What Are Agents?

Knowledge is of two kinds. We know a subject ourselves or we know where we can find information about it.

—Samuel Johnson
  (in a speech)

THE BIRTH OF THE AGENT

The first agent is lost in the pages of history. At what point during the evolution of mankind from the roaming hunter-gatherer to the settled farmer, the need for agents developed is unclear. Was there an intermediary between roaming tribes, someone who was persona grata, or perhaps someone who negotiated inter-tribal marriages? In Sholem Aleichem’s short story “Tevye the Milkman,” the matchmaker plays a significant role, showing that in this function, “agents” have been in business for a very long time.

Certainly by the time that villages had aggregated into kingdoms, the role of ambassador had come into being. Ambassadors acted as agents for their king and were therefore political and trade agents. In the dark ages in Europe, Jews were not allowed, because of religious prejudice, to carry out many professions and thus were forced to become users. A moneylender would be a financial agent, sometimes representing many money providers and negotiating on their behalf for the best return on capital deployed.

HUMAN AGENTS TODAY

People have been doing business for a long time. The only intelligent agent whom people had was another human being. A human being is currently the finest agent technology in the world, and as it appears from current research, will continue to be so for quite a while. Unfortunately, human agents have 168 hours available to work in a week. But can only work 84 hours—and at that figure would burn out quickly, that is, less than 50 percent of the global business day.

What are some of the features of a human agent? A human agent
- Is focused on a task.
- Is a specialist with skills that I do not have.
- Has access to information relevant to a task.
- Has the contacts to provide the service.
- Can provide the service at a fraction of the cost of doing it myself.
- Provides a service I cannot get any other way (e.g., being a secret agent).

We use human agents everywhere in our present-day society. We use them to perform services, locate information, and get prices and other information so that we can make some decision or can purchase a product or a service. These agents provide a valuable service that makes life easy for their customers. Many of these services have been developed over the past fifty years.

The following is a partial list of the types of human agents whom we use today:

<table>
<thead>
<tr>
<th>Insurance agent</th>
<th>Sports agent</th>
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<tr>
<td>Booking agent</td>
<td>Intelligence agent</td>
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<td>Travel agent</td>
<td>Publishing agent</td>
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<td>Talent agent</td>
<td>Financial agent</td>
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<td>Medical agent</td>
<td>Sales agent</td>
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<td>Real estate agent</td>
<td>Environmental agent</td>
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<td>Social agent</td>
<td>Leasing agent</td>
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<td>Conference agent</td>
<td>Rental agent</td>
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<td>Advertising agent</td>
<td>Investment agent</td>
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<td>Media agent</td>
<td>Foreign agent</td>
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<td>Modeling agent</td>
<td>Home health agent</td>
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<td>Recruiting agent</td>
<td>Military agent</td>
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<td>Security agent</td>
<td>Agent provocateur</td>
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This list is long and encompasses many areas. Furthermore, if you substitute the word “assistant” for “agent,” then this list would expand even more, for example, medical assistant or legal assistant. The people engaged in these professions make extensive use of computers and have their own systems to manage their individual businesses. Now consider the duties and services that are offered by the agents in that list. These agents:

- Provide information and descriptions of the service or the product.
- Locate the best sources, companies, and locations.
- Find and suggest the best prices or provide a series of options.
- Negotiate agreement between the purchaser and the offered.
- Prepare and distribute documentation, contacts, and agreements.
- Monitor results and resolve problems.
- Provide any additional information and offer clarification.
- Collect revenue, fees, and commissions, or distribute funds.
- Terminate the service or product in the event of nonpayment.
- Send out renewals and reminders to start the process all over again.

What we consider most significant is that the majority of all these duties can be **automated** by using software. Software agents can perform all these tasks and more. Many people will say that this process will not happen, but we have only to look at numerous examples in the past in which similar automation has taken over.

For example, the gasoline retail industry used to have attendants pump gas into a car’s gas tank—until an automated pump system was designed and is now used in almost every gas station in the world, thus putting an end to the employment of the friendly, smiling person who filled up your car and cleaned your windshield. At that time, pundits claimed that this concept would never work for these reasons:

- People would not be able to work out how to fill up their own car’s gas tank.
- People would drive away and not pay.
- People would always want someone else to do the work for them.

