The Development of the Software to Optimize Geophysical Field Oil and Gas Exploration

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Abstract: The quality of planning and the results of geophysical oil and gas exploration largely affect the efficiency of exploratory research, the quality of static models and, ultimately, the efficiency of oil-and-gas fields operation. One of the ways to improve the quality of geophysical exploration is the use of specialized software at its planning stage. In this work the analysis of the existing software in the scope of geophysical exploration planning is made; the urgency of development of the given class software on the basis of Russian package is noted. The ways of development of the software to optimize geophysical field oil and gas exploration are suggested.

1. Introduction

The quality of planning and the results of geophysical oil and gas exploration largely affect the efficiency of exploratory research, the quality of static models and, ultimately, the efficiency of oil and gas fields operation. The methods, which enable to enhance geophysical exploration, comprise such ones as the use of modern information technologies, including specialized software, at the stage of exploration planning.

In this article, based on the analysis of the existing software products to optimize geophysical field exploration, development of Russian package of application software PLEKS used in geophysical oil and gas exploration planning, is suggested.

2. Research

Today the information technology market comprises the products in the scope of geophysical exploration planning, which contain both similar and partly different functions implemented at different technological levels. For example, the software products of such companies as ION (MESA), GeoSeisControl (Pikeza) and others are well known. Let us regard them in detail.

MESA is a software product designed for planning seismic acquisition. It was developed by GreenMountainGeophysics Company, which in 1997 was in turn acquired by ION.

MESA is used in onshore and offshore projects to optimize the exploration scheme and plan. Its advantage is clear, user-friendly interface. The main functions of the product are [1]:

- exploration planning and analysis of the subsurface area coverage for 3D/3C seismic survey;
- static modeling, ray tracing and illumination analysis;
- chronological tracking of the project and statistics of seismic crews'work.

The MESA software packages complex includes:

- MESA Field is ideal for planning three-dimensional seismic survey on the basis of advanced technologies with the use of the basic analytical package;
- MESA Professional provides for a full set of tools for planning and analysis of three-dimensional full-wave survey;
- MESA Expert is a tool for planning three-dimensional surveys with maximum opportunities including static modeling and enhanced ray tracing.

This product is one of the most popular in its segment and is used in many large geophysical companies.

The Pikeza software package has been developed by CJSC NPTS "GeoSeisControl" since 1999 and is positioned as the software for planning and methodical-technological control of field seismic surveys [1].

The Picasa-4 package, as well as MESA, is widespread in Russia and is used in many projects. An example is the work [2], which describes the technologies which enabled to obtain high-quality results despite the occurrence of the survey target under complex natural, landscape and administrative conditions.

The Pikeza-4 version comprises a number of software, including those intended for [1]:

- survey plan visualization, color charts, seismic SEGY files viewing; control of design parameters;
- conversion of maps, association of maps;
- common points coordinate transformation;
- coordinates and heights generation, which performs the functions of data interpolation and data separation with a specified interval.

There are other software products in this area, for example Gedco Omni and Tessaral, enabling model calculations for planning areal shooting schemes.

