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JUSTIFICATION OF THE EFFECTIVENESS OF SOFTWARE FOR THE DESIGN OF OPEN-PIT MINING

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JUSTIFICATION OF THE EFFECTIVENESS OF SOFTWARE FOR THE DESIGN OF OPEN-PIT MINING

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Abstract: *The article notes that the economic feasibility of implementing a project based on deposits directly affects the economy of the country and the region, as well as the construction of new facilities, the use of the most balanced approaches and design solutions in a complex will allow*

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achieving the set goal of increasing production volumes and bringing the enterprise to a new level of development. In order to achieve the above goals, it has been proven with the implementation of investment projects using software for the design of open-pit mining, it is possible to further develop the region, agriculture with appropriate infrastructure for the development of cities and rural settlements and additional jobs will be created, which will provide favorable conditions for the growth of living standards, income growth of the population. The Alastri software product is presented, which is applicable for planning open-pit mining operations, which implies a large cycle of technological processes. An analysis was performed during the design of quarries using software that pays special attention to determining the optimal contours of the quarry and drawing up a calendar for ore mining, which show the feasibility of mining a mineral deposit.

Keywords: *feasibility study (feasibility study), feasibility study (TER), working draft, design estimates, quarry, design, optimal contour of the quarry, mining complex.*

Annotatsiya: *Maqolada, konlar asosida yirik loyihalarni amalga oshirishning iqtisodiy maqsadga muvofiqligi mamlakat va mintaqa iqtisodiyotiga bevosita ta'sir qilishi, shuningdek yangi ob'yektlarni qurish va loyihaviy yechimlardan foydalanish ishlab chiqarish hajmini oshirish va korxonani yangi rivojlanish darajasiga ko'tarish maqsadiga erishishga imkon berishi ta'kidlangan. Yuqorida aytib o'tilganlarga erishish maqsadida ochiq konlarni loyihalash uchun dasturiy ta'minot yordamida investitsiya loyihalarini amalga oshirish bilan mintaqani, shaharlar va qishloq aholi punktlarini rivojlantirish uchun tegishli infratuzilmaga ega qishloq xo'jaligini yanada rivojlantirish imkoniyati paydo bo'ladi va qo'shimcha ish o'rinlari yaratiladi, bu esa aholi daromadlari va turmush darajasini o'sishi uchun qulay shart-sharoitlarni ta'minlashi isbotlangan. Maqolada Alastri dasturiy mahsuloti katta texnologik jarayonlarni nazarda tutuvchi konlarda ochiq kon ishlarini loyihalash va rejalashtirish uchun qo'llanishi keltirilgan. Dasturiy ta'minot yordamida karyerlarni loyihalashda foydali qazilmalar konini qazib olishning maqsadga muvofiqligini ko'rsatadigan eng maqbul karyer konturlarini aniqlashga alohida e'tibor berish va ruda qazib olishni rejalashtirishni amalga oshirish kabi tahlillar keltirilgan.*

Kalit so'zlar: *texnik-iqtisodiy asoslash (texnik-iqtisodiy asoslash), texnik-iqtisodiy hisob-kitob (texnik-iqtisodiy hisob-kitob), ishchi loyiha, loyiha-smeta hujjatlari, karyer, loyihalash, karyerning optimal konturi, konchilik kompleksi.*

Аннотация. *В статье отмечены что экономическая целесообразность реализации проекта на базе месторождений напрямую влияет на экономику страны и региона, а также строительство новых объектов, использование наиболее взвешенных подходов и проектных решений в комплексе позволят достигнуть поставленной цели по наращиванию объемов производства и выходу предприятия на новый уровень развития. Для того чтобы достичь вышеуказанные цель доказано с реализацией инвестиционных проектов с помощью программного обеспечения для проектирования открытых горных появляется возможность дальнейшего развития региона, сельского хозяйства с соответствующей инфраструктурой для развития городов и сельских поселений и будут созданы дополнительные рабочие места, что обеспечит благоприятные условия для роста жизненного уровня, роста доходов населения. Представлены программный продукт Alastri которые применимый для планирования отрытых горных работ, что подразумевает собой большой цикл технологических процессов. Выполнен анализ при проектировании карьеров с помощью программного обеспечения которые особое внимание уделяется с определением оптимальных контуров карьера и составлению календарного планирования добычи руды, которые показывают целесообразность отработки месторождения полезных ископаемых.*

