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Evaluation of Inventory Cost in Supply Chain using Case Based Reasoning

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Abstract

Supply Chain Management is a set of synchronized decision & activities, utilized to effectively integrate suppliers, manufacturers, transporters, warehouses, retailers & customers so that the right product or service is distributed at the right quantities, to the proper locations& at the appropriate time, in order to minimize system wide costs while satisfying customer service level requirements. Under the mode of supply chain Inventory is the biggest obstacle. The Inventory not only influences the cost of single enterprise but also resist the cost of whole supple chain. The SCM is required to improve the performance. In this paper, the case-based reasoning approach to support the sourcing decisions

Keywords: Supply chain, sourcing, sourcing decisions, case-based reasoning, Supply chain management system, inventory cost, simulation based optimization.

1. INTRODUCTION

IN today's competitive business environment industry is recognizing the importance of efficient and effective supply chain management. Supply Chain can be viewed as a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. These autonomous or semiautonomous business entities that perform all processes associated with the flow and transformation of goods and services from the raw material stage to the end user. The objective of supply chain management is to produce and distribute merchandise at the right quantities, to the right locations, at the right time, in order to minimize system wide costs while satisfying service level requirements. These Supply Chain has significant effect on the organizations cash flow and cost and ultimately its competitiveness and profitability. To realize the objective, the successful supply chain management requires effective support of advanced information technology and information system. Many information systems have been developed for the SCM from enterprise resource planning into the newly developed advanced planning and scheduling system and e-commerce solutions. However, the capability of current information systems to support collaborative planning and control in the supply chain system wide level is limited due to the complexity and dynamics of the supply chain in today's globalized business environment. Recently, agent based system technology have been applied as a new paradigm for conceptualizing, designing and implementing the software system, which offers the potential to overcome many limitations of current information systems for the SCM.

Figure 1: Supply chain process

There are several challenges in effective supply chain decision making. The first challenge is that the information across all the departments and enterprises is distributed, dynamic, and disparate in nature. Secondly, in a present-day enterprise, decision centers reside in different departments. For instance, consider the refinery supply chain shown in Fig. 1.

These decisions are usually based on the department's own constraints, and the upper management handles the conflicts. Most often, the decisions are taken independent of the interdependency of various factors contributing to the overall business process of the enterprise. The decisions are optimized locally within the departments but do not assure a global optimum for the enterprise. Of course, decision support tools exist for local decision-making, e.g. planning and scheduling systems, inventory management systems, market trading optimization systems, etc. A mere electronic integration of these tools would not solve the problem and there is a need for a unified approach for modeling and analysis of supply chains, which explicitly captures the interactions among enterprises and within the departments of an enterprise.

On the other hand, in order to optimize performance of a supply chain in inventory cost considers the retailer that maintains the inventory of particular product. Since customer demand changes over time to time the retailer can only use the historical data to predict the demand. Retailer's objective is to define at what point to reorder the batch of products and how much to order in order to minimize the inventory ordering and holding cost.

Inventory management start and end with supply chain management because many of the opportunities to improve efficiencies start with shorting order to receipt time without curing additional cost. Inventory control elements are the integral part of any supply chain. They control the flow of material within the supply chain.

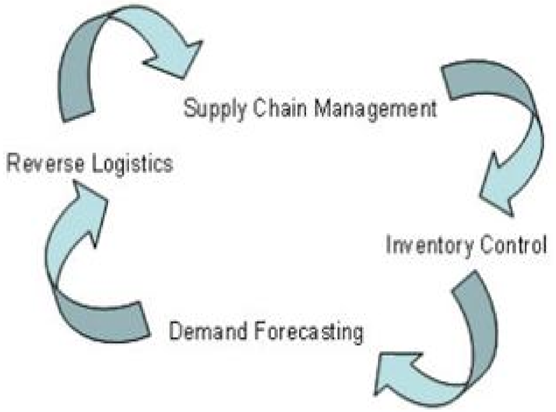

Fig 2. Inventory cost

2 Related Works

Sourcing decisions in a supply chain are made based on only minimizing cost. Rarely, consequences of sourcing decisions in inventory levels, lead-times, and customer service levels are considered. Sourcing decisions have a large impact on manufacturing, inventory disposal, and distribution in a supply chain. Therefore, sourcing decisions directly affect the efficiency of the whole supply chain. For this reason, sound decision making procedures and strategies for sourcing can be the key to the survival and success in marketplace.

