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Business environment scanner for senior managers: towards active executive support with intelligent agents

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Abstract

A good knowledge and understanding of the business environment is a basic premise for strategic management. A system that is able to help managers actively scan the environment contributes to active executive support. This paper examines the relevance of an intelligent software agent approach in environmental scanning activities and exploits ways that an agent can help in accomplishing scanning tasks. It then describes a prototype system that is currently under development. The system is designed to make use of potential business environment information resources on the World Wide Web to extract useful information for managers. Using pulp and paper industry as a case context, it is shown in this paper how the agent is constructed and how it provides up-to-date industry news and market information to managers.

1. Introduction

Monitoring and dissemination of information are important roles for managers (Mintzberg, 1975). Managers seek information to envisage the future, support their decision making, or justify intuition-based decisions. A good knowledge and understanding of the business environment constitute a basic premise for strategic management. The external world must be obtained, filtered and processed (Daft and Weick, 1984; Wang and Turban, 1993). Environmental scanning is defined by Aguilar as ''the acquisition of information about events, trends, and relationships in an organization's environment, the knowledge of which will be of assistance to top executives in identifying and understanding strategic threats and opportunities'' (Aguilar, 1967). In keeping themselves informed about changes and developments in the business environment, managers develop and accumulate an in-depth knowledge of their operating context, and this knowledge is updated and refreshed constantly.

Traditionally the managerial understanding of the business environment has often been characterized by intuitive and fragmented activity (Fahey et al., 1981; Nanus, 1982) and was unable to draw much on information technology (Aguilar, 1967). As the environment increases in scope, dynamics and complexity, the task of grasping its changes becomes increasingly demanding. The variety of information to be scanned expands, the interval between the scanning efforts needed shortened, information to be digested exploded. All these call for valuable time and effort from managers, while the oversupply of information associated with the easy accessibility of various kinds of electronic information can be especially, or already is, a burden. It is becoming more and more difficult to extract relevant information from voluminous data and to discern the most significant changes from voluminous happenings.

Executive support systems and DSSs in general have traditionally addressed mostly how to analyse pre-defined problems, and how to satisfy some pre-articulated and predefined information needs of managers. The information needs are often derived from the decisions that are to be made and from the analytical methods to be used. The systems respond only to pre-defined information requests (Carlsson and Walden, 1994; Carlsson, 1995). Such systems are largely not flexible enough to adapt to frequently changing information requirements. They monitor but do not scan actively; data are mostly aggregated but not interpreted and are limited to situation follow-up, exception reporting, budgeting and other standard analysis. In terms of the information content, they stem mostly from internal, transaction-based accounting systems and could not provide much competitive information. Databases contain primarily hard, quantitative data (King and O'Leary, 1996). The support offered has been basically passive in nature (Carlsson and Walden, 1994).

In overcoming these limitations, the concept of active support systems emerged as an alternative solution (Carlsson and Walden, 1994; Manheim, 1989; Mili, 1990).

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These earlier efforts presented fairly visionary and abstract statements for active DSSs. For example, an active support system is expected to ''take the initiative without getting specific orders'' and ''respond to non-standard requests and commands'' in an ambiguous and complex context (Manheim, 1989). In more recent years, there have been continuous efforts advocating an active support approach, developing active support methods and systems in order to examine the specifics of such a methodology (Carlsson and Walden, 1994; Carlsson, 1995; Carlsson, 1997; Vanharanta, 1995; Walden et al., 1994). These fruitful studies have emphasized the ability of a support system to provide a knowledge-rich environment, to represent and validate users' intuitive understanding, to allow users to express the internal logic of their context in the way perceived, and to enhance users' productivity. The studies also reveal the effectiveness of fuzzy logic and hyperknowledge techniques for the construction of active strategic management support systems. However, to incorporate an active environmental scanning capability into such systems to a satisfying extent still remains an unresolved problem and has been reported rarely.

The intelligent agent approach adds diversity to the new paradigm of active support systems. Intelligent software agents are computational programs or entities that act to accomplish delegated, specialized tasks on behalf of the users (Maes, 1994; Wooldridge and Jennings, 1995). Agents act, with some degree of autonomy, towards reaching certain user-specified or automatically generated goals. Agents participate actively in accomplishing tasks. The user needs only to specify a high-level goal instead of issuing explicit instructions, leaving the ''how'' and ''when'' decisions to the agent. While active support implies a more active role for the tool of ''supporting'', agents seem to have much to offer in this respect.

Agents can potentially have many uses in executive support, for example, automated e-mail handling, meeting scheduling, Web browsing, Internet news detecting and alert, external information gathering and filtering (see Fahey et al., 1981; King and Jones, 1995; King and O'Leary, 1996; Liu, 1996). Huge amounts of research and development efforts in these areas have been or are being carried out (Liu, 1996). How should we use software agents in scanning the business environment for managers? Is it an appropriate approach for executive support and how much can they best support?

Our research aims to build up a useful tool for environmental scanning and to investigate the applicability of software agents in providing active support to executives. This article examines the relevance of the intelligent software agent approach in environmental scanning activity and exploits ways that an agent can help in accomplishing scanning tasks. It then describes a prototype system that is currently under development. The system is designed to make use of potential business environment information on the World Wide Web to extract useful information for managers. The scanning of the pulp and paper environment is used as a case context to illustrate how the system provides most up-to-date business environment information for managers to use.