All of these reasons turned out to be wrong.

Looking at the big picture, we know that the Western world economy has made a transition in the last twenty years: a transition from manufacturing to service. It can be viewed that the whole service industry is that of agents. If so, then a longer-term view might be that the Western world is basing its economy on a short-term opportunity that in the next twenty years will rapidly shake out. Those who spurn manufacturing (where goods are actually produced) may live to regret that decision.

In the Internet-supported global economy of the future, a great many service jobs that currently employ thousands of people will disappear in the same way that manufacturing jobs disappeared during the 1970s and 1980s.

In Section Two of this book, we shall describe in more detail the personal and industrial applications of software agents, with specific case studies.

In conclusion, then, a human agent is someone who performs some act on behalf of another that he or she is uniquely qualified to undertake.
IN THE BEGINNING

In 1964, Arthur C. Clarke started work on his book, and subsequently the film, 2001—A Space Odyssey. He created what is arguably the best-known computer of all—HAL (Heuristically Algorithmic Computer). HAL, which had to perform a long and difficult space mission, was given intelligence by its creator.

HAL had been trained for this mission as thoroughly as his human colleagues—and at many times their rate of input, for in addition to his intrinsic speed he never slept. His prime task was to monitor the life-support systems, continually checking oxygen, pressure, temperature, hull leakage, radiation and all the other interlocking factors upon which the lives of the fragile human cargo depended. He could carry out intricate navigational corrections and execute the necessary adjustments to their environments and doling out minute amounts of intravenous fluids that kept them alive.

The time might come where HAL would take control of the ship. In an emergency, if no one answered his signals, he would attempt to wake the sleeping members of the crew by electrical or chemical stimulation. If they did not respond he would radio Earth for further orders. (Source: 2001—A Space Odyssey. By permission of Ray Book.)

HAL is the result of the fertile imagination of a brilliant science fiction writer. However, fiction has a habit of often becoming fact. It is the concepts and actions that Arthur C. Clarke devised so long ago that today’s software agents are beginning to mimic. If you have read the book, you will know that HAL came to an abrupt and a sticky end when it had to be destroyed because it had gotten out of control and had started to murder the spaceship crew.

Indeed, we have a long way to go before we reach the sophistication of the HAL 9000 series (it was supposedly incapable of making an error)—and the software agents we will design should surely not murder people! The important point is that we have started the journey. As we will see in Section Two, we have started toward the sophisticated use of software agents in space. Arthur C. Clarke has helped shape and direct the future of software, robotics, space flight, and agent technology, and most of all, the communications satellite that he invented and documented in 1948.
Another seminal figure in the world of agents is Isaac Asimov, the famous scientist and science fiction writer who created the Three Laws of Robotics. We believe that in time all agents should abide by these laws, which are as follows:

1. A robot may not injure a human being, or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

We will see whether these famous “laws” play any part in the design of modern agents. Since software agents have already become known as “Bots”—short for “software robots”—it seems logical that at some point in the future when they become more intelligent, these laws will apply.

**TYPES OF AGENTS**

Stan Franklin and Art Graesser at the Institute for Intelligent Systems at the University of Memphis list a number of “approved” definitions of agents, which at times seem to conflict. They attributed this conflict to the mind-set of each player who has her or his own vision of what an agent should be, on the basis of the player’s own work in the field. However, the list is instructive and enlightening as it defines in many ways what agents do in the context of the major agent developers and researchers:

**The MuBot Agent** (http://www.crystaliz.com/logicware/mubot.html)  
“The term agent is used to represent two orthogonal concepts. The first is the agent’s ability for autonomous execution. The second is the agent’s ability to perform domain oriented reasoning.” This definition comes from an online white paper by Sankar Virdhagriswaran of Crystaliz, Inc., defining mobile agent technology. **Autonomous execution is clearly central to agency.**

**The AIMA Agent** (Russell and Norvig 1995, page 33)  
“An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors.” AIMA is an acronym for “Artificial Intelligence: a Modern Approach,” a remarkably successful new AI text that was used in two hundred colleges and universities in 1995. The authors were interested in software agents embodying AI techniques. Clearly, the AIMA definition depends heavily on what we take as the environment, and on what sensing and acting mean. If we define the environment as **whatever provides input and receives output, and take receiving input to be sensing and producing output to be acting, every program is an agent.** Thus, if we want to arrive at a useful con-
trast between agent and program, we must restrict at least some of the notions of environment, sensing and acting.

