The 2006 International Arab Conference on Information Technology (ACIT'2006)

Methodology of Development of Multicriterion Assistance Expert System to ASP Piloting

N. Taghezout [1] and K. Bouamrane [2]
[12]Computer Science Department, University of Es-Senia Oran, BP 1524, El-M' Naouer, 31000, Oran, Algeria
[1]taghezoutnour@yahoo.fr
[2]kbouamrane@yahoo.fr

ABSTRACT

The decision-making aid is primarily concerned with the problem resolution which rests on a clear identification of the decision situations. It considers the decisional behavior as a point not necessarily guided by a single criterion but as a possible resultant of several criteria. Our study aims at improving the quality of decision brought to the decision-making process by proposing an expert system for piloting a dynamic, evolutionary and robust structure.
The interest of an expert system within the framework of production is underlined by the function use. The latter expresses the needs for decision-making aid and consumes expertise. The system carries out the preselection of a set of acceptable resources. This is in collaboration with the operator. The potential solutions of the arising problem are treated by a sorting procedure which allows to carry out a last selection to a better resource: This resource satisfies some criteria known as delay, cost and quality. The decisional modules, which are based on the expert system, are added to the multi - agent structure dedicated to piloting. The agent actions are concretized through the analysis and reaction procedures. This allows launching adequate decisions.

Key words: *Expert system (ES), Decision, multicriterion Assistance, Automated System of Production (ASP) , Multi Agent.*

1. INTRODUCTION

In a company, the products are renewed, the means change, and the know-how evolves. The ES are precisely programs conceived to be evolutionary. Their design, makes the knowledge base (containing the production rules) accessible to any expert, even a non data processing specialist.
Thanks to ES, the specialist's knowledge then becomes available to the other specialists who thus have the possibility of adding their own knowledge or modify that which is in memory. This allows the data processing system to take into account improvement and evolution of the work methods and follow the company progression. Moreover, when a new member integrates into the company, he immediately gets the experience acquired by his Predecessors [6].
Indeed, each realization of an ES is integrated in a particular environment of development and should be adapted to the framework of use. An ES is developed, for example, to safeguard an accumulated expertise, diffuse it through time, diffuse it through space, and formalize design knowledge.

The computerized decision-making systems and expert systems are used to help the company managers to make decisions, by providing [4] them fast and effective recommendations. The aim is to solve complex problems using competence at least equal to that of several consultants or managers who would be experts in the same field.
Various applications of ES have been thus developed and empirically validated in fields such as strategic analysis, technology acquisition, production control marketing planning and production workshop piloting assistance (ALEXIS) [6].
This paper presents the expert system as a tool of assistance at the decision-making in resolving the problem of reassignment and allocation of operations to the resources of a disturbed workshop. It is particularly featured by the collaboration of multi agent model of structure of real time piloting of the system, studied according to the expert system reasoning.
The distributed artificial intelligence has been taken into account in two different but complementary ways: in the first stage, it appears in the multi agent modelling of the

production system. Its principles and methodologies are described in Section 2. As for the aspect of multi expertise, it has been prepared through various knowledge base co-operation . We present the methodology of expert system development in Section 3. The fourth section is devoted to an example related to the ES reasoning. In conclusion, this paper attempts to focuses, as a scientific contribution, on its future perspectives.

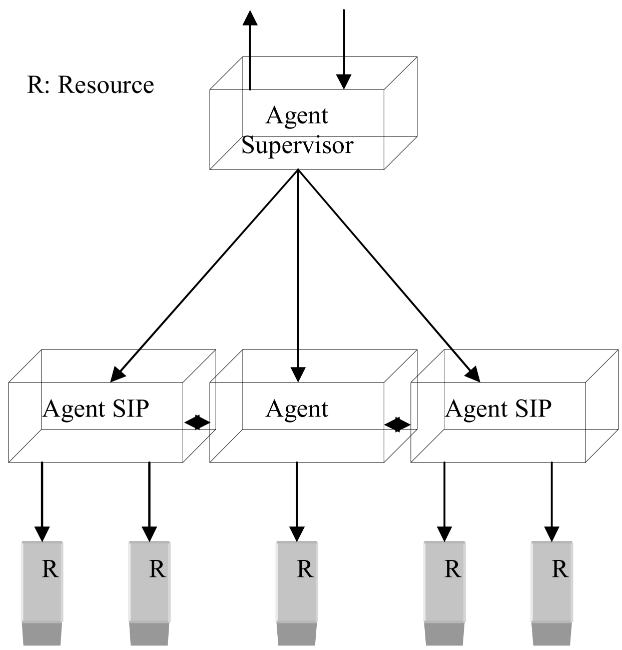

Figure1. Modelling of the piloting structure distributed and supervised by the model multi agents.