2. Scanning the business environment

2.1. Understand the scanning tasks

Environmental scanning is aimed at creating a reasonable appreciation and vision of the context for business operation, and to alert managers to the possible shift or invalidation of old appreciation. Scanning is both purposeful search and undirected viewing. A complete scanning process is an iterative process of search and noting (data collection), meaning developing and impact analysis (interpretation), as well as learning (adaptive action taken) (Aguilar, 1967; Choo, 1995; Daft and Weick, 1984; Wang and Turban, 1993). First, changes and developments in the business world are sought and collected. The sensed trends and events are identified as meaningful issues and only those that are relevant are selected. Incoming data are filtered according to management interests and *frames* that are used to define problems and their dimensions. Meanings are attached to events based on beliefs, assumptions and knowledge. Descriptions and explanations of events are developed using this knowledge. The nature of the selected issues is understood in the light of internal capabilities and business missions to see whether their influence is negative, zero or positive, controllable or uncontrollable, potential losses or gains, time press, etc. They are then recognized as a threat, an opportunity, or a crisis based on how likely future conditions are envisaged.

From business intelligence perspective, every change or development in the external environment creates signals and messages that an organization may need to heed. However, some of the signals may be spurious (not indicative of a true change), some weak (early representatives of potentially significant developments, difficult to detect), and some confusing (difficult to analyse and interpret) (Ansoff, 1975). So, the key issues are: how to detect weak signals which easily stay out of our sight; how to recognize spurious and irrelevant signals to ensure selective attention; how to attach meaning to signals and analyse their impacts on business; how to interpret confusing signals and resolve conflicts.

2.2. Understand managers' scanning behaviour

Three elements: information needs, information seeking preference and *information use* comprise information behaviour (Choo, 1995). Information seeking and use are driven by information needs and they in turn create new information needs. Information behaviour as a whole is then seen to be influenced by the contingencies of managerial work: the problem situation, managers' organizational

Table 1
Manager's external information needs

PPIndustry
Pulp and paper industry news and policy; structural changes such as mergers, acquisitions and joint ventures involving big players, competitors or new entrants into the industry, as well as information concerning the possibility of own company; financial market information (stock performance of own company, competitors, wood, pulp and paper price information).
Product Market
Pulp (BHW, BSW, mechanical pulp) and fine paper (coated woodfree and uncoated woodfree of different grade) market: regional and world production, price, demand, supply, capacity development, market shares.
Industry Technology
PP industry technology: production technology (pulping and paper making), process technology, service technology, problems involving existing products, new product development, fundamental technology breakthrough.
Competitor
General information about competitors (current and potential) and new entrants: products, production, market share, stock performance, annual reports, technology innovation, structural changes. For example: Enso, International Paper, KNP, Mead Corporation, Metsa Serla, Potlatch Corporation, UPM Kymmene.
Customer
Printing and writing industry news and policy, markets, printing technology developments, structural changes, general information about current or near-potential customers, their markets, their problems, mergers and acquisitions involving them, customer value and demand.
Substitute
Electronic publishing industry in general and electronic paper in specific: news and policy, product and technology development.
Supplier
Raw materials: purchasing considerations for current and potential products; wood, pulp, chemical prices. Equipment: pulping and paper making machinery, machinery technology development. Energy: electricity industry, electricity price.
International Dimension
By country, region and world: government actions and policies (government decisions affecting the industry), macro economics (GDP, exchange rate, industrial production, consumer index), law, trade regulation and legislations, events of a general nature: political, demographic, national, etc.

roles, and their personal traits (Choo, 1995). They can be examined at three levels: the situational level, cognitive level and affective level. At the situational level, the characteristics of the work or problem situation determine the ways that information is used and assessed as useful or not. At the cognitive level information is needed, sought and used to bridge different kinds of cognitive gaps. At the affective level, emotions and psychological states influence the preferences and methods of information seeking (Choo, 1995).

Managerial activities take place in an environment that is 'informational overloaded, socially constrained, and politically laden' (Choo, 1995). When seeking information, managers do not have the energy, the time or the cognitive need to be comprehensive and systematic and to read long documents. They simplify and limit their information search based on experience and familiarity. They change direction frequently depending on what they find. It is a dynamic process that unfolds over time and interacts actively with the information environment. As new information is obtained and as the manager reflects and acts on the problematic situation, the perception of the situation changes, creating new uncertainties and priorities. The newly perceived problematic situation then leads to revised information behaviour (Choo, 1995). As scanning goes on, the new information and interpretation acquired also tend to change their cognitive frames of reference, which in turn affect what they will perceive in their environment and how they will scan. Old frames can constrain the ways the world is perceived. Paradoxes, anomalies, contradictions and conflicts give rise to new perspectives. Questioning and challenging old mental models are a very important component of scanning, that is, learning (El Sawy, 1984; El Sawy, 1985; El Sawy and Pauchant, 1988).

2.3. Managers' needs for external information

Managers' information needs may range from being impossible to articulate to highly specific. A widely cited description is Aguilar's 16 types of external information, which were grouped into five areas: Market tidings, technical tidings, Broad issues, Acquisition leads and others (Aguilar, 1967). Market tidings are information about current and likely future activities in the market and competitive field. Technical tidings are product and process technical information new and unknown to the company. Broad issues are events happening outside the industrial environment, for example government actions and policies, and general economic situation. Acquisition leads refer to leads for acquisitions, mergers and joint ventures, especially information concerning possibilities for the manager's own company. Based on Aguilar's framework and the discussion without managers about the specific concerns in the PP industry, we summarize their external information needs in Table 1.