S. Yung et al. stated that research in coordination of supply chains can be categorized into the following four areas:

1. Modeling of Supply Chains – the processes and functionality of supply chains must be organized and coordinated efficiently to achieve better performance. Recently, constraint network model have been studied and applied.
2. Modeling of Information Flows – which provides the communication among facilities within the supply chains, where real-time data are critical in supporting decision making. It enables quick response and accurate data transmission. Electronic data interchange (EDI) is one of the most popular applications. However, EDI is a closed environment for facilities within the supply chain. Internet provides a channel to support communication for both the facilities within and outside the supply chains.
3. Human Computer Interface (HCI) – the amount of information generated from a supply chain is overwhelming. It is important to have a good interface for users to input and retrieve data or information. Recently, many research have focused on software agents to model the behavior of the users and use the captured behavior to support design of better graphical user interface (GUI).
4. Optimization Method – optimization is an important research area to search for better resources allocation in supply chain management. Some mathematical models have been applied to increase the performance of supply chains. But such research can be computational intensive if the number of facilities is large.

Cheung and Powell (1996) formulate a multi-stage dynamic distribution problem with stochastic demand. Stocking levels at warehouses have to be determined before observing demand at customers.

After demand is realized, the flow of goods from warehouses to customers is optimized. They apply the technique of network recourse decomposition (Powell and Cheung 1994) to approximate the recourse functions and solve the multi-stage problem efficiently. From computational experiments, they make the important observation that overlapping service region (i.e., one customer served by multiple warehouses)

V. Misra et al. survey the Supply Chain Management Systems and states that, six characteristics define current supply chain management philosophy: 1) Shared Information, 2) Organizational Relationships, 3) Inventory Management, 4) Total Pipeline Coordination, 5) Readiness to adopt Flexibility and 6) Costing Issues. They regarded Agent-Based SCM is the vision and states that: Agents can help transform closed trading partner networks into open markets and extend such applications as production, distribution, and inventory management functions across entire supply chains spanning diverse organizations.

Extending the Shen, Coullard and Daskin (2003) study, there have been a number of recent papers on integrated supply chain design. Shen (2006) and Mak and Shen (2010a) provide detailed reviews of these works. In particular, Ozsen et al. (2008, 2009) consider the e_ect of storage capacity at facilities under single and multiple sourcing. Unlike the traditional approach in which capacity is defened as the maximum demand that can be assigned to a facility (e.g., Geoferion and McBride 1978), the authors impose an upper bound on the amount of space that can be occupied by inventory at a facility. Chen, Li and Ouyang (2011) consider the possibility of probabilistic facility disruptions, in case of which orders can be re-routed to available facilities, and the resulting impact on the optimal configuration of facilities.

3. CASE-BASED REASONING

Case-based Reasoning is one of emerging field of Artificial intelligence research area. It is mostly used in problem solving in the artificial intelligence applications. Case-based reasoning may be defined the approach which utilize the experience gained from solving past problems. This approach maintains all information of past problem solving experience that is called the case. The collection of all these past experiences is stored in form of case base. There are various factors which define the efficiency of this approach. The major factor is the numbers of past experiences stored in case base. The new problem should be identified in term of the experience of past problems faced. The new upcoming problem is considered as new case. The strategies of finding the similar case for the new case regarding the past case stored in case base is another major factor of defining the efficiency of the case-based reasoning approach. The evaluation of selected case & indexing of suggested case for future use are another factor of defining the performance of case-based reasoning system.

The case-based reasoning finds out the solution of new problem in 4 REs phases. In first phase, regarding the new coming problem which is considered as new case, particular case is selected from the cases stored in the case base of the case-based reasoning system.

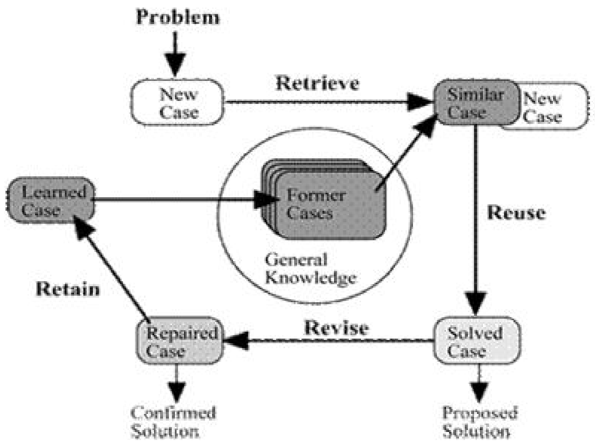

Figure 3: Case-based reasoning

4. TAKING SOURCING DECISIONS IN SUPPLY CHAIN

There are four major decision areas in supply chain management: 1) location, 2) production, 3) inventory, and 4) transportation (distribution), and there are both strategic and operational elements in each of these decision areas.