The Maes Agent (Maes 1995, page 108) "Autonomous agents are computational systems that inhabit some complex dynamic environment, sense and act autonomously in this environment, and by doing so realize a set of goals or tasks for which they are designed." Pattie Maes, of MIT's Media Lab, is one of the pioneers of agent research. She adds a crucial element to her definition of an agent: Agents must act autonomously so as to "realize a set of goals." Also, environments are restricted to being complex and dynamic. It's not clear whether this qualification rules out a payroll program without further restrictions.

The KidSim Agent (Smith, Cypher, and Spoehr 1994) "Let us define an agent as a persistent software entity dedicated to a specific purpose. 'Persistent' distinguishes agents from subroutines; agents have their own ideas about how to accomplish tasks, their own agendas. 'Special purpose' distinguishes them from entire multifunction applications; agents are typically much smaller." The authors are with Apple. The explicit requirement of persistence is a new and important addition here. Though many agents are "special purpose," we suspect that this is not an essential feature of agency.

The Hayes-Roth Agent (Hayes-Roth 1995) Intelligent agents continuously perform three functions: perception of dynamic conditions in the environment; action to affect conditions in the environment; and reasoning to interpret perceptions, solve problems, draw inferences, and determine actions. Barbara Hayes-Roth of Stanford's Knowledge Systems Laboratory insists that agents reason during the process of action selection. If reasoning is interpreted broadly, her agent architecture does allow for reflex actions as well as planned actions.

The IBM Agent (http://activist.gpl.ibm.com:81/WhitePaper/ptc2.htm) "Intelligent agents are software entities that carry out some set of operations on behalf of a user or another program with some degree of independence or autonomy, and in so doing, employ some knowledge or representation of the user's goals or desires." This definition, from IBM's Intelligent Agent Strategy white paper, views an intelligent agent as acting for another, with authority granted by the other. A typical example might be an information-gathering agent, though the white paper talks of eight possible applications. Would you stretch "some degree of independence" to include a payroll program? What if the agent called itself on a certain day of the month?

The Wooldridge & Jennings Agent (Wooldridge and Jennings 1995, page 2) "... a hardware or (more usually) software-based computer system that enjoys the following properties:

- autonomy: agents operate without the direct intervention of humans or others, and have some kind of control over their actions and internal state;
social ability: agents interact with other agents (and possibly humans) via some kind of agent-communication language; 
reactivity: agents perceive their environment (which may be the physical world, a user via a graphical user interface, a collection of other agents, the internet, or perhaps all of these combined), and respond in a timely fashion to changes that occur in it; 
pro-activeness: agents do not simply act in response to their environment, they are able to exhibit goal-directed behavior by taking the initiative.”

The Wooldridge and Jennings definition, in addition to spelling out autonomy, sensing, and acting, allows for a broad but finite range of environments. It further adds a communications requirement: What would be the status of a payroll program with a graphical interface and a decidedly primitive communication language?

The SodaBot Agent (Michael Coen http://www.ai.mit.edu/people/sodabot/slideshow/total/P001.html) “Software agents are programs that engage in dialogs [and] negotiate and coordinate transfer of information.” SodaBot is a development environment for a software agent being constructed at the MIT AI Lab by Michael Coen. Note the apparently almost empty intersection between this definition and the preceding seven. We say “apparently” since negotiating, for example, requires both sensing and acting. And dialoging requires communication. Still, the feeling of this definition is vastly different from that of the first few and would seem to rule out almost all standard programs.

The Foner Agent (Lenny Foner—Download from ftp://media.mit.edu/pub/Foner/Papers/Julia/Agents—Julia.ps or online at http://foner.www.media.mit.edu/people/foner/Julia/ [click on “What’s an agent? Crucial notions”]) Foner requires much more of an agent. His agents collaborate with their users to improve the accomplishment of the users’ tasks. This process requires, in addition to autonomy, that the agent dialog with the user, be trustworthy, and degrade gracefully in the face of a “communications mismatch.” However, this quick paraphrase doesn’t do justice to Foner’s analysis.