2. DESCRIPTION OF THE PRODUCTION SYSTEM

At the end of this project of an expert system realization, new workshop modelling structures have been elaborated. This is according to the industrial reflexions launched by the expert system. Simulation has also contributed to the improvement of basic structure. This has allowed testing various workshop configurations. And finally, the developed system considers the production follow-up which aims at maintaining the data up-dated. This data describes the state running of the workshop.

2.1 MULTI AGENT STRUCTURE OF HYBRID PILOTING

We consider a production system made up of several integrated stations of production ISP led agents. Each agent (ISP) is specialized in the operations of production, it is of a cognitive type. It has sufficient knowledge to make decisions, its role is then:

a. To manage locally in real time the processes of allocation of tasks, queues, etc

b. To manage the availability of the necessary elements to the realization of operational tasks. The system then consists of a set of co-operative agents under the control of a supervisor (Figure1). This structure has been used in many projects and showed its effectiveness [8], [13].

2.2 THE AGENT STRUCTURE (ISP)

An agent is composed of five subsystems [15] :

- Information subsystem: allows ensuring communication between the subsystems and managing local information.
- Communication subsystem: ensures the connection between ISP and the other agents, the production system components.
- Interface subsystem: allows the information exchange between the human operator and the agent.
- Control/Order subsystem: ensures the order of production resources and transmits the follow-up information to the information subsystem.
- Decision subsystem: this subsystem is responsible for the set of decisions made during the problem realization process.

2.3 PROPOSAL

The decomposition in subsystems has been adopted, to try out several naturally multicriterion decision-making processes: the decision subsystem has undergone some modifications which consist in adding [13]:

a) A module of analysis and reaction in order to take into account the state of workshop at any moment.

b) A set of behaviours associated with each ISP.

The Communication protocol is composed of six (6) basic primitives [8]; [12] they allow to describe generically the stages of communication (Request, Acceptation, Reservation, Relaxation, Acquittement and Transfer).

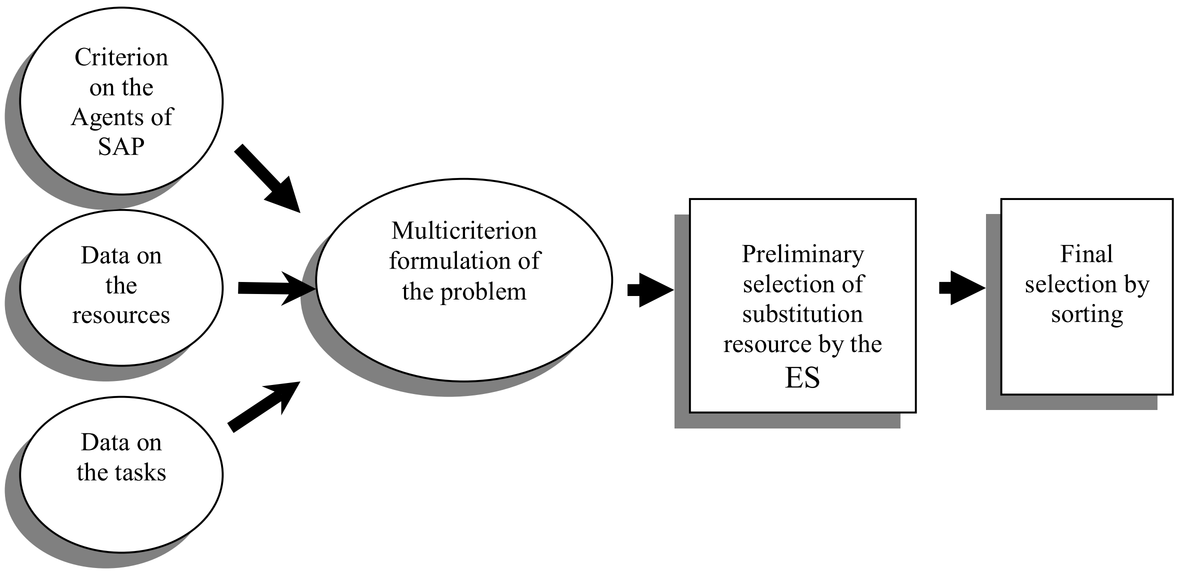

Figure2. Decision-making process for the allocation problem resolution of tasks: application to resources (ISP).