4.1 Location Decisions:

The geographic placement of production facilities, stocking points, and sourcing points is the natural first step in creating a supply chain. The location of facilities involves a commitment of resources to a long-term plan.

4.2 Production Decisions:

The strategic decisions include what products to produce, and which plants to produce them in, allocation of suppliers to plants, plants to DC's, and DC's to customer markets. As before, these decisions have a big impact on the revenues, costs and customer service levels of the firm. These decisions assume the existence of the facilities, but determine the exact path(s) through which a product flows to and from these facilities.

4.3 Inventory Decisions:

These refer to means by which inventories are managed. Inventories exist at every stage of the supply chain as either raw material, semi-finished or finished goods. They can also be in-process between locations. Their primary purpose to buffer against any uncertainty that might exist in the supply chain.

4.4 Transportation Decisions:

The mode choice aspects of these decisions are the more strategic ones. These are closely linked to the inventory decisions, since the best choice of mode is often found by trading off the cost of using the particular mode of transport with the indirect cost of inventory associated with that mode.

These decisions play very critical role in the supply chain system. They configure the business processes required to purchase goods and services in a supply chain. It helps in supplier selection, single vs. multiple suppliers, contract negotiation.

Sourcing decisions are crucial because they affect the level of efficiency and responsiveness in a supply chain, In-house vs. outsource decisions- improving efficiency and responsiveness.

There are various components of Sourcing Decisions as given below:

- In-house versus outsource decisions.
- Supplier evaluation and selection.
- Procurement process.
- Overall trade-off: Increase the supply chain profits.

There are a lot of benefits of effective sourcing. It generate better economies of scale can be achieved if orders are aggregated. It provide more efficient procurement transactions can significantly reduce the overall cost of purchasing. The effective sourcing design collaboration can result in products that are easier to manufacture and distribute, resulting in lower overall costs. It produce the good procurement processes can facilitate coordination with suppliers. It's appropriate supplier contracts can allow for the sharing of risk. Firms can achieve a lower purchase price by increasing competition through the use of auctions.

5. Implementation:

The tool is designed in modular approach. Every module handles the specific case-based reasoning phases. There are following modules as given below:

- Query Dialog
- Similarity Dialog
- Result Dialog
- AutoAdaptationDialog
- Revise Dialog
- Retain Dialog

We design the analyzer tool that can be applied in supply chain management system. Hence the motivation of designing tool is to analyses the performance of supply chain management system.

Designing

COLIBRI provides the visual builder tools required to generate CBR systems without dealing directly with the source code. It is built on top of the jCOLIBRI framework and enables the composition of its CBR components. The COLIBRI Development Process consists of:

- Expert users design new templates that define the behavior of a CBR system by means of tasks.

- Users are able to find and retrieve the most suitable template according to the prerequisites of the CBR application they wish to build.

- Users configure the retrieved template by selecting the components that provide the behaviour required by each task in the template.

- Once the configuration is completed our graphical environment generates the source code of the application.

- Complementary tools let users compile, execute and evaluate the generated application.
- The components required to instantiate the templates are generated by developers.

Case Design:

The Case Designer tool is used to define the structure of the cases. In jCOLIBRI cases contain a Description, Solution, Result and Justification components. Each component or compound attribute corresponds to a Java Bean that contains the defined simple attributes with their corresponding getter and setter methods.

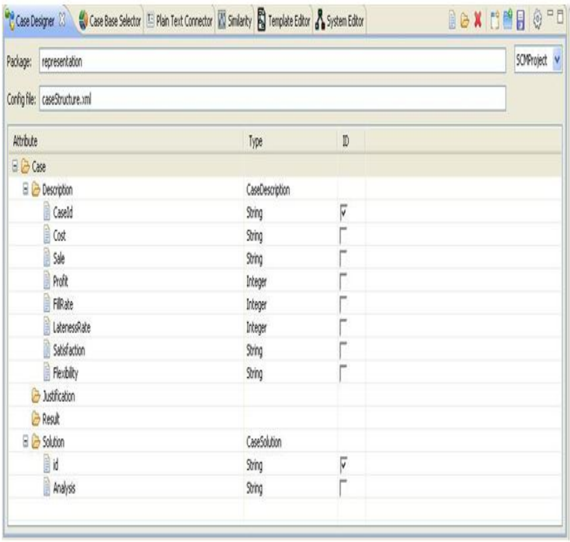

Fig 4 shows the Case Design.

