the decision to be made can have positive results.

Contributions to Decision Support Systems

Previous research suggests that DSS has not lived up to expectations, hence, its support has been limited [Silver, 1991, Radermacher, 1994]. There have been cries for decision support systems that are adaptable [Agarwal et al., 1994; Bui et al., 1999; Chaung, 1998; El-Najdawi et al., 1993; Shaw, 1993]

The development of ALSTA provides decision-makers with an effective tool to support the decision making process. This tool affords decision-makers to evaluate the benefit of new technology, thus explaining that benefit. ALSTA enable decision-makers to evaluate

the merits of their needs since every consultant can give an argument as to what system will be needed. Business entrepreneur need simple methods to evaluate the benefits of technology.

The research provides strong evidence that vividly indicates the utilization of ALSTA improves decision-making effectiveness. As a value added benefit, a methodology was provided for evaluation of DSS in a laboratory setting.

To the best of this researcher's knowledge, this study is the first to evaluate an agent based DSS with a traditional DSS and the support of a human consultant concurrently in the same experiment. The objective is to see whether the agent based DSS is more effective than the traditional DSS and as effective as a human consultant. Previous studies evaluated DSS against pen and pencil; DSS against MIS; there was one study that compared two different types of DSS. The methodology was developed from previous study and can provide a basis for future research.

Contributions to Human Computer Interaction

One of the buzz phrases in the IS community is "Human Computer Interaction". This subfield is promoted in journals and conferences and is gaining momentum very fast [Zhang et al., 2004]. This research is timely in is contributions to this area.

The dissertation proposes by embedding software agents with applications, in this instance DSS, can enrich a user's experience with the system. Zhang et al., {2004] states that HCI "are concerned with ways humans interact with information, technologies, and tasks, especially in business, managerial, organizational, and cultural contexts". The results of ALSTA as an effective DSS illustrated that point.

This research fills the part of the gaping hole in the IT adoption domain and decision support systems. Its setting is based in the decision-making phase of IT implementation. The study provided much needed empirical evidence to show the usefulness of software agents and the benefit of enhanced human computer interactions.

IMPORTANCE OF THE RESEARCH TO PRACTICE

Implications for Managers/ Decision Makers

ALSTA, the agent based DSS developed for this study provided more effective support for decision-makers than NADSS, the traditional DSS. More effective support empowers the decision maker and reduces the risks experiences by decision makers in a high stakes environment like IT implementation.

Use of ALSTA lead to more informed decision-making. These results were greater for novice users than knowledgeable users. Novice users make up a large part of the

decision-makers fabric. Any tool that can reduce risk, educate and lead to an overall better understanding of the problem domain, can only serve to empower a user and make better decision-makers.

Implications for Developers

Decision support systems have garnered mixed review, primarily because they were unable to deliver on promises made. The technology of a traditional DSS does not enable. ALSTA provides an instance of new technology that can invigorate new life into decision support systems.

FUTURE RESEARCH CONSIDERATIONS

The study has given some evidence of the importance of software agents as DSS in the area of IT implementation. In addition, this study added some structure and clarity to ill and undefined terms about software agents. The study has made important theoretical contributions, heightening our awareness about software agents and their roles as DSS in the area of IT implementation. This study has gone beyond theory and produced empirical evidence of the validity of agent based DSS. It presents a model that evaluated an agent based DSS against support rendered by a human consultant and a traditional DSS. Most of the hypothesis proposed through this model has been supported empirically. Of course, along with the contributions of this research, many questions still remains open, and suggestions for further research are triggered.

The research suggests that ALSTA can be used as a surrogate for a human consultant. On the measures of ALSTA was found to be at least equally effective as HDSS. More work is needed to examine at a micro level the different measures that ALSTA can be compared to a human consultant. There is a need to isolate if there are areas that ALSTA can outperform HDSS. On further examination, issues like factors or conditions that can affect ALSTA outperforming HDSS or HDSS outperforming ALSTA.

There is a need to develop new instruments that are more specific to evaluation of agent based systems, as well as instruments designed for comparisons of systems.

Replication of this research in the future with business decision makers in a laboratory can be beneficial. Other experiments that can add validity to this study include a field experiment as well as a longitudinal study. Conducting the experiment under these various conditions can aid examining the external validity of the study. If the results are similar, conclusions can be drawn as to a strong external validity. If the results are different, more issues will be open to examine the role of different factors on the DSS effectiveness.

Modularizing ALSTA as a tool to be used for various decision-making and training domains is another area of interest. This can prove the usefulness of agent-based software across many domains.

Improving and optimizing ALSTA on several measures such as ease of use, Future research is needed to increase.

Future research is needed to generalize the findings of this research in other domains. As it stands the results and conclusions are specific to this study. Additional work is needed to develop new instruments to measure evaluation of agent based DSS and especially comparison with human decision support consultants.

Overall, this research should be perceived as many positive steps in different areas. First for agent research, it gives some theoretical grounding and also demonstrates the usefulness of agent-based systems. Second, it adds to further understanding of the IT implementation process, thirdly it demonstrates a means towards making decision support systems more effective, and fourth it demonstrates another means of enriching the human computer experience.

APPENDIX A: CASE STUDY

This case is developed from a real situation that was observed from practice.

Case 1

A business owner: You have ten employees: a secretary with a standalone PC, an office assistant, seven warehouse stock/delivery men and an inventory secretary. Your secretary and the other office assistant have little competency. Your clients have been very irate whenever they are conducting business with you and you cannot give them updated information (just in time) on their orders. Many have left to do business with your competitors. You have begun to feel the impact of not being able to give your clients up-to date information and run a more efficient organization.

Current need: You have over two hundred clients and over two thousand inventory records. You want to be able to do the following

- Access clients and suppliers records while sitting at your desk
- Input data from your desk that your secretary can later access
- View and edit reports from your desk
- Have any changes done in the warehouse reflected available to all authorized personnel
- Manage critical files
- Share and update documents
- Share the sole laser printer

APPENDIX B: Network Solutions Supported by ALSTA

Network solutions supported by ALSTA

Peer to peer

Server based -Dedicated file server

Software:

NOS: Novell, Windows NT, Windows 2000, Windows 2003, Windows 9X

Client software: Windows NT, Windows 9X and Windows 2000, Windows Me

APPENDIX C: The Prototype Systems

Two decision support systems prototype were built: an adaptive DSS: ALSTA and a non-adaptive system: NADSS. These systems will be used in this study during a laboratory experiment to evaluate the effectiveness of ALSTA as a DSS that can assist the user during the IT implementation decision-making process. The IT implementation decision in this study involves the task of selecting a feasible solution for an office that will like to efficiently share and centralize their data, resources and applications. The systems support the user in evaluating potential solutions for that will fit their business needs. The software systems are built using Visual Basic 6.0 as front-end interface driven by Microsoft Access database backend. The following diagrams show the work-flow model of the prototypes.

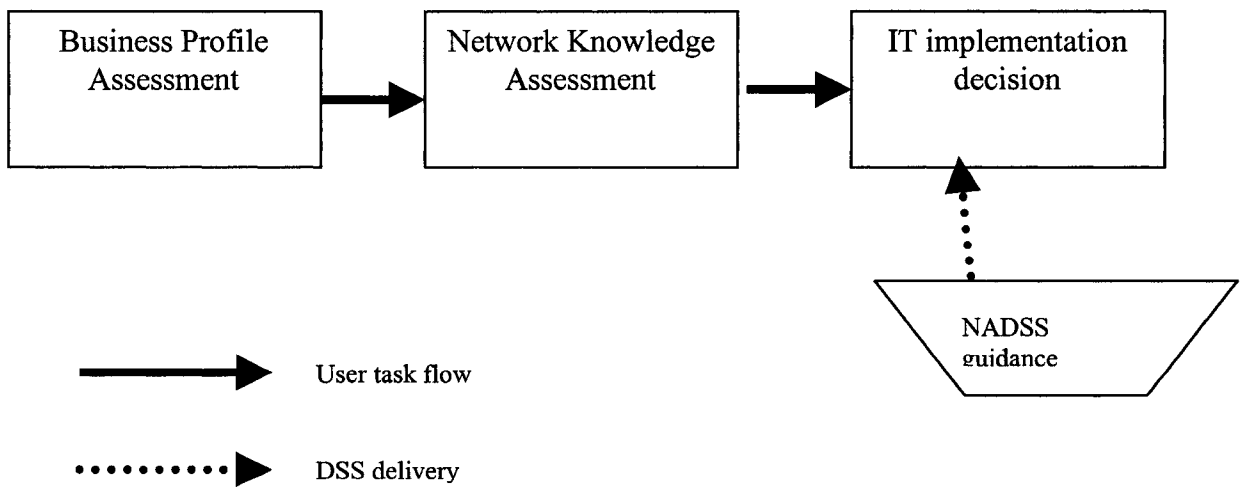

Figure C-1 Prototype of NADSS

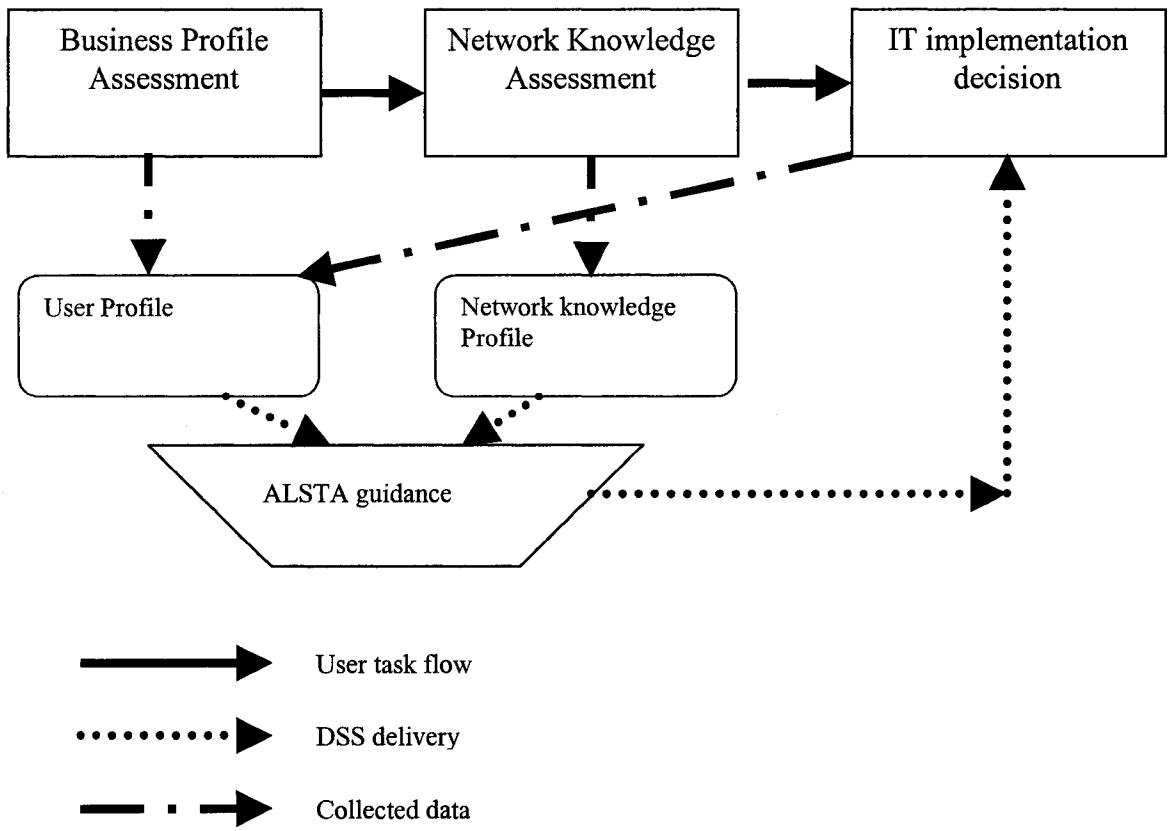

Figure C-2 Prototype of ALSTA

Figure C.1 shows the user work-flow for the non-adaptive variant DSS: NADSS while figure C.2 shows the same for ALSTA. The experiment involves the user moving through three distinct phases. In the first phase of the experiment, both systems collect data on the business profile, which allows the system to determine a business user profile of the decision maker. The data collected involves characteristics such as the decision maker's future business goals, financial situation, risk preferences, and buying styles. In the next phase the domain knowledge: for this research, computer networking; of the user is assessed. This phase evaluates the level of knowledge that the user has about the

problem domain. In the next phase the business scenario is presented. The user is then faced with the critical choice of selecting the appropriate technology to meet the business goals. The system provides decision support during this decision making process.

The type of support rendered by the two software systems as well as the human consultant, although similar contains some distinct differences. ALSTA uses the data collected in phase 1 and Phase 2 to customize its support to the user. The non-adaptive version: NADSS although it collects the data about the user profile as well as his knowledge of the domain does not utilize the information collected to customize its support for the user. Both software models will have the same user interfaces to promote homogeneity. The human consultants like ALSTA will use data collected from Phase 1 and Phase 2 as a means of recommended the best technology fit for the business.

