POTENTIAL DEVELOPMENTS OF EXPERT SYSTEMS USING INFORMATION ABOUT EXPLICIT AND TACIT KNOWLEDGE

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ABSTRACT

Carrying out activities in any field of knowledge (economy, medicine, chemistry, biology, systems engineering etc.) have always need a sort of information or knowledge volume, as regards those activities, needing a succession of decisions and choice between two or more alternatives. Moreover, the performance in any field of knowledge needs some scenarios issuance, regarding some critical indicators that define a short issue.

The intelligent systems technology has in view the solving of some complex issues in different fields that need the human expertise, being though restricted in the situation of concrete applications. Either we talk about human intelligence or artificial intelligence (emulation of intelligence by the help of computer), an intelligent system should be able to transform data into information and information into knowledge. The optimal exploitation of the two informational resources (knowledge bases and databases) needs the designing of each of the two components as a natural extension of the other, all within an integrated system.

Key words: *Expert Systems, Explicit Knowledge, Tacit Knowledge, Rule, Artificial Intelligence.*

1. INTRODUCTION

In order to develop intelligent systems and to assist the human deciding responsible in different situations, specific to the organizational frame, the concept of *knowledge* has been emphasized; some other times, we talk about knowledge, information or data that define a short issue; taking over and processing of data have introduced the database technology within systems engineering. In process of time, the database technology has been significantly developed by perfecting some mechanisms, taking over, storing and processing a higher volume of data.

On the other hand, the systems engineering was emphasized by an explosive development of *the intelligent systems technology*, this assuming the solving of some complex issues, upon basis of the human expertise gathered in the past and following some learning and reasoning processes very closed to those belonging to the biological brain. In this way, during the last five decades, together with other distinct fields of the systems engineering, intelligent systems programming has been imposed more and more within the artificial intelligence (denoted by AI). Moreover, the field of AI has been individualized extremely fast as a different field, separately, for everything that includes systems engineering. When we mention about AI techniques, we think of those programming techniques for the expert systems, neuronal networks, pattern recognition or hybrid systems. As result, we actually talk on one hand about tens of different fields where we find large spread applications for the intelligent systems technology (examples of fields as economy, chemistry, biology etc.). On the other hand, we talk about an almost extreme diversification into components globally named "technology of the intelligent systems" [3], [4], [5], [6].

2. EXPERT SYSTEMS – DEFINITIONS, STRUCTURE

As regards the concept of expert systems (denoted by ES), the researchers have been mainly offered some functional pragmatic definitions. For instance, Edward Feigenbaun showed that "the expert systems are those programs conceived in order to rationalize and solve some problems for which a human expertise is usually required" [11].

Louis Frenzel [12] describes the expert system as "a private program that includes a basis of knowledge and an engine of inferences; this programs is seen as an intelligent counselor within a private field"

P.G. Pigford and G. Baur show that "the expert system is a program product that emulates the human experts behavior and solves issues of the real world associated to a private field of knowledge" [15].

In accordance to our opinion, ***the expert systems*** *(ES) represent those programs belonging to the AI field. Such programs store knowledge of the human experts from a well defined field, process and manipulate the human experts' knowledge, reaching to own conclusions, finally given to the human deciding responsible. Subsequently, the human deciding responsible in the field for which an expert system is developed will remain the only entitled to select or not the conclusion offered by the ES, eventually " to flirt" this conclusion by the experienced achieved.*

From the above mentioned definitions, one might emphasize some conclusions:

- regarding from the conceptual point of view, the expert system aim towards the reestablishing of the human argument, upon basis of the expertise achieved from the experts;
- the expert systems dispose of knowledge and ability of developing activities closed to or even similar to the human reasoning;
- ES dispose of reasons for invoking the knowledge and expressing the expertise, behaving as "an intelligent system";
- ES are able to store knowledge, to establish connections and to reach for conclusions, solutions, recommendations, advices upon basis of facts and processing of uncertain knowledge (it is about the evasive fuzzy knowledge, modeled by Zadeh);
- As a level of information achievement the expert system are based on the principle of separating the knowledge (knowledge base), by the program under process (the inference engine).

