On DSS Implementation in the Dynamic Model of the Digital Oil field

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Abstract. Decision support systems (DSS), especially based on the artificial intelligence (AI) techniques are been widely applied in different domains nowadays. In the paper we depict an approach of implementing DSS in to Digital Oil Field (DOF) dynamic model structure in order to reduce the human factor influence, considering the automation of all production processes to be the DOF model clue element. As the basic tool of data handling we propose the hybrid application on artificial neural networks and evolitional algorithms.

1. The DSS in the DOF framework

The idea to apply definitely decision support systems in the oil production domain – not a full functioning automatic control system (ACS) - was born due the impossibility of the latter’s implementation (ACS face with the strict demand of rigid rules which cannot be satisfied because of the fuzzy conditions of an oil field processes).

On the basis on the conducted research results, we suppose that in general, modern DSS, applied in the DOF, provide the following classification as follows [1].

- By the interaction with the user (passive, active, cooperative);
- On conceptual level (communication-driven, data-driven, document-driven, knowledge-driven, model-driven);
- By the application field (task-oriented; hierarchical decision support systems, distributed DSS);
- By way of support (model-oriented, focused on data, focused on documents, focused on knowledge).
- that provide specialized solutions, based on facts.

Speaking on the data processing tools, in the era of Big Data [2] it is fair that software developers for oil industry apply artificial intelligence techniques, and therefore, we can talk about the application the industrial intelligent DSS. This is justified in terms of the efficiency of the results, because in this industry basic requirements to the decision support systems applied are as follows:

- work in real time, under severe time constraints on decision-making, limited computer resources and the uncertainty caused by fuzzy info input;
- continuous operation mode;
- reduction of the operator involvement in the object control;
- real time diagnostics allowing to prevent the equipment failure.

Companies that have ready-made solutions for the industry, represent the possibility of "adaptation" of standard solutions for a specific user, using (including) into the methodology development as their own unique methods and algorithms, as well as the user tested ones.
Such a situation cannot provide to the researcher "pure" state of art for the proper analysis of methods and algorithms applied.
It can be concluded that the topic of oil industry software methods is almost closed and the materials to make reliable and reasoned conclusions on are virtually absent.
In general, the structure of the DSS in the oil industry is not different from the structures of systems used in other domains.

2. The essence of the DOF framework
The basic clue of the digital oil field approach is the real time production management that is intended to somehow enhance the oil production recovery and to significantly assist the human (oil field operator, decision-maker etc).
We claim that the most vital DOF elements are:
- Data management (the level of collecting information from millions of sensors);
- Workflow automation;
- Real time decision support;
- Providing operational efficiency;
- Virtual representation of the production processes;
- Visualisation.

These points include each other either form subsets – and the basic target is to provide the total qualitative control under the oil field. The scheme of the DOF that we propose is represented on the Fig. 1.

3. DOF Dynamic Modelling

3.1. Classical approach of developing dynamic model
Dynamic modelling - is a methodology of analysis, in which the overall process is described in a mathematical model form in which all of the tasks and intermediate processes are presented as a system of interrelated indicators calculated.
The method of dynamic modelling is used most often in conditions of inability to automate an entire class of processes, related to decision support systems, and the inability to take into consideration (applying traditional systems) the multi-variance of the problems solutions.

Applying the dynamic modelling the company’s business processes are described as a mathematical model, in which all tasks are presented as a system of interrelated calculated indicators.

The particular importance is given to the overall combination of the factors, determining the successful implementation of all processes involved. So, the first step in the study the dynamic behaviour is a preliminary analysis of broad industrial aspects that contain a significant number of interactions.

The described method involves the construction of an iterative algorithm in the recursive actions simulation mode. It is peculiar - whatever the first initial decision is, all subsequent decisions must come from the state, resulting from the initial decision.

In general, the object of dynamic modelling is a system in which the processes are described by differential equations, where the system or some of its elements are replaced with a model that possesses the dynamic properties similar to the original ones. As mentioned above, the company is considered as a complicated system. In itself, the modelling provides a scientific basis, around which the controlled objects are grouped. The mathematical models apply method of establishing a causal relationship between any desired number of factors.

Models indicate as the described system will evolve in time. The history of the oil and gas industry is especially important for the dynamic simulation, in particular, that part of it which relates to the specific decisions and the facts explanation, as well as the linear theory of information systems with feedback.

Visualized model creation allows to analyze the possible various processes’ development directions, to discover and reflect the interdependence of these processes. For example, applying a dynamic modelling can provide:

• to estimate the effectiveness of space load, the usage of material resources;

• to analyze and model the impact of external factors on the efficiency of the enterprise as a whole, and in certain areas, and so on.

Dynamic modeling, integrated with strategic planning, allows to build standalone applications that solve specific problems, taking into account built-in system simulation models of processes, and to display the modelling results on the specific dashboards, used in the process of decision-making support.

3.2. Building a model, based on AI driven DSS

Taking into account the successful experience of industrial application of the DSS, based on the artificial intelligence (AI) techniques, such as neural network approach in hybrid combination with evolutionary algorithms (genetic algorithm) approach we propose to withdraw the long and sophisticated process of building a ‘classical’ dynamic model from the oilfield production process control and to introduce the DSS (subset of DSS’s) into the DOF structure (see the Fig. 1).

The idea is as follows. On the basis of the retrospective data, stored in the databases, we train the core of the the system. We apply the methods, depicted in [4][5][6].

After the process of the training is over, the profile of the system is generated and we start to handle the oil production information in real time. Since we apply the approach of implementing DSS, the operator has the opportunity to correct the decisions, made by the core of the system and to initiate the process of post-training (retraining). So, we assume because of the fact of corrections of DDS inference, there is a linear dependence on the terms of DSS industrial exploitation and the quality of solutions, offered to the users.

4. Acknowledgment

This paper is published due the financial support of the Russian Science Foundation (RSF) via the grant No 15-19-00196.
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