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Some aspects of modeling in the planning and analysis of development

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Abstract. The development of solutions, the selection of technologies to ensure the target levels of production and recovery of reserves require a reliable basis for research – qualitative data and adequate models that have acceptable predictive power. At the same time, the choice of approaches and tools for solving practical problems of development management should depend on the characteristics of the associated processes that determine the requirements for the result, resource constraints, the complexity of the description of the control object, and so on.

The authors of the article offer a review of the experience of applying the hierarchy of models within the technological chain of substantiation of operational decisions on the selection of geological and technical measures. The use of different-level models in the context under consideration makes it possible to obtain reliable estimates of the effects of activities in conditions of time-bound and labor-intensive constraints allocated to the solution of the problem.

Keywords: model hierarchy, selection of geological and technical measures, management of field development, technological decision support chains, down scaling

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The procedures for the selection and justification of geological and technical measures require periodic updating, changes and optimization of business processes. The influence of external and internal factors (deterioration of the structure of reserves, old assets, decrease in the efficiency of capital investments, etc.) prompts to look for more effective solutions, both in terms of cost optimization, and in terms of obtaining a cost-effective technological effect. The period of significant increment in additional production obtained through time-tested decisions inevitably ends, and in order to maintain production levels at the target level, research and development of new opportunities are necessary. At the same time, the development of solutions, especially for "complex" geological and technical measures (for example, aimed at additional recovery, development of hard-to-recover reserves), takes time; it is necessary to take into account that the maximum effect from the replication of technology can be obtained only after working through a whole complex of organizational, methodological, and technical issues.

To optimize the process of introducing new technologies, it is advisable to use the so-called proactive engineering support, which is:

- Formalization of procedures for the selection of new technologies;
- Adaptation and unification of the methodological support of the process;
- Making relevant changes in business processes;
- Development of auxiliary IT automation tools;
- Procedures for staff retraining and knowledge transfer.

Figure 1 shows a schematic mapping of the characteristic duration of engineering support stages in comparison with the potential effects provided by geological and technical measures of various levels of complexity.

It is obvious that adequate and reliable reservoir models are required as a basis for research in order to reproduce various scenario impact conditions.

Let us consider several levels of management of the field development process, where numerical experiments are required to obtain justifications for the decisions made (Fig. 2).

Selection and justification of a field development strategy. At this stage it is important to receive a fundamental answer about the potential profitability from the operation of the facility, to identify key design solutions. The stage is characterized by the creation

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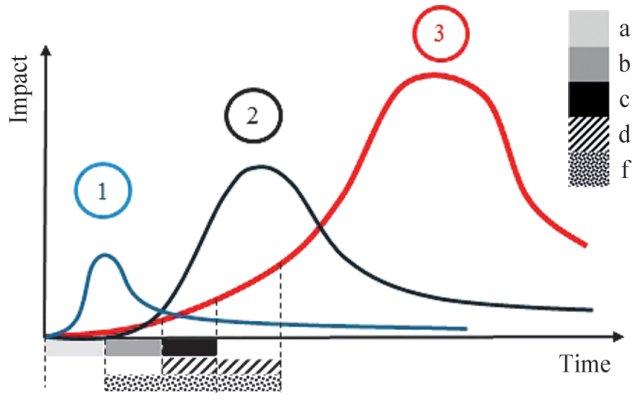

Fig. 1. Stages of engineering support for geological and technical measures of various levels of complexity. 1 – "Easy" geological and technical measures on optimization of technological potential; 2 – geological and technical measures to increase the productivity index of hydraulic fracturing, introduction; 3 – geological and technical measures for the development of non-drained reserves of vertically inclinded wells, side-tracks. a – selection of technologies, b – development of methods, c – adaptation of processes, d – adaptation of tools, e – training of personnel

