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LIMITS OF FURTHER DEVELOPMENT OF TECHNOLOGIES OF UNDERGROUND COAL EXTRACTION AND THE METHODOLOGICAL PROCEDURE IN SYSTEMATIC SEARCH FOR NEW TECHNOLOGIES

Summary. The paper discusses problems of methodological search for new technical and technological solutions in underground coal mining. Principles following which ensures achieving optimum goal are presented. In methodological procedures the determined sequence of stages is essential. Undertaking a task requires a deep analysis of literature, a survey of patent applications and verification of solutions known in the past - and not realized then because of technological barriers from the point of view of their present suitability.

The methodological procedure makes it possible to avoid many mistakes causing delays in the progress as it was many times the past. The author gives examples of turning points of development in the history of mining technologies and mechanization of mining.

Every solution has the limit of its developmental potential and after reaching it, it is necessary to replace it with a different, completely new solution. It is essential to recognize when machines and instruments are close to this limit in order to transfer to new solutions. The author states that many of the machines and technologies currently used in mining are close to the limit of their further developmental potential. Thus, it is necessary to start now the work on new solutions. Such a necessity refers, for instance, to coal extraction systems, techniques of heading drivage, drives of mining machines of a difficult starting conditions. The paper discusses many examples of the successful use of methodological procedures in the area of mechanization of mining.

1. GENERAL REMARKS

Numerous external factors cause the change of requirements which are to be met by machines, mechanical systems and technologies. Changes in original concepts already occur at the initial stages of their development. The constant evolution with maintenance of the original thought led to the development of contemporary mining machines and equipment such as supports, plough systems, or shearer loaders.

In the process of the development of different machines and technologies we can distinguish certain common stages, Fig. 1. Decisions undertaken during the first stages of the development very often determine the result. In the past an individual invertor took decisions, nowadays it

