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DIALECTICAL CONTRADICTIONS IN DEVELOPMENT AND IMPLEMENTATION OF INNOVATION INTELLIGENCE POTENTIAL IN MINING ENGINEERS

Dialectical contradictions generating problems in performance of coal mines are the strategic landmarks in the creative research and innovation activity of mining engineers. Striving for success involves resolving of dialectical contradictions in the development and implementation of innovation intelligence potential in mining engineers as a governing factor of innovation fruitfulness.

The dialectical contradictions in the development and implementation of innovation intelligence potential at the stage of innovation creation are discussed. At this stage, it is required to resolve contradictions in thinking of a mining engineer. A breakthrough arises from breaking stereotype vision and from pushing and overshooting the limits of the prevailing way of thinking. The procedure is developed for the need–can contradiction resolution and creativity intelligence buildup in an engineer to form the innovation potential which is a way toward the breakthrough thinking and original decision-making.

The contents and nature of contradictions at the stage of innovation implementation originate from the specific performance of an engineer, and from such intelligence properties as vision, power and will. The approaches and means used by the outstanding Soviet mining engineers–innovators to overcome contradictions and implement inventions are described. In the present-day conditions of the Russian coal mining industry, the fruitful integration of innovation and promotion skills can form an exclusive innovation intelligence potential in a mining engineer, which is of specific value for both the person and mining company.

Keywords: *coal mine, mining engineer, novelty, innovation, dialectical contradiction, development, innovation intelligence potential, innovator, conservative, creation, introduction.*
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Introduction

Many researchers address the issues of innovative thinking development in mining engineers. These researches aim at valuation and expansion of human capital assets of coal mining companies, and at motivation and encouragement of personnel [1–4]. Investment and efficiency of investment in human capital assets of coal mining companies is audited [5, 6]. The guidance of the personal and corporate development of mine personnel is developed [7–11]. Some functions and structure of innovation intelligence potential of mining engineers are revealed [12]. The innovation intelligence potential of a mining engineers is understood as the level of the reason and creativity of intelligence toward organizational and technological innovations in combination with the power and will to implement these innovations in actual subsoil use [12].

The dialectical contradictions in technology and economy, which impede advancement of modern coal mining are disclosed in [13]. **Figure 1** depicts the hierarchy of the major dialectical contradictions.

The revealed contradictions in the coal mine performance serve landmarks in creative search and innovation activity of mining engineers. Moreover, they can be the criteria of innovation capability of a mining engineer. The higher-level contradiction in the hierarchy demands for more appreciable intelligence resources of a mining engineer to find a solution to eliminate inconsistencies (Fig. 1). The special professional knowledge and skills of a mining engineer, as well as intelligence and intuition become in high demand. The process of cognition involves also the functions of vision, power, will and creativeness of intelligence [12]. The intellectual work follows the laws of dialectics, integrates and combines various intelligence resources and overcomes dialectical contradictions. The scientific literature lacks the analysis of these contradictions and their overcoming. In the meanwhile, the absence of such analysis makes impossible an effective methodology of the purposeful development of innovation potential in mining engineers. This study aims to identify and explain the major dialectical contradictions in the development and implementation of innovation intelligence potential in mining engineers in renovation of coal production.

Dialectical contradictions at innovation incipience

When searching an innovation solution to deal with a dialectical contradiction and its after-effects for the technology and management, a mining engineer's intelligence faces a range of the own dialectical contradictions. The engineer experiences collision of the traditional ideas on