An expert system designer should take in view *some requirements* at which the designed expert system should respond to:

- reducing of risks;
- successive learning;
- simulating the creativity.

Reducing of risks of potential non-compatibility of information that will be gathered into the database; this risk is possible, since it integrates a high volume of information, experience and valid knowledge, coming from the most various sources. As a matter of fact, the high dimension of the database and the heterogeneous feature of the knowledge that is about to be processed and manipulated will offer a specificity to the expert system, as programming techniques by AI (we can see an obvious difference between this programming technique, as comparing to the classical programming techniques).

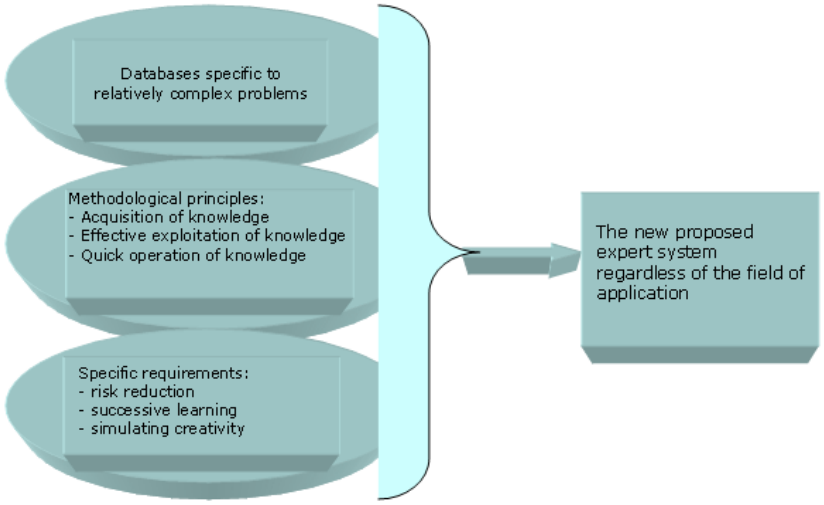

Fig. no. 1 Work principles and requirements that condition the expert systems designing

Successive learning is the feature by which a proposed expert system should be able to gather new knowledge or information, to manage in a dynamic formula the reasoning proposed, to be adaptable to the new methods of analysis and reasoning and as much as possible, to be able to adapt to the major changing come within the external environment.

Stimulating the creativity signifies a type of characteristic that confers or should confer to the information instrument proposed by the designer some specific attributes for the human expert, as the intuition or imagination (and to anticipate future activities of some decisions, to reach to reasoning by analogy etc.).

The aspects previously mentioned can be synthesized within a graphical form, as results from fig. 1.

3. INTRODUCTIVE ASPECTS WITHIN THE KNOWLEDGE MANAGEMENT

It is well known the fact according to which, starting with the 50's and up to present, we have assisted to major influences induced into the organizations life, either of business or other type [3], [4], [5], [6]. In accordance to Peter Drucker, the explosion of computers networks has especially lead towards dramatic modifications in the organizations life, as well within the management theories associated to these; putting into practice the computers networks is equivalent to a veritable revolution into the business world, and certainly that this phenomenon will be

emphasized in the next years [10]. Starting with 80's and up to present, the market value of a company has begun to be given more frequently by the value of non tangible assets of which that organization dispose of, assets that can be synthesized by the *"knowledge"* syntagm (inventions, innovations, patents, factory brands, designs, symbols, abilities of employees execution, cognitive abilities of the employees, the creative ability of the employees, the deciding persons vision, the experience gathered etc.) [3], [4], [5], [6]. In the same time, papers from the systems engineering field have developed tens of approaches in time, as regards the definition of knowledge, classification and their processing; the databases or *knowledge databases have been a central element for any performing information instrument.* Therefore, one might resort to two different angles of approach, upon basis of the "knowledge" syntagm, since we can see that this concept has remained a major interest factor:

- from the view of deciding persons in management and the economy of the business organizations;
- from the view of software designers, based on AI techniques.