The Brustoloni Agent (Brustoloni 1991, Franklin 1995, page 265) “Autonomous agents are systems capable of autonomous, purposeful action in the real world.” The Brustoloni agent, unlike the prior agents, must live and act “in the real world.” This definition excludes software agents and programs in general. Brustoloni also insists that his agents be able to respond to external, asynchronous stimuli in a timely fashion.

As these definitions make clear, there’s no general agreement as to what constitutes an agent or as to how agents differ from programs.

Stan Franklin and Art Graesser have their own definition:
An autonomous agent is a system situated within and a part of an environment that senses that environment and acts on it, over time, in pursuit of its own agenda and so as to effect what it senses in the future.

Analyzing the key items in this very diverse list shows that

- Autonomous execution is clearly central to agency.
- Agents must act autonomously so as to “realize a set of goals.”
- The explicit requirement of persistence is a new and an important addition.
- Agents reason during the process of action selection.
- An intelligent agent is acting for another, with authority granted by the other.
- Agents interact with other agents (and possibly humans when specified to do so) via some kind of agent-communication language.
- Agents engage in dialogs [and] negotiate and coordinate transfer of information.
- Agents are capable of autonomous, purposeful action in the real world.

We see that agents are, by consensus, autonomous, goal seeking, persistent, reasoning, productive, and communicative.

Although none of the preceding preclude the three laws of robotics, the lack of ethics as a guiding principle by the main agent developers in the world is, nevertheless, quite frightening. We think that it is important to add to the definition the restriction that agents work on behalf of others, that is, they are NOT self-motivating.

This addition should separate agents from life. This distinction is important, since agent technologies already include artificial intelligence and will inevitably lead to computer life. But as our definition of human agents shows, agents act on behalf of others. If they have their own goals, these goals are not part of their function as agents.

We did consider including the Murch Johnson definition of agents; however, we deferred on the side of caution, preferring not to add any more to the already crowded field.

**ATTRIBUTES OF AGENTS**

Agents are fundamentally different from software packages and other commercial programs. They must have special characteristics or attributes. We will delve a little deeper than we did in the preceding list of agent qualities to show that agents must have the following characteristics:
Adaptability: An agent must be able to work on multiple platforms, networks, and software operating systems, and at the same time be able to solve technical problems by itself without input from the owner.

Mobility: An agent should be able freely to roam networks and the Internet according to decisions made internally by itself about where to find information and data to achieve its goals. It must be able to interact with other agents in multiple networks and environments.

Transparency and accountability: An agent must be completely transparent to the owner/user if required but must have features for logging where it has been, what it has done, whom it did contact, and when. Also, it must produce this information on demand.

Ruggedness: If an agent is required to traverse networks, both large and small, it must be rugged; able to deal with errors, low resources, underpowered servers, and incomplete data; and interpret different kinds of data, codes, and so on. It should be able to solve as many problems as it can without human intervention.

Self-starters: An agent must be able to start and stop on the basis of its own criteria and to decide to gather information using the owner's priorities. The required frequency may be as soon as possible, hourly, daily, weekly, or monthly. The agent needs the ability to decide when to start/stop and when to deliver its results and what interface to deliver.

User centered: The agent should act in the best interests of its owner and the preferences that have been set for it—the start of the Laws of Robotics? It must carry out its duties as prescribed and not deviate. But it might have the ability to suggest possible new ways of thinking. Also, it might offer new ways to achieve results or correct ways of thinking.

<table>
<thead>
<tr>
<th>Property</th>
<th>Meaning</th>
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<tbody>
<tr>
<td>Reactive</td>
<td>Responds in a timely fashion to changes in the environment</td>
</tr>
<tr>
<td>Is autonomous</td>
<td>Exercises control over its own actions</td>
</tr>
<tr>
<td>Is proactive, purposeful</td>
<td>Is goal-oriented</td>
</tr>
<tr>
<td>Is a continuously running process</td>
<td>Is temporally continuous</td>
</tr>
<tr>
<td>Communicates with other agents, perhaps including people</td>
<td>Is socially able</td>
</tr>
<tr>
<td>Changes its behavior on the basis of its previous experience</td>
<td>Is adaptive and can learn</td>
</tr>
<tr>
<td>Is flexible</td>
<td>Is able to transport itself from one machine to another</td>
</tr>
<tr>
<td>Has believable &quot;personality&quot; and emotional state</td>
<td>Has character</td>
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These attributes are very demanding and require a fundamentally different approach to constructing software than has been attempted before with different languages, protocols, and expectations or results.