3. EXPERT SYSTEM OR INTERACTIVE DECISION MAKING SYSTEM

3.1 COMPUTERIZED DECISION-MAKING SYSTEMS AND EXPERT SYSTEMS

The systems supporting the leaders in management and decision-making can be numerous. For example, the interactive decision-making systems (IDMS) and expert systems (ES) are regarded as interesting tools of support. The interactive decision-making systems are computerized systems which allow the user to accede to data and models in order to make the best decisions [2]. They are used to treat more structured parts of the problem. The user, however, relies on his intuition, knowledge of the field and fixed goals. This is to formulate the problem, modify and control the resolution process, as well as interpret the results [1],[14]. As for expert systems, they can replace or assist Man in the fields where an insufficiently human structured expertise constitutes a precise and sure work method, a method which is completely transposable on a support data-processing and prone to revisions or complements according to the accumulated experience.

3.2 METHODOLOGY OF AN ES DEVELOPMENT

The principal difficulty during the expert system realization is knowledge collection. This critical stage of development often requires a long and tiresome step with the field experts [4].
It is even more delicate that, in an ES, knowledge is intended to evolve, thus it should be easily readable and modifiable by a data processing specialist, or even by the expert himself.
The resolution principle implying the expert system is given in Figure2.

3.2.1 SYSTEM DEVELOPMENT

Knowledge Representation
When a sufficient quantity of relevant information is collected, the knowledge engineer proceeds to the knowledge representation. In this work, the principal source of knowledge is the various information collected, either ,through interviews with experts in the company, or from production catalogues and handbooks . The knowledge representation means that its structuring and the reasoning method development allow the system to find an answer. The representation by decision rules is the technique used in this work. It permits to reach a conclusion thanks to the execution of decision rules. The inference strategies, namely the back and front chaining, are at the basis of expert system reasoning.

Thanks to the interface user, the user communicates with the expert system. For this reason, the acceptance or non acceptance of the system by its user depends on the concept of interface user.

Knowledge Base

It contains all knowledge related to resources and tasks. The stored data are used thereafter to solve the breakdowns. This is thanks to the resolution tool, and inference engine. The knowledge base is permanently fed by the case studies made by simulations of the production system. These simulations are carried out during the experiments of the various methods such as, PROMETHEE, AHP and ELECTRA 1[3],[5],[13].

Rule Description

The rule basis includes the rules presented in the form of production rule of the type: If "condition" then "conclusion"

3.2.2 LISTING RETAINED CRITERIA

The decision-making suggested in this work rests on several selection criteria. The work carried out in [7], [8], and [13] has drawn up a list of criteria used basically for: the resolution of problems relating to the decision-making processes of allocation, and reassignment of the operations on broken down resources. A solution should be given to the operator by carrying out the best compromise between the three conflict criteria namely, cost, delay and quality. The most relevant criteria in our study are gathered in Table1 and Table2.

CRITERION CODE	**TITLE**	**AXIS OF SIGNIFICANCE**
C1	The production cost.	cost.
D1	Operational Time of an operation resource	Time
D2	Time of a resource preparation of an operation	Time
D3	the potential transfer time	Time
D4	Next date of availability	Time
Q1	Attrition rate	Quality
Q2	Characteristic tool	Quality
Q3	Level of specialization	Quality

Table1: List of Criteria Retained for the Allocation Process.

CRITERION CODE	TITLE	AXIS OF SIGNIFICANCE
C2	upstream storage cost of the machine	Cost
Q4	machine reliability Indicator	Time

Table2: List of Criteria Retained for the Reassignment Process (D1, D2, D3, D4, C1, C2, and Q4).

3.2.3 SOFTWARE ARCHITECTURE

The application includes several classes such as interface class, supervisor class, production agent class (ISP), expert class, resolution tool class …

3.2.4 VALIDATION

Validation is the final stage of system realization. It allows detecting (and possibly correcting) the very largest majority of dysfunction scenarios, it can thus affect the final realization of certain stages quoted previously.

4. EXAMPLE OF APPLICATION

Sorting Module

This class aims at treating the potential solutions of arising problem given by the first selection of resolution tool. It also attempts to better carry out a last selection of the resource satisfying the criteria, delay, cost and quality.

We consider a structure of piloting made up of a supervisory agent and of 4-5 agents ISP. Let us suppose the arrival of a work order made up of several spots T1-T7. In Figure 3, we can see a view of the simulation tool on the tag1, the simulator tool permits to animate the task model in concordance with the user interface (tag2).

5. CONCLUSION

The realization of this research has allowed to explore a world where the access to information, as well as accumulation of experiment and expertise constitute one of the fundamental dimensions of company competitiveness. The validation consists in checking logics of inference of the knowledge basis, i.e. checking whether the expert system gives anticipated results by simulating "case-test".

The quality of work provided in this project is to be confronted permanently with the results obtained in various experiments such as AHP[9], TRI ELECTRA[3],[11],[10] and the other multicriterion methods.