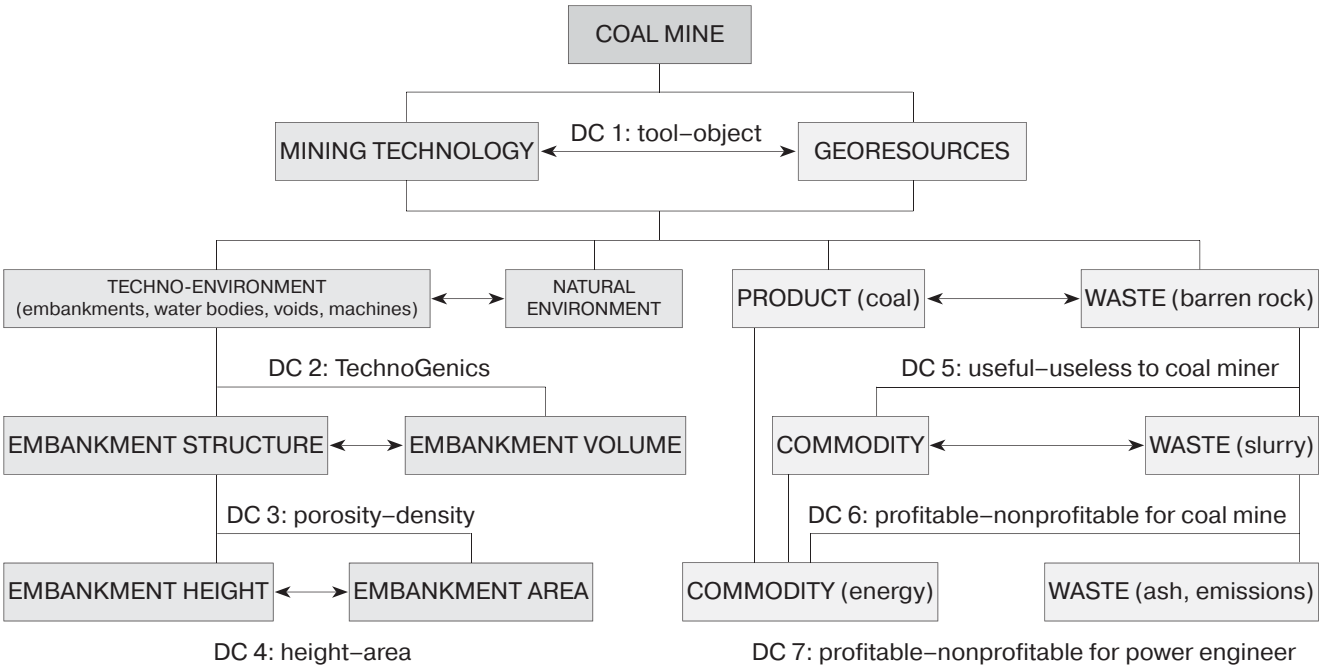

Fig. 1. Hierarchy of major dialectical contradictions (DC) in mining industry

a subject to be improved and the demand for a cardinally new vision, which is the old–new dialectical contradiction. The engineer is not happy with the existing solution but is incapable to find a progressive solution yet. The latter requires specific resources of brainwork and time.

At the same time, intelligence of an engineer is constrained in its search of novelty by the required commercial applicability of the idea [14]. This is the applicable–inapplicable dialectical contradiction. Its overcoming needs improvability of a proposal up to its application suitability. Furthermore, creative thinking is limited by the requirement of profitability of the proposal for a company. The profitable–nonprofitable dialectical contradiction dictates further perfection and adaptation of a novation.

On the other hand, a cardinally new solution is governed by the need of pushing the intelligence limits of a person in order to burst into the unknown; on the other hand, these aspirations are straitened by an inner censor—applicability and profitability of the proposal, which restrains thinking and imagination. To handle these dialectical contradictions, they are to be separated in time. In this case, first, new solutions are generated without assessing their feasibility and economic efficiency. This liberates innovation intelligence and allows a stretch of imagination to find an ideal solution. Then, the creative process consists in finding nonconventional methods, materials and conditions to realize new ideas up to their applicability and profitability.

Further on, an engineer faces another contradiction between ‘need’ and ‘can’. Any dialectical contradiction to be overcome imposes such requirements for the intelligence of a mining engineer, which are impossible to fulfill at first. The solution found should be a breakthrough. The traditional intelligence is unprepared for such way of thinking, as a rule. Neither knowledge, nor intent thought or search can help. The intelligence of a new quality is needed. The procedure of boosting reason and creativity in the intelligence potential of a mining engineer to handle the need–can dialectical contradiction is described in **Fig. 2**.