THE IMPACT OF THE INTERNET

Many people consider “agents” and Internet to be connected. The reason for this perception is that agents first came to the attention of the public through Internet agents (such as search agents). An agent can, of course, operate in any environment, even a mainframe with no network. In that environment, it would be limited to operating on the local data but would still be extremely useful. Such an agent might be an alert agent in a banking environment for certain conditions of liquidity or debt. The agent might flash a warning on an officer’s screen—or perhaps when a stock price reaches a certain level—and then buy or sell.

Of course, as the number of computers in a network grows and therefore becomes accessible, the use of agents to act on the distributed data becomes more valuable. For that reason, the Internet with its millions of hosts is the ideal environment for agents to be useful in and therefore to stimulate the growth of the underlying technologies that make the agents work.

Another factor that the Internet has brought is the ability for agents to act on other people’s data. The example that follows of a computer travel agent is possible only because the Internet has given access to third-party networks previously closed or available only to a limited user-group (e.g., SABRE).

In 1997, Andersen Consulting built an experimental agent called “Bargain Finder,” which can help you get the best price on the Internet for a CD. In 1997, a new agent, “RoboShopper” from RoboShopper, Inc., could do the same thing for many items, such as cigars, computers, electronics, books, games, magazines, toys, and other items. Current restrictions on these offering are the places where they shop and being limited to internal lists of places to find such items or information. Therefore, RoboShopper will look for books at Amazon, Barnes and Noble, and perhaps another three sites, but will ignore new companies and new opportunities. Another recent example is Jango, which started life as a desktop shopping agent, similar to RoboShopper, but which has been bought by Excite and integrated into their search engine. These agents are not “intelligent” in that they are not capable of defining their universe of search and acquiring new targets. So if a new bookshop arrives on the Internet, you have to tell these agents that it exists, because they cannot find it for themselves.

One area of research in agent theory, as we will see in Chapter Five, is how agents will negotiate with other agents, that is, how they will purchase on your behalf. Doing this will take agents beyond the current horizons of compiling lists to present back to you, into decision making. However, even when all this is in
Travel and Computer Agents

As the Internet has grown, many of the tasks that people delegated to a traditional human agent are now possible to do by yourself.

An example is travel. Five years ago if I had wanted to fly to Europe, I would have to go to a travel agent. Why? Because travel agents had access to the world’s booking computers such as American Airlines’ SABRE, and they had exclusive discount deals that enabled them to provide me with “special” prices. They could also ticket me, and then I was ready to fly. In addition, they could find me suitable “recommended” hotels and book me into them, and provide me with a car at my arrival point. With their contacts, they could put together a “package” that, if I had booked things individually, I could not match.

Today I can access SABRE myself through the Internet, choose my flight using a search engine to scan all flights and prices, and pay for it online via a credit card; and when I get to the gate, I can pick up my ticket. The same SABRE system can also book my car and hotel. I can travel via the Internet to Europe and look at hotels, ask questions about rooms and meals, and provide a much more tailored service to my requirements than can the travel agent who has to serve thousands of travelers and therefore has a bland “average” selection of hotels.

But doing that arranging also takes time. If I am planning the family vacation and, like Chevy Chase, must go to Wally’s World, I might want to take the time as a family exercise to travel via the Internet to Europe, choose my destinations and my hotels, and have my whole family join me in the excitement of learning. But since more than 50 percent of all travel is for business, I might just want it “all handled” for me (incidentally, that is the reason most executives give to explain why they don’t use computers).

In that circumstance, I still need an agent. Now I have the option of using a human agent or an electronic equivalent.

The electronic travel agent would ask me a few key questions (questions that if it were a “good” agent, it would store up in an intelligent profile of my likes and dislikes). Also, it would travel the Internet and evaluate on my behalf all the flights and all the options from all the airlines (SABRE estimated that there are sometimes more than 3,000 possible combinations of flights/prices to many popular destinations each day) and would present me with a decision point on the best three options. Or maybe once I trusted the agent’s judgment, it would just book the flight on my behalf (after negotiating the best deal) and present me with my itinerary.