One of the perspectives concerns the expert system improvement to consider the time response constraint. This should modulate its reasoning according to its given time. The possibility here is only if one manages sufficiently to model the events to include causality and coordination relations among the decision making agents (ISP).

Another aspect would be to give the possibility of expressing certain dubious sizes (a similar work is under development by using the sorting ELECTRA method): we think of a comparison of the results obtained.

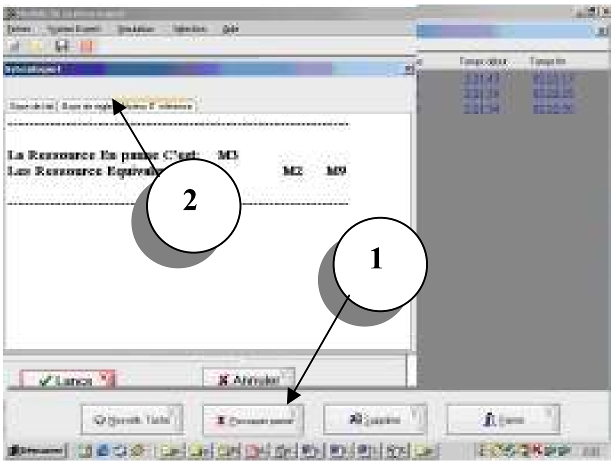

Figure 3. Execution of Simulation.

And, finally, we envisage to equip the making decision agents by new decision-making assistance capacity against any new disturbances. This is to highlight situations corresponding to dysfunction phenomena.

REFERENCES

[1] Bouamrane K., Taghezout N., “Modelling and Cognitive Simulation in Dynamic Situation Decision-Making for Regulation of an urban transportation System,“ *in Proceeding of the 4th International Multiconference on Computer Science and Information Technology, CSIT* , Amman, Jordanie, Vol.2, ,pp 412-421, April 5-7,2006.

[2] Ibrahim N., “Systèmes Multi agents : nouvelle approche pour une décision distribuée, “*DESSID, Research Report, enssib*, mars 2002.

[3] Maystre L.Y. “Méthodes multicritères Electre, description, conseils, pratiques et cas d’applications à la gestion environnementale,“ Polytechnics and University Presses Lausanne, 1994.

[4] Mille A., “Système expert pour le contrôle prédictif de qualité en production industrielle,“ *CCMV Collection of Knowledge*, November 2004.

[5] Mousseau J., “ Validation empirique d’une procédure de désagrégation pour la méthode Electre Tri, “*In Optimisation et décision, actes de Francoro*, Sousse, Tunisie, page 237-248, 4-7 April 1998.

[6] Negrello L., “ Systèmes experts et Intelligence Artificielle,“ *CT 157 édition november 1991 Cahier Technique Merlin* Gerin n°157.

[7] Ounnar F., “ Prise en compte des Aspects décision dans la Modélisation par réseaux de Pétri des systèmes Flexibles de Production, “ Doctoral Thesis, INPG 2000.

[8] Rouba B., Taghezout N., “ Un processus décisionnel multicritère basé sur l’approche multi agent pour le contrôle des SAP “, *Colloque sur les Méthodes et Outils d’Aide à la Décision,MOAD* , Saida Algerie, November 2004.

[9] Rouba B., Taghezout N. , “ Proposition d’intégration de la méthode AHP comme outil de calcul des poids des critères pour les méthodes multicritères “, *Colloque sur l’Optimisation et les Systèmes d’Information, COSI,* Bejaia, Algerie, June 2005.

[10] Roubellat F.. “Ordonnancement d’atelier en temps réel d’ORABAID à ORDO, “ *Review of Automatics and Applied Production*, Vol. 8, no 5, pp 683-713, 1995.

[11] Roy B., *Aide multicritère à la décision: méthodes et cas*, ECONOMICA Press, 1993.

[12] Saaty T., “Multicriteria Decision Making: The Analytic Hierarchy Process, “RWS Publications, Vol.I, Pittsburgh, 1996.

[13] Taghezout.N, Hamdadou.D, “Expérimentation et Intégration de la méthode ELECTRE 1 dans un système d’aide à la Décision appliqué aux SAP “, in Proceedings *5ème Séminaire National en Informatique de Biskra, SNIB,*Algérie,Vol .1 ,pp 196-206, 2-4 May 2006.

[14] Taghezout N., “Issues de Coopération dans la Réalisation d’un SIAMD dédié au pilotage de SAP, “ *in Proceedings Conférence Internationale CIIA*, Vol.1, pp 91-98,15-16 May ,2006.

[15] Trenteseaux D., “ Conception d’un système de pilotage distribué supervisé et multicritère pour les systèmes automatisés de production, “ Thesis INPG Valenciennes 1996.