Original vision is a function of intelligence or intuition, including abstraction, generalization, heuristic enlightenment... Success loves preparation. The theory of inventive problem solving can help in this case [15, 16]. According to this theory, the successful solving of inventive problems (IP) is a successive mental deepening to formulation of an administration contradiction (AC), technical contradiction (TC) and a physical contradiction (PC). Then, it is required to *envisage* an ideal final result (IFR). The methodical tooling of the theory allows selecting methods of physical contradiction solving to reach IFR [17, 18].

A useful approach to finding a surprise decision within a creative search is the *What if...?* question. Putting and discussing this question liberates perception from false limitations and promotes challenging hypothesizing. The analysis and working out of such hypotheses lead to original ideas on implementation. This approach is actively used by foreign consultants and marketing scientists [19].

An effective solutions of a distinguishing character deserves application for a utility patent. The application, expertise, necessary expert explanations and finalization contribute to building-up innovation potential. Passing of all steps of this way inevitably ends with the innovation climb and inventive problem solving skills, and enables handling the inner solution to the need–can contradiction in an engineer. Thus having succeeded, the engineer’s

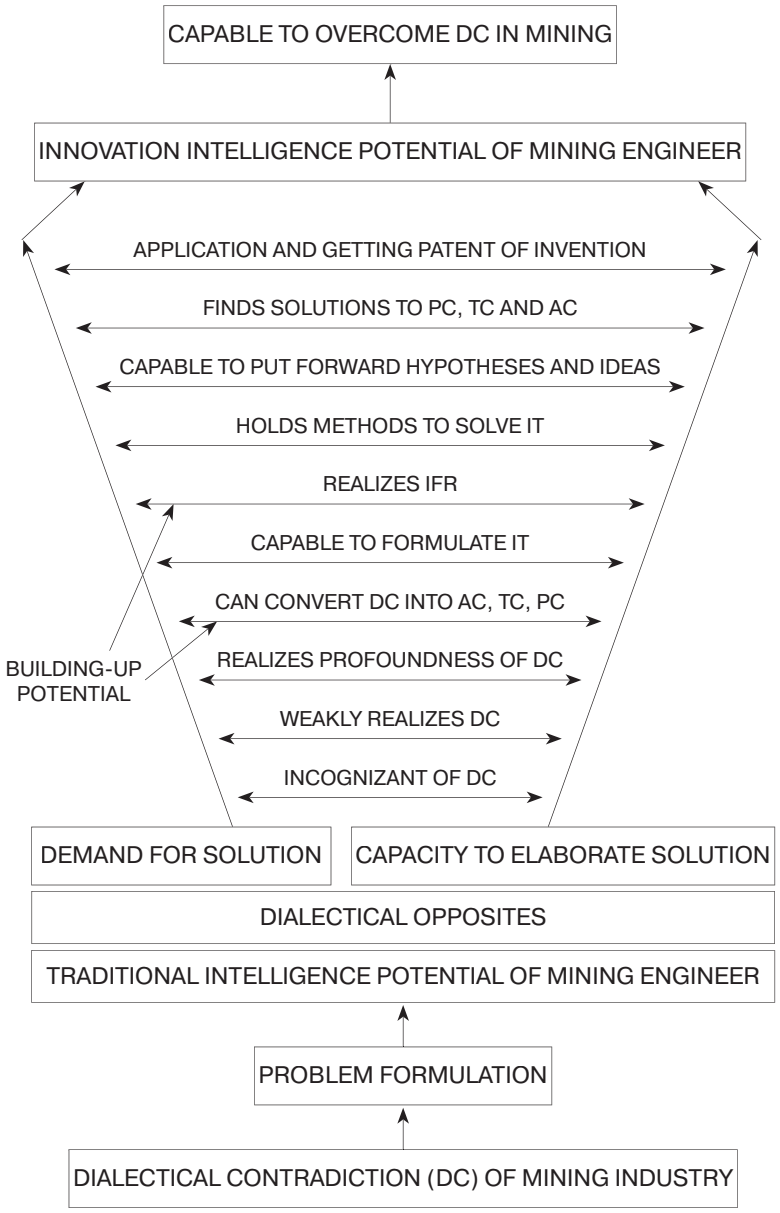

Fig. 2. Overcoming need–can dialectical contradiction in innovation intelligence potential of mining engineer

intelligence acquires a potential of finding breakthrough solutions to urgent dialectical contradictions of a mining company.