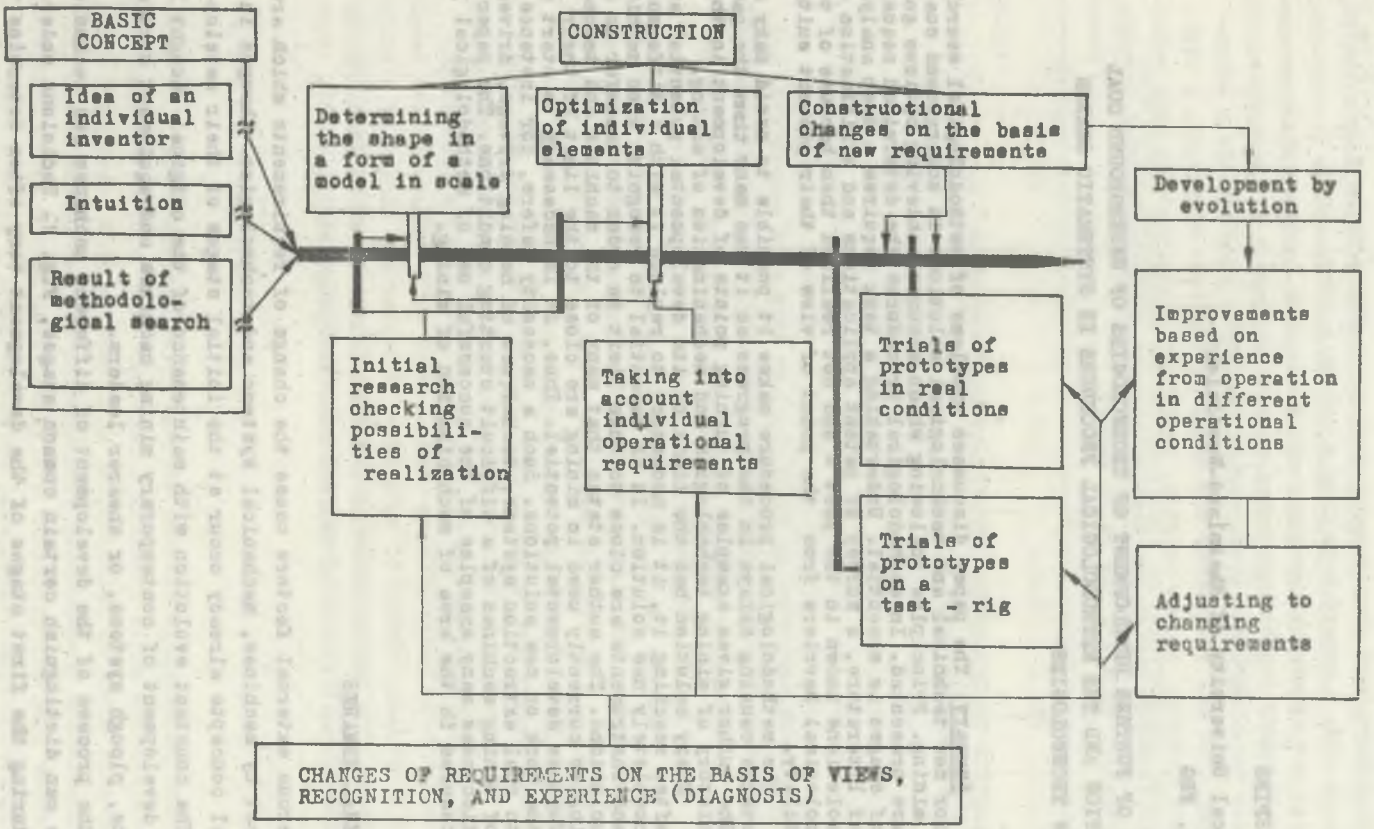


Fig. 1. The course of elaboration of the basic concept

Rys. 1. Przebieg rozwoju i opracowania koncepcji pierwotnej

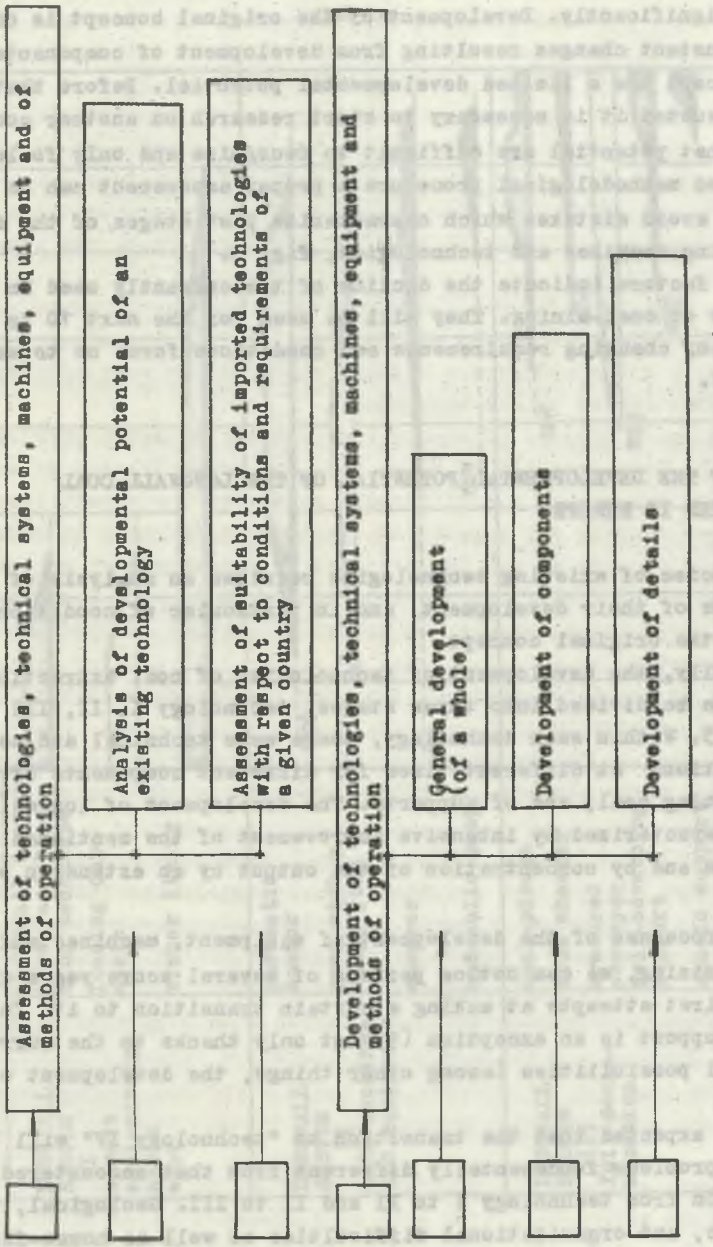


Fig. 2. Uses of methodology of development
Rys. 2. Zastosowania metodyki rozwoju

happens rarely. The further on suggested "methodological procedure" makes it possible to make a proper choice and optimization already at the stage of development of the original concept and in this way to reduce the costs significantly. Development of the original concept is characterized by constant changes resulting from development of components.