Managers often deal with messy problems in fuzzy settings where particulars can make a crucial difference. So very often they prefer concrete information to abstract information. Concrete information about specific individuals, organizations or relationships provides managers with the details and nuances that they need to evaluate the relevance and applicability of the information (Auster and Choo, 1993; Auster and Choo, 1994; Choo, 1995).

2.4. Sources of information

It is generally agreed that executives use a variety of complementary sources in scanning their business environment: human sources and documentary sources, internal and external. Managers interact extensively with individuals outside the formal chain of command and they are well connected with outside information sources. Ways to reach human sources include phone calls, mail, business trips, meetings and visits.

Documentary sources include memoranda, salesman's reports, the R&D department's monthly progress report, media (radio/TV/newspaper), trade shows and exhibitions, trade/general/government publications, publications of industry groups, professional journals and newsletters, business periodicals, industrial or professional conferences, scheduled reports from consultants, legislation and jurisdiction at home and abroad (Aguilar, 1967). Many of these are available on the Web.

Sources are evaluated and chosen by a number of criteria: their accessibility, their ability to offer reliable and relevant information, the richness of the information, and so on. Typically, managers prefer information sources and communication channels that can provide them with a sense of the hidden dimensions of the situation. Familiar, habitual information sources tend to be used first (Choo, 1995).

Information sources do not exist in isolation. The various sources feed on and off one another while often overlapping with each other, forming several intertwining ''information food chains'' (Choo, 1995). A source takes in and processes information before re-transmitting it, sometimes adding value and sometimes introducing distortion. Sources high up in the information chain summarize and interpret data, while sources low down in the chain (close to the event) provide rich details and allow the user to develop his own sense of the situation. Managers tend to use documentary sources for information close to the event and human sources for information that help in interpreting ambiguous situations (Choo, 1995).

In scanning activities, extensive information networks which include both short and long information chains are necessary to ensure a sufficiently broad and thorough sweep of the external environment, so that important signals are not missed but are correctly read (Choo, 1995). This suggests to us the need for a balance between sources at the low end of the chain and sources at its high end.

3. How can intelligent agents help?

Agents have many properties attractive to us. They can: be purpose- or goal-directed; take initiative autonomously; create goals proactively for a specialized purpose; decide own course of actions dynamically while responding to its environment; self-learn and learn from the user, and so on. Such an approach allows users to move away from computing details while focusing on more conceptual constructs. It reduces complexity and increases efficiency. Agents can be used to perform actions that we cannot or prefer not to do ourselves. The delegation of functions supports user mobility. As such, intelligent software agents are claimed and are expected to be able to reduce information overload and work overload for us humans (Etzioni and Weld, 1995; Etzioni and Weld, 1996; Maes, 1994). Users working with an agent have three responsibilities: specifying goals, controlling the agent and training the agent explicitly or implicitly.

Information access and management is an area of great activity for software agents. Software information agents specialize in facilitating information access and assimilation by automated information gathering, filtering, searching and interpreting. Agents can be used to locate information sources, to combine intelligently disparate streams of information from multiple distributed resources to respond to a specific request from users with relevant, synthesized results. They are also very useful for answering queries that require logical or heuristic deductions or induction, or require numerical computation using algorithmic models, to discover hidden patterns and relationships from large data sets (data mining), to uncover findings that could be missed by human experts.

An agent can remain active all the time to visit periodically the information sources, monitor information, look for trends, identify new information, fuse the information with other relevant data, extract implied information and distribute results to its user. It increases the user's current awareness of new leads and ensures that information for the user is updated automatically as often as necessary. This is becoming an invaluable service as such tasks would be very difficult or simply impossible for a human alone.

The very first idea of agent approach suggests task and responsibility delegation. However, when scanning and interpretation activities are delegated to an agent, there is also a risk that the peculiar perspectives of executives on certain events or changes may get lost. So when we expect software agents to take over certain responsibilities from the managers, we also expect them to be able to incorporate the managers' perspectives in fulfilling these responsibilities. Theoretically, an agent can resolve this problem by learning gradually how to better assist the user by observing and imitating the user, understanding the user's interests and needs and keeping track of the evolution of his interests and preferences in accomplishing these tasks, inducing and maintaining a dynamic user profile. It can receive positive and negative feedback from its user by asking explicit instructions from the user or asking other agents for advice. In this way, an agent takes into account the situational and cognitive information needs of users.

Successful ESSs have relied very much on a friendly interaction environment and the interaction between the user and the system. Usually it is the user who initiates system actions. Interaction with and an understanding of

the system process are believed to be very important success factors in these applications. However, with tasks like scanning for information, we believe that the process can be more automated. It differs from traditional black-box type applications in that it learns from the user during its running process and it gives the user an explanation for its processing when so requested.

4. MasterScan: a business environment scanner

MasterScan is designed as an agent-based system intended to enable continuous searching, watching and sense-making of the business environment on behalf of managers. In this section we describe the prototype system that is currently under development. The scanner agent uses business information available on the Web and mainly does three things for its user: (1) it periodically visits selected Web sites and reads their page content or watches these sites for changes; (2) according to the users' specific interest, it filters the accessed information to a limited amount that reflects market tidings, technical tidings, acquisition leads or broad issues concerning a specific business segment; (3) it compares, relates and integrates information from different sources, watches out for significant events that call for special attention and sends e-mail messages to its user to inform and alert him or her about the changes.