Dialectical contradictions at innovation implementation

The dialectical contradictions described above, and their resolvability are intrinsic to the block of reasoning and creativity in the innovation intelligence potential of a mining engineer, and to the stage of innovation origination. The stage of innovation implementation features the dialectical contradictions of the other kind, governed by the change in the essence of activities, and by such intelligence properties as vision, power and will.

Innovations in mining involve mostly technology-/economy-/management-based improvement of the existing production process flows or their components. A novation proposed by a mining engineer comes across an innovation intelligence potential of another mining engineer in charge of performance of a system or a subsystem. The head responsible for the operation capability of the system looks at novelties with alert as a rule. The head–innovator relationship is an image of the innovator–conservative dialectical contradiction rooted in psychology and realizable in different manner. The result of this contradiction resolution depends on the level of business potentials of opposing mining engineers and on the character of their mutual relations (**Fig. 3**).

A new outlook of an innovator often runs into traditional thinking of a managing engineer beware of any changes. The stereotype thinking of a manager (and the innovator's colleagues) fears probable risks due to novation and obstructs viewing of opportunities. It is often difficult to evaluate profitability of a proposal and payback straight

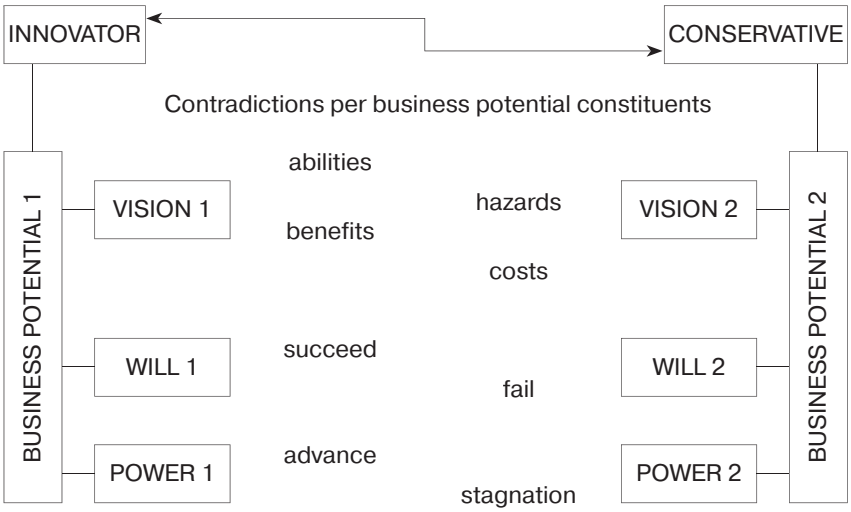

Fig. 3. Components and contradictions in business potentials of innovator and conservative

away. The innovator is to undertake additional calculation and validation, ample explanation and persuasion, and needs mother wit.

The innovation constraints are also the succeed–fail and the advance–stagnation contradictions. The disbelief in success of an innovation proposed, anxiety of loss of position, and unwillingness to risk and to change anything at all were and are the common phenomena in community of the Soviet time and present-day Russian mining engineers. An innovator is attacked from all sides with the doubts, "Are we able to implement this innovation? You know, some company tried and failed...We wish no harm to inflict... Why? We need no changes. It works the old way..." Weak motivation of personnel toward innovation in mining companies adds to the bad attitude [20]. And only strong will and power of an innovator, exceeding the same qualities of opponents, make the innovator a guide to the goal.

An inventor can benefit from 'What do we loose? Let's try!' approach when resolving the innovator–conservative contradiction. This approach galvanizes the opposite side into re-appraisal of the situation and into balancing risks and profits. In fact, to 'try' is not to 'accept'. As a result, resistance weakens, which offers an innovator a 'foothold' to jump to success.

Experiencing and overcoming misfortunes and failures, trials and finalization of innovations, etc. lead to accumulation and development of special knowledge and promotional potential of a mining engineer. Those who put forward an invention and promote it up to innovation become the most valued staffing resource and a human capital asset of a company.