Ключевые слова: *технико-экономическое обоснование (ТЭО), технико-экономический расчет (ТЭР), рабочий проект, проектно-сметная документация, карьер, проектирование, оптимальный контур карьера, горнодобывающий комплекс.*

Introduction

In order to industrially develop mineral deposits by attracting foreign investments, promote the increase of geological exploration works, and implement the Resolution of the Cabinet of Ministers of the Republic of Uzbekistan dated June 23, 2020, No. 403 "On measures to further improve the licensing procedure for subsoil use," 34 strategic types of mineral deposits were put up for auction. By the Decree of the President of the Republic of Uzbekistan No. UP-6319 dated October 6, 2021, "On measures to further stimulate geological exploration works and improve the taxation procedure for subsoil users," a special procedure was established from January 1, 2022, for offering the right to use a subsoil area for geological exploration or extraction at previously explored subsoil areas of hydrocarbons, precious, non-ferrous, rare, and radioactive metals, and other types of mineral deposits with significant commercial potential for competitive bidding [1, 2].

Methods and materials

Meeting all the conditions for the efficient development of mineral deposits requires detailed

pre-project and project documentation. The development of pre-project and project documentation is carried out according to the Resolution of the President of the Republic of Uzbekistan No. 332 dated July 25, 2022, "On measures to further improve the procedure for conducting expertise of pre-project documentation for investment and infrastructure projects, procurement documentation for tenders, technical specifications for public procurement, and contracts" [3].

The Resolution stipulates that projects are developed in the following options:

- Development of the Feasibility Study (FS)/Preliminary Economic Calculations (PEC) of the project followed by the development of the working documentation of the project;
- Development of the working project.

The development of the above-mentioned projects is carried out by a design organization based on an approved technical specification that has passed expertise at the State Unitary Enterprise "Center for Comprehensive Expertise of Projects and Import Contracts" under the Ministry of Economy and Finance of the Republic of Uzbekistan.

Currently, the republic is gradually developing small deposits with ore reserves of less than 5 million tons, which lie shallow from the surface, and it is economically advantageous to work them using open-pit mining methods. Significant advantages of open-pit mining over other extraction methods (such as underground mining) include the ability to organize safe mining operations, low capital and operating costs, unlimited possibilities for using high-performance mining and transportation equipment, and a more complete extraction of minerals from the subsoil [4, 5].

At the same time, the practical implementation of these advantages of open-pit mining requires project solutions, the application of scientific methods, and modern technical and technological tools. The quality of project planning and all technical decisions made within it determine the economic viability and the entire fate of the mining enterprise as a whole [6, 7].

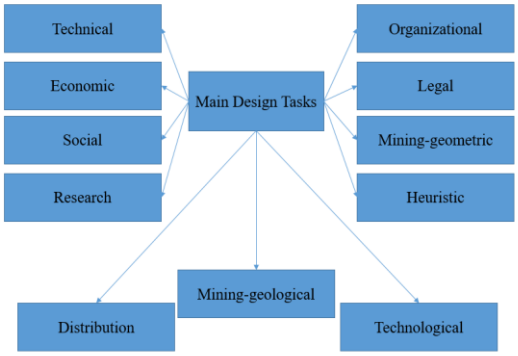

Fig. 1. Systemic complex of the main tasks in open-pit design

Incorrect and insufficiently justified design decisions and their implementation lead to a significant decrease in the efficiency of open-pit mining and deposit development [8].

The design of mining and ore processing enterprises includes sections such as:

- Geological section;
- Mining section;
- Mining-mechanical section;
- Processing section;
- Tailings management;
- Master plan and transportation;
- Infrastructure (power supply, water supply, heating, etc.).