The idea previously invoked is more explicitly illustrated in figure 2.

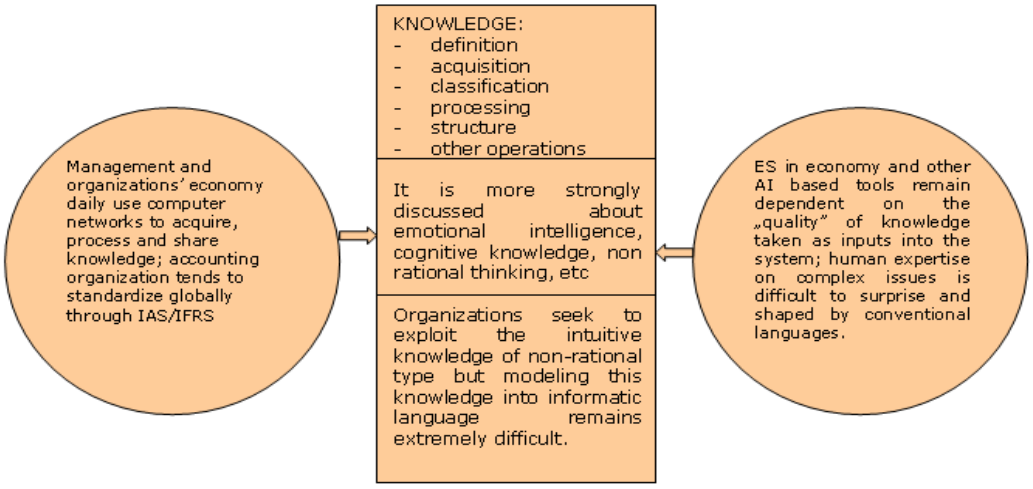

Fig. no. 2 Outlooks of knowledge approaching

From the applied management point of view, starting with 80's and up to present, syntagma as *knowledge management, organization that learns, human capital, intellectual capital, intangible assets, information revolution, e-learning, business process re-engineering etc.* [7], [8], [9] have become extremely familiar. We appreciate that a major concept that is located at "*the intersection*" of different syntagma mentions, as well as other similar, is represented by the *knowledge concept;* identically, various techniques of programming, as well as AI techniques programming (in our case, the decision expert systems), are especially focusing upon we have already named *knowledge* (fig. 2). From the software engineers' point of view, it is especially well known the interest for what we call database; data mining has been a major direction of interest for all programming techniques (including in our situation, synthetically said, we will use the *VISUAL FOX PRO language in designing an own expert system, in order to process databases associated to complex economic issues*). But what knowledge represent? In what way the know-how is achieved step by step within an organization? But what about the level of an employee? How is the knowledge processed and exploited within an organization? How are the knowledge defined in Orient towards the Occident? In what measure the knowledge can be modeled and then mechanically processed? What are the limitations in knowledge processing, when more specialists from different fields are involved? How can be the ecart solved for fields as medicine and systems engineering in knowledge exploitation? What about the economy and systems engineering?

One of the major classifications as regards the knowledge is that sharing the knowledge in the next two classes [7], [8], [9]:

- ***the explicit knowledge*** signifies knowledge rationally gathered and that can be transferred by usual processes of teaching, learning, communication etc.; these can be detached by the owner and processed in various ways at the organizational level (knowledge that can be reached in manuals, encyclopedia, databases etc.);
- ***implicit knowledge*** signifies non rational knowledge, such as the knowledge deriving from the experience or intuition of individuals, situation where the sending or processing becomes relatively more difficult (we know intuitively or from experience how to accomplish various activities, or how to behave in various social contexts, but sometimes it is difficult to explain verbally the way of fulfilling these actions.