4.1. The system developing environment and agent architecture

The system is implemented using the ABE Agent Builder (Agent Building Environment Developer's Toolkit) from the IBM Intelligent Agent Research Center. The tool is downloadable from the Web free of charge. The basic principles underlying it are quite intuitive—that an agent is understood as having a brain, sensors and effectors. It thus provides different frameworks or components for developing different parts of the agent: *engines* (reasoning mechanism) and *libraries* for the brain; *adapters* for sensors and effectors; *views* as an interface for maintaining the rules and giving instructions to the agent; *agent control* for initialization and overall control of the running agent (IBM Home Page). Applications can be developed by adding context-specific adapters, engines and libraries. In our case the task of agent development actually becomes a task of writing our own application-specific adapters and analyser engines, of building the agent control program, and of building up the library. The adapters are written in Java using Symantac Visual Cafe Pro. The domain analyser engines can use fuzzy reasoning procedures and the libraries use KIF format (Knowledge Interchange Format) for storage. The agent architecture is shown in Fig. 1.

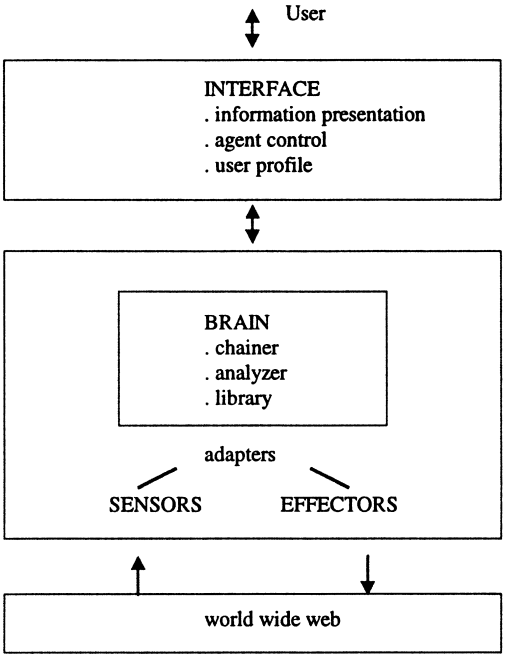

Fig. 1. MasterScan agent structure.

4.2. Agent control and user profile

Agent control offers a user the power to manipulate the agent. By agent control, the system can be configured dynamically by selecting and connecting alternative adapters, engines and libraries. Agent control is also responsible for the starting, stopping and monitoring of agent activities. User profile offers a user the capability to customize the agent to his own changing preference. It defines, for example, favourite URLs, user's most concerned market segments, news interests, key words, key concepts to use, and so on. The decision as to which indicator to monitor and which URL to search is based on values specified in rule atoms and can be updated by the user through modifying his profile.

4.3. Adapter definitions

Adapters are intended to connect real-world applications to the agent. Each adapter deals with a particular application domain (e.g. file management, Internet and Web applications, database applications), device type or protocol and performs three functions; *event notification*, *condition sensing* and *action effecting*. An adapter watches for significant events in its domain and notifies the engines when they occur. Should the engines, in the course of their inferencing, need more information from any adapter, they can request it through sensor-calls. Sensors are responsible for answering engine queries. When an engine needs to take action in the application world, it will request it through effector-call. Adapters and engines relate to each other through events and attached procedures. Adapters only relate to each other through the engine's chaining.

Table 2
Adapters for field intelligence agents

Adapter domain	Adapter definition		
	Trigger events	Sensors	Effectors
ProductAdapter	ProductPriceEvent	ProductPrice()	UpdateProductPrice()
	NewProductEvent	NewProduct()	UpdateNewProduct()
	NewProductIdeaEvent	NewProductIdea()	UpdateNewProductIdea()
TechnologyAdapter	NewTechnologyEvent	NewTechnology()	UpdateNewTechnology()
	TechnologyNewsEvent	TechnologyNews()	UpdateTechnologyNews()
IndustryAdapter	IndustryActionEvent	IndustryAction()	UpdateIndustryAction()
	IndustryPolicyEvent	IndustryPolicy()	UpdateIndustryPolicy()
	IndustryMergerEvent	IndustryMerger()	UpdateIndustryMerger()
	LegislationNewsEvent	LegislationNews()	UpdateLegislationNews()
CompetitorAdapter	CompetitorProductPriceEvent	CompetitorProductPrice()	UpdateCompetitorPrductPrice()
	CompetitorNewProductEvent	CompetitorNewProduct()	UpdateCompetitorNewProduct()
	CompetitorMarketShareEvent	CompetitorMarketShare()	UpdateCompetitorMarketShare()
	NewEntrantEvent	NewEntrant()	UpdateNewEntrant()
CustomerAdapter	CustomerNeedsEvent	CustomerNeeds()	UpdateCustomerNeeds()
	CustomerDemandEvent	CustomerDemand()	UpdateCustomerDemand()
	CustomerProblemEvent	CustomerProblem()	UpdateCustomerProblem()
SupplierAdapter	SupplyPriceEvent	SupplyPrice()	SupplyPrice()
	SupplyQualityEvent	SupplyQuality()	SupplyQuality()
	SupplyAvailabilityEvent	SupplyAvailability()	SupplyAvailability()
	SupplierProblemEvent	SupplierProblem()	SupplierProblem()
NewsAdapter	USNewsEvent	USNews()	UpdateIndustryNews()
	CanadaNewsEvent	GermanyNews()	UpdateCustomerIndustryNews()
	GermanyNewsEvent	UKNews()	UpdateSupplietIndustryNews()
	UKNewsEvent	CanadaNews()	UpdateSubstituteIndustryNews()
	FinlandNewsEvent	FinlandNews()	UpdateCustomerNews()
		IndustryNews()	UpdateSupplierNews()
		CustomerIndustryNews()	UpdateCompetitorNews()
		SupplietIndustryNews()	UpdateUSNews()
		SubstituteIndustryNews()	UpdateGermanyNews()
		CustomerNews()	UpdateUKNews()
		SupplierNews()	UpdateCanadaNews()
		CompetitorNews()	UpdateFinlandNews()
MarketAdapter	StockNewsEvent	StockNews()	UpdateStockNews()
	StockPriceEvent	StockPrice()	UpdateStockPrice()
EconomyAdapter	GDPEvent	GDP()	UpdateGDP()
	IndustryProdictionsEvent	IndustryProdiction()	UpdateIndustryProdiction()
	CustomerPriceEvent	ConsumerPrice()	UpdateConsumerPrice()