In the mining section, the design of the open-pit mine is included. The process of open-pit mining design, particularly for open-pit mines, involves the justification of technical and technological decisions, economic efficiency, environmental and industrial safety of constructing a new or reconstructing an existing open-pit mine, determining its key parameters, and major economic indicators [9, 10].

The design of an open-pit mine, as part of a mining complex, consists of the following stages:

- Designing the development of the deposit (scheme, system, and method of development);
- Designing transportation routes and communication schemes;
- Designing the development of the open-pit mine's working horizons;
- Justification of the volumes and timelines for carrying out capital and preparatory mining (construction) works;
- Designing the technology and comprehensive mechanization of open-pit mining;
- Designing the permissible environmental impact of open-pit mining;
- Designing the technological processes for mining operations and auxiliary systems of the open-pit mine;
- Designing the infrastructure (power supply, water supply, heating, etc.);
- Designing the master plan of the open-pit mine, etc.

Depending on the complexity of the project, geological conditions, decision-making sequence in the design process, and other factors, the content and order of presentation of the project's sections may differ from what is outlined above. However, it is important to note that each section must include initial data, a task statement, a brief description of proposed solution options, justification of the criteria for comparison and selection of the most rational option, and a detailed elaboration of the chosen option, proving its economic efficiency, technical feasibility, and environmental and industrial safety [11].

Currently, in modern design, all project tasks are solved (from 3D modeling of deposits and assessment of their reserves to planning, design, management of mining operations, and product quality indicators at enterprises) using various software programs.

Today, there are about a dozen software programs available for effectively solving the tasks of open-pit mine design. Their functionalities are similar, but the choice of one among several possible programs for automating mining-geometric calculations and optimizing mining management requires in-depth analysis. For example, the Micromine software is widely used globally and constantly improves its innovative products for the mining industry. These products include Micromine Nexus, Geobank, Origin, Beyond, Alastri, Spry, Pitram, Precision Mining. Among them, Beyond, Alastri, Spry, and Pitram are used for open-pit mine design (Fig. 2) [12, 13].