Maynard and Mehrtens mentioned that business will largely exploit in the future ***the intuitive knowledge*** [13].

Gammack and Young proposed that *types* of knowledge should be classified in various categories (classes), depending upon techniques of acquisition that can be applied for their gathering and introducing them into the databases; as consequence, we deduct that when we work with similar types or classes of knowledge, it will allow the use of similar acquisition techniques. In this way, the two researchers reached the conclusion that a major issue of AI and knowledge engineering development derives from the ecart existing between various *classes of human activity knowledge and acquisition techniques of it, in order to build a future knowledge base.* In the way invoked here, by techniques of knowledge acquisition, we understand the techniques of their describing and formalization, into an accessible computer mathematical language. We can also see that it is not easy to define the knowledge syntagma, considering the imprecision of the human language, no matter the angle of approach of this topic (fig. 2). From the systems engineer point of view, the previously invoked definition as regards *the knowledge* ("a much more finished form of various already existing information for organizations or individuals mind") is not a very attractive one, since it is relatively non pragmatic and hard to be formalized in an accessible computer mathematical language. Sharing of knowledge in ***two high classes*** previously mentioned (explicit knowledge and implicit knowledge) do not represent a significant interest for systems engineering, even if we appeal to fuzzy logic in order to formalize the implicit knowledge. These two classes are too large and do not allow the direct definition of the production rules, on which the inference engine will be based upon (as a matter of fact, it is necessary to divide in a tree way structure the two large classes of knowledge, depending upon the data type and symbols associated, eventually information). As result, we reach to a certain dilemma: What is the most adequate approach in order to define and classify knowledge, so that they will be able to synthesize the human expertise on a PR issue, into an accessible computer language? Maintaining the approach angle specific to systems engineering, we define knowledge as a small sequence, a small part, from the expertise gathered by society, regarding solving a PR (short) problem of medicine, chemistry, economy etc.

4. WORK STEPS AND INSTRUMENTS IN BUILDING THE EXPERT SYSTEMS

Most of treaties and papers about the expert systems describe and illustrate, depending on situations, certain steps that should be followed by designers, when this proposed to build an ES for a well defined issue (PR) [1]. In a great part, some techniques of knowledge acquisition are presented, in connection or not to the steps that should be followed so as to build an expert system.

Regarding our point of view, we talk about a number of sever steps, structured into the systemic conception, as steps to be followed on the road of building an ES:

- describing the PR issue;
- expertise appeal;
- experts appeal;
- knowledge acquisition;
- successive explanations between participants;
- defining the inference rules;
- Testing and validating the model.

Describing the PR problem. In this step, a general enouncement of PR issue is necessary, which should be relatively short and well defined, and for which a volume of expertise should exist, that can be subsequently described by a mathematical language. In this step, the first contact between the human expert for PR issue (physician, economist etc.) and the expert in designing and building of ES takes place.

Appealing to expertise. The expertise, in a general way, signifies an intensive knowledge, specific to issue's field, reached by training, reading or long experience; one might say that expertise is gathered step by step by a person, by *informal learning;* for each profession, there are hundreds of details and "small secrets" denoted by skills, which can be gathered by individuals only by exerting the profession during years.

Appealing to experts. By antithesis with employees having an average qualification level, experts have a supplementary characteristic, meaning that they learn from success and mistakes made in the past; they admit the failure and learn from it; they think by analogy and develop a selective type memory (similar to a well know chess player, developing in time certain patterns, in accordance to which they will subsequently act, when they will meet similar situations). It is difficult to define in few words what represent the features, characteristics or abilities that a person assigned as expert should have; moreover, we talk about various levels of "degrees of expertise". In this way, the following question is inevitably asked: how much expertise should a qualified person have on a field, in order to be accepted as expert?