At the same time, there are less known products in this field, for example the PLEKS application software package (ASP).
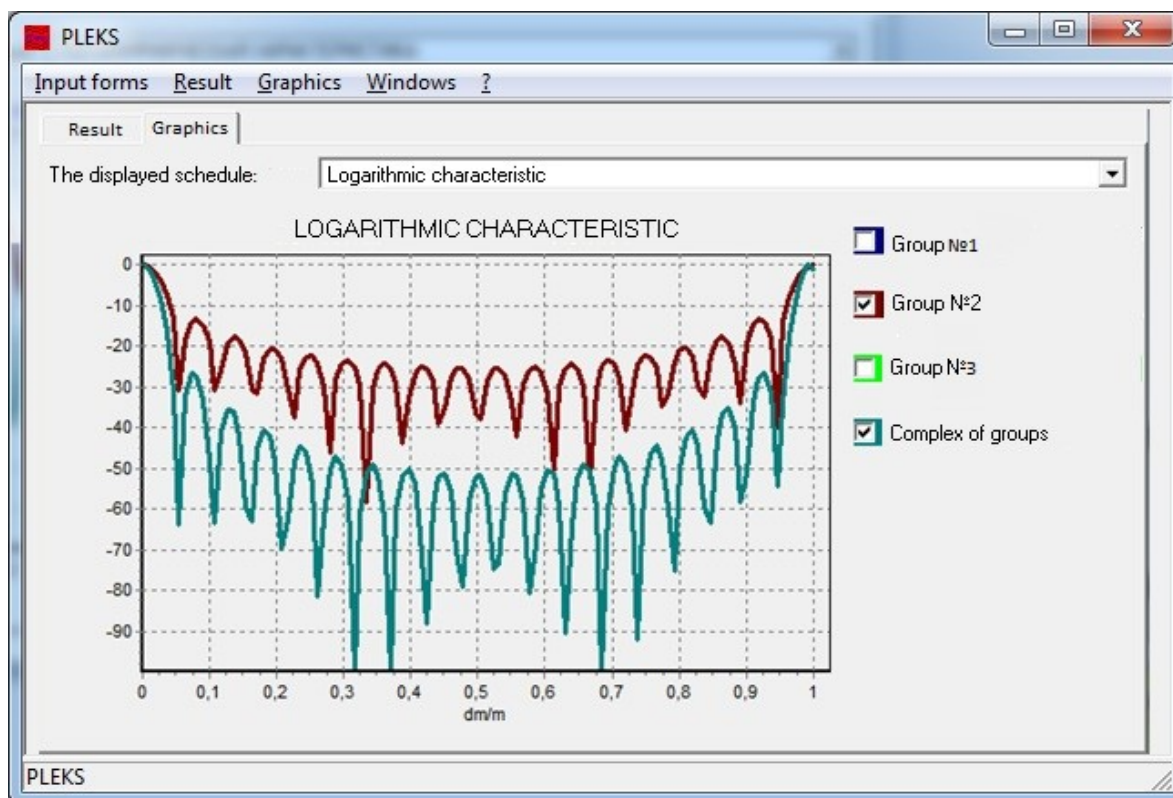
The PLEKS ASP is a system of scientific research type, designed to optimize seismic exploration, related to calculation and analysis of interference systems and networks. The package is designed for use at the stage of seismic operations planning, and enables task setting, solving and evaluating the efficiency of solving the task.

The algorithmic content of the PLEKS package can be regarded as an advantage. The following functions have been implemented here:

- evaluation of the areal shooting scheme noise immunity in three-dimensional seismology methods.
- rendering of optimal shooting schemes of the three-dimensional seismology method.
- calculation and rendering of KND diagrams characterizing the potential noise immunity of the grouping complex in the three-dimensional seismology method;
- calculation of spectral and integral characteristics of both individual groups of free structures and their complexes;
- summation of the seismic field, both synthetic and experimental according to the grouping law with selected parameters;
- calculation of optimized parameters of the groupings, etc.

Special attention was drawn to adaptation of the package to the South of the Tyumen region. A distinctive feature of these areas, in contrast to the sparsely developed Northern territories, is the occurrence of a large number of engineering facilities (roads, settlements etc.). This circumstance restricts the operation of regular survey network, as well as the application of certain research methods. The activity of the engineering facilities is an additional source of hindrances that must also be considered in planning and implementation of geophysical exploration. Under such conditions use of piecewise-regular and irregular survey networks is the most appropriate variant.