In terms of their information domains we have ProductAdapter, CompetitorAdapter, CustomerAdapter, SupplierAdapter, IndustryAdapter, TechnologyAdapter, MarketAdapter, NewsAdapter, and EconomyAdapter. In Table 2, definitions of these adapters are given. An adapter definition describes its domain, the trigger events it generates (as drivers of engine inferencing) as well as the sensors (i.e. what queries it answers) and effectors (i.e. what actions it performs) it has.

As an example, the NewsAdapter is intended to link the agent with industry news on the Web. It enables the agent to first get access to the news sites and read the news, then filters the accessed information and adds these contents to the news link of its user's agent page. In performing these functions, the NewsAdapter generates *NewNewsEvent* distinguished by countries: *USNews-Event, GermanyNews-Event, UKNewsEvent, Canada-NewsEvent, FinlandNews-Event*. These events will cause certain rules in the conduct set of the chainer to be activated and the chaining started. The chaining operation will result in effector-calls to the NewsAdapter, which updates the agent page news content. When the agent wants to examine the NewNews to see if there is news concerning the customer industry or supplier industry, the engine will activate boolean sensor calls CustomerNews(), SupplierNews(). If the value is true, then effector-call UpdateCustomernews() and UpdateSupplierNews() will be performed to add new substance to Customer News and Supplier News on the agent page.

4.4. Engines and the library

The engine that comes with the current version of ABE is a chainer engine (a forward-chaining rule interpreter), which simply observes triggering events from adapters, calls adapter sensors to invoke a query and calls adapter effectors to invoke an action in the adapter's specific domain. For our purpose more engine capability is required

and some analyser engines are needed. Given a set of facts sensed by adapters, an analyser engine further processes on these facts, relating and interpreting them, answering queries from the chainer. Quite like an adapter, each analyser provides sensing functions for the chainer and can register one or more analytical procedures. However, it is not an adapter because it does not truly interact with an external application world. On the other hand, it also functions as an engine in the sense that it is driven by adapter events and it calls adapter sensors and effectors.

A library manages the persistent storage and retrieval of objects that are needed for engine inferencing and are grouped as conduct sets. A conduct set is a set of rules and long-term facts used for inferencing on behalf of a particular client (anyone, anything or any group) and is stored in a collector. The library also contains metadata about conduct sets: predicates, sensors and effectors that are used in the rule set and the long-term fact set. The grouping information as well as metadata about such grouping information, for example, user lits, can also be stored in the library. Where a client or a collector represents a particular user, collector metadata can be used to hold profile information for that user. Rules link events, conditions and actions together. They are formalized using KIF syntax:

(⇒ (antecedent expression) (consequent expression)),

where expressions are built from logical atoms and an atom consists of a named predicate followed by a list of terms: (predicate term_list). Rules in the form of:

when *trigger-events*

if *conditions*
then *actions*

are formalized as:

(⇒ (AND (trigger events) (sensor conditions))

(effector actions)).

Trigger events are specified in the form of: (EventName *EventDomain:EventName*); sensor conditions and effector actions are specified as atoms.

In our system, a CollectorUser for a specific user will consist of a group of conduct sets such as ConductSet_News, ConductSet_Industry, ConductSet_Technology, ConductSet_Product, ConductSet_Customer, ConductSet_Competitor, ConductSet_Supplier, etc. These different conduct sets are used by the agent in inferencing about the different domains.

For example, the following is a rule in the conduct set of the NewsAgent:

(⇒ (AND (EventName ‘‘NewsAdapter : USNewsEvent″)

(USNews?USNews))(UpdateUSNews?USnews))

This rule is triggered when the NewsAdapter notifies a USNewsEvent. The engine calls sensor USNews() to get the news content and then calls the effector UpdateUSNews() to add the news ubstance to the agent page. The detailed structure of such a NewsAgent is shown in Fig. 2. A full functional analyser engine will include a knowledge-based intelligent filter and classifier as well as an intelligent interpreter capable of learning.

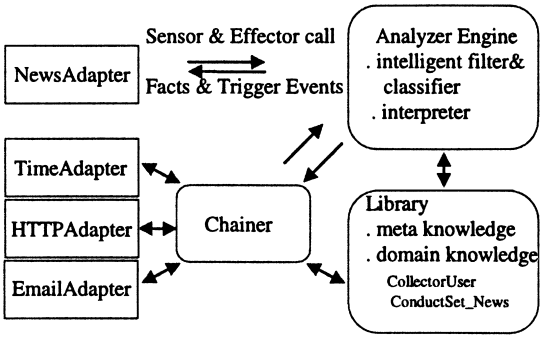

Fig. 2. NewsAgent.