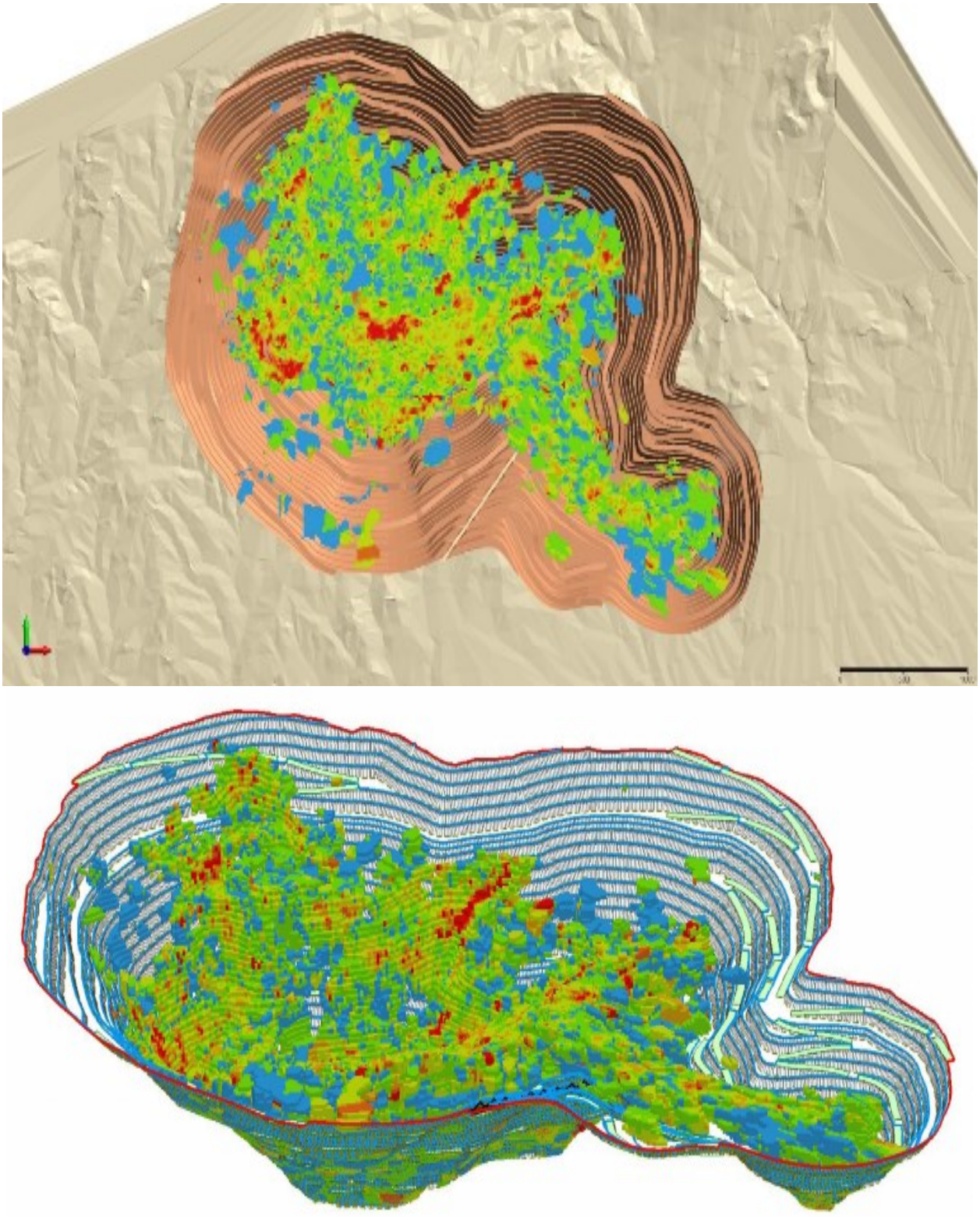

Fig. 2. 3D open-pit mine design

The Beyond software product is used in the design process to optimize both open-pit and underground mining operations. The platform allows for the creation of reliable mining plans that ensure maximum profitability while considering real-world constraints for mines.

Results and discussion

The Alastri software, applicable for open-pit mining planning, encompasses a large cycle of technological processes. Depending on the required level of detail in the schedule, it is possible to calculate parameters for drilling and blasting, excavation, transportation, waste dumping, stockpiling, and many other processes and operations of the enterprise. The interface window is shown in Fig. 3.

The planner covers a comprehensive range of detailed solutions, from the start of excavating rock with an excavator to dumping or stockpiling. The program allows for quick calculations of various planning scenarios. The interface window is shown in Fig. 3.