Finally, beyond the qualities and abilities of a person accepted as expert, it is useful to remind the fact that, once achieved this statute, the person in cause runs some *specific activities* in order to solve a new problem (depending on situations, it defined an issue, reformulates the issue, analyses in a comparative way the problems from the past, thinks by analogy, ignores the rules followed in the past, develops other rules, learns from experience, can explain

the solution at which it reaches, can offer fast, partial or final solutions, is aware of his abilities limit etc.). All these activities should be developed by an efficient, fast and of low cost expert; the final result should confer "a plus of quality" for the organization where he activates. In order to imitate a human expert, all ES created, no matter the field of application, should have all the features previously mentioned, and to respond exactly to the same requirements invoked (in the manner this thing would be possible under pragmatic point of view).

Acquisition of knowledge

Depending upon the PR issue type proposed to be solved by the new ES created, on the type of knowledge and the already existing expertise at that time, more techniques are planned and selected, in order to gather available knowledge, in order to define them completely, as well as in order to build the most convenient basis of knowledge, which will be then processed by the inference engine.

Successive explanation between participants

Finally, in order to have a relatively complete image as regards the sever steps taken in view for building an ES, we can recall two activities or steps that should be taken into consideration by the software designer, meaning:

- in a first step, the designer has directly collaborated with the human expert, in order to acquire the necessary knowledge and on defining the facts basis, on which the future ES will be created; it is essential that different types of knowledge, information or data should be described in detail and in an accessible computer language;
- preliminarily on designing the inference engine, all participants at creating an ES should ensure that they have acquired high quality knowledge, for the issue in cause (they can appeal to updates, upgrades for the current database, as well as on improving the rules of describing the data that will be processed).

We mention that this step on creating an ES is being in a direct connection with other steps of this demarche, including the step of testing and validating the model proposed by the designer.

Defining the rules

As previously illustrated, even in a general way, the mechanism by which the inference engine performs activities for any ES, it is no longer opportune to insist over rules approached as basic concept in applying the ES; anyway, these rules are developed and are explained successively within the research work (including sections where the ES architecture is presented and its functionality is validated).

In the general way, *one might mention* that most of expert system in progress are based on rules of type IF...THEN...ELSE, rules stored within the knowledge database.

Testing and validating the model

After conceiving the inference model, we can talk now about a step of consulting and validating the conceived ES, situation when end users are solicited to make a dialogue in a successive way to the ES:

- the user addresses questions in order to clarify the level of reaching the objective aimed by the ES or other related aspects;
- ES accepts questions of the user and formulates, according to situations, more detailed or more synthetic answers

The expert systems can address on their turn questions and can expect answers from users. The same way of consulting can also be used by the expert systems designer, during the development steps, when the user interface is tested and also the explicative module.

As conclusion, as result of the issues invoked as regards the steps in progress, for building an ES, figure 3 illustrates a diagram of systemic conception, as regards this demarche:

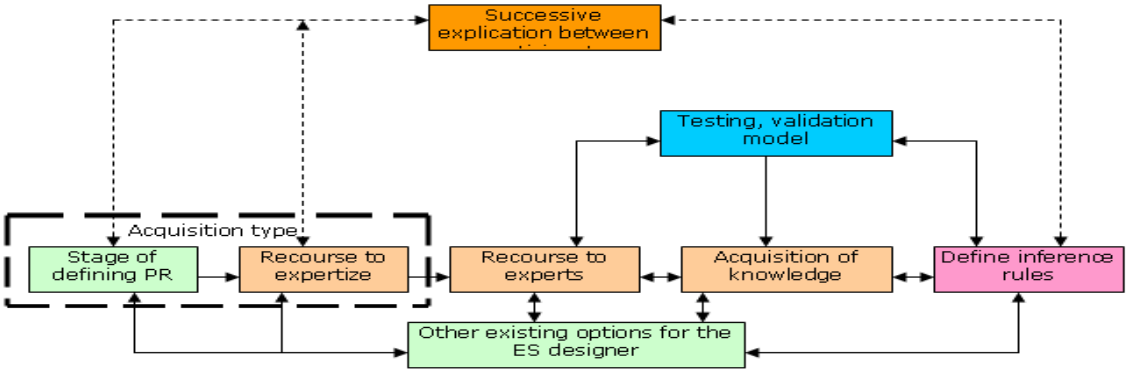

Fig. no. 3 Steps of progress within ES building

5. POTENTIAL DEVELOPMENT

We emphasize the fact according to which the model of knowledge conversion, as well as different ideas promoted by Nonaka professor have generated a major interest in fields as logics, knowledge management, systems

engineering, mathematical modeling etc. [14]. During decades, a high number of researchers have extended and amplified the issue of sharing the knowledge in implicit and explicit knowledge, making a strong relation of this topic with the life of organizations and computers networks (Internet, Intranet, etc.) [3].
Having in view the classifications previously mentioned, we understand that different databases on which various types of expert systems rely on (data signify the raw material processed by such an information system), including the expert system applied in economy, ***include lastly the implicit and explicit knowledge in various percentages.***
As a matter of fact, while various information are synthesized and processed within the internal structure of an expert system (this internal structure signifies its inference engine about which we will subsequently discuss), it becomes more and more difficult for a researcher to make a differentiation between data, information and knowledge. While we accept the ideas promoted by Nonaka and other analysts [14], we think it is more preferable that future developments as regards ES to focus especially over the implicit and explicit knowledge (inclusive on the idea of favoring processes of k knowledge externalization, knowledge information at which we previously referred to) [7], [8], [9].
On the other hand, a conclusion is imposed: various information instruments, more and more performing, that are successively offered by researchers (remark available including for expert systems of economic field) have the major and unquestionable part of *favoring the human deciding person in the process of reaching an absolute knowledge.* In the way Apurya and Singh propose, what we actually called *absolute knowledge* is a correct equivalent for what the invoked authors call "*winsdom*" and *"enlightenment"*. If we come back to the pyramidal structure of knowledge proposed by Apurya and Singh, then a part of the previous figure can be reformulated as it is graphically emphasized in fig. 4.
Obviously, we can understand that what has been named "absolute knowledge" has been always and will remain a major desiderate, an ideal that individuals try to reach step by step within the knowledge process; the effective reach of this desiderate will not be possible at least in the near predictable future, for humanity [7], [8], [9]. As emphasized, *the basic idea proposed in fig, 4 shows that potential developments of the expert systems can include in the future two different knowledge databases, meaning:*
- a knowledge database able to include knowledge exclusively from the category of those named ***explicit knowledge*** (in this class, data relatively quantifiable can be included, such as: accountancy information that are afterwards processed by means of the proposed expert system);
- a knowledge database able to include exclusively from the category of those named ***implicit knowledge*** (in this class, data relatively non-quantifiable can be included, such as: information resulted from the experience of an accountant, able to take over the balance sheet data, form the experience of the superior deciding person etc; in this situation, appeal to the fuzzy logic becomes necessary, and thus, data can be processed simultaneously by the expert system with the previous database).