Business Profile Determination Phase

This phase is designed to determine business management characteristics of the users. In this section there is no right or wrong answers because each question is associated with facts or perceptions of the user. The data collected in this phase is used to determine the business user's profile. Each question is based on a concept or concepts related to the entrepreneur business management style and business environment. They include a series of questions related to the future business goals, financial strength, risks, buying styles, computer competency and level of computer support that the business user has. Based upon the collected information an initial assessment is made which is used to create the business user's profile. In this system, once the profile is created it will not be updated,

since it will be used during a laboratory experiment. However, in the actual system, which is designed to be used by the user multiple times over time, the profile will be changed to reflect any change in the user's situation. The feature is the same for the all treatments: ALSTA, HDSS and NADSS.

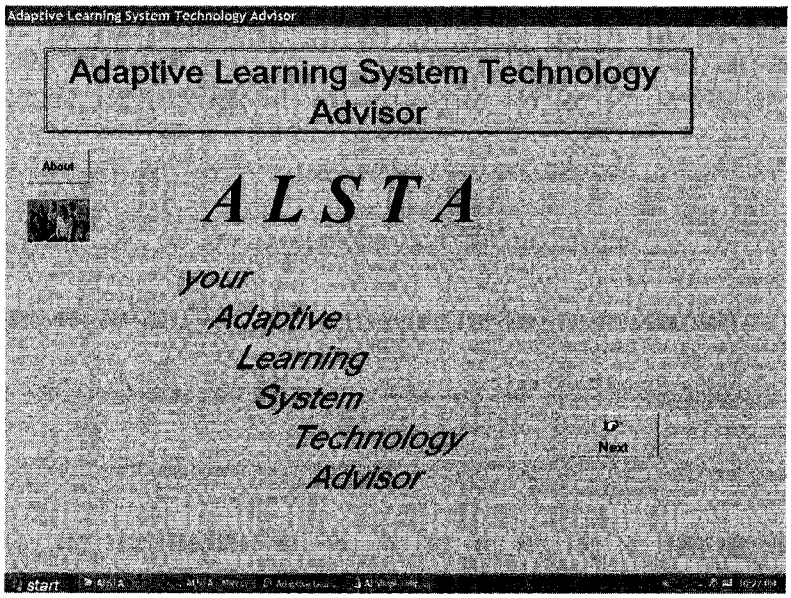

Figure C-3 ALSTA opening Screen

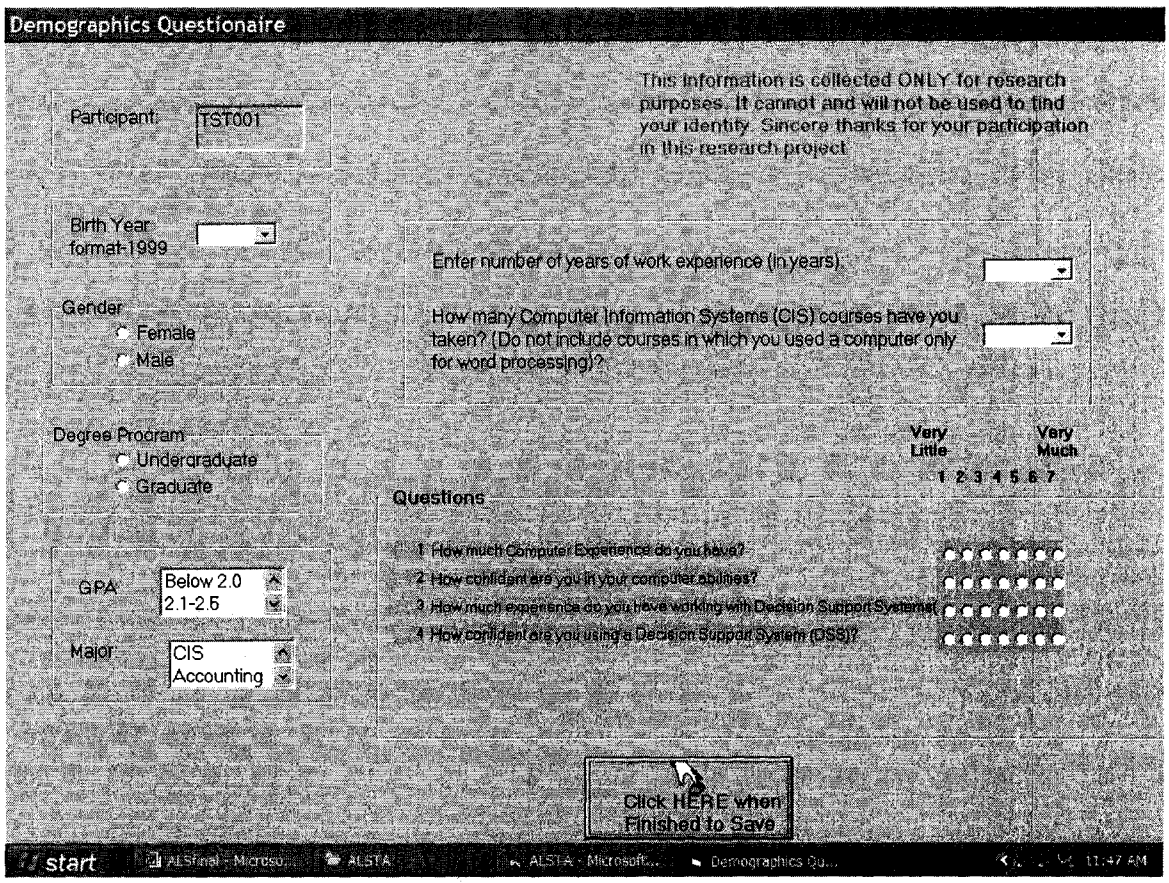

Figure C-4 Demographics Questionnaire screen

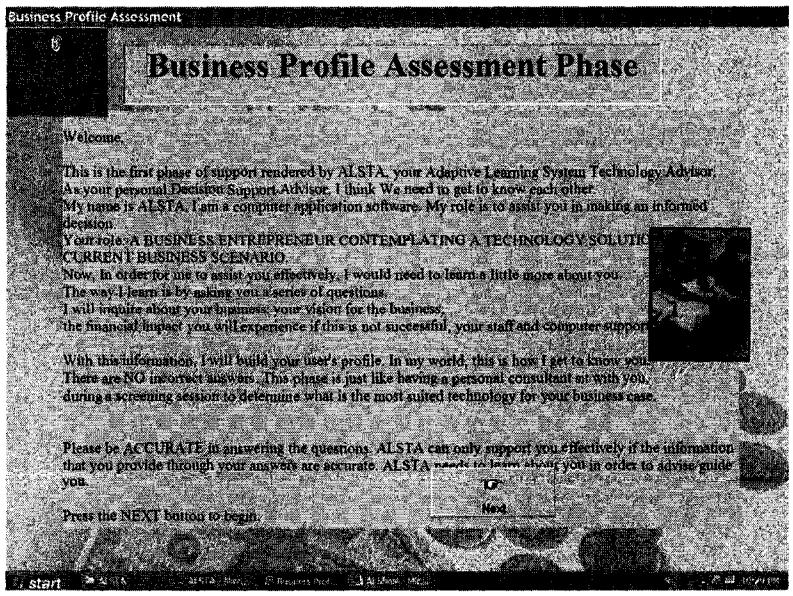

Figure C-5 Business Profile Assessment screen

Figure C-3 shows the first screen the user sees when he starts the application. This is followed by an introductory screen which gives overall information about the application and how to use it.

Once the user enters the system he/she is prompted then given a demographic questionnaire C-4. This is then followed by the Business Profile phase screen figure C-5. This is the introductory screen to the business profile assessment. It gives information about this phase. The user enters this phase after the NEXT button is pressed.

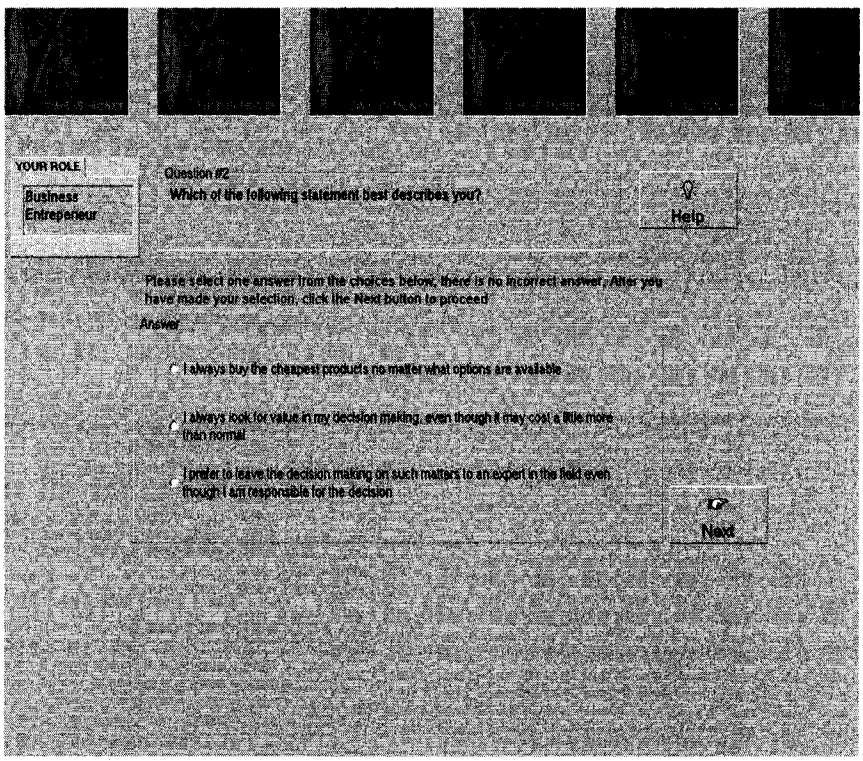

Figure C-6 Typical Business Profile Assessment Questionnaire

This screen, figure C-6 is an example of a typical screen in the Business profile assessment phase. There is a question followed by choices of answers. It is essential that

the user chooses an answer that best describes him. Once the user selects an answer, he can press NEXT to proceed to the next question. The system then proceeded to make an initial assessment of the user's knowledge of the domain. These profiles are important in customizing the support necessary to properly evaluate the user's needs. As the user interacts with the system, over time these profiles will be updated to reflect the changing support needs of the user.

The user will be provided with HELP on a few questions, to assist him in understanding the question.

Domain Knowledge Determination Phase:

This phase is designed to determine the user's domain knowledge. In this research this domain is computer networking. Figure C-7 shows a typical screen in this phase. In this phase, the user is asked to answer several questions. These questions help to determine the initial skill and knowledge level of the user. With ALSTA, if it is determined that the user does not have a certain knowledge base, ALSTA will end this phase quickly and proceed to the next.

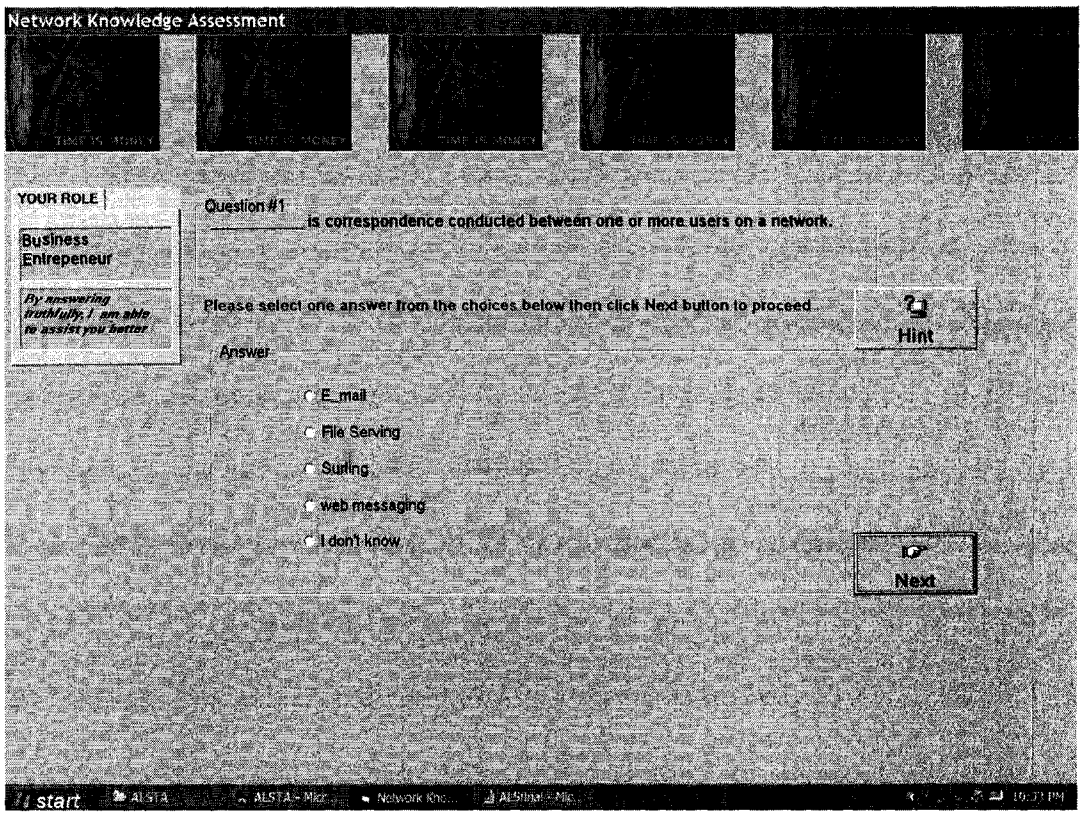

Figure C-7 Typical question asked during knowledge assessment phase

Business Case Presentation Phase:

This phase is the IT implementation decision-making phase. The user given a current business case evaluates the case and determines the best IT network solution among the system's supported platforms that will fulfill their business need. Figure C-8 shows the case presentation screen.