The main disadvantage of the package is its level of technological development, inferior to other modern packages of this class. To date, the package is the software, implemented for the Windows operating system that enables to enter data as numbers and the text, and present the results in the form of the text and numbers, graphs (Figure 1), diagrams and maps.
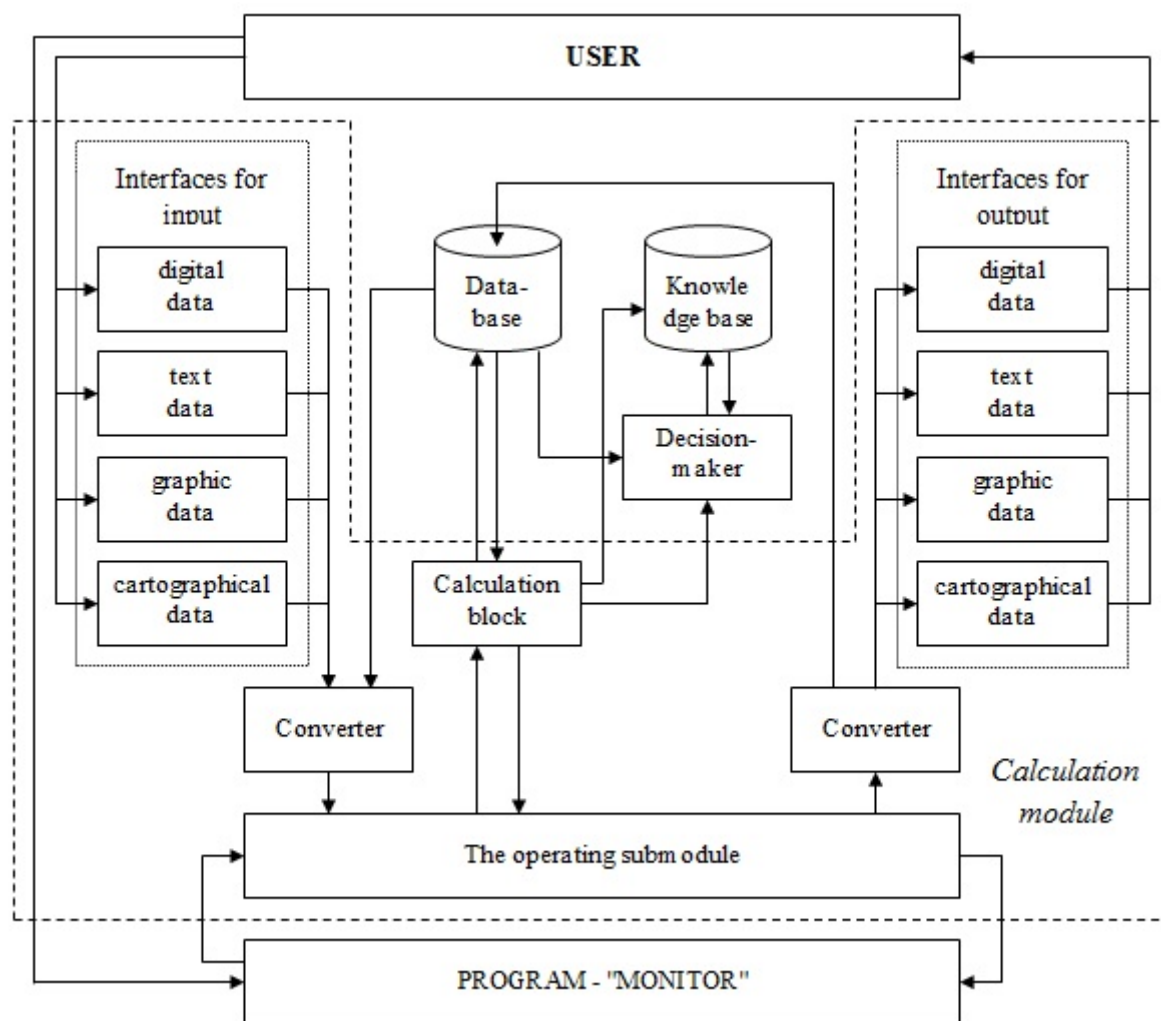
Figure 1. Example of calculation result as a graph.

When adapting the package to the modern technological level the following basic principles have been formulated:

1) the whole calculation part is implemented in Fortran and C and is used in the new version of the software "as it is", i.e. without changes. This will enable to speed up the process of adapting the software and avoid the occurrence of errors in previously debugged code. It is implemented as **dll**;

2) all interfaces are developed using modern tools and principles of programming;

3) the control module, which is a software shell, is responsible for the interaction between calculation parts, data and interfaces. It is the software shell which displays different interfaces, launches the calculation module and provides for data exchange between them.

As a result, the architecture implemented in the latest version of the PLEKS package (Figure 2), enables further development of the package and includes the following elements:

1) the program-monitor for launching the required calculation module;

2) the database and knowledge base, necessary for normal operation of the software and storage of the source and result data;

3) the decision maker, providing for methodological support of work with the package;

4) calculation modules designed to solve specific application tasks.

Figure 2. Generalized architecture of the PLEKS software complex.

Such architecture enables to present the package as a kind of shell in which calculation modules are built. This approach enabled to create a package using both the existing software libraries that were part of the earlier versions of the product, and newly developed software modules created using new tools.