Case Base Selector:

The case base organization is selected; the tool can generate the source code that configures it

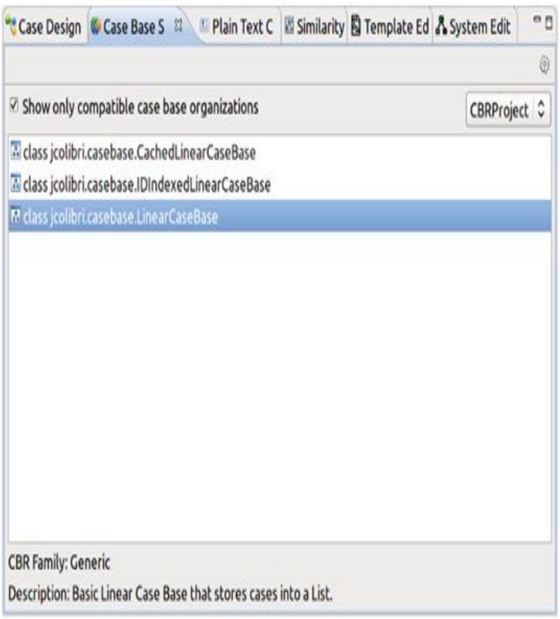

Fig 5 shows the Case Base Selector

Plain Text Connector:

It configures the Plain Text Connector by selecting a text file containing the cases. Each line defines a case and attributes are separated by specific character. The tool allows selecting the file, defining the separator and mapping every column with an attribute of the case.

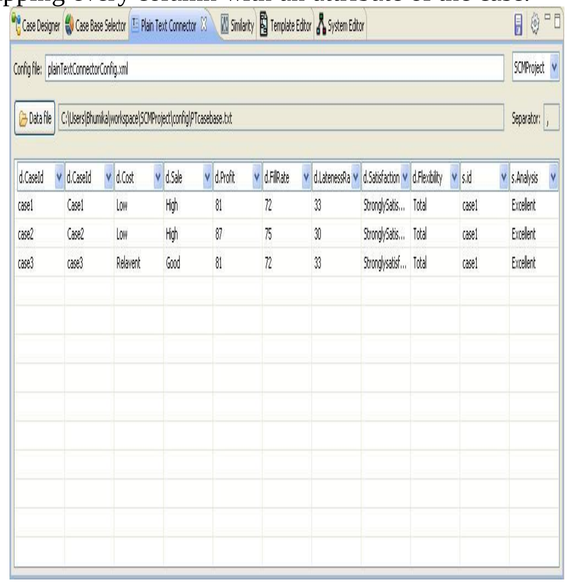

Fig 6 shows the Plain Text

Similarity

It defines the similarity configuration of the CBR system. Note that some applications won't use this feature if they do not execute the Nearest-Neighbor algorithm. Compound attributes are configured with a global similarity function, whereas simple attributes use local similarity functions. These functions are automatically obtained from the jCOLIBRI library.

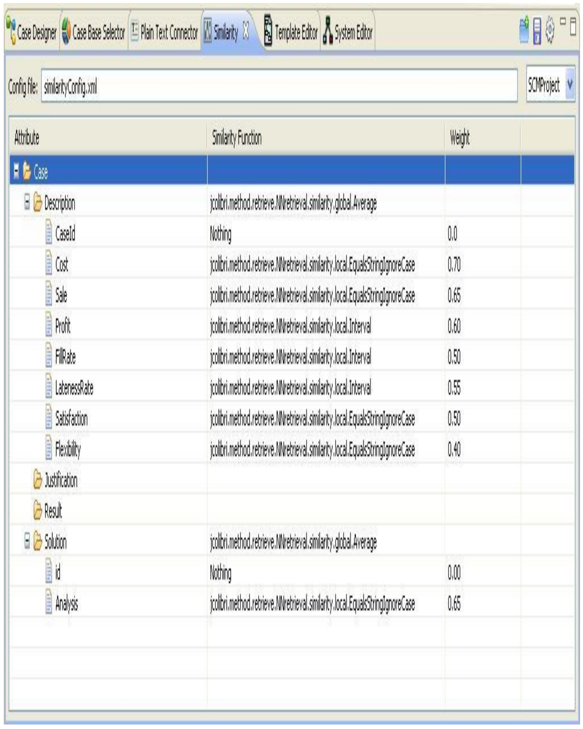

Fig 7 shows the similarity

The running window will first show the

Fig 8 shows the running window.