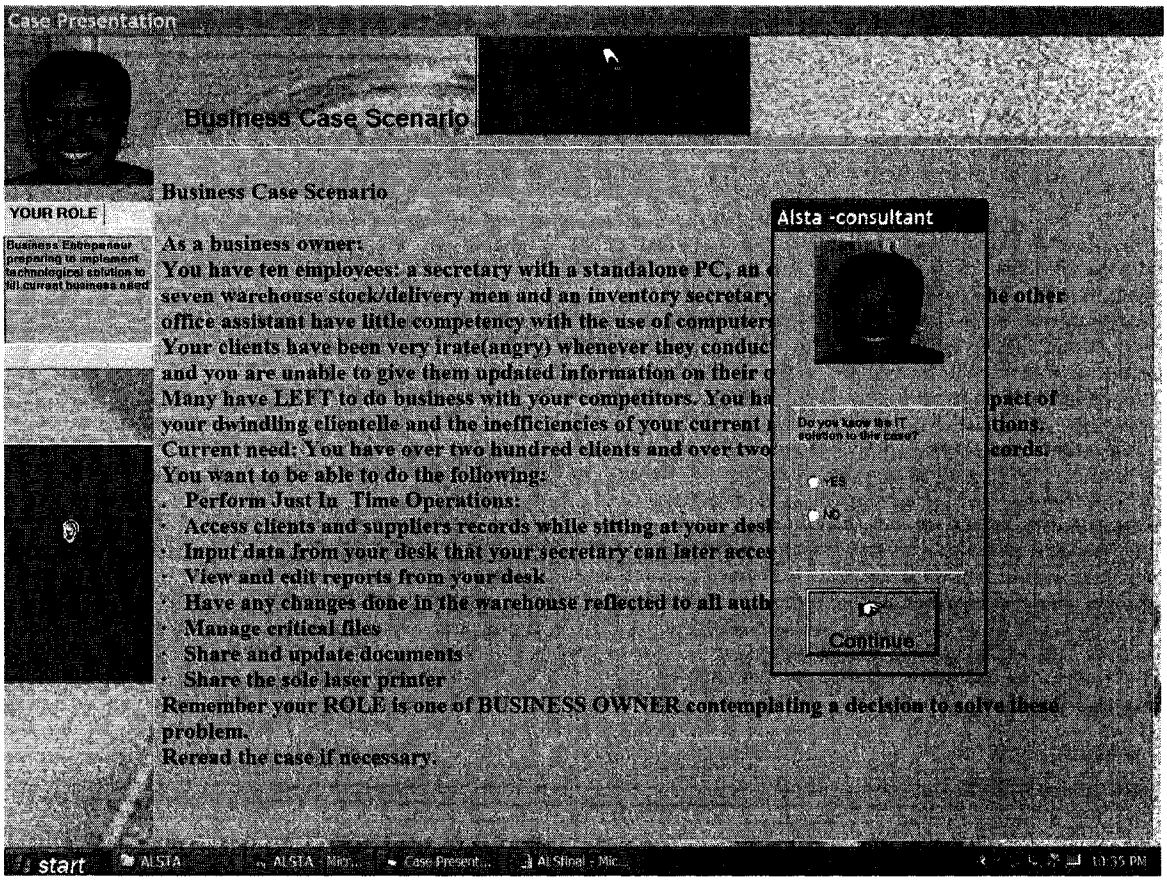

Figure C-8 Business case presentation screen

After viewing the case, the user then decides among several options, the best network solution for the business. While the user is determining the network platform, the system renders support to assist him in making the best possible decision. All the decision aids have the same platforms and models to generate support. ALSTA provides customized support to adapt to the user needs, task and context. NADSS provide generalized support. It can also be expected that the human consultant will provide customized support.

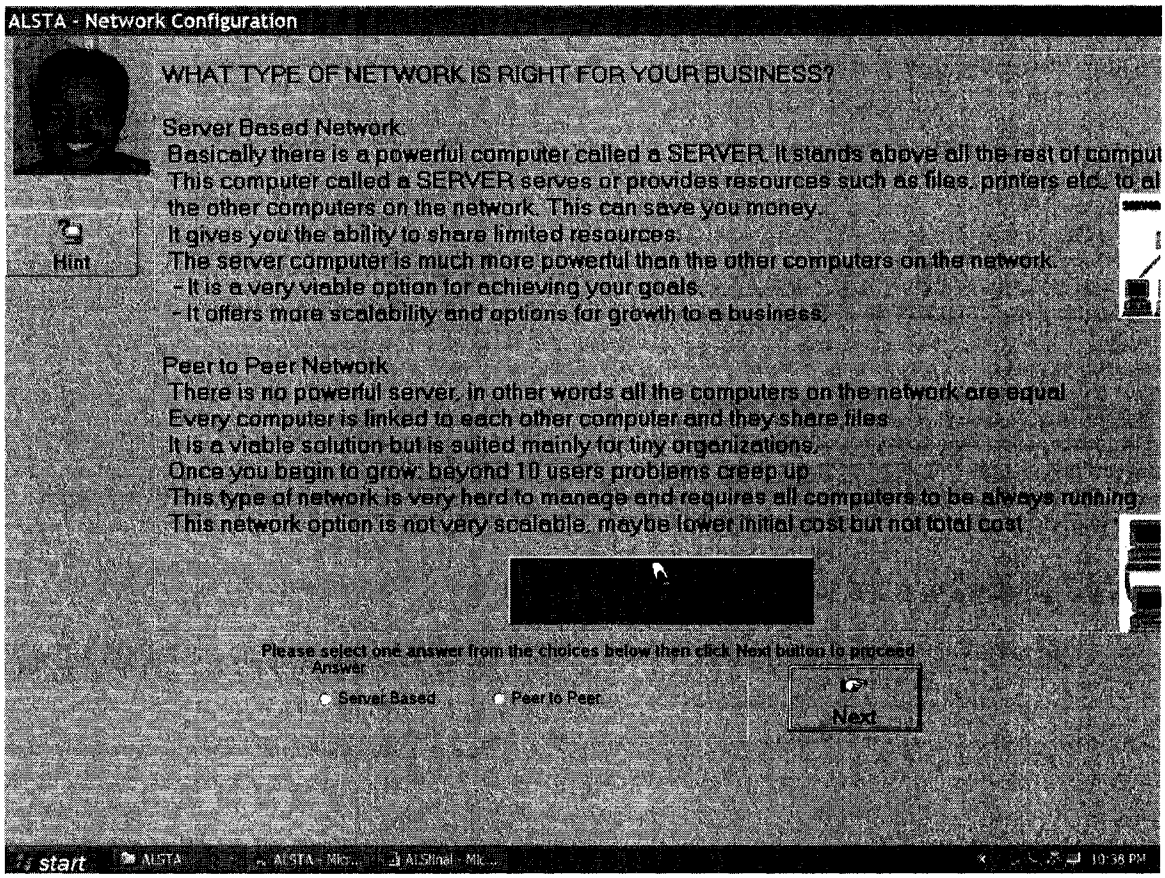

Figure C-9 sample screen for selection of network platform

Figure C-8 shows the introductory screen for the business case. After the introductory screen ALSTA may provide support in the form of a tutorial if needed. ALSTA also provides tutorial on several concepts as needed. It determines the user's network knowledge level from the network knowledge Assessment phase. Even though NADSS gather user profile it does not provide tutorial support. It can be expected that the human consultants will provide any needed explanations to the users. If the user is a novice,

information is given in a tutorial manner. If the user is knowledgeable about network specifications, he/she will be directed to the configuration page where he can make his selections regarding the different network specifications. Even, when the knowledgeable user is making specification selections, ALSTA is monitoring the selections for inconsistencies and omissions and will advice the user as such.

Thus, with both NADSS and ALSTA, the knowledge base is the same. However their major differences are the way they present content to the users. NADSS presents traditional decision support whereas ALSTA dynamically adapts to various users and presents customized support.

Data collection With the Prototype Systems:

The research data for this study was collected during a laboratory experiment. The system collected all the data transparent to the user while the user was using the system. This approach reduced the time needed for data collection and processing. It also minimizes human errors thus increasing the accuracy of the data. The demographics and perceptions data collection are also integrated into the system

The data collected from the business profile as well as the network knowledge assessment was stored in files, which was used for data analysis.

