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SUPPORT SYSTEMS FOR DECISION AND NEGOTIATION PROCESSES

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MULTICRITERIA APPROACH FOR INTELLIGENT DECISION SUPPORT IN SUPERVISORY CONTROL

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Abstract : When a process is being disturbed, the supervision function changes the established planning, in accordance with different norms and constraints. The operator still remains beside the regulation automatisms to perform manual operations. The great number of actions and the conflictual nature of some objectives make his task complex. He must reach quantitative and qualitative objectives with imperfect and temporal informations. To assist him, we study a decision support model following a multicriteria approach involving the supervision problematic. AI techniques and DSS are used to develop the aid tool. An industrial study worked out by EDF is used as a support.

Keywords : Supervisory Function, MCDA, DSS, AI, Spinning Reserve

1. The Supervision Problematic

The mastery of a production system is taken on by information and decision subsystems which make up the production management (MERCE 87) (Fig.1). The decisions made in normal conditions by the management system provide for the orders and the regulation of the production system, in accordance with commercial, technical and financial constraints.

The evolution and adaptation of production with time is handled by a supervisory function (Fig.2), which is divided in three tasks taken on differently according to the degree of automation (SHERIDAN 84, TABORIN 89) : production system initialization, monitoring state (yield and security), default diagnosis and correction in case of dysfunction. The supervisory function cannot be completely automated when the process is complex. That's why the supervisory operator stays near the regulation automatisms. Our study will be limited to the compensation (in case of process disturbance) or correction (in front of production hazards) tasks to be operated after a default diagnostis.

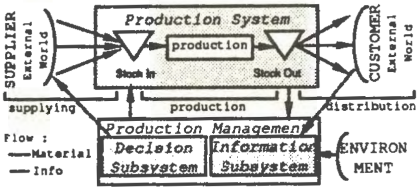

Figure 1

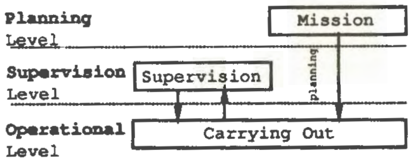

Figure 2

Rasmussen's researchs (87) pointed out that in a context of problem resolution the operator activities go through different phases : detection, situation evaluation, decision making (prediction, evaluation, alternative according to the identification and the fixed operative goals...), actions specification and execution. In case of dysfunction, the number of potential actions and the conflictual nature of some objectives make his task complex. Moreover, the huge number of possible defaults in nature often throws the operator into unknown and unexpected situations, in which he has to act following a knowledge based behavior. The specificity of the industrial process supervision field is (MONDOT 90):

- the controlled universe and the system change with time;
- the system must act on the external world;
- the system knowledge of its environment is often insufficient;
- the system has a final activity.

For those reasons, an ideal system must be capable of reasonings (i) non-monotoneous with time : the world isn't static; (ii) on incompleteness : the world isn't a closed field; (iii) on incertainty : the knowledge of the world is not perfect; (iv) on the actions and their effects : pertinent choice of action.

The operator has to satisfy quantitative and qualitative objectives from imperfect information distributed in time. We study how to help the operator to choose the action to be performed, in accordance with his own preference system and with the objectives to be reached. Our purpose is to specify a decision assistance model for the supervisory operator when dysfunctions affect the production process. We must further the cooperation between assistance tool and man, the latter being the centre of the decision process.

2. The Spinning Reserve Problem

We present a problem encountered by Electricité de France (EDF) when disturbances affect the power system (JOURDIN 90). The Power System Operation main objective consists in balancing generation and consumption under security rules and in minimizing exploitation costs. Disturbances which occur at any time on the power system may make the daily generation planning non operational. Then, the operator in charge of Power System generation load balance executes a set of non automatic actions constituting the 'MRT' function (this stands for setting up the spinning reserve). Today, actions are elaborated in order to give a current response to a disturbance without an accurate view of future consequences on costs, or reserves. The main objective of the MRT system is to take into account an extended view integrating in mid-term objectives, exploitation costs, security with the immediate needs.