First user fills the attribute the supply chain system to evaluate the performance. Every attribute has their distinct attribute & their levels.

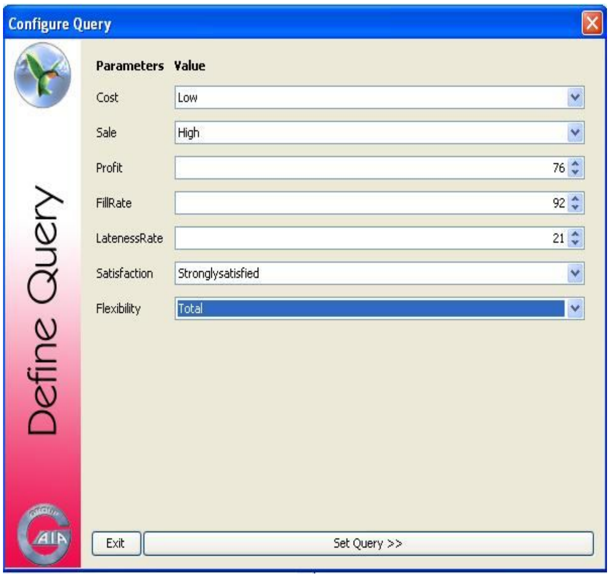

Fig 9 shows the Query Dialog

Next to set the similarity function & weight value assigned to the attributes. We also pass the value of K for K-NN algorithm

Depending on the values specified the next window show the retrieved cases. The upper tab show the similarity found. This window shows number of cases depending on k value.