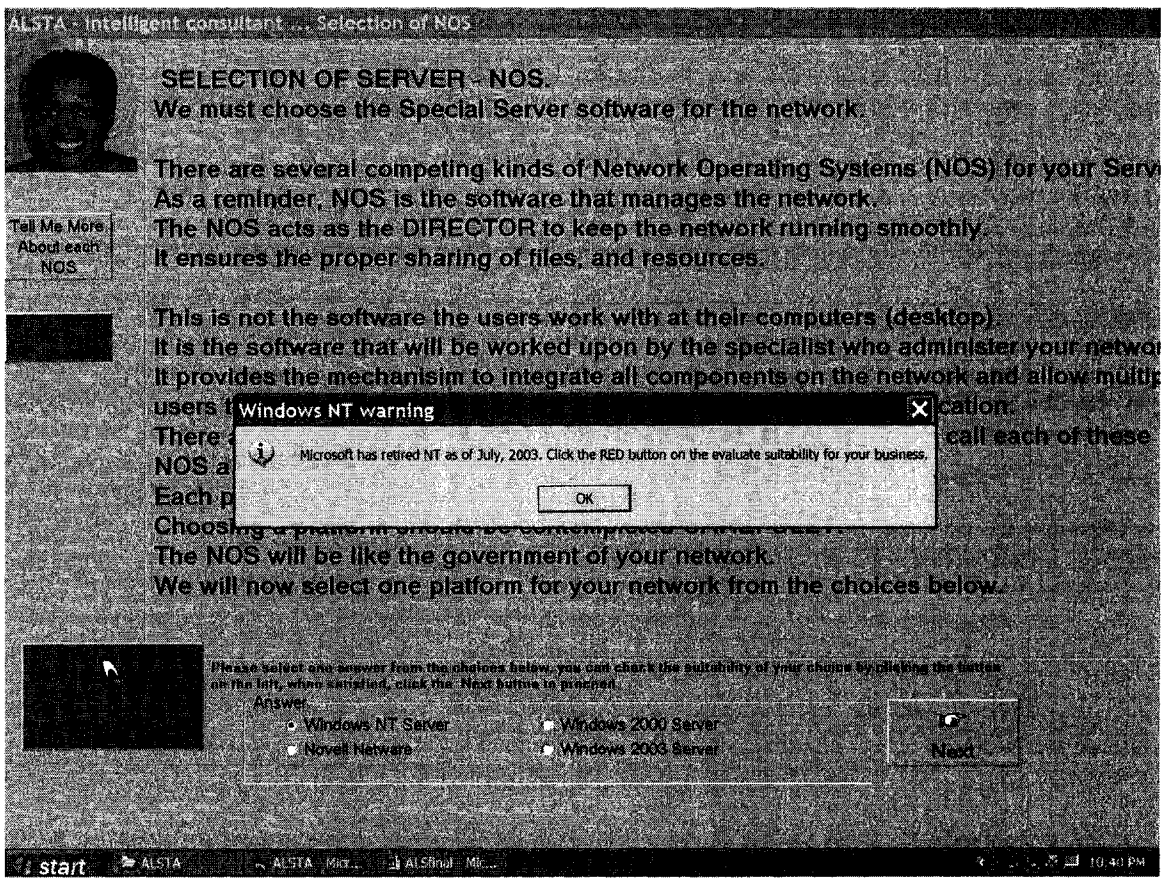

Figure C-10 Sample screen with system initiated prompting

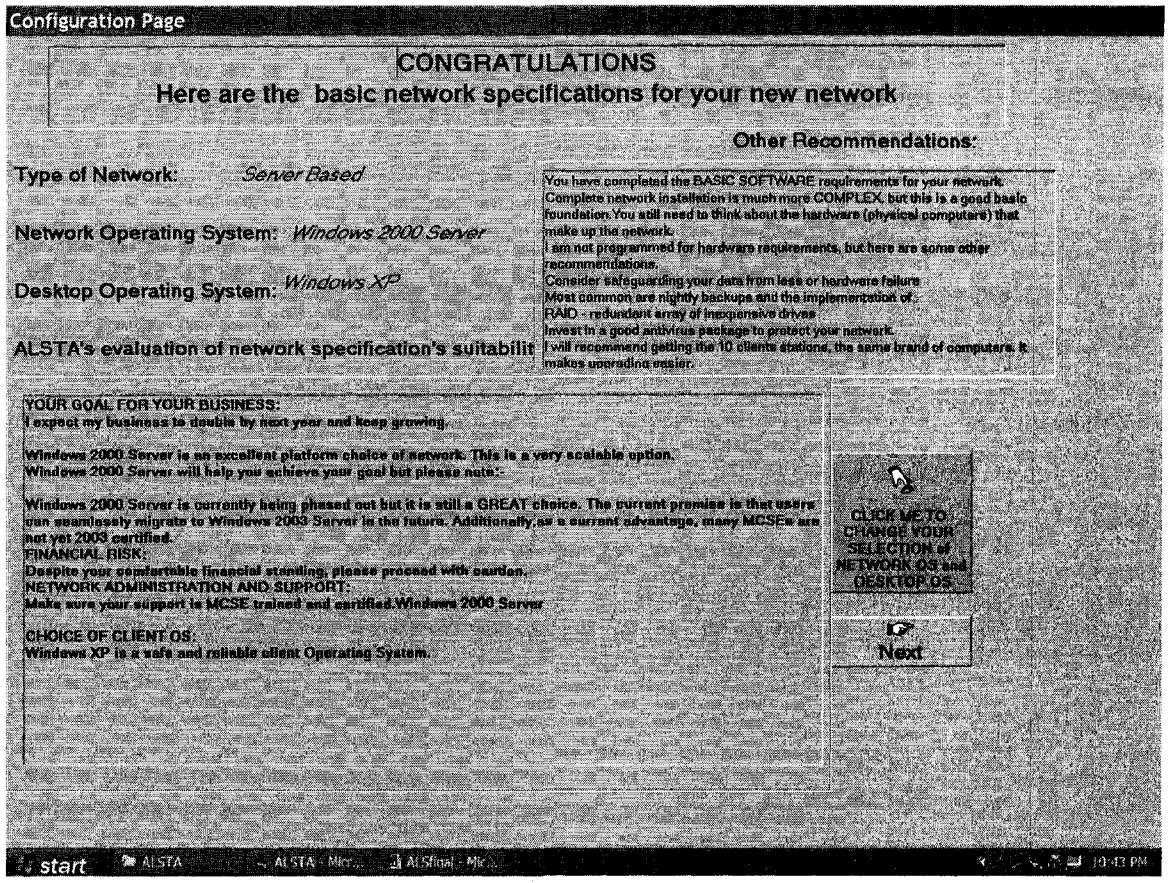

Figure C-11 Sample Screen, user sees after platform is selected

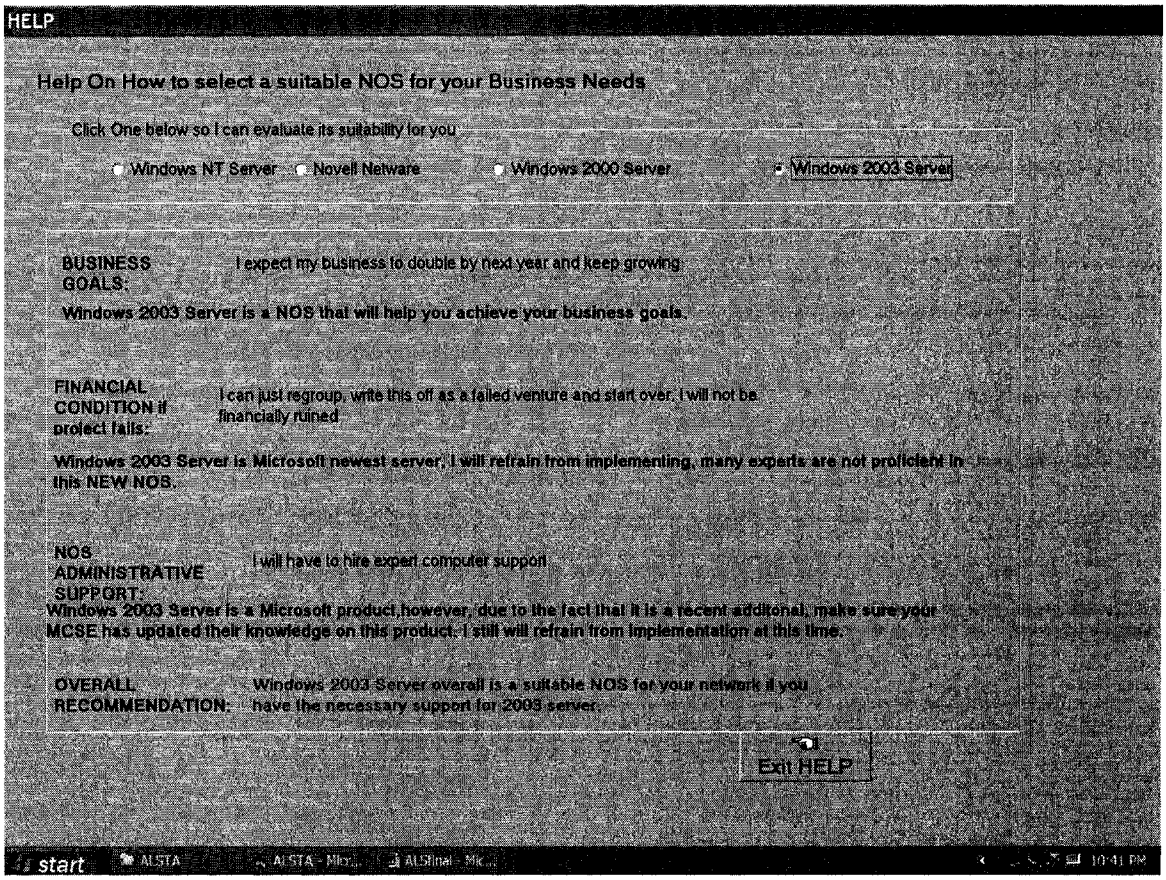

Figure C-12 Sample user initiated HELP screen

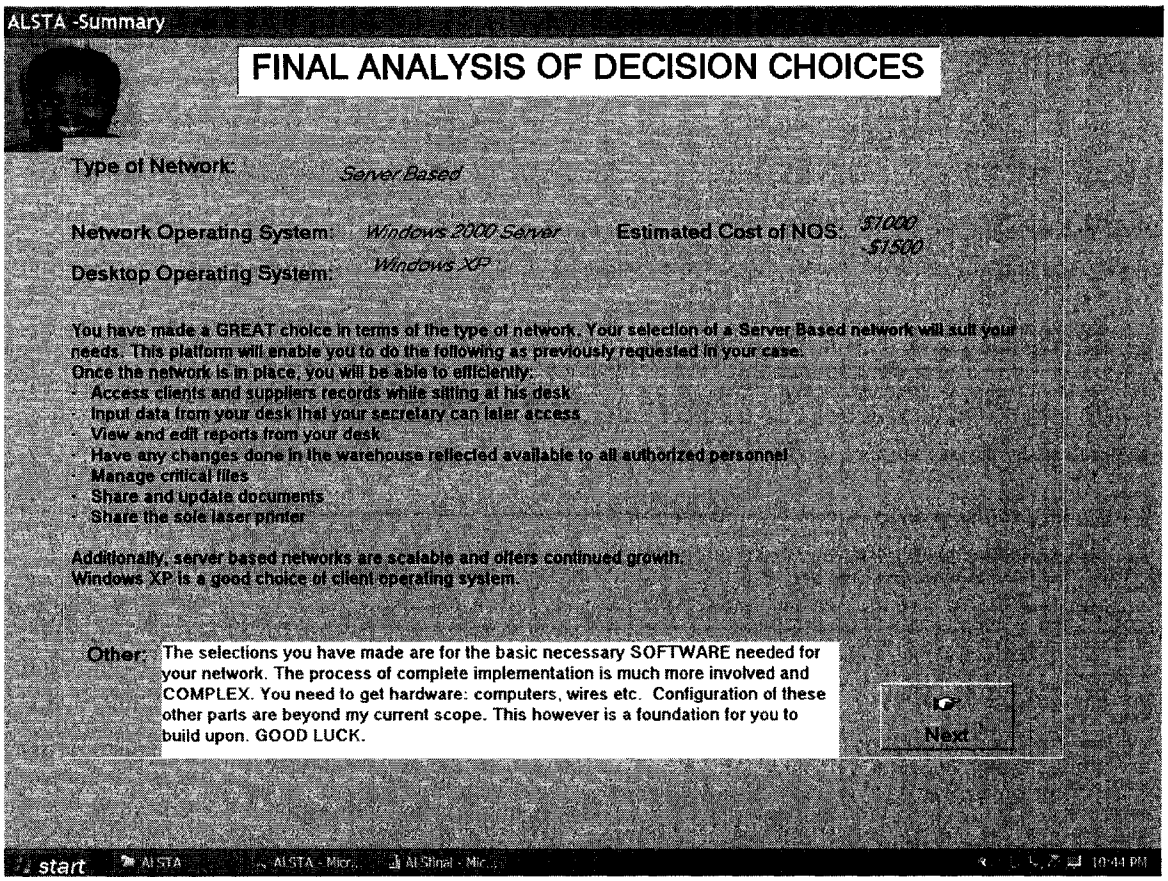

Figure C-13 Screen illustrating final analysis of decision choices

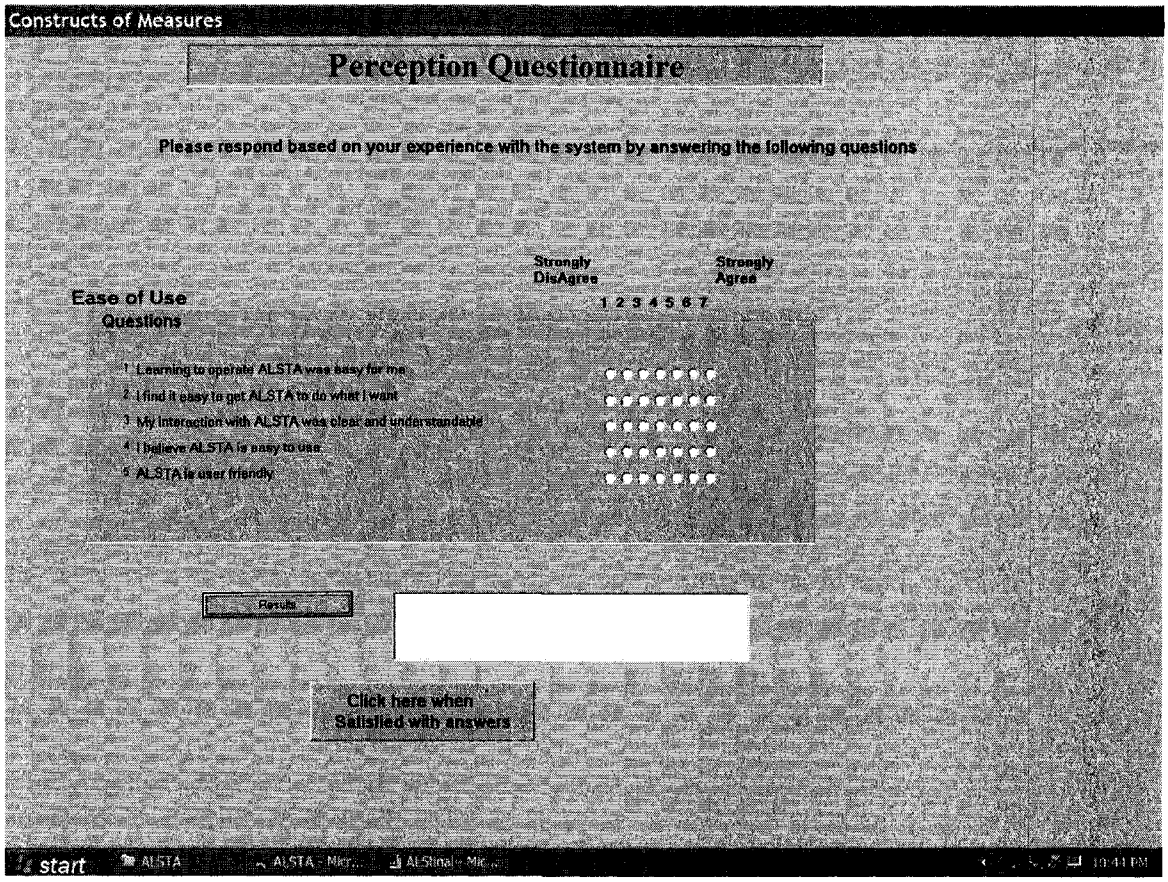

Figure C-14 Sample screen with perception questions

The perception questions were shown to the user as figure C-13. The last page of the perceptions questions gives the user a chance to give open- ended feedback by providing a text link labeled Additional comments. All answers to the perception questions will also be recorded in a file.

APPENDIX D: Construct Measures

List of items by construct

Scale by construct:						
1	2	3	4	5	6	7
Strongly disagree	Quite disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Quite agree	Strongly agree

Question codes:

Ease of Use

Learning to operate (A) is easy for me

I find it easy to get (A) to do what I want it to do

My interaction with (A) is clear and understandable

I believe (A) is easy to use

(A) is user friendly

Image

Using (A) improves my image

Because of my use of (A), others see me as more valuable to my business

Relative Advantage

Using (A) enables me to accomplish task more quickly

Using (A) improves the quality of work I do

Using (A) makes it easier to do my job

Using (A) enhances my effectiveness on the job

Using (A) gives me greater control over my work

Confidence in decisions/ Intention to implement decision

I have no difficulty telling others about the results of using (A)

I will implement (A)'s recommended choice of system.

Understanding of problem domain

Explanations

Were the explanations presented in an appropriate form?

Are your happy with the explanations given by (A)?

Were the explanations easy to understand?

Decision Making Satisfaction

Utilization of (A) has enabled me to make better decision

As a result of (A), I am better able to set my priorities in decision making

Using data generated by (A) has enabled me to present my arguments more convincingly

(A) has improved the quality of decisions I make in this organization

Perceived Ease of Use (IT)

Learning to operate the network would be easy for me

I would find it easy to get the network to do what I want it to do

My interaction with the network would be clear and understandable

I would find the network easy to use

The network would be user friendly

Perceived Usefulness

Using the network would enable me to accomplish my task quicker

Using the network would improve my job performance.