The scientific methodology of successful contradiction resolving is currently being developed by theoreticians and practitioners in coal mining in Russia. History of the mining art contains various useful approaches and methods applied by innovators to implement their ideas.

Mining engineer N. A. Chinakal, when introduced his novel shield tunneling technology in 1935–1940, experienced all bugs of the innovation procedure of the time (disbelief, negation, derision...). He had to overcome obstructions on all scales of the coal sector: starting from workmen and finishing with the sectorial people's commissariat. He passed all the way and failed. And only involvement of the Communist Party's highest rank members allowed beating down sluggishness the coal sector machinery in Kuzbass [21]. The outstanding mind and creativity, the incredible will and power of the inventor turned the novelty into a large-scale and effective innovation.

Success of the USSR Honored Inventor and innovator N. G. Chernykh can be explained, alongside with the paramount innovation intelligence potential, by the favorable innovation environment. Nagornaya Mine Director V. M. Erpylev encouraged innovators and even pooled creative teams to solve specific problems [22]. The Director himself put forward challenging ideas and motivated and inspired other inventors. The Director's business potential fitted the innovation level and ensured prehension of novelties. Owing to such innovation activities, the Mine achieved outstanding results, and the team of seven innovators was awarded the USSR State Prize in 1975 [22].

Creative performance of inventor N. G. Chernykh was a success in the Soviet time [23]. However, in the last three decades, he fails to implement even a few of his inventions [24–26]. He unceasingly pursues improvement of mining equipment, invents, publishes articles in mining periodicals, forwards his proposals to coal mining companies and participates in scientific conferences, but managers of coal companies neglect the inventions.

Naturally, the coal industry is an inert economic sector prone to conservatism for the sake of safety and stability. Inventors in mining always experience difficulties in

promotion and implementation of their innovations both in the time of the Soviet Union and modern Russia, and on all scale of management.

For example, V. P. Romanov as the Head of Kuzbass Coal Mining and Processing Integrated Works advanced an idea to access the west side of the Lenin deposit by heading fringe drifts under the bottom of the Inya River. The whole engineering personnel of Belovo and Leninsk-Kuznetsky Mines, backed up by the City Communist Party Committee, turned against the proposal. The reason was the probability of the mine flooding in that case. The controversy reached the First Secretary of the Kemerovo Region Party Committee. And only the favor of the latter, though within the personal responsibility of the inventor (!), helped V. P. Romanov, and Belovo and Leninsk-Kuznetsky Mines won through to new coal reserves without extra capital inputs [27].

Regarding the mine renovation of the time, V. P. Romanov said, "Bringing mechanization of longwalls appeared to be the most difficult mission. Miners totally refused novation. I realized quite well: love cannot be forced, given such opposition, machines would be kept under repair all the time rather than work. How can I turn people toward progress and break the petrified conservatism of minds?" Romanov found promising Chief Mining Engineer A. A. Manko and told him straight, "If you want to raise up to leadership, bring machines to longwalls. You'll be down-graded if you don't do this. We need personnel who place the stake on the mechanization" [27].

Manko said nothing and made light of the novation. Then, Romanov sent a crew of specialists to the mine. They analyzed feasibility of new machinery introduction and demonstrated the positive of that prospects to the Chief Mining Engineer. After that Romanov invited a crew of foremen "who should be engaged in adaptation of the emerging technology. We ventilated the subject over a cup of tea and vodka shots. The working people appeared to be literate and supported the initiative. Manko got nowhere to go. He "rolled up his sleeves" and achieved. Gradually mechanization became a consensual decision in Belovo and Leninsk-Kuznetsk" [28].

In 1995 the author of this article became a witness of a collision at the Kemerovo meeting between an innovator, Professor V. D. Yalevsky, and his scientific colleagues who conservatively criticized and repulsed the idea of a modular mine. The pure will and confidence of the innovator, supported by progressive engineers–practitioners, enabled materialization of the brainchild. Time has shown the soundness of the concept which is already implemented in some mines in Kuzbass [28]. The innovator–conservative dialectical contradiction was not always resolved in favor of a creator. Numerous illustrations of negative attitude of conservatives and failure of innovations in mining are widely described [21, 23, 27, 29–32], and even more of them remain yet the part of the language. Many very fruitful and effective innovations in the coal mining industry in Russia are killed by the short vision, conservatism and haughtiness of different scale engineering management.