The advantage of this architecture is the flexibility of the developed software product that will enable its further development in the future.

The knowledge base and the decision-making block, along with a functional content, is a distinctive feature of the package and enables to accumulate experience and knowledge and effectively use calculation modules in the solution of practical problems. The decision-making block can be used both when solving weakly-formalized problems and building the solution graph by using the existing software modules. When developing this module the experience of creation and use of expert systems for solving problems in various fields of activities is taken into account. For example, in one such work [3] the issue of development of neural expert systems, in which, apart from other things, neural networks are used, was considered.

The development of the new version of the package was carried out using the principles of object-oriented approach. Given that it was based on the existing mathematical apparatus, implemented in earlier programming languages, the paradigm of object-oriented programming was adopted to implement the possibility to present data in different forms, depending on the user's needs at a specific

point of time. This approach is relevant due to the fact that the basis of geological and geophysical software is often made up of complex algorithms, often developed based on authors' methods, but they may not have a user-friendly graphical interface satisfying the user. This issue, in terms of the software under study and other tasks in Geology and Geophysics, is presented in the work in more detail [4].

Thus, taking into consideration the urgency of further development of the software to optimize geophysical field oil and gas exploration, as well as the importance of development of domestic technologies in Russia, the development of the PLEKS package for planning and quality assessment of geophysical oil and gas exploration appears expedient.

The tasks to be solved are:

a) adaptation of the package to the modern technological level;

b) development of the algorithmic content of the package based on the analysis of the existing software of this class.

In this case a top priority task, according to the authors, is precisely the technological development of the package. So, within this task, apart from other things, we are to determine the most appropriate technologies and tools for the development of the package, as well as the architecture, which will enable painlessly add modules with new algorithmic functionality.
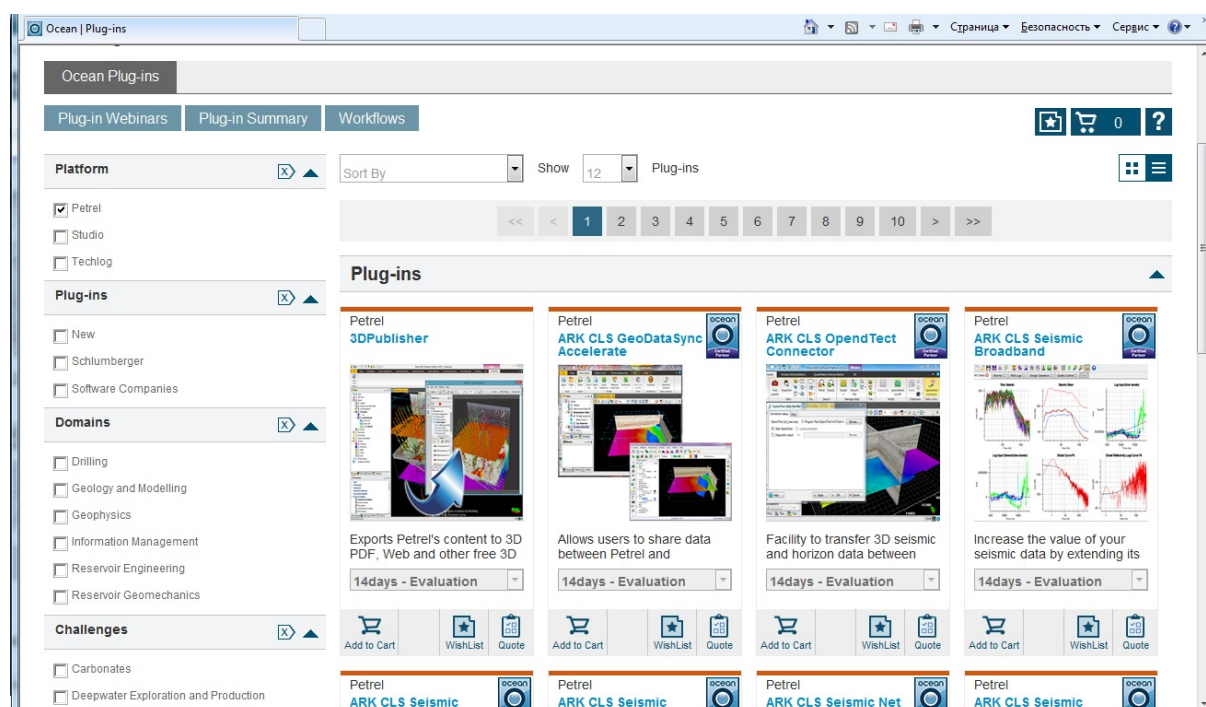
The development of specialized software can be implemented as both a separate software package and a module (modules) supplementary to the existing specialized software.