A feasibility study of MRT into an aid tool (named SMART) has given a heuristic decision process following a monocriterion approach (GANDIBLEUX 90, CARTIGNIES 91). But SMART searchs optimal actions and the performance of actions is represented into a aggregated synthetic function $\alpha_t(a)$. These approaches characterise a decision making : the system helps to dictate the right solution to the operator (Roy 90).

3. The MULCRIDESSIS Project

The search for optimal actions becomes difficult when the problem has different objectives measured into different units, these objectives are mutually conflictual and the decision-maker has different possibilities to accomplish these objectives; those points characterize the nature of a multicriteria decision in a complex environment (KO 88, LIGEZA 88). Also, the mathematical methods (OR and MCDM) require a well structured problem and are useless in front of the information problems encountered. Too formal, such methods cannot be used here. So, to help a supervision operator in front of disturbances, we propose an original approach named MULtiCRiteria Intelligent DEcision Support System In Supervision. This's an approach of a decision aid type (see ROY 85) in which the decision to be reached is not anymore optimal but satisfying, by organizing rationally the temporal process of decision research (DE BRUYNE 81, LEVINE 89). MultiCriteria decision aid aims at improving the performances of operator faced to several alternatives and with a variety of criteria to evaluate and compare actions. MCDSS are systems in which interactive computer-based systems help decision-makers to deal with different multicriteria real-world situation. Taking the cognitive aspects of human decision making in account, IDSS proposes an alternative to the mathematical approach. Such a system includes empirical and efficient strategies extracted from specific decision problems.

Our goal is an on-line development of a solution realizing a compromise between antagonistic objectives under constraints. The aim is to give tools to the supervision operator to elaborate solution by knowing more precisely consequences of actions in the global solution. To give a real approach of the problem, hypothesis are : (i) the set A of potential actions is not stable, (ii) qualitative information will not be quantified (symbolic methods are used); (iii) comparison of actions is based on n criteria (criteria family is used differently in accordance with the state of the process decision (Fig.3)); (iv) the procedure helps the operator building correction.

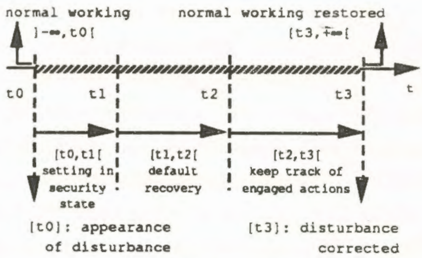

Figure 3

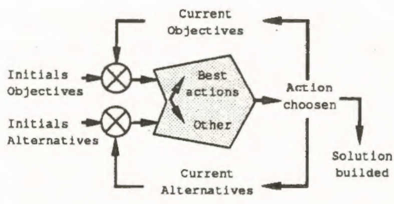

Figure 4

The core of our problem is how to evaluate an action in a current context, at a precise time. In this way, we examine the following points : (1) What criterion is to be used, when, and how to maintain coherence with time ? (2) How to handle the incompleteness in the decision process and what are the consequences of information lacks (imprecision-incertainty-incompleteness) on the decision process ? (3) How to explain or remove incomparability of actions due to information lacks, and how to deal with the evolution of preferences with time ? (4) What are the interaction and cooperation modes between the operator and the aid system ?

The analyse developed demonstrates that the problem responds to a choice problematic : the system must select a better action, optimum or satisfecum ($P\alpha$). But one action is not sufficient to recover the default, and k-choice is needed. Most, time has a strategic place in the decision and govern the decision process. In consequence we integrate time in the problematic and we talk about a Dynamic Multichoice Problematic : $P^{k}\alpha|_{t}$ (Fig.4). To conceive such an aid, a synergy between 3 models is required :

• **the problem model** : because of the random aspect of a disturbance, the system is capable to identify and to model the situation disturbed. And after, characteristics are communicated through the knowledge. Those tasks are assumed by the diagnosis and forecast function.