V. P. Romanov described one of such stories in his book *A Bed of Coal*. That time he was the Director of the Stalin Mine. "…Minister Zasyadko arrived…I knew that our chiefs were going to offer the minister a warm welcome, that is to drink deep in a special cottage. Tomorrow, suffering from a hangover, they would go to the mine and every trifle would annoy them and put them out of temper. I invited the guests to examine a new heading machine at work operated by its designer Lifereshno. The creator actuated his 'baby'. It roared and broke the roof. The minister made the air blue, gave up and went away. The inventor rushed after him trying to explain something to Zasyadko's back but he didn't even turn his face around. So, a reasonably good machine never went into the world because of the minister's bad attitude causeв by pain in the head after booze" [26].

The minister's power of his top administration position clenched the matter and furnished the bold victory over the innovator. The destiny and busy life of the latter, and enthusiasm of his comrades, and huge investment of the mine were destroyed in a moment, and the arrogance of a big boss defeated the progress.

Conclusion

Dialectical conditions in advancement of coal industry shape necessity and dialectical contradictions in development of innovation intelligence potential in mining engineers. The contents of these contradictions vary per stages of innovation process. Creation of a novelty calls for resolving contradictions in the thinking of a mining engineer. A breakthrough arises from breaking stereotype vision and from pushing and overshooting the limits of the prevailing way of thinking. The resolution procedure for the need–can contradiction in the intelligence and creativity potential of an engineer dictates a stage-by-stage build-up of the creative potential up to the level of creation of an invention. The theory of inventive problem solving, the experience of foreign commercial production companies, and advice of consultants and creativity coaches can help.

The Russian economy and coal industry amass methods of effective commercialization of innovations. The innovation experience of mining engineers of the Soviet time is a helping hand on this way. That time was rich with innovative breakthroughs in the coal mining sector and, also, with dramatic economic losses because of sluggish implementation or total rejection of the advanced and promising proposals.

The success of the modern time innovation depends, among other things, on capacities and attitude of a company towards development and implementation of promotional potential of mining engineers–innovators. The growth of the promotional potential can follow two paths: (1) the prideful innovation implementation or (2) the overcoming of all difficulties and obstacles on the way toward renovation, which forms specific intelligence skills, power, and will in a mining engineer. The innovation potential defines the professional value and competitive strength of an engineer.