How soon will we eliminate human travel agents? Not as fast as some people think. Currently no agent exists that can do any of the preceding tasks.
place, there are still some features that no electronic agent currently has, such as the following:

- Because travel agents deal with many people and are often affiliated with large groups of agents or other corporations, they can negotiate very special prices from airlines, car rental companies, and hotels. They negotiate these prices on the basis of volume. Your personal electronic agent doesn’t have this clout—yet.
- Human travel agents (if they are any good) invest time and money in evaluating the quality of packages, hotels, and amusements. Again, they have the advantage that they deal with huge numbers of people and can therefore start to build a knowledge base (which is often not being computerized although doing so is increasing) of the “good, the bad, and the ugly” of options and destinations. Such knowledge enables them to select the best for you. Again, your personal agent does not currently have this broad history of experience to draw on, and since all Internet hotel sites are advertisements, the agent will be taking destinations at face value.

These problems can be overcome. There are excellent guides published by Michelin and Fodor, which will see the opportunity to make their evaluations available online. Your agent will then be able to check these for recommendations.

The “volume” discount is more complex. It implies that your agent has knowledge of, and access to, a pool where all electronic (and human) agents post their forthcoming requirements for travel. A “pool” agent is constantly using the updated information to negotiate with a group of airline agents to get the best price for the pool if all purchasers agree to use their airline. Your agent would negotiate with a group of pool agents who might post potential prices available if your agent were to subscribe to their pool versus another pool.

This is the kind of facility or infrastructure that agents which move into decision making will need, but it is not available yet. It is the lack of this infrastructure that is holding back agent development. If we look at the parallels in the development of communications, we can see that:

- The use of phones didn’t take off until there were a sufficient number of users and an effective switching and directory system.
- Corporate networks required intelligence at the node, that is, a PC.
- Corporate WANs required routing, that is, directories.
- The Internet didn’t take off until TCP/IP became an accepted standard for packet switching, along with the advent of the hyperlink protocol known as HTTP and the ability to see that linkage simply by using a browser.
- The Internet Web world didn’t take off until the advent of Yahoo and the search engines that could find relevant locations, that is, a form of directory.
The requirements for a “directory” in these early communications systems underwent several evolutions. The simple telephone White Pages gives a person’s name, telephone number, and address. This simple directory was quickly supplemented by the Yellow Pages, which goes beyond who you are and tries to describe what you do. This is as far as Ma Bell went. Any user of the Yellow Pages knows that they perform only a very basic function. The granularity of the information is poor. Looking up attorneys will give you all attorneys, when you might be looking for a specialized service and so might waste hours calling around the wrong type of attorney. In addition, there is no attempt in the Yellow Pages to add value by providing feedback on quality or information on critical items such as fee structures.

But then, other companies began to fill the gaps in granularity. The Yellow Pages show you all the hotels and restaurants in New York City, but Fodor gives people a way to judge which hotels and restaurants are right for them. Consumer guides help people sort out which companies make the best freezers and cars, and airline guides tell you which airlines fly where and at what cost.

THE CURRENT STATUS

Software agents today are living in a fairly barren wilderness. They don’t have even a true global White Pages, much less a Yellow Pages. The standards that they require to be accepted are still evolving. We might describe them as being the first generation. Until these standards become more widely accepted, they cannot perform effectively. Once these standards are in place, the agents will require tools such as Yellow Pages from which they can gather information and make decisions. These tools must be much more sophisticated than the existing directory structures. The world standard for directories is x.500, an ANSI standard. Like all standards, it was designed nearly twenty years ago when the technicians who designed it thought it would be pretty damned wonderful just to have one computer talk to another. It barely makes the grade today in letting anyone know who you are, that is, a name, and makes no pretense in handling what you are or how well you do your job.

The effective software agent, then, is still a long way away. Can we ignore agents for five years? We do not think so. There are a number of software agent areas where this level of sophistication is not necessary to produce real and valuable results. As we will show, agents are already in use in a number of major corporations and are helping businesses become more productive and more responsive to customers. The astute CEO/CIO or Line of Business manager will realize that unless the company starts to use agents now and starts the organizational learning curve today, many of these benefits will come too late and will require a costly and steep ramp up when they do become necessary.

The final reason for understanding this new technology is that even the primitive agents of today require information from corporate Web pages to be effective.