Using the network in my job would increase my productivity.

Using the network would make it easier to do my job.

I would find the network useful in my job.

APPENDIX E: EXPERT'S QUESTIONNAIRE

Questions accompanying each case to be completed by consultants

What technological solution do you recommend to this user? Base your recommendation on the list of system supported by ALSTA (see attached list)

Explain briefly why you recommended the software above

List any further information that you would like to have had before making a software recommendation to this user.

APPENDIX F: OPTIMAL SOLUTION FOR BUSINESS CASE

Successful IT decisions

Server Based

NOS: **Windows 2000 Server**

DOS: **Windows 2000/XP**

APPENDIX G: CONSENT FORM

Principal Investigator: Dessa David, Doctoral Student, Graduate Center, CUNY

SCIS, Baruch College, 1 Baruch Way, NY, NY 10010

My name is Dessa David and I am a student in the Computer Science PhD Program at the Graduate Center of the City University of New York (CUNY), and Principal Investigator of this project, entitled Adaptive Learning System Technology Advisor: a model for business entrepreneurs to implement IT. I am requesting your participation in a laboratory experiment. You will be given a business scenario and asked to assume the role of a business entrepreneur contemplating a decision to implement technology for his/her business. The software based decision support system (DSS) will render you support as you contemplate your decision. You are not responsible for the actual implementation of IT but rather you are responsible for making the decision regarding whether or not they would adopt IT. After using the computer you will be asked a series of questions about your perceptions of the DSS.

The complete experiment is expected to last approximately 45 minutes. Your academic performance will not in any way be affected whether you participate in this study. You will receive $5 gratuity for participating in this experiment, and the possibility of winning a raffled prize – digital camera. There are no foreseeable physical discomforts or financial risks associated with using the software. While there may not be any direct benefit to you, you will be given an opportunity to learn about decision support systems

and get the chance to participate in this study, which may contribute to a better understanding of how system support could be improved in decision support systems.

The data collected will be kept confidential and reported only in group form. I may publish results of the study, but names of people, or any identifying characteristics, will not be used in any publications. If desired you can see the data collected from only your participation, by providing me with your address and I will send you a copy in the future.

If you have any questions or concerns regarding this research, please feel free to contact me: Dessa David, principal investigator at Dessad@aol.com or her advisor Professor Linda Friedman at 646-312-3361. If you have any questions about your rights as a participant in this study, you can contact Hilry Fisher, Sponsored Research, graduate school, City University of NY, (212) 817-7523, hfischer@gc.cuny.edu

Thank you for participation in this research. By signing below, you accept and understand the terms of this research study as stated above and that your participation is totally voluntary.

_____	Dessa J. V. David
Full Name	Full Name
_____	_____
Signature	Signature
____/____/03__	____/____/03

APPENDIX H: Instructions read to subjects prior to experiment

Good_____, {morning, afternoon, evening, night}

My name is Dessa David and I am a student in the Computer Science PhD Program at the Graduate Center of the City University of New York (CUNY), and Principal Investigator of this project, entitled Adaptive Learning System Technology Advisor: a model for business entrepreneurs to implement IT. I am conducting a research project on decision support systems. The main purpose of this experiment is to identify factors that can improve support in decision support systems.

I am requesting your participation in this experiment. In this project I am requesting that you role play as a business manager/ owner embarking on a decision to implement an information technology solution to solve your business needs. In that light, I would like you to imagine that you just got a job managing this company or inherited this business. In either case you are the one responsible for making the hard decisions of the company. In a moment, I will read the case describing the situation you inherited. Think about yourself and how you will approach this solution.

{Read Case}.

Now you have heard the case, do you have any questions?

To assist you with your decision, some of you will be using one of two software based decision support system while others will sit with a human personal consultant. You will make your decision with the assistance of your respective support system.

Before the experiment begins, I will like to collect some demographics data (gender, major, year of birth, etc). This data is collected only for research purposes. It cannot be used and will not be used to identify you individually. After this data is collected, you will begin to use the system. You will go through three stages: business profile assessment, network knowledge assessment, decision-making phase.

In the business profile assessment stage, you will be asked several questions about your goals, buying habits computer support, financial risks. This may be used to determine the suitability of your decision for your business, given your goals and circumstances. In the network knowledge assessment phase you will be asked a series of questions about IT. This is used to determine your current knowledge level of the subject. Thos may be later used to provide guidance to you during the decision making process. In the third phase you will actual go through the process of making a decision. You will select the basic components of the solution.

Once the process is over, there is a questionnaire for your feedback about your perceptions on the system. To finish there is a questionnaire on network knowledge.

Your participation is voluntary. However, I suggest you participate in this study. While there may not be any direct benefit to you, you will be given an opportunity to learn about decision support systems and get the chance to participate in this study, which may contribute to a better understanding of how system support could be improved in decision support systems.

Do you have any questions?

I have the consent form required by City University of NY Institutional Review Board for the protection of human subjects. Please read the form and sign at the bottom before the study starts, then, return it to me.

Once again, thank you for your participation, please be attentive during this process.

APPENDIX I: Information sheet handed to subjects

Thank you for participating in this research project. The experiment you participated in was designed to test effectiveness of ALSTA: an agent based DSS. One third of the subjects in this experiment utilized ALSTA: an intelligent DSS during the experiment, the other theirs utilized NADSS, a non-adaptive DSS and the third interacted with person human consultants.

We ask that you not discuss the experiment with anyone.

If you have any questions or concerns, please feel free to contact me: Dessa David, principal investigator.

You may want to learn about the results of the questionnaire you filled out today.

If you have any questions about your rights as a participant in this study, you can contact Hilry Fisher, Sponsored Research, graduate school, City University of NY, (212) 817-7523, hfischer@gc.cuny.edu

APPENDIX J: DEMOGRAPHIC QUESTIONNAIRE

Year of birth: _____

Gender: () Female ()Male

GPA: ( )1.50 –1.74 ( )2.75 – 2.99

What is your major? _____

How many years of work experience do you have? (round months to nearest years)

( ) None _____ years

How many course have you taken in which you had to use computer (do not include the courses in which you used the computer only for word processing)?_____

Please answer the following by circling the appropriate value from the range of values.

	Very Low	Very high
Computer Experience	1….2….3….4….5….6….7	
How confident are you in your computer abilities?	1….2….3….4….5….6….7	
How much experience do you have in working with decision support systems (DSS)?	1….2….3….4….5….6….7	
How confident are you with using a DSS?	1….2….3….4….5….6….7	

APPENDIX K: AGENT CONFERENCES

Table K-1 Upcoming conferences – Table taken from Agentlink.org 2/23/03

Acronym	Description	City	Country	Start Date	End Date
IJCAI-05	Nineteenth International Joint Conference on Artificial Intelligence	Edinburgh	UK	2005-07-31	2005-08-05
ECAI 2004	European Conference on Artificial Intelligence	Valencia	Spain	2004-08-23	2004-08-27
ECAI 2004	16th European Conference on Artificial Intelligence	Valencia	Spain	2004-08-23	2004-08-27
4th EIS 2004	International ICSC Symposium on Engineering of Intelligent Systems	Maribor	Slovenia	2004-06-28	2004-07-02
ISMIS 2003	Fourteenth International Symposium on Methodologies for Intelligent Systems	Maebashi City	Japan	2003-10-28	2003-10-31
ISWC2003	2nd International Semantic Web Conference	Sanibel Island, Florida	USA	2003-10-20	2003-10-23
IAT 2003	International Conference on Intelligent Agent Technology (IAT 2003)	Beijing	China	2003-10-13	2003-10-17
WI 2003	IEEE/WIC International Conference on Web Intelligence (WI 2003)	Beijing	China	2003-10-13	2003-10-17
UbiComp 2003	The Fifth International Conference on Ubiquitous Computing	Seattle	USA	2003-10-12	2003-10-15
MATA 2003	5th International Workshop on Mobile Agents for Telecommunication Applications-- Toward 3G Beyond Networks, Ambient Intelligence and Spontaneous Networking	Marrakech	Morocco	2003-10-08	2003-10-10
KIMAS'03	Integration of Knowledge Intensive Multi-Agent Systems	Cambridge, MA	USA	2003-10-01	2003-10-03
ICEC 2003	Fifth International Conference on Electronic Commerce	Pittsburgh, PA	USA	2003-10-01	2003-10-03
CRIWG'2003	9th International Workshop on Groupware	Grenoble	France	2003-09-28	2003-10-02
Euro-Par 2003	International Conference on Parallel and Distributed Computing	Klagenfurt	Austria	2003-09-26	2003-09-29
CINC'03	The Sixth International Conference on Computational Intelligence & Natural Computation held under the auspices of JCIS 2003	Cary, North Carolina	USA	2003-09-26	2003-09-30
JCIS 2003	7th Joint Conference on Information Sciences	Cary, North Carolina	USA	2003-09-26	2003-09-30
IVA 2003	The 4th International Working Conference on Intelligent Virtual Agents	Irsee	Germany	2003-09-15	2003-09-17
IDAACS'2003	IEEE Second International Workshop on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS'2003)	Lviv	Ukraine	2003-09-08	2003-09-10
IWACS-2003	1st International Workshop on Autonomic Computing Systems	Prague	Czech Republic	2003-09-03	2003-09-05
KES'2003	Seventh International Conference on Knowledge-Based Intelligent Information & Engineering Systems	Oxford	UK	2003-09-03	2003-09-05

HoloMAS 2003	1st International Conference on Industrial Applications of Holonic and Multi-Agent Systems	Prague	Czech Republic	2003-09-01	2003-09-03
IDA 2003	The 5th International Symposium on Intelligent Data Analysis	Berlin	Germany	2003-08-28	2003-08-30
PDCS-2003	PDCS-2003: 16th International Conference on Parallel and Distributed Computing Systems	Reno, Nevada	USA	2003-08-13	2003-08-15
IJCAI-03: Workshop	Workshop on Agents and Automated Reasoning	Acapulco	Mexico	2003-08-11	2003-08-11
IJCAI-03 Workshop, AI & AC	AI and Autonomic Computing: Developing a Research Agenda for Self-Managing Computer Systems	Acapulco	Mexico	2003-08-10	2003-08-10
IJCAI-03	The Eighteenth International Joint Conference on Artificial Intelligence	Acapulco	Mexico	2003-08-09	2003-08-15
AKSS-CE	Invited session on: Automated Knowledge and Service Sharing in Agent-Enabled Concurrent Engineering	Madeira Island	Portugal	2003-07-26	2003-07-30
ISPE/CE2003	10th ISPE INTERNATIONAL CONFERENCE ON CONCURRENT ENGINEERING: RESEARCH AND APPLICATIONS	Madeira Island	Portugal	2003-07-26	2003-07-30
SSSW-2003	THE FIRST EUROPEAN SUMMER SCHOOL ON ONTOLOGICAL ENGINEERING AND THE SEMANTIC WEB	Cercedilla	Spain	2003-07-21	2003-07-26
AUTONOMY 2003 (AAMAS workshop)	The First International Workshop on COMPUTATIONAL AUTONOMY - POTENTIAL, RISKS, SOLUTIONS	Melbourne	Australia	2003-07-14	2003-07-15
AAMAS 2003	Second International Joint Conference on Autonomous Agents and Multiagent Systems	Melbourne	Australia	2003-07-14	2003-07-18
EGTMAS (AAMAS workshop)	Evolutionary Game Theory for Learning in MAS	Melbourne	Australia	2003-07-14	2003-07-15
AAMAS 2003 (workshop)	Agentcities: Challenges in Open Agent Environments	Melbourne	Australia	2003-07-14	2003-07-15
WSABE (AAMAS workshop)	Workshop on WEB SERVICES AND AGENT-BASED ENGINEERING	Melbourne	Australia	2003-07-14	2003-07-15
DALT 2003 (AAMAS workshop)	First International Workshop on Declarative Agent Languages and Technologies	Melbourne	Australia	2003-07-14	2003-07-15
AOIS 2003	5th Int. Workshop on Agent-Oriented Information Systems	Melbourne	Australia	2003-07-14	2003-07-15
AOIS 2003 (special track)	Agent-Oriented Methodologies: special track (aamas workshop)	Melbourne	Australia	2003-07-14	2003-07-15
AAMAS (list of workshops)	The Second International Joint Conference on Autonomous Agents & Multi Agent Systems	Melbourne	Australia	2003-07-14	2003-07-15
AAMAS-03 (workshop)	AAMAS-03 Workshop on Agent-Mediated Electronic Commerce V:Designing Mechanisms and Systems	Melbourne	Australia	2003-07-14	2003-07-15
AAMAS 2003 (workshop)	Embodied Conversational Characters as Individuals	Melbourne	Australia	2003-07-14	2003-07-15
IASSE-2003	12th International Conference on Intelligent and Adaptive Systems and Software Engineering	San Francisco	USA	2003-07-09	2003-07-11
Fusion 2003	Fusion by Distributed Cooperative Agents	Cairns	Australia	2003-07-08	2003-07-11