5. Scanning the pulp and paper environment with agents

In the following sections we first give a description of the pulp and paper background and pulp and paper information resources on the Web. Then we show how to scan the PPI environment with the agent.

5.1. The pulp and paper industry (PPI) and its environment

The pulp and paper industry is a supplier of various pulp, paper and board products, both for industrial and consumer use. If we choose to focus on specifically two kinds of products, pulp and fine paper (woodfree), then the major competitive environment and general business environment would consist of the following elements Table 3.

5.2. Pulp and paper information sources on the Web

From Section 2.4 we can have an idea of what kinds of sources managers often use for acquiring external information. We found that almost all kinds of external information sources (refer to Section 2.4 and Table 3) have at least a presence on the Web where the contact information is available. Some information is directly available and ready to search, while naturally many high-end sources such as a broker’s information service and an industry analyst’s reports cannot be accessed without a fee. After a quick examination of those sites, we choose some sources that we think are more information-rich and are freely available. They include the following *pulp and paper specific* sources as well as *general* business sources:

- The Pulp and Paper Jumplist (http://www.pulpandpaper.net)

Table 3
Pulp and paper business environment

Inside PPI
Competitors: producers of pulp and fine paper
Products: pulp (BSW, BHW, mechanical pulp), fine paper
Process technology: pulping technology, paper-making technology, product improvement
New entrants: pulp and paper producers around the world
Industry and Trade Associations:
Consultants: technology, marketing
Supplies
Raw Material: pulpwood (pine, spruce, birch, aspen, poplar, eucalyptus, similar fibers), chemical additives (filler and coating minerals)
Equipment: pulping machine, paper machine
Energy: electricity
Suppliers: forest industry, wood dealer, chemical industry
Customers and markets
Pulp: paper industry
Paper: publishing industry, printing industry, consumer
Geography: Europe, North America, Asia, country-specific economic conditions and laws
Substitutes
Non-paper publishing media: electronic publishing media
Broad environment
Government regulations: Ministry of Trade and Industry, Department of Commerce
Fundamental technology developments:
Ecological environment:

- IRIS Forest Products Industry Director (http://www.cdc.net/~primus/IRIS/irisfp.html)
- Walden's Paper Report and Fiber-Board Report (http://www2.walden-nott.com)
- Forest Inventory and Analysis Database Retrieval System (http://www/srsfia.usfs.msstate.edu)
- Forest Finland (http://www.metla.fi/forestfin)
- Foex (http://www.foex.fi)
- Pulpes (http://www.pulpex.com)
- Steve Shook's Internet Original Directory of Forest Products, Wood Science and Marketing (http://weber.u.washington.edu/~esw)
- Dr Ed Yardeni's Economics Network (http://www.webcom.com/~yardeni/sitemap.html)
- The Economist Intelligence Unit (EIU) (http://www.sys1.tpusa.com/infosrc/eiu)
- Latest news from the Ministry of Trade and Industry in Finland (http://www.vn.fi/vn/ktm/english/euindpol.htm)
- Stock Market Information (http://quote.yahoo.com)
- SEC EDGAR archives (http://www.sec.org)

Through these sources we should be able to reach pulp and paper press releases, prices, industry statistics and trade news, association publications, company information, country analyses, economic analyses, market analyses (security analyst reports), some industry study reports, product and raw material as well as energy prices. Through company home pages we can reach their product information and their annual reports.

5.3. Using the agent

As a Web-based application, the system uses a Web browser as its running environment. The scanning results are presented as the Web content of a user's agent page, which serves as the system's user interface. An agent page contains displaying panels as well as hyperlinks leading to multiple viewes of the business environment at various levels. When a user opens his agent page, the main menu is always easily accessible to him. The agent runs day and night on a periodical basis. Every one of its scanning efforts can add new contents to the page. In this way, each time the user visits his agent page he can get access to environmental information as up-to-date as possible. Dated information will be stored for later use.

Here, we give examples of using the agent to get access to pulp and paper industry news as well as pulp price information through the sources we have chosen. Suppose that the user is interested in pulp and paper industry news. In this example we used the *Pulp and Paper Jumplist* news as the source and we assumed that the user is interested in the most up-to-date news concerning pulp and paper in Finland, the UK and Canada, together with news about pulp prices.

The agent's scanning activity is triggered by content changes at the sites. Whenever a change is detected, the agent will read the page, screen out the unwanted news and only update the agent page with news concerning Finland, the UK and Canada as well as news concerning pulp prices. When the user chooses the PPNews button, the newly acquired (unread since last time) news headlines will be displayed as is shown in Fig. 3.

Suppose that at this point the user would also like to know more about the most recent country forecast analysis for the UK, he can then go directly to the country report via the hyperlink UK. When he clicks on it, the country report will be displayed in the right panel (Fig. 4). This information is acquired by the agent through searching *Dr Ed's Economic Network*. With such a function, the user is able to jump to any news about identified key elements such as a specific customer, competitor, or customer industry and competitor industry in general.

Now we assume that the user might have identified a news item concerning pulp price and would like to know some details about the price data. When he clicks on the hyperlink pulp price, the pulp price information obtained from *Foex* will be displayed in the right panel (Fig. 5). In this way, news leads are expected to serve as background information for the price index and to facilitate the interpretation of price changes.