References

1. Petrenko E. V. Promotion of innovation activity in the coal sector. *Ugol*. 2006. No. 1. pp. 30–33.
2. Galkin V. A., Osharov A. V., Vorobeva O. V. Personnel of a mining company-key factor of production safety and efficiency enhancement. *GIAB*. 2015. No. 11. pp. 225–237.
3. Chernov A. I., Korkina T. A. Improving the efficiency of a coal-mining enterprise management. *GIAB*. 2017. No. S37. pp. 275–281.
4. Artmyev V. B., Volkov S. A., Galkin V. A., Makarov A. M. The formation of an action personnel reserve as a strategic move SUEK at the present stage of development of the company. *GIAB*. 2018. No. 11. pp. 23–29.
5. Galkina N. V., Kilin A. B., Kostarev A. S. Potential of technological innovation in development of an industrial company: definition, structure, model. *GIAB*. 2015. No. 562. pp. 18–29.
6. Korkina T. A. Control of investment in coal mining personnel: Targets and means. *Ugol*. 2009. No. 8. pp. 52–56.
7. Belkin V. N., Belkina N. A., Antonova O. A. Innovative activity of business managers as a condition for modernization of regional labor potential. *Economy of Region*. 2018. Vol. 14, No. 4. pp. 1327–1340.
8. Korkina T. A. Formation and use of human assets in industry as an innovation development factor. *Regional Competitive Ability and Education in the Context of Global Challenges. IV Ural Science and Business Vernissage Proceedings*. Chelyabinsk : Entsiklopedia. 2017. pp. 195–200.
9. Volkov S. A. Innovative activity and performance of the human capital of a coal company. *Region: Systemy, Economika, Upravlenie*, 2019. No. 1(44). pp. 146–150.
10. Zhunda S. V., Stepashkin A. L., Dovgenok A. S. Enhancing the value of a supervised employee is the key task of a manager *Ugol.* 2018. No. 10(1111). pp. 90–93.
11. Fedorov A. V., Samarin S. V., Kuletskiy V. A., Makarov A. M. et al. Motivating performance evaluation as a personnel training tool at a coal mine. *Ugol.* 2011. No. 5(1021). pp. 90–93.
12. Prokopenko S. A., Gritskevich T. I., Ravochkin N. N., Dyagileva A. V. The essence of the intelligent and innovation potential of a mining engineer. *GIAB*. 2020. No. 7. pp. 155–177.
13. Prokopenko S. A., Lesin Yu. V., Li A. A., Shadrin V. G. Dialectical contradictions and resolutions toward innovative development and ecological safety enhancement in modern-day coal mining. *Eurasian Mining*. 2020. No. 1. pp. 79–83. DOI: 10.17580/em.2020.01.16
14. Shaydullina V. K., Pavlov V. P., Sinelnikova V. N., Efimova N. A. Novickaya L. Yu. Legal issues of patenting in the coal industry: challenges of the digital economy. *Ugol*. 2019. No. 1(1114). pp. 58–62.
15. Altshuller G. S. Finding idea. Introduction to the theory of inventive problem solving. Novosibirsk: Nauka, 1986. 209 p.
16. Altshuller G. S. ARIS means victory. Inventive problem solving algorithm ARIZ-85-V. Rules of play with no rules. Petrozavodsk : Kareliya, 1989–280 p.
17. Kaplan L. A. A new approach to analyzing and resolving contradictions. Hwaseong. 2011. 188 p.
18. Petrov V. Inventive problem solving algorithm. Teaching aid. Tel Aviv, 1999. 256 p.
19. Williams L. Revolution. Well-tried market seizure technique. Moscow : Mann, Ivanov i Ferber, 2012.
20. Volkov S. A., Mashnyuk A. N., Konakova O. V. Motivational environment of a coal-mining facility: content, state, development directions. *Ugol*. 2019. No. 8. pp. 62–69.
21. Zvorygin L. V., Kurlenya M. B., Chinakal N. A. Mining—The life and destiny. Novosibirsk : SO RAN, 2001. 184 p.
22. Bezmatyorykh V. Mining elite forge. *Ugol Kuzbassa*. 2014. No. 6. pp. 64-67.
23. Pidenko A. Chernykh—A creator and an inventor. *Shahterski krai.* 2009. No. 26.
24. Chernykh N. G. Engineering adaptable assemblies for the fewer process continuous technology of roadway heading. Kemerovo: Kuzbassvuzizdat, 2001. 153 p.
25. Chernykh N. G. Travel mechanism of underground mining machines. *Ugol*. 2012. No. 12. pp. 48–51.
26. Chernykh N. G. Validation of a new conception of technological and organizational resilience in coal fuel production. *Ugol*. 2012. No. 6. pp. 86–87.
27. Romanov V. P. Coal seam. Kemerovo : Vest, 2003. 259 p.
28. Elevsky V. D. The impossible is possible. *Ugol Kuzbassa*. 2016. No. 3. Available at: http://uk42.ru/index.php?id=3135 (accessed: 14.10.2021)
29. Yuzhakov V. F. Wanted: Innovators. *Ugol Kuzbassa*. 2013. No. 6. pp. 42–46.
30. Prokopenko S. A. Is there any point for the Russian R&D in inventing innovation products for miners? *Gornaya Promyshlennost*. 2012. Vol. 3, No. 103. pp. 76–80.
31. Alferov S. B., Lyukhanov V. V. Import-substituting products of the Machinostroitelny holding ZAO. *Mining Industry*. 2012. Vol. 1, No. 101. pp. 38–43.
32. Prokopenko S. A., Ludzish V. S., Li A.A. Recycling possibilities for reducing waste from cutters on combined cutter-loaders and road builders. Waste Management & Research. 2017. Vol. 35(12). pp. 1278–1284. DOI: 10.1177/0734242X17731154 EM