ICAIL 2003	the International Conferecence on Artificial Intelligence and Law	Edinburgh, Scotland	UK	2003-06-24	2003-06-28
IEA/AIE-2003	The 16th International Conference on Industrial & Engineering Applications of Artificial Intelligence and Expert Systems	Loughborough	UK	2003-06-23	2003-06-26
ABA	The 3rd International Workshop on "AGENTS for BUSINESS AUTOMATION"	Las Vegas, Valencia, and Washington DC	USA and Spain	2003-06-23	2003-10-08
CEEMAS 2003	The 3rd International/Central and Eastern European Conference on Multi-Agent Systems	Prague	Czech Republic	2003-06-16	2003-06-18
AI'2003	The Sixteenth Canadian Conference on Artificial Intelligence	Halifax, Nova Scotia	Canada	2003-06-11	2003-06-13
SABIS	Software Agents in Business Information Systems	Colorado Springs	USA	2003-06-04	2003-06-06
BIS-2003	6th INTERNATIONAL CONFERENCE ON BUSINESS INFORMATION SYSTEMS(BIS-2003)	Colorado Springs, Colorado	USA	2003-06-04	2003-06-06
e-Society 2003	Special track on Intelligent Agents IADIS INTERNATIONAL CONFERENCE e-SOCIETY 2003	Lisbon	Portugal	2003-06-03	2003-06-06
II2	Intelligent Information Systems 2003	Zakopane	Poland	2003-06-02	2003-06-05
ICMAT2003	The Second International Conference on Active Media Technology	Chongqing	China	2003-05-29	2003-05-31
Workshop at IEEE CCGrid 2003	Agent Based Cluster and Grid Computing at IEEE CCGrid 2003	Tokyo	Japan	2003-05-12	2003-05-15
FLAIRS-2003	SPECIAL TRACK on INTEGRATED INTELLIGENT SYSTEMS	St. Augustine, Florida	USA	2003-05-12	2003-05-14
CASA'2003	The 16th International Conference on Computer Animation and Social Agents	New-Brunswick, New Jersey	USA	2003-05-07	2003-05-09
SELMAS 2003	2nd International Workshop on Software Engineering for Large-Scale Multi-Agent Systems	Portland, Oregon	USA	2003-05-03	2003-05-04
ICSE 2003	International Conference on Software Engineering 2003	Portland, Oregon	USA	2003-05-03	2003-05-04
Agent-Based Simulation 4	The 4th International Workshop on Agent-Based Simulation	Montpellier	France	2003-04-28	2003-04-30
ICEIS 2003	5th International Conference on Enterprise Information Systems	Angers	France	2003-04-23	2003-04-26
ICEIS 2003	5th International Conference on Enterprise Information Systems	Angers	France	2003-04-23	2003-04-26
FAMAS'03	Formal Approaches to Multi-agent Systems--worshop in conjunction with ETAPS 2003	Warsaw	Poland	2003-04-12	2003-04-12
AISB 2003	Cognition in Machines and Animals	Aberystwyth, Wales	UK	2003-04-07	2003-04-11
AAMAS-3	The 3rd Symposium on ADAPTIVE AGENTS AND MULTI-AGENT SYSTEMS	Aberystwyth, Wales	UK	2003-04-07	2003-04-11
IMS 2003	7th IFAC Workshop on Intelligent Manufacturing Systems	Budapest	Hungary	2003-04-06	2003-04-08
CHI 2003	The CHI 2003 Conference on Human Factors in Computing Systems	Fort Lauderdale	USA	2003-04-05	2003-04-10

ETAPS 2003	The European Joint Conferences on Theory and Practice of Software	Warsaw	Poland	2003-04-05	2003-04-13
CATA-2003	ISCA 18th INTERNATIONAL CONFERENCE ON COMPUTERS AND THEIR APPLICATIONS	Honolulu, Hawaii	USA	2003-03-26	2003-03-28
AMKM-03	Agent-Mediated Knowledge Management (AMKM-03) at Stanford University	Stanford	USA	2003-03-24	2003-03-26
AAAI 2003	The 2003 AAAI Spring Symposium Series	Palo Alto	USA	2003-03-24	2003-03-26
SAC2003-CM	Coordination Models, Languages and Applications: Special Track of the 18th ACM Symposium on Applied Computing (SAC 2003)	Melbourne, Florida	USA	2003-03-09	2003-03-12
SAC 2003	Special Track on E-Commerce Technologies	Melbourne, Florida	USA	2003-03-09	2003-03-12
IAWIC-2003	International Conference on Computational Intelligence for Modelling Control and Automation	Vienna	Austria	2003-02-12	2003-02-14
CIMCA-2003	International Conference on Intelligent Agents Web Technologies and Internet Commerce	Vienna	Austria	2003-02-12	2003-02-14
SOCO/ ISFI 2003	5th International ICSC Symposium on Soft Computing and Intelligent Systems for industry	Tenerife	Spain	2003-02-12	2003-02-15
IAWTIC'2003	International Conference on Intelligent Agents, Web Technology and Internet Commerce - IAWTIC'2003	Vienna	Austria	2003-02-12	2003-02-14
AgentLink/CologNet	Logic-Based Agent Implementation An AgentLink/CologNet Symposium	Barcelona	Spain	2003-02-03	2003-02-03
IUI 2003	International Conference on Intelligent User Interfaces 2003	Miami	USA	2003-01-12	2003-01-15
HICSS36	Mini Track on Mobile Software Agents and their use in Industrial Applications as part of the Software Technology Track of the 36th Annual Hawaii International Conference on Systems Sciences	Big Island, Hawaii	USA	2003-01-06	2003-01-09
HICSS 2003	HAWAII INTERNATIONAL CONFERENCE ON SYSTEM SCIENCES	Big Island, Hawaii	USA	2003-01-06	2003-01-09
HICSS 2003 minitrack on Mobile Software Agents	Mobile Software Agents and their Use in Industrial Applications Minitrack Part of the Software Technology Track Thirty-sixth Annual HAWAI'I INTERNATIONAL CONFERENCE ON SYSTEM SCIENCES	Big Island, Hawaii	USA	2003-01-06	2003-01-09

Table K-2 Agent prototypes developed at MIT [4]

PROJECTS Applications Matrix	Electronic Commerce	Information Filtering	Eager Assistants	Information Navigation	Community Building and Referrals	Network Management
Amalthea	☐	☐	☐	☐	☐	☐
Apt Decision	☐	☐	☐	☐	☐	☐
Butterfly	☐	☐	☐	☐	☐	☐
BUZZwatch	☐	☐	☐	☐	☐	☐
Calendar Agent	☐	☐	☐	☐	☐	☐
Challenger	☐	☐	☐	☐	☐	☐
Development E-Commerce	☐	☐	☐	☐	☐	☐
e-markets Special Interest Group	☐	☐	☐	☐	☐	☐
Electronic Profiles	☐	☐	☐	☐	☐	☐
Expert Finder	☐	☐	☐	☐	☐	☐
Footprints	☐	☐	☐	☐	☐	☐
Friend of a Friend Finder	☐	☐	☐	☐	☐	☐
Hanging Messages	☐	☐	☐	☐	☐	☐
HeretoThere	☐	☐	☐	☐	☐	☐
Hive	☐	☐	☐	☐	☐	☐
HOMR	☐	☐	☐	☐	☐	☐
Impulse	☐	☐	☐	☐	☐	☐
InShop: Item Recommender, Recipe Recommender, Mapper	☐	☐	☐	☐	☐	☐
Kasbah	☐	☐	☐	☐	☐	☐
Learning Curve	☐	☐	☐	☐	☐	☐
Let's Browse	☐	☐	☐	☐	☐	☐
Letizia	☐	☐	☐	☐	☐	☐
MARI: Multi-Attribute Resource Intermediary	☐	☐	☐	☐	☐	☐

[4] – taken from http://agents.media.mit.edu/projects/applications.html

Market Maker	☐	☐	☐	☐	☐	☐
Maxims	☐	☐	☐	☐	☐	☐
MindShare	☐	☐	☐	☐	☐	☐
Mobile Agents for Routing Discovery	☐	☐	☐	☐	☐	☐
Mondrian	☐	☐	☐	☐	☐	☐
NewT	☐	☐	☐	☐	☐	☐
PDA@Shop	☐	☐	☐	☐	☐	☐
Periscope	☐	☐	☐	☐	☐	☐
Remembrance Agents	☐	☐	☐	☐	☐	☐
Restaurant Recommendation System	☐	☐	☐	☐	☐	☐
Reputation Mechanisms	☐	☐	☐	☐	☐	☐
Sardine	☐	☐	☐	☐	☐	☐
Segué	☐	☐	☐	☐	☐	☐
Straum	☐	☐	☐	☐	☐	☐
Tete-a-Tete	☐	☐	☐	☐	☐	☐
Trafficopter	☐	☐	☐	☐	☐	☐
Visigeek	☐	☐	☐	☐	☐	☐
Webdoggie	☐	☐	☐	☐	☐	☐
Wherehoo	☐	☐	☐	☐	☐	☐
World Dialog	☐	☐	☐	☐	☐	☐
Yenta	☐	☐	☐	☐	☐	☐

Table K-3 Agents – taken from Agentlink.org 2/23/03

Title	Description
ADVICE	Virtual Sales Assistant for the complete Customer Service Process in Digital Markets Objective : The overall objective of the ADVICE project is the development and real-world testing of an intelligent virtual sales and service system beyond simple product listing or intelligent product search
AgenCom	AgenCom provides an architectural framework for developing, deploying, and managing e-business applications. The architectural framework is based on n-tier distributed environment where any number of tiers of application logic and business services are separated into agents that communicate with each other across a network.
AGENT ACADEMY	A Data Mining Framework for Training Intelligent Agents
Agentcities	AgentCities is a worldwide initiative designed to help realise the commercial and research potential of Agent based applications. The objective is to construct a worldwide network of agent platforms based on the FIPA Agent standard. Each platform will be supported by different organisations and host diverse populations of agents able to access each other's services.
AgentCities.NET	Testbed for a Worldwide Agent Network-Take Up Measure: Trial/Testbed. European Union Project.
AgentCities.RTD	Testbed for a Worldwide Agent Network-Research and Deployment. European Union Project.
AgentLight	AgentLight is an effort to take current Multi Agent Systems (MAS) theories
ALIVE	Architecture and authoring tools for prototype for Living Images and new Video Experiments Objective : The goal of the project is to develop an architecture and a set of tools, both generic and application dependent, for the enhancement of narrative spaces. This will be achieved in testing the two aspects of this goal: telepresence (inclusion of real objects into virtual worlds) and augmented reality (inclusion of artificial object into real worlds).
AMBIESENSE	Ambient, personalised, and context-sensitive information systems for mobile users. The AmbieSense project looks into the future of the Ambient Intelligence Landscape - a landscape where computing surrounds you while mobile users are on the move. AmbieSense focuses on travellers and tourists as end users. It will take one important step towards ambient, personalised, and context-sensitive information spaces for mobile citizens.
ANDROID	Active Network Distributed Open Infrastructure Development The android project is a Framework V project on application level active networking. The principal objective of this project is to prove the feasibility of providing a managed, scalable, programmable network infrastructure capable of supporting the future needs of the Information Society. The management of active networks, the extent to which management information must be shared, and the communication mechanisms required by the management system are currently open research issues. The detailed scientific objectives of the project are to develop innovative solutions to the open research problems identified above, and test the solutions through a combination of implementation experiments and modelling.
ANIMATED AGENTS	Integration of Animated Agents into Virtual Learning Environments for Socially Disadvantadged People. IST project reference: IST-2001-52204
Asi@IT&C	Multi-Agent Systems (MAS) Social Sciences and Integrated Natural Resource Management (INRM).The objective of this project is to organise a course in a university context to explore and to transfer know-how on MAS. The activity area is agriculture - modelling, information systems, research and environmental system - and society - quality of life.