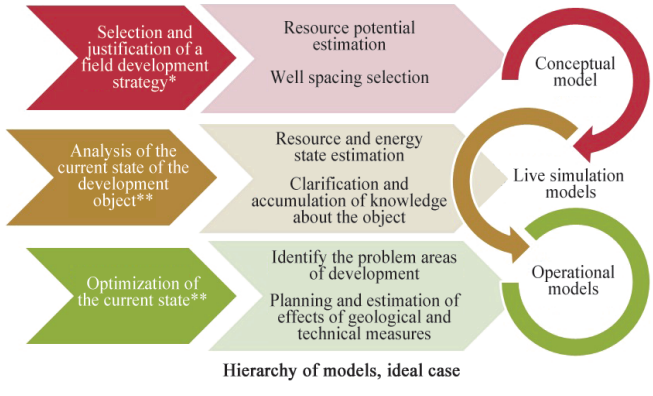

*Fig. 2. Levels and objectives of development management. * Strategic management level. ** Operational level of management (monitoring)*

of conceptual hydrodynamic models, multivariate calculations, long-term forecasts.

Analysis of the current state of the development object. At this stage, monitoring of the implementation of design decisions, clarification and accumulation of knowledge about the object are conducted. The stage is characterized by the creation and adaptation of operational models reflecting the resource and energy state of the object.

Optimization of the current state. At this stage, problems that reduce the effectiveness of development management are identified, and comprehensive preventive measures are taken to influence the reservoir in the form of a program of measures aimed at achieving the target indicators. The stage is characterized by the creation of predictions of potential effects from exposure to justify the geological and technical measures.

Thus, ideally, a hierarchy of models with different levels of detail should be created at different levels of development management, ensuring consistent simulation results that complement each other. Unfortunately, the expected value of the simulation results in reality can be extremely low. There are a number of significant, in our opinion, reasons for this:

- the complexity of the models used does not match the quality of the input data: high uncertainty and large errors in the initial information inevitable lead to erroneous estimates;
- the choice of methods, by which the problem is solved. takes place without a preliminary assessment of time and labor resource costs, and also without a clear idea of the degree of accuracy of the result, which will be enough to get a satisfactory answer;
- there are organizational gaps in the interaction of services that deal directly with the modeling processes (as a rule, these are dedicated project groups) with the services of potential end users interested in getting a practical result (these are development planning and production control services). The modeling process occurs independently and in isolation from the tasks associated with practical solutions for managing development.

In order to increase the effectiveness of model experiments, in our opinion, it is necessary:

- consider models as an integral part of the chain of analysis, justification and decision making;
- for each stage of analysis and decision making, use an adequate class of models that ensures the required accuracy of the result with acceptable time costs;
- ensuring the quality of the source data should be an obligatory stage of work, within which a reliable base for modeling is created.

Table 1 shows an example of the technological chain of measures justification and proposed acceptable level of detail for the models.

The effectiveness of the approach to the use of multi-level models is implemented today in modern oil and service companies. A number of examples of successful cases have been published in sources (Shigapova, Nugaeva, 2016; Khatmullin et al., 1999, 2015; Programmnyi kompleks «NGT Smart», 2010; Kostrigin et al., 2009, 2010; Khasanov et al., 2009 Khatmullina et al., 2014; Zagurenko et al., 2013).

Based on the analysis of the positive experience of using this approach, we can conclude about the viability of the practice of applying multi-level models in the context of business decision-making processes in the field of planning and analysis of development. At the same time, the principle of "down scaling" (a gradual increase in the complexity of models as we check the adequacy of the results obtained on simpler models) in many cases reduces the labor costs for creating and maintaining full-scale 3D models. Replication and adaptation of the approach to the use of the hierarchy

	Stages of technological chain	Function	Acceptable level of detail
1	Data collection and analysis	Check of data reconciliation	0-2D
2	Analysis of the current state of object	Creation of actual view of the current resource and energy state of the deposit	2D models Integral 3D
3	Problems diagnostics		
4	Decision making	Prediction of treatment effect	Detailed 3D
5	Experience accumulation	Post evaluation, error corrections	Hierarchy of models

Tab. 1. Technological chain of substantiation of operational activities

of models in different technological chains will allow, in our opinion:

- adjusting the data verification (reconciliation) processes to create a reliable decision-making base;

- optimizing the decision-making process in the field of oil production: improve the reliability of the estimates obtained while reducing the cost of decision development.

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