• **the resolution model** : on the basis of the disturbance characteristic, the system defines objectives to satisfy and determines qualitative and quantitative criteria to be served with time into the decision process taking into account the quality information. Also, the new available actions comes upgrade the set of alternatives. System uses a set of analytical techniques and problem-solving methods (algorithms and heuristics) for select, evaluate and aggregate criteria. Conditions necessary in decision situation are the system capability to dynamically analyze and interpret the problem modelling in order to identify and determine significant criteria and methods (available in the knowledge base) to be proposed and used by the resolution model $P^{k}\alpha|_{t}$ in accordance with the cognitive evaluation of the operator. The decision aid process works out a solution interactively with the operator : such solution is composed of different actions on power plants to respond to the disturbance in searching the best compromise between qualitative (risks, on long-term impact...) and quantitative (technical constraints, costs...) objectives.

• **the user model** : Because the supervision operator is the decision-maker and the decision aid tool is a computer, the tool must be conceived at any stage to the end-user. The Intelligent Decision Support Systems are used to assist the operator and to be able to support and amplify the skills of the operator faced with disturbances. Function of such assistant is to complement the operator in his analyze phases and to solve problems with a good knowledge of consequences stemming from each action. It means that the system must be a help for the user during the whole decision-making process, and so we need to extract his skills and we need a modelling of his skills with the goal to help the human operator. The most important point is to integrate the end-user model throughout the design step. It means that we must have a cognitive model of end-user, specially in the knowledge acquisition phase (AUSSENAC 89). The model must include the end-user mental representation of the problem when the end-user is executing a given task (DESPRES 91). An initial technical assessment of the expert's knowledge and expertise will be necessary in order to establish whether the available knowledge representation formalism will be able to cope with the problem (CHANDRASEKARAN 87). The new perspective is to introduce 'situated cognition' as a capacity to behave adaptively within an environment, as Clancey (85) said. All these objectives must reckon with the qualitative aspect of information and so lead us to manipulate qualitative mathematic concepts in the multicriteria model. For this, AI techniques are required at several levels : (i) to construct the conceptual model in this specific domain; (ii) to extract and to model the user knowledge in order to use the criteria; (iii) to aggregate the criteria with qualitative rules.

To experiment concepts, we develop a mock-up structured in four parts (Fig.5) : (i) *the operator component* is the decision-maker, (ii) *the simulator* reproduses the French electricity production network by giving **values** in real-time (automatic regulators, disturbance and frequency), (iii) *two scenarii* reproducing real situation encountered in the past by EDF (both are composed by power plant models, and characteristics of the dysfunction) and (iv) *the supervision system* includes different functions : monitoring of the current state, diagnose the dysfunction, forecast the evolution of the network set point, and identification of potential actions. Those parts run with a simple interface. Today, the other functions are implemented with the final interface.

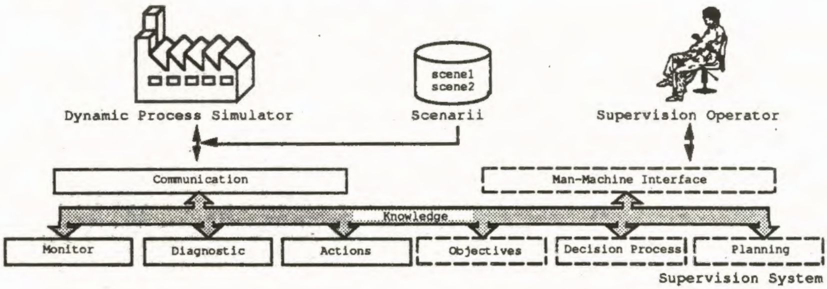

Figure 5

The mock-up is developed on VaxStation with different tools : Pascal (the simulator), CommonLisp (the supervision units), C (the dialog protocols), DataViews (the interface), and KnowledgeCraft (the knowledge representation and manipulation).

4. Acknowledgments

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