6. Discussion and conclusions

Continuous monitoring of the business environment by agents can help managers in maximizing limited resources (time and effort) and enhances productivity. An agent

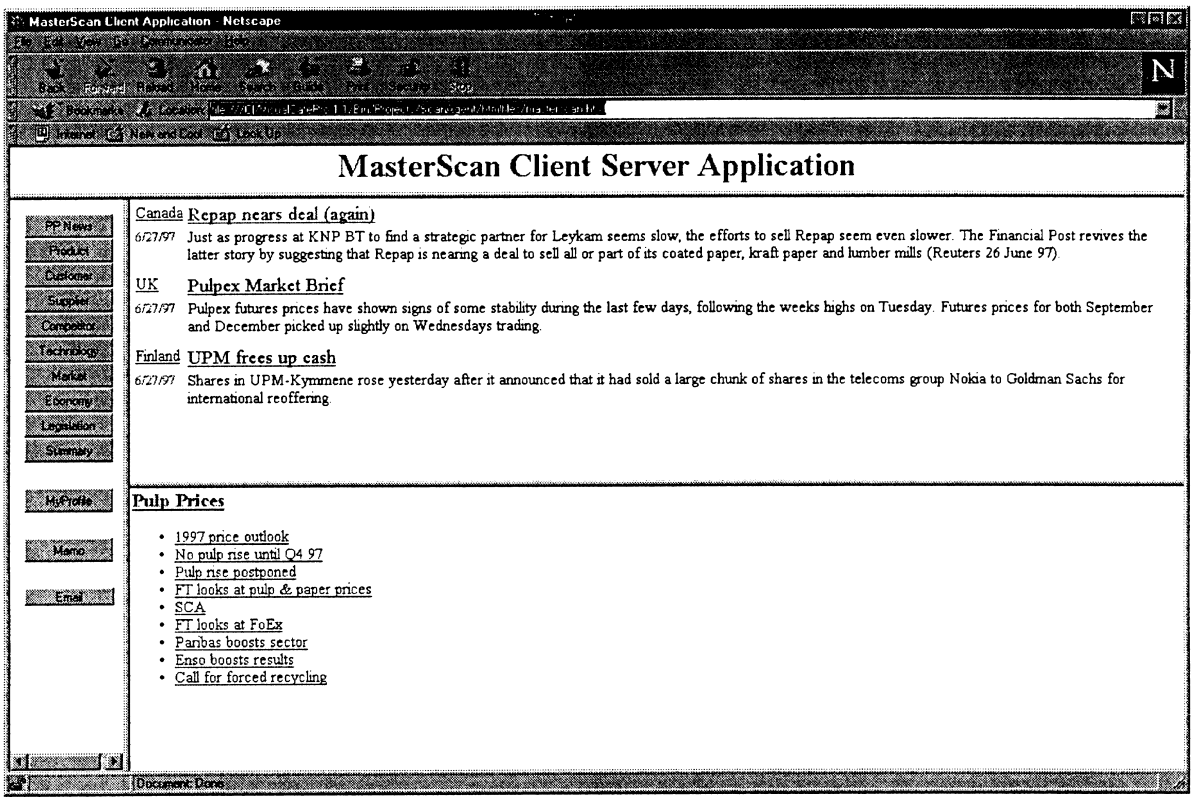

Fig. 3. Pulp and paper industry news.

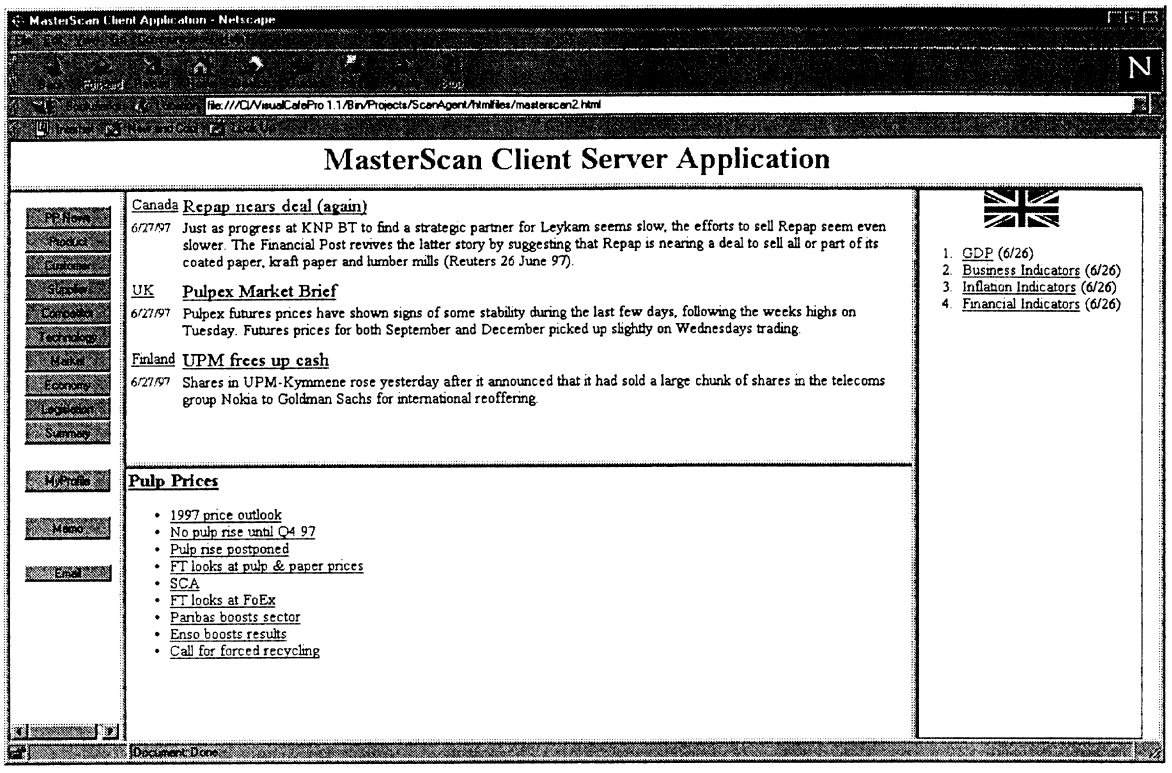

Fig. 4. With country report.