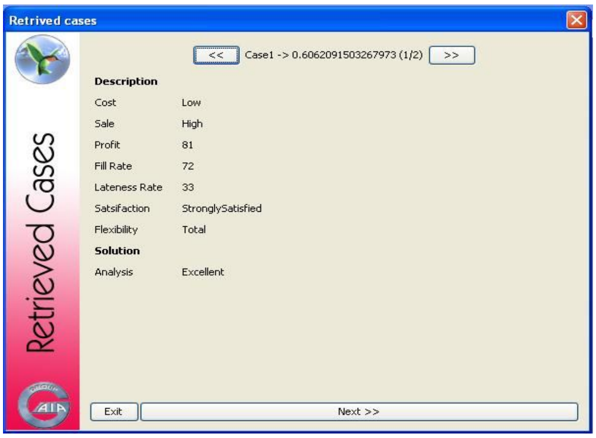

Fig 10 shows the Retrieved Case

Next window uses the inbuilt functions that use the

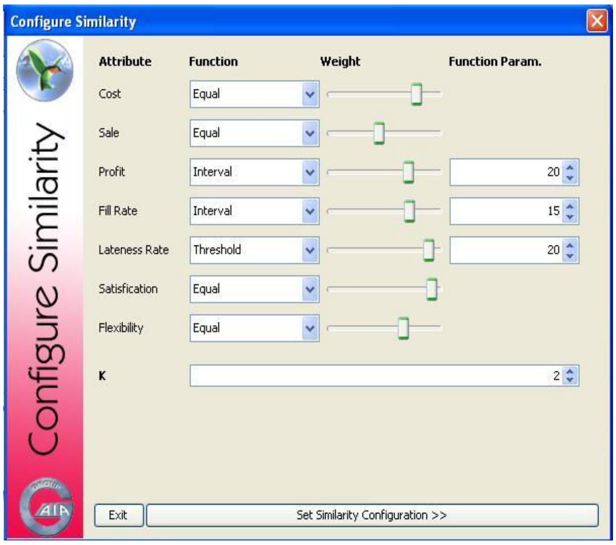

Fig 11 shows the Configure Similarity Dialog

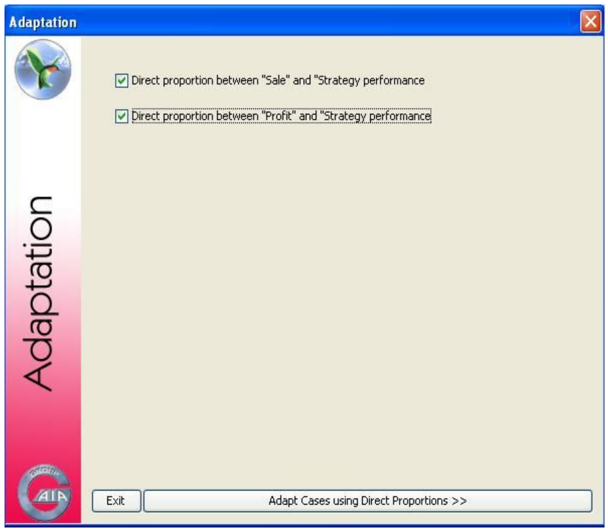

Fig 12 shows the Adaption Dialog.

Next step is to revise the cases. This step revise the values entered & do not allow the propagate the errors in the next step.

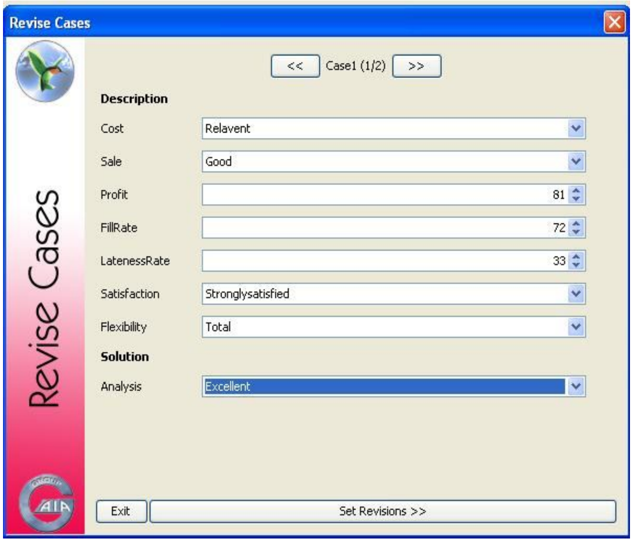

Fig 13 shows the Revised Case Dialog.

Finally after the revision of the solution the final solutions are stored with unique case id as given below.

Fig 14 shows the Retain Dialog.

For repeating the whole cycle there is the options in the dialog.

6. Conclusion

We can say that case-based reasoning (CBR) puts forward a paradigmatic way to attack AI issues, namely problem solving, learning, usage of general and specific knowledge, combining different reasoning methods, etc. In particular we have seen that CBR emphasizes problem solving and learning as two sides of the same coin: problem solving uses the results of past learning episodes while problem solving provides the backbone of the experience from which learning advances. The current state of the art in Europe regarding CBR is characterized by a strong influence of the USA ideas and CBR systems, although Europe is catching up and provides a somewhat different approach to CBR, particularly in its many activities related to integration of CBR and other approaches and by its movement toward the development of application-oriented CBR systems.

The massive memory parallelism trend applies case-based reasoning to domains suitable for shallow, instance-based retrieval methods on a very large amount of data. This direction may also benefit from integration with neural network methods, as several Japanese projects currently are investigating [Kitano-93]. By the fourth trend, method advances from focusing on the cognitive aspects, what we particularly have in mind is the follow-up of work initiated on creativity (e.g. [Schank-89]) as a new focus for CBR methods. It is not just an 'application type', but a way to view CBR in general, which may have significant impact on our methods.

The trends of CBR applications clearly indicate that we will initially see a lot of help desk applications around. This type of systems may open up for a more general coupling of CBR – and AI in general - to information systems. The use of cases for human browsing and decision making is also likely to lead to an increased interest in intelligent computer-aided learning, traning and teaching. The strong role of user interaction, of flexible user control, and the drive towards total instructiveness of systems (of 'situatedness', if you like) favours a case-based approach to intelligent computer assistance, since CBR systems are able to continually learn from, and evolve through, the capturing and retainment of past experiences.

Case-based reasoning has blown a fresh wind and a well justified degree of optimism into AI in general and knowledge based decision support systems in particular. The growing amount of ongoing CBR research - within an AI community that has learned from its previous experiences - has the potential of leading to significant breakthroughs of AI method and applications.

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