In case of the development as a separate software complex the resulting product will be independent and will not require any additional specialized software. The implementation can take place using one of the existing integrated software development environments such as Microsoft Visual Studio or Embarcadero RAD Studio.

Implementation as a supplementary module can be performed, for example, for Petrel of Schlumberger.

Petrel is an integrated platform that provides users with the ability to cope with various challenges from seismic interpretation to dynamic modeling [1]. To develop additional subroutines and launch them directly in Petrel a specialized development environment Ocean is used.

Ocean enables to create a variety of plugins for the Petrel complex. The plugins themselves can then spread among the users of the system. Plugins created by other developers may also be purchased and used. There are a number of works devoted to the subject, where, for example [5], we consider the development of a plugin for automatic correlation of well sections. Some plugins developed by both the very company and third-party developers, are presented on the site of Ocean Store (Figure 3).

Figure 3. Site of Ocean Store.

Apart from Petrel there are other similar products. One of them is Russian software complex TimeZYX, developed by the TRAST Information Technology Laboratory. This complex is designed for static and dynamic modeling and monitoring of oil-and-gas field development.

TimeZYX is represented by three blocks of application modules on the single open platform of the same name: static modeling, dynamic modeling, monitoring and optimization of field development. Great attention is paid to the design and development of software intended for automation of the processes of formation, storage, verification and transmission of the output geophysical data in various formats to third parties [1]. Among the articles dedicated to this software product, we can emphasize the work [6], which considers the current domestic software system of the DV series that are intended for 3D seismic and static modeling, entering the line of software modules of the open platform TimeZYX. Their specification is given in comparison with major foreign analogues. It is shown that their application by specialists in various fields at all stages of geological-geophysical exploration and development of oil and gas fields, as well as in building of regional static models enables to efficiently perform a comprehensive analysis of multidisciplinary data and obtain three-dimensional static and dynamic models.

However the TimeZYX system does not provide for a tool for the development of functionality through independent development and introduction into the routines complex.

3. Conclusion

Thus, in this paper the expediency of the development of the PLEKS software for planning and assessment of the geophysical field oil and gas exploration quality has been proved. Other existing software products of this class have been reviewed. Possible ways of development of the application software have been observed.

Based on the analysis of the material the following conclusions have been made:
- to plan geophysical field exploration mainly imported software is used;
- at the same time, there are domestic products which are of certain interest;

- further development of the software to optimize geophysical field oil and gas exploration on the basis of the PLEKS package is suggested;
- the development should go the two following ways: as a separate software product, and as an adaptation of individual modules to the existing systems of static model quality assessment.

References
[1]   Turenko S K and Akhmadulin R K 2015 Development of the software to optimize geophysical field oil and gas exploration *Geology, geophysics and development of oil-and-gas fields* **8** 30-3

[2]   Leontiev I V and Krutov A L 2016 Conquest of Siberia, or seismic survey in the delta of the Yenisei river *Oil. Gas. Innovations* **1** 30-4

[3]   Bakanovskaya L N 2015 Revisiting the development of neural network expert systems *Materials of the XI International scientific and practical conference "Conduct of modern science" Economic science* **3** 11-14 DOI:org/10.17686/sced_rusnauka_2016-1785.

[4]   Ahmadulin R K 2016 Experience of applying the principles of object-oriented programming when developing applications in Geology and Geophysics *Automation, Teleautomation and Communication in Oil Industry* **1** 38-42

[5]   Lapkovsky V V, Istomin A V, Kontorovich V A and Berdov V A 2015 Correlation of well logs as a multidimensional optimization problem *Russian Geology and Geophysics* **56(3)** 487-92 DOI: 10.1016/j.rgg.2015.02.009.

[6]   Larin G V 2010 Effective computer tools of the Geologist and Geophysicist in the Exploration of Oil and Gas Fields *Geophysics* **3** 3-15