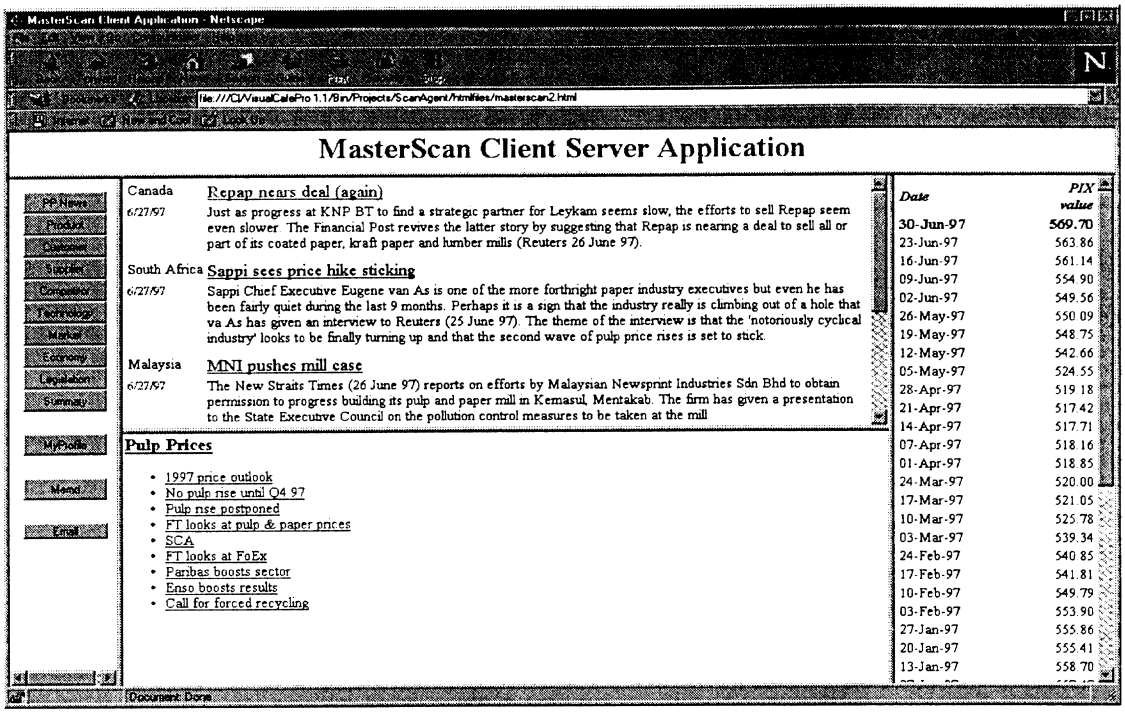

Fig. 5. Pulp price.

system that relentlessly scans the environment and intelligently incorporates varying sources of information can flexibly deal with changing information needs and actively provide its user with the most up-to-date information that strategic decisions can be based on. When scanning is delegated to software agents, managerial perspectives can be incorporated into the process. So managers do not lose their peculiar views as a result of using software agents, as they may with human agents. An agent's scanning activities can be guided, trained and controlled according to the user's preference perhaps easier than that of human agents. When its goal is clear the agent system takes initiatives, interacts with data, applications and services on the Web to accomplish its task. It does not need explicit instructions step by step by the user and it does not complain. The agent system is meant for its end-user's personalized use and are easily customized. It is an adaptive approach for support and it plays an active role in support. Internally the scanning agent is a knowledge-based construct though it works in a different mode from traditional KBS.

Closely related work in this area includes the research of Elofson and Konsynski (1991) and Elofson et al., 1997). While we have focused on managerial scanning activity and the information needs of top managers in strategy formulation, they have mainly addressed the expertise-distribution and knowledge-sharing issues in the process of collective, organizational environmental scanning activity. While in their studies it was assumed that intelligence was provided by some ''intelligent analysts'', in ours it is the roles our agent needs to play. In seeking of intelligent executive support, (Chi and Turban, 1995) proposed a distributed multi-agent system framework (DIEIS) that aims to help managers in complex information processing, including business environmental scanning and interpretation (Wang and Turban, 1993). Their research focused on support of collaboration and addressed issues of communication and coordination between agents.

This research aims to build up an effective tool for environmental scanning and active executive support. The system can also be used to investigate the potential usefulness of Web resources for top management. In addition, continuous running of the system may actually produce a valuable database or a warehouse of external data for a company. Future research will include: plug-in of commercial data sources and companies' internal data sources; expand agent functions to more complete data warehousing tasks; develop a multi-agent system to accomplish interrelated complex tasks; integrate the scanning system with the data warehouse as well as higher level strategic interpretation and strategy formulation support applications; and test the effectiveness of the agent approach in providing active executive support.

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