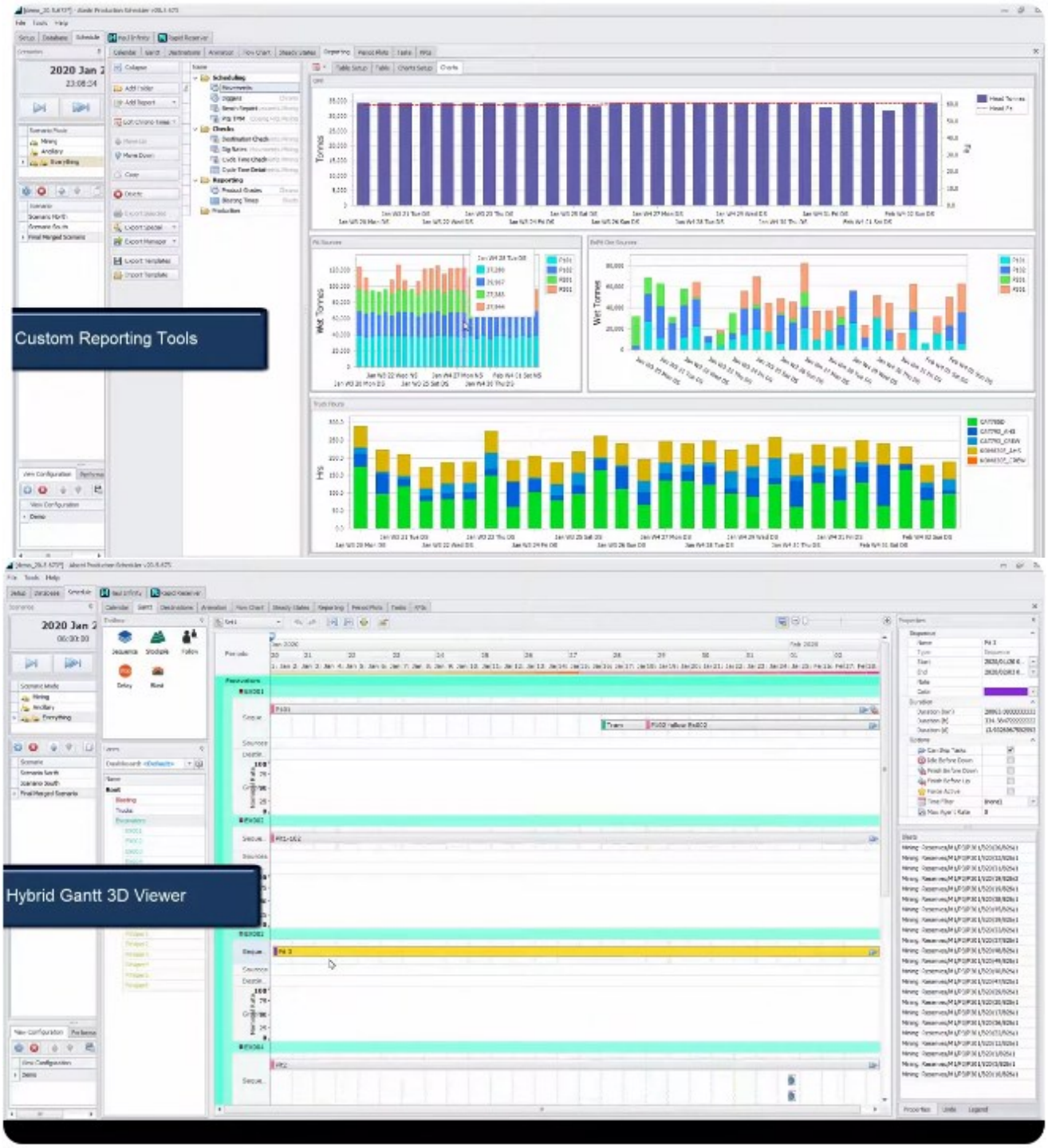

Fig. 3. Interface window of the Alastri software product

In mining operations, not only equipment is involved, but also people, materials, technologies, and automated systems. Micromine Pitram integrates all the data related to these components to create a complete real-time operational overview and provides valuable information to dispatchers or other employees of the mining enterprise. This leads to increased production volumes and significant cost reductions. The interface window is shown in Fig. 4 [14, 15].

When designing open-pit mines using software, special attention is paid to determining the optimal pit contours and developing a mining schedule, which demonstrates the feasibility of extracting mineral deposits [16].