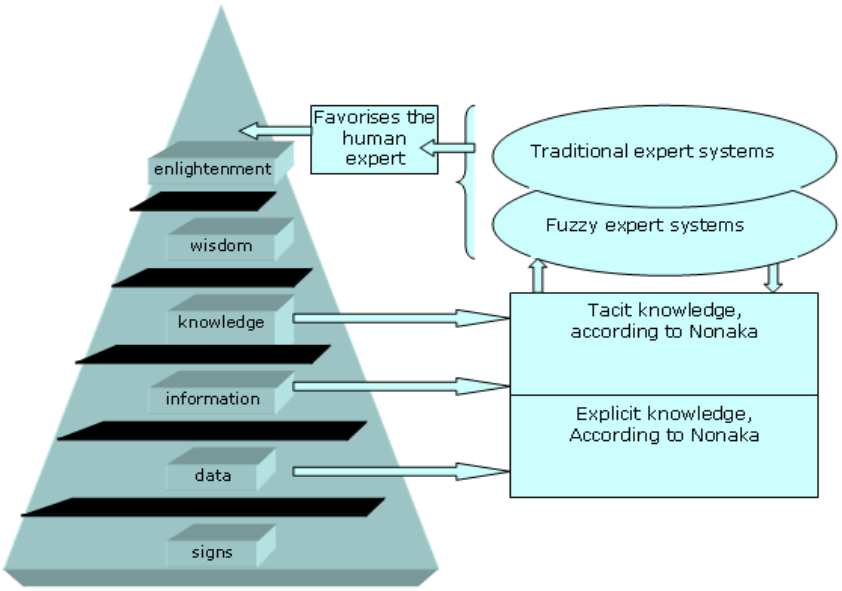

Fig. no.4 Potential developments of the expert systems by appealing to two types of knowledge

We define the expert system as an information instrument able to process operatively the explicit and implicit knowledge, associated to a more specialized issue, so as to offer intelligent solutions to the human expert; taking into account these

solutions, the human expert will be able to get closer step by step to the so-called „enlightenment", meaning the highest form of understanding the issue in cause.

6. CONCLUSIONS

The conceptual dimensions of the knowledge based economy need new ideas and approaches, as regards the decision factors. The innovation and technological adoption, the information infrastructure, adoption, adapting and using of knowledge within the internal economic production, will have as result a higher added value of goods and services. This aims on increasing the probability of the economic success, and as result, the economic development into the current world economic will be extremely competitive and globalised [2].

The expert systems represent one of the most important areas of the Artificial Intelligence (AI). They model the human ability on solving problems and developing the field, being placed in a larger context of the knowledge evolution.

The interest for the expert systems technology and their applications has proven an ascendant continuous trend, although the funds allocated to the field were lower.

In the last years, a growing of the entire field of artificial intelligence could be seen, which has progressed as an active discipline and in continuous development. Currently, most of research themes are directed towards the Artificial Intelligence, and especially towards the Expert Systems.

Tendencies of development of the field have aimed on improving the process of knowledge acquisition, by using genetic algorithms and intelligent agents on accomplishing Internet applications (intelligent search engines and Internet browsers), and for the electronic commerce (customers or intelligent sellers, methods based upon artificial intelligence on inter-agent communication).

The inquisitive mind of the human beings has always reached to make his life more easy and to find means of better leaving standards. Therefore, this technique has known peaks, at which the simple humans haven't dared to dream or think of. This aspect makes us think that things won't stop here.

The virtual world has changed the way people think. For this reason, companies should understand the high importance that the expert systems have.

One can appreciate that on worldwide level, the following tendencies in the expert systems field manifest:

- accomplishing some strong KBSs (Knowledge Base Editor- source or editor code), perfectly adaptable to that field, on which basis one might pass on building/designing some expert systems;
- accomplishing tandem system, able to combine the main solving on knowledge based ways with the procedural solving ways;
- making the standardization of concepts, notions of field work;
- Coupling expert systems with the databases.

Synthesizing, if there is a modern and motivated management, when possibilities of carrying out an expert operational system exist, as well as a team of experimented designers, at which competent and motivated users are added, and then the problem of carrying out an expert system has become similar to that of accomplishing an investment able to be conducted by inspiration. Also, we should take into consideration the desire of creating an expert system, able to be designed and implemented in a practical way, proving performance and usefulness for the economic agents.

As final conclusion, an expert system can be created for both simple issues, of small sizes, as well as for complex issues. The small size issues solicit the human expert less, and building the knowledge database is being accomplished pretty soon. For the complex issues, the human expert is solicited for a longer time, and issuing the knowledge base will impose a longer period of time.

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