ASIMIL	Aero user friendly SIMulation based dIstant Learning The objective of the RTD ASIMIL project is to develop radically new approaches for improving the future training and re-training of the work force in aeronautics, building on new cognitive approaches enabled by emerging technologies. ASIMIL project covers intelligent, adaptable learning environment and new multimedia content, supporting the processes applied in real training situations.The work has been split up into 7 work packages: Project Management (WP 1), Quality Assurance, Assessment, Evaluation and Validation (WP 2), Dissemination & Implementation (WP 3), User Requirements & End-User Special Interest Group Establishment (WP4), Desktop Simulators (WP 5), Intelligent Agents & Multi-Agent Systems (WP 6), and Virtual Reality (WP 7).
B-MAN	Business Mobile Agent Networks B-MAN aims to allow Europe to exploit its strengths and to overcome the barriers for digital technologies by a migration strategy and business model for distributed workflow management based on an in-depth analysis user needs and enterprise requirement, developing a formal model of ownership and authentication management in an agent-based architecture for distributed workflow management.
BAP	Business Mobile Agent Networks B-MAN aims to allow Europe to exploit its strengths and to overcome the barriers for digital technologies by a migration strategy and business model for distributed workflow management based on an in-depth analysis user needs and enterprise requirement, developing a formal model of ownership and authentication management in an agent-based architecture for distributed workflow management.
BIDSAVER	Business Integrator Dynamic Support Agents for Virtual Enterprise The BIDSAVER Project aims at the assessment and development of a framework for the constitution and operation of Virtual Enterprises, with the participation of SMEs searched through web based information agents, dynamically organised according to best-fit criteria. The Project will deliver a methodology, reference process and data models, and relevant ICT infrastructure tools, to allow for standardised cooperative project conduction and for dynamic search of Partners through the Web, suitable for both the fast constitution and the dynamic upgrade and the operations of the Virtual Enterprise; and a legal framework for the management of relationships among the Virtual Enterprises Partner and between the market and the Virtual Enterprise.
CHARISMATIC	Charismatic's objective is to develop essential technologies required to establish a new tourism industry, exploiting Europe's unique position in Global Cultural Heritage by combining the heritage subjects with realtime technologies. The project combines research from 2 previously distinct areas: modelling sites of cultural importance, recreating people and events using advanced virtual humans. Charismatic intends to bring the technologies of Virtual Reality, 3D visualisation, and intelligent avatars together inorder to offer the market a creative, professional and entertaining way to enjoy heritage as well as preserve it.
CLOCKWORK	Creating Learning Organisations with Contextualised Knowledge-Rich Work Artifacts he CLOCKWORK project focuses on the engineering domain. It will combine knowledge rich dynamical simulation tools, formal documentation and informal rationale to closely integrate working, learning, collaboration and negotiation, within and between organisations. This involves the extension and integration of previous work on agents, knowledge modelling, document discourse tools, simulation and machine learning.
COGENTS	Agent-based Architecture for Numerical Simulation. IST Project Reference: IST-2001-34431
COGITO	E-Commerce with guiding Agents based on Personalized Interaction Tools Objective : The project aims at improving consumer-supplier relationships in future e-commerce interfaces featuring agents, which can converse with users in written natural language ("chatterbots").
COGVIS	Cognitive Vision Systems The objective of this project is to provide the methods and techniques that enable construction of vision systems that can perform task oriented categorisation and recognition of objects and events in the context of an embodied agent. The functionality will enable construction of mobile agents that can interpret the action of humans and interact with the environment for tasks such as fetch and delivery of objects in a realistic domestic setting.
COLLABORATOR	Collaborative Framework for Remote and Mobile users. The major goal of the project is the realization of a software environment called Collaborator (Collaborative Framework for Remote and Mobile Users) to provide a shared workspace supporting the activities of virtual teams. The project will not only provide a collaborative tool, but will promote the use of state of the art technologies (web, agent technologies etc), integration in a seamless way of these technologies, ubiquitous and seamless access to services (from fixed or mobile networks), as well as personal mobility support. The solution will be validated in a real context represented by companies from different sectors of the industry (Telecommunications, Construction) showing its applicability, interoperability, usability and flexibility. IST Project Reference: IST-2000-30045

COMMA	Corporate Memory Management through Agents Objective : The main objective of the project is to implement and trial a Corporate Memory Management framework based on Agent technology.
CoMMA-COGs	Cognitive Architectures for Social Agents The CoMMA-COGs project (Cooperative Man Machine Architectures - Cognitive Architecture for Social Agents) is part of the Multi-Agent Systems group's larger aim to develop integrated architectures for multi-agent systems. In this larger context we hope to give an account of motivation in integrated agent architectures that exploits relevant research in cognitive science. A new branch of computer applications is opening up based on virtual animated worlds, where human users, their software representatives and a host of services co-exist in a networked environment. This promises to be a major area for the application of agent-oriented techniques.
CORAS	A Platform for Risk Analysis of Security Critical Systems. CORAS aims to develop a framework for precise, unambiguous, and efficient risk analysis of security critical systems. The framework will be obtained through adapting, refining, extending, and combining methods for risk analysis developed within the safety domain, semiformal description methods (in particular, methods for object oriented modelling), and computerized tools (supporting the above mentioned methods). The integration of risk analysis and semiformal modelling will receive special emphasis.
CORMAS	Natural Resources and Multi-Agent Simulation This website is devoted to the applied modelling of relationships between societies and their environment. The website presents CIRAD scientists' and their partners' work on multi-agent systems and on management of renewable natural resources.CORMAS, a simulation computer program, can be downloaded free of charge. You will also be able to access application examples (with a models library) and publications.
COSA	COSA stands for Complementary Objects for Software Applications. The goal of Project COSA is to improve software reliability and productivity by at least one order of magnitude. COSA is based on the premise that one of the primary causes of the software unreliability crisis is the practice of basing software construction on the algorithm. COSA is a non-algorithmic, signal-based software construction (composition) and execution model. Software creation consists of connecting elementary concurrent objects (cells) together using a graphical software composition environment. Cells can be combined into high-level, plug-compatible components and/or applications. There is no programming language to learn, no procedures, no subroutines and no compile/run cycles.
COSI	Complexity in Social Science The principle objective of the project is to assess critically and develop new ways of thinking about social processes, modelling and complex organisations. The approach is based on the notion of complexity modelling. The network is grounded on this new paradigm and has a specific goal: understanding and modelling socio-cognitive processes in the context of real organisational systems. The network is naturally pluri-disciplinary and pluri-institutional in order to increase awareness of the use of complexity theory in social science promote the new culture of pluri-disciplinary research applied to concrete industrial problems initiate an emergent European research movement in the domain of the simulation of social science.
COSIN	Coevolution and Self-Organization In dynamical Networks. The aim of this project is to develop a unified set of Complex Systems theoretical methodologies for the characterization of Complex Networks, helping addressing fundamental question about stability, efficiency and functionality of these networks. IST project reference: IST-2001-33555
CRESCCO	Critical Resource Sharing for Cooperation in Complex Systems This project investigates, at a foundational level, the critical aspects and bottlenecks in dynamic and extremely complex global systems emerging from the integration of heterogeneous communication infrastructures, highly dynamic mobile user populations and selfish agent entities. The focus is on the efficient management of limited and scarce communication and computing resources to ensure co-operation and efficient access to advanced services in such environments, by investigating the design and implementation of high-speed, cost-effective and reliable communication and computing solutions.
CROSSMARC	Cross-lingual Multi Agent Retail Comparison CROSSMARC will develop next-generation technology for electronic-retail product comparison, drawing on techniques from language engineering, machine learning and user modelling.
Crumpet	Creation of User-friendly Mobile services Personalised for Tourism. The baseline for the project is an open-source standards-based middleware intelligent agent framework, that is being extended to support nomadic applications, devices, and networks. The community for this middleware contains over 100 developers and there is a commitment to enhance and strengthen the software during the lifetime of the project (additions will include security and support for new technology developed by open standards bodies such as FIPA, OMG and W3C).

DAMMAD	Design and Application of Multi-Agent Models for Decision Support. The DAMMAD project objectives include: (1) Design of a conceptual model of decentralised agent-based intelligent system for decision support, supported by a software environment, so as to be able to test the quality of the model both theoretically and experimentally. (2) Development of a software environment that adapts and extends the functionalities of the present KSM platform, enabling it to support the design of societies of autonomous agents, whose behaviours are integrated by flexible interactions patterns. The extended software environment, termed SKADS (Social Knowledge Agents for Decision Support), will come with a methodology that allows for the systematic formulation, validation and maintenance of SKADS based agent societies. (3) Demonstration of the potential of the proposed concept, and of the Distributed Artificial Intelligence approach in general, to manage industrial problems in the field of road transport management, so as to acquire a realistic feedback about the feasibility of this type of models in complex real-world environments.
DBGLOBE	DBGlobe: A Data-centric Approach to Global Computing.
DEEPSIA	Dynamic on-linE IntErnet Purchasing System based on Intelligent Agents. The objectives of DEEPSIA are to offer: A catalogue customised to the purchaser's needs, dynamically updated by intelligent agents; Purchasing via an intelligent agent designed to seek, collect and organise information according to preferences expressed by the purchasers, taking into account their profile and previously stated needs; A knowledge database of frequently used and authorised suppliers.
E-ARBITRATION	Electronic Arbitration Tribunal: an Alternative Dispute Resolution for SMEs Objective : E-Arbitration-T will provide a networked dispute resolution forum within the e-Commerce community. It will analyse and define the technological requirements the necessary infrastructure and the regulatory framework for establishing and co-ordinating an internationally-distributed Arbitration Tribunal using networked computers and intelligent multi-agent systems as their primary means of communication.
E-BREADMAKING	E-commerce Of Bread-Making Equipment Based On Expert System, Distributed Agents And Virtual Reality. IST Project Reference: IST-2001-52086
E-COLLEG	Advanced Infrastructure for Pan-European Collaborative Engineering. E-Colleg will make use of enabling technologies (e.g. Jini, CORBA, RMI) for collaborative engineering based on advanced infrastructures. The work will augment existing integration technologies by scaleable, platform-independent services for dynamic configuration of infrastructure with secure access management for distributed teams, services and data, to support multi-site and multi-platform and dynamic tool integration on the basis of novel agent technology. It is further intended to demonstrate the feasibility of this approach through pan-European collaborative engineering showcases for image processing and telecommunication systems
E-DYNAMICS	E-learning Dynamic and ubiquitous System based on Adaptive Intelligent Agents and Natural Language Interaction. IST Project Reference: IST-2001-52093
E-GADGETS	Extrovert Gadgets. The Gadgetware Architecture Style (GAS) provides a common conceptual framework for designers and people, to use e-gadgets as building blocks for composing gadgetworlds. Each e-gadget implements portions of style-specific hardware and software in addition to its custom behaviour. The GAS provides the infrastructure for the formation of gadgetworlds. The nature of the infrastructure (centralised or ambient) is a research issue. Gadgetworlds can be used for the needs of mobility challenged people, young children, mature generations, and any ordinary people. Their collection in a space adds ambient intelligence to it.
EDEN-IW	The Environmental Data Exchange Network for Inland Water (EDEN-IW) project aims to develop at European level a service integrating disparate heterogenous government databases on inland water. The prototype produced in this project creates a new standard for environmental data exchange and thereby eases environmental reporting and planning. This is achieved by a sophisticate set of software agents that advertise, broker, and exchange the data requested by the user. IST Project Reference: IST-1999-10151
EICSTES	European Indicators, Cyberspace And The Science-Technology-Economy System
ELIN	Information Processing, Information Systems; Innovation, Technology Transfer; Telecommunications. The project plans to develop and implement:- An intelligent agent concept for: 1. Intelligent Content and Capture Management of News like filtering, digitising, segmenting, indexing, extracting, and summarising the streamed audiovisual news media for dynamical generation of a personalized newspaper; 2. Intelligent Dialogue Management of News through seamless interfaces between wireless, TV, "electronic paper" and WEB using interactive gateways like MHP and mobile devices; 3. Intelligent Advertisement Management suited for content and technology that are adapted to the new-streamed audiovisual media and Meta service possibilities over seamless interfaces between TV and WEB.

EPI-SPARK	Enhanced Protection of IPR by streamlined Provision of Access to Regulatory Knowledge Objective : The aim of the project is to design, develop, manage, assess and commercially exploit a fully functioning prototype Internet e-commerce site providing IPR protection services. The prototype will become the basis for a fully commercial site run by a company set up for this purpose.
ERMIS	Electronic commeRce Measurements through Intelligent Agents. IST Project Reference: IST-1999-21051
ETEMSOLUTION	Electronic commeRce Measurements through Intelligent Agents. IST Project Reference: IST-1999-21051
EXPLANTECH	Exploitation of Agent-based Production Planning using the ProPlant Technology Objective : The mission of the ExPlanTech Trial is to enhance new technological and business opportunities in the global IT market by introducing and exploiting a novel project driven production planning technology in two industrial end user sites.
FAME	Facilitating Agent in Multicultural Exchange. The FAME project develops a new vision for computer interfaces, which replaces and extends strictly human-computer interaction by computer-enhanced human-to-human (CEHH) interaction.
FEEL	Non-Intrusive Services to Support Focussed, Efficient and Enjoyable Local Activities Objective : The main objective of the project is to deal with the problem of the intrusiveness of today's mobile technology and how introducing the idea of non-intrusive services can enhance work in local environments realised partly by disappearing computer environments.
FIRMA	The FIRMA project is developing agent-based social simulation models integrating representations of natural and social systems to support policy and business strategy analysis relating to water supplu and demand management during the period of anticipated climate change. The agent based modelling is providing a robust alternative to naive scenario analysis of, for example, the International Protocol on ClimateChange (IPCC).
FLAGS	Foundational Aspects of Global Computing Systems. The project aims to provide a unifying scientific framework and a coherent set of design rules for global systems resulting from the integration of autonomous interacting entities, dynamic multi-agent environments and ad-hoc mobile networks. The focus will be on the issues of co-operation and antagonism, stability and fault-tolerance, as well as communication and motion in such global systems.
GALECIA	Group for Advanced Learning Environments using Communication and Information Aids. The GALECIA project main goal is to evaluate the implementation of multimedia, ICT based material when applied to different courses with distinct methodologies, ODL schemes and cultural realities.
GUARDIANS	Gateway for User Access to Remote Distributed Information and Network Services Objective : The GUARDIANS project will identify the technology for the next generation of Information Management tools and specify how the required infrastructure will allow distributed components to interwork. Information Management in this context is taken to have a wider meaning than just the content that is of interest to users.
HEALTHY MARKET	A Virtual Marketplace For The Implementation Of Healthy Nutritional Plans.
IBROW	The objective of IBROW is to develop intelligent brokers (i.e. intelligent software agents) that are able to distributively configure reusable components into knowledge systems through the World-Wide Web. The WWW is changing the nature of software development to a distributive plug & play process, which requires a new kind of managing software: intelligent software brokers. IBROW will integrate research on heterogeneous DB, interoperability and Web technology with knowledge-system technology and ontologies.
ICITIES	Information Cities. The Information Cities project models the aggregation and segregation patterns in a virtual world of infohabitants (humans, virtual firms, on-line communities and software agents acting on their behalf). The objective is to capture aggregate patterns of virtual organisation, emerging from the interaction over the emerging information infrastructure, a virtual place where millions (or billions) meet of infohabitants meet, co-operate and trade.
IMAGE	Intelligent Mobility Agent for Complex Geographic Environments. The IMAGE project attempts to build on the existing and future infrastructure and know-how in order to get one step ahead from any previous attempt on mobility information to citizens. IMAGE will design and develop an open, modular technical platform (the "IMAGE platform") that will facilitate a win-win e-business environment so as to introduce a holistic approach to end user's, personalised electronic access to useful services for everyday life needs (where travel is a core element).