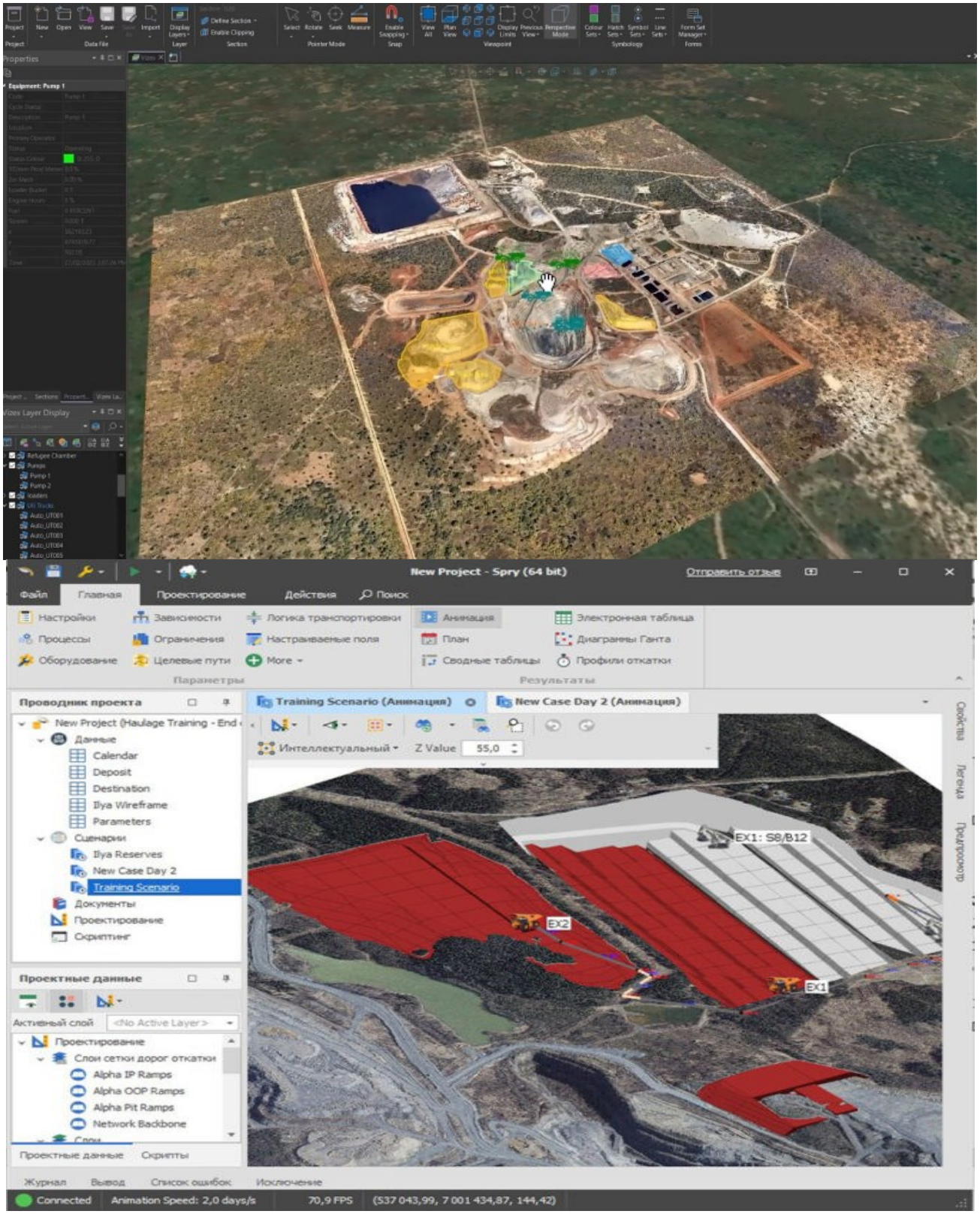

Fig. 4. Interface window of the Spry and Pitram software products.

When determining the optimal pit contours, the following tasks are performed:

- Construction of optimal pit contours with various parameters and economic indicators for mining;
- Determination of the economically justified final depth of pits;
- Sensitivity analysis of changing parameters that affect the economic performance of the optimal pit contour, among others.

In the pit planning process, the following tasks are completed:

- Selection of the most rational direction for the development of mining operations in the pit;
- Automatic selection of the rational direction for mining operations;
- Consideration of time parameters and interdependencies in the operation of excavator faces and unloading points;
- Planning of the work for the loading and transportation complex;
- Comparative analysis of planned and actual performance indicators;
- Planning the work parameters of excavators considering their technical condition and the quality of the ore in the mining faces, among others [17].

Conclusion

In conclusion, it can be stated that the Beyond software product, which ensures maximum profitability while considering real-world constraints for mines in the design and optimization of open-pit and underground mining operations, allows for the creation of reliable mining plans. The Alastri software, applicable for open-pit mining planning, encompasses a large cycle of technological processes, allowing the calculation of parameters for drilling and blasting, excavation, transportation, and many other processes. The Spry software used for mine planning enables the rapid creation of various scenarios for mining and dumping operations, while the Pitram software enhances management control at mining enterprises and helps improve enterprise management through consolidated reporting, planning, and optimization.

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