IMASS	Information Management and interoperability of content for distributed Systems of high volume data repositories through multi agent Systems. Objective : The I-MASS project will study the problems caused by these developments by developing agent-based tools and the development of the concept of the Virtual Reference Rooms, by means of which access to heterogeneous objects can be realized.
INCO-COPERNICUS	(CEE DG XII) "EMG-net : European Research network for Intelligent Support of EMG Studies" Description: EMG net is an European research network for intelligent support of electromyography (EMG) studies between information technologies (IT) and medical teams. Its objective is to capitalize knowledge in the domain of EMG by focusing on the following main tasks: completion and enhancement of the available knowledge further standardization of the EMG case representation, techniques and methods for EMG diagnosis dissemination of the competence of each node as well as the joint competence of the partners collected through their active collaboration.
INFOCITIZEN	Agent based negotiation for inter- and intra-enterprise coordination employing a European Information Architecture for Public Administration. InfoCITIZEN project aims at- establishing a common Enterprise Architecture among the participating EU countries tested in representative public administration segments, and - deploying a distributed, Internet-based information system that supports the above for all actors involved (citizens, administrations, private sector), building on emerging technologies (e.g. mobile agents, middleware, xml) and solving incompatibilities and complexities that exist today.
IRIS	Incorporating Requirements of People with Special Needs or Impairments to Internet-based Systems and Services
KNOWMAN-SYST	Intelligent agent-based knowledge management system specifically adaptable for SMEs in the building and craft sector
LEAP	Lightweight Extensible Agent Platform (LEAP). The LEAP project is addressing the need for open infrastructures and services which support dynamic, mobile enterprises. It will develop agent-based services supporting three requirements of a mobile enterprise workforce: Knowledge management (anticipating individual knowledge requirements), decentralised work co-ordination (empowering individuals, co-ordinating and trading jobs), travel management (planning and coordinating individual travel needs). Central to these agent-based services is the need for a standardised Agent Platform. Project LEAP will develop an agent platform that is: lightweight, executable on small devices such as PDAs and phones; extensible, in size and functionality; operating system agnostic; mobile team management application enabling, supporting WAP and TCP/IP; FIPA compliant.
LIAISE	Local Intelligent Agent as Informed Sales Expert. Objective : The LIAISE funded project aims to produce a commercial tool to aid in the configuration and quotation of complex highly configurable multivendor systems along the whole systems value chain. The LIAISE system suggests a new approach to e-commerce providing a new solution to implement B2B system and consequently new services.
M - Learning	Mobile Communications Technologies for Young Adults Learning and Skills Development. Project m-learning will investigate the feasibility of delivering micro-modules of on-line learning via technologies which are portable, easy to use and exciting, using mobile phones, palmtop computers and other personal digital devices. Development work with m-learning will include design, development and trailing of a prototype multi-agent "intelligent" system to evaluate learner knowledge and preferred learning styles/strategies and assist with personal development planning including tailoring of micro- courses to suit individual needs.
MABE	Multiagent business environment. The general project objective is to develop and to implement an IT infrastructure to establish eBusiness standards for networking, enterprises, based on agent technology (agents can be seen as software modules with intelligent and autonomous features). MaBE will develop a multi-agent business environment to enable dynamic and automated combination of multiple, complementary and alternative services between different users and providers along the whole value chain. This enables internet-based and knowledge-driven discovery and selection of any business services, supporting service registration, resource allocation, negotiation, co-operation as well as automated collaboration processes and pre-selection of services within a net-economy. MaBE also develops the connection of the common business environment to electronic marketplaces for business services.
MAGECC	Assessing the role of Multi-Agent Coordination and Control as an independent engineering discipline. The proposed assessment project aims to establish whether it is possible to develop generic coordination and control functionality and support across a wide range of application domains based on multi-agent technology. The project assesses whether sufficient grounds exist for establishing multi-agent coordination and control as a technology domain (like the domains for vision, natural language and speech, which already exist today).

MAGICSTER	Embodied Believable Agents. Design a believable conversational interface agent, which makes use of gaze, facial expression, gesture and body posture as well as speech in a synchronised fashion; Evaluate the use of the conversational agent in laboratory conditions to determine which aspects of the embodied agent are important for what types of human-computer interaction; Develop and document the agent architecture and components to enable other research and development teams to prototype and evaluate new versions of the agent interface in new domains and for novel tasks.
MANTRIP	Management Testing and Reconfiguration of IP based networks using Mobile Software Agents. Objective : The main goal of the project is to design, develop, test, validate and provide a set of novel network management applications based on Mobile Agent Technology (MAT) for managing IP based networks and to evaluate MAT in the context of Network Management.
MAP	Mobile Adaptive Procedure The MAP project will develop a system supporting civil servants while they interact with citizens; it is a front-end e-assistance system. Special software agents will "listen" to the interaction in real-time, using advanced speech-recognition technologies, to identify the topics discussed. An expert system will select from the knowledge base of the administration the most pertinent information; then MAP will proactively propose it to the civil servant. The system will assist the interaction with the citizens in a seamless way, whenever they contact the administration: while on the move, on the net, face-to-face.
MAP-SCM	Interactive, Plan-based Software Agents for Distributed Supply Chain Management . In the project MAP-SCM we investigate computational mechanisms for three key capabilities required by the next generation of supply chain management systems that have received surprisingly little attention in existing systems. Firstly, the effective control of supply chains based on incomplete, inaccurate, and unreliable information. Secondly, to make supply chain processes more reliable, planning systems have to plan for accomplishing robustness, even when facing significant disturbances. Thirdly, most current systems do not learn from experience to become better over time.
MIKS	The MIKS (Mediator agent for Integration of Knowledge Sources) system research project aims at extending the functionalities of the MOMIS (Mediator environment of Multiple Information Sources) system.
MISSION	Multi-agent Integration of Shared Statistical Information over the (inter)Net. Objective : MISSION aims to provide a software solution that will address the issues raised by this context. It will utilise the advances in statistical techniques for data harmonisation, the emergence of agent technology, the availability of standards for exchanging metadata and the power of Internet information retrieval tools.
MOBILE	The project MOBILE realizes a multilaterally secure platform for Location Based Services. On this platform ontology based mobile services are dynamically, individually, and context oriented found as well as adapted to any mobile device by means of mobile agents. Especially, security issues such as profiling user data and movement (privacy protection), usability of mobile services (integrity and availability), and reliable billing and accounting (non-repudiation) are addressed and multilaterally balanced.
MYTHS	Models and Types for Security in Mobile Distributed Systems. MyThS seeks to develop type-based foundational theories of security for mobile and distributed systems. By relying on strong typing as the basic principle, MyThS addresses the foundations of programming languages and paradigms that allow static detection of security violations, and aims at developing type theoretic methods and tools that enable formal analyses of security guarantees appropriate for systems and applications on the global computing platform.
NECA	A Net Environment forn embodied emotional Conversational Agents
ON-TO-KNOWLEDGE	Tools for content-driven knowledge management through evolving ontologies. Objective :The On-To-Knowledge project will develop methods and tools and employ the full power of this approach to facilitate such knowledge management. The On-To-Knowledge tools will help office workers who are not IT specialists to access company-wide information repositories.
ONTO - LOGGING	Corporate Ontology Modelling and Management System
PATTERNS	Patterns To Adopt Knowledge Based Solutions To Software Management Problems. Objective : PATTERNS aims to create an inter-networked architecture of Knowledge Centres and distributed end-users that will support their transformation in knowledge driven and learning organisations. PATTERNS will provide a dynamically adaptive architecture that will allow organisations to increase their knowledge capacity, capitalise on that knowledge into business processes and manage the distributed knowledge embedded in Management Practices.

PELLUCID	A Platform for Organisationally Mobile Public Employees. The aim of the Pellucid project is to develop a flexible and adaptable platform to assist organisationally mobile employees at middle and higher levels of public sector organisations. Organisational mobility, in which employees move from one department or unit to another, is becoming increasingly common, and brings its own problems and opportunities. The Pellucid platform is a multi-layer, agent-based system to aid these employees in acquiring, reusing and sharing knowledge and experience, benefiting both them and the effectiveness and efficiency of the organisation.
PERSEO	Personalised multichannel services for advanced multimedia stream management.This project is targeting an extension of a currently active IST project dealing with personalisation issues. The extension will rely on the development of intelligent and automatic audiovisual stream management tools, both from the content provider and from the final consumer points of view. We will integrate the innovative management of multimedia contents offered by different providers together with a personalised access to this information through universal multiplatform interfaces, taking advantage of existing standardisation efforts on MPEG-7 and MPEG-21 and delivering the contents through UMTS terminals and conventional e-learning Internet portals.
PISA	Privacy Incorporated Software Agent: Building a privacy guardian for the electronic age. Objective : PISA addresses the European policy to foster the security and privacy for the users of new combinations of telecommunications, information technology and media, and the need for interoperability and coherence at a global level. The project is positioned at the crossroad of developments of Software agents, the Internet and E-commerce.
PLANET	PLANET is a coordinating organisation for European research and development in the field of Artificial Intelligence Planning and Scheduling and in particular aims to promote the transfer of this leading-edge technology into European industry.PLANET is a Network of Excellence, funded by the European ``Information Society Technologies Programme (IST)''.
PTAs	Intelligent Agents as Personal Trading Assistants for Transactions in Electronic Markets. In the follow-up of the recent advances in telematic services and information technologies, we are currently experiencing a revolution in the way that financial and commodity markets operate. In particular, brokerage agencies have enabled small-scale investors to participate in various marketplaces through Internet: huge parts of the US contracting volume is supported electronically, and Europe will catch up to similar amounts soon. However, the incessant rise of the number of operations realised by investors with limited experience has exceeded the capacity of many agencies to provide expert brokers, who advise investors respecting the most adequate operations for their profile, and who support them during the enactment of market operations.
RACING	Rational Agent Coalitions for INtelliGent Mediation of Information Retrieval on the Net
SAFEGUARD	Safeguard aims to enhance the dependability and survivability of Large Complex Critical Infrastructures (LCCIs), such as distributed electric and telecommunication networks. Modern automation systems underlying LCCIs include different levels of automation, regulation and control, but "intelligent" functions relating to critical issues such as safety and system survivability are usually monitored or executed by human operators. The problem addressed in this project is becoming more acute since the business models of LCCIs are becoming increasingly complex in a competitive environment. The impact of these new models is to make the system more difficult to control and more prone to failure.
SAFIRA	Supporting Affective Interactions for Real-time Applications. Objective : SAFIRA will provide a framework to enrich interactions and applications with an affective dimension, bringing to the software community an enabling technology to support affective behaviour and control in real-time multi-agent systems interacting with users.
SHUFFLE	An agent based approach to controlling resources in UMTS networks. Objective : The project will create a novel architecture for efficient, scalable & robust real time control of resources in 3rd generation mobile systems in the context of realistic business models of network providers, service providers and customers.
SIMWEB	SimWeb will provide European businesses in the digital contents sector with insights and tools which will enable them to take informed business strategy decisions and become more competitive by adapting their traditional B2C business models to the new, demanding reality. To achieve this objective, SimWeb will design and implement sector models based on innovative, reusable, and highly scalable multi-agent simulation technology. These computer-based models, calibrated to market data extracted from extensive sector surveys, will then allow market participants in the digital contents sector to run through an almost unlimited variety of social and economic scenarios, and observe the impact they have on their businesses in particular, and on the competitive digital contents landscape in general. The insights gained during these simulation runs will permit them to adjust their own business models to the new competitive demands. Games will be implemented, which allow non-technical and business-focused users to learn from the results of the simulations and also provide an innovative dissemination process

SPARTA	Security Policy Adaptation Reinforced Through Agents. Objective : SPARTA (Security Policy Adaptation Reinforced Through Agents) proposes to develop a software application, based on the newest agent technology, consisting of several modules in order to reach and maintain a high level of the IT security.
STARLITE	To integrate PSTN and Internet services within a heterogeneous network and service architecture.
SWAN	SWAN project - IST thematic network contract IST-1999-14124 Standardisation & dissemination support actions for waterborn telematic networks & applications.
TELECARE	A Multi-agent Tele-supervision System For Elderly Care
TORRENT	Technology for a Realistic End User Access Network Test-bed. TORRENT is building a test-bed for residential multi-service access networks that will allow the project to demonstrate the benefit of intelligent control, both for the customer and the network operators.
TRANSMODALBOTS	TRANSMODALBOTS is a Spanish project supported by the european fund ERDF, leaded by the Gijón Port Authority (http://www.puertogijon.es), which started the 01.01.2000 and will end the 01.01.2003. It investigates families of XML based Intelligent Agents in the Port and Maritime Industry, and has recentlly presented the TMB project to join the XML interest Group of ISIS (http://www.ist-isis.net/) through another IST project named SWAN (http://www.ist-swan.net/swanhtml/).
VESPER	To develop a VHE enabled 3rd generation communication environment.

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