Each concept has a limited developmental potential. Before that potential is exhausted it is necessary to start research on another concept. Limits of that potential are difficult to recognize and only following the suggested methodological procedure a proper assessment can be made in order to avoid mistakes which characterize past stages of the development of mining machines and technologies, Fig. 2.

A lot of factors indicate the decline of the currently used in Europe technologies of coal-mining. They will be used for the next 10 to 15 years but many changing requirements and conditions force us to seek new technologies.

2. LIMITS OF THE DEVELOPMENTAL POTENTIAL OF THE LONGWALL COAL MINING USED IN EUROPE

Any criticism of existing technologies requires an analysis of the whole process of their development, and in particular of conditions connected with the original concept.

Historically, the development of technologies of coal extraction used in Europe can be divided into three stages: technology I, II, III described in Fig. 3. Within each technology, there were technical and technological transitions at different times for different components of winning and transporting coal, and of supports. The development of longwall systems was characterized by intensive improvement of the mentioned mechanical systems and by concentration of the output by an extension of longwalls.

Studing processes of the development of equipment, machines and technologies in mining, we can notice periods of several score years which divide the first attempts at making a certain transition to its full use. The shield support is an exception (9) but only thanks to the current technological possibilities (among other things, the development of power hydraulics).

It can be expected that the transition to "technology IV" will be connected with problems fundamentally different from that encountered during the transition from technology I to II and II to III. Geological, technical, climatic, and organizational difficulties as well as human-factor engineering will not make it possible to shorten the transition period to less than twelve to fifteen years for all existing methodological and technological possibilities.

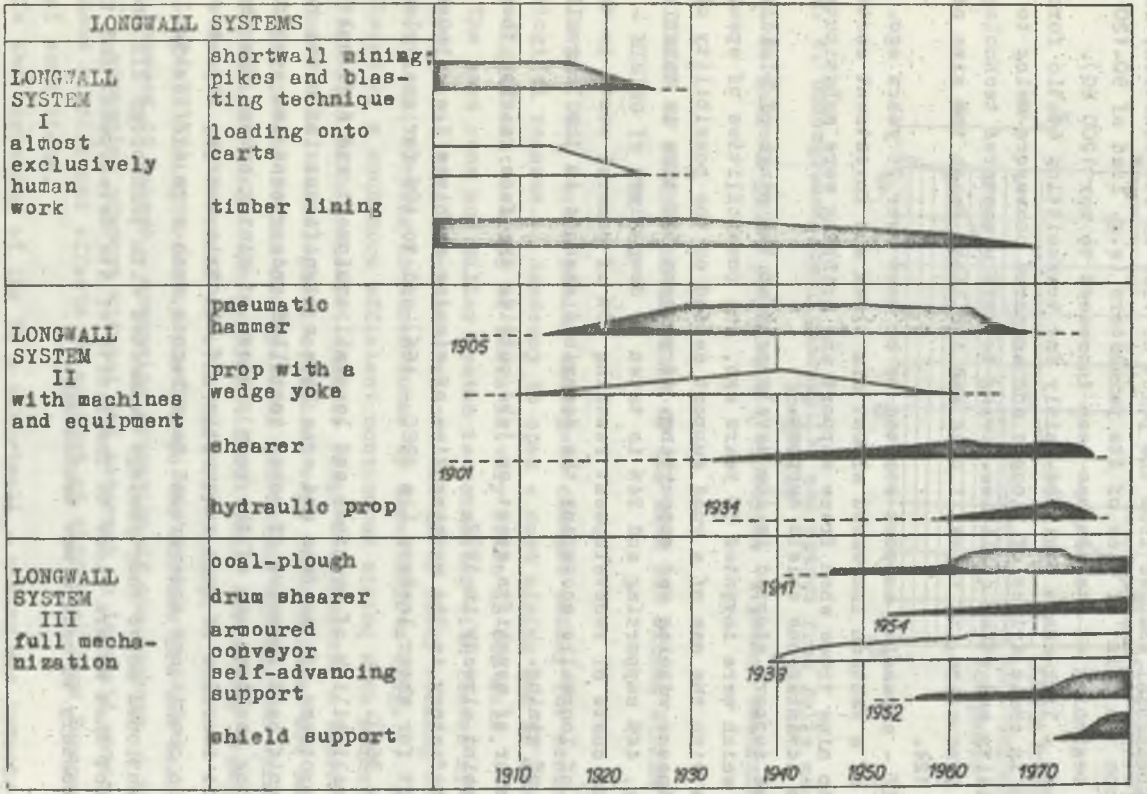


Fig. 3. Longwall technologies since 1900

Rys. 3. Systemy ścianowe od roku 1900

Discussing future technologies it is necessary to determine the potential for further development of the currently used in longwall systems elements of winning and transporting coal and of supports:

- The pan of the armoured conveyor as a component of a conveyor has undergone fundamental changes from the point of view of its function, and also from the point of view of its parameters (e.g. load of 90-120 kG in the beginning of its use has been increased to max 1200 kG).
- The round - link chain designed mainly for transmitting static forces is used in chain drives of ploughs and armoured conveyors owing to its flexibility and other qualities. Owing to well - mastered technology of its production, it is still used and its links reach the size of ø 34 x 124.
- The self - advancing support started to be used over 25 years ago. The weight of a section increased almost six times and investment costs eight to nine times when frame support and cribbing were substituted by more advantageous shield support.
- The road support stopped in its development at the stage of yielding arches which were invented 50 years ago, and possibilities of speeding up jobs with the use of a road support depend on the possibility of symultaneous winning and supporting. At present 32% time is taken by winning, 44% supporting and 24% is taken by down-time.
- Enormous costs of redevelopment reaching 60% of general costs in the region of longwalls accompany the described changes in the longwall system of mining.
- The number of manshifts spent on jobs outside the face reached the critical point already in 1972.
  Dissatisfactory is the working time of winning machines i.e. abount 50% manshift for shear loaders (in 1980 - 46%) and to 40% for coal ploughs (1975 - 36%).
  The unreliability of machines and longwall equipment and difficult to solve problems of the face end area have a significant influence here.
- The significant increase of power installed underground and specificity of mining machines and of the very process of mining caused the characteristic increase of unit consumption of electric energy, Fig. 4.
- Climatic conditions underground have become much more difficult.

The mentioned above shortcomings connected with technology III indicate the fact that we are close to the limits of its development and that it is necessary to seek a new technology.

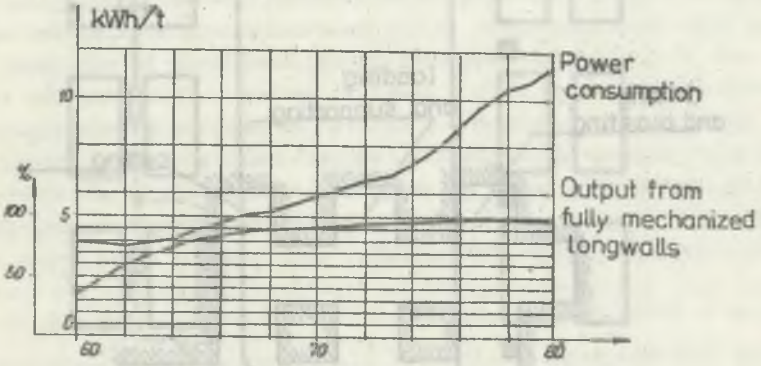


Fig. 4. Underground power consumption and output from fully mechanized longwalls

Rys. 4. Zużycie prądu pod ziemią i wydobycie z pełną mechanizacją

3. LIMITS OF FURTHER DEVELOPMENT OF THE ROOM AND PILLAR SYSTEM OF COAL - - MINING IN THE USA

In the USA, coal - mining undergoes changes mainly for economic and geological reasons. A tendency to open - cast mining can be observed, but significant overlay of rocks is very often an obstacle.

The used room and pillar system is connected with losses of about 30-40% in pillars, sometimes reduced to 12% by risky working of pillars. Conventional working in three rooms by three shifts (Fig. 5) has been replaced by a much more efficient continuous mining with a cutter - loader equipped with a wheeled chassis (Fig. 6). However, a typical mistake was made: new technological solutions were mounted on an old base, which was appropriate for an old cycle of conducting mining, and which led to only partical use of the machines (about 30%). New safety regulations have caused the decrease of even that efficiency.

Longwall mining tried in the USA in the fifties has not been introduced because of labour - consuming operation of the support. A hydraulic self - advancing support widened the interest in longwall systems but without significant effects on account of different from European geological conditions.

In the beginning of the 70 s schortwall - mining was introduced (shortwall - mining being a combination of a self - advancing support and a continous miner) along the wall of 50-80 m (Fig. 7). This technology has been given up because the choice of two elements from different systems turned out to be inappropriate on account of difficulties faced when controlling the roof with a big web of a "continuous miner" (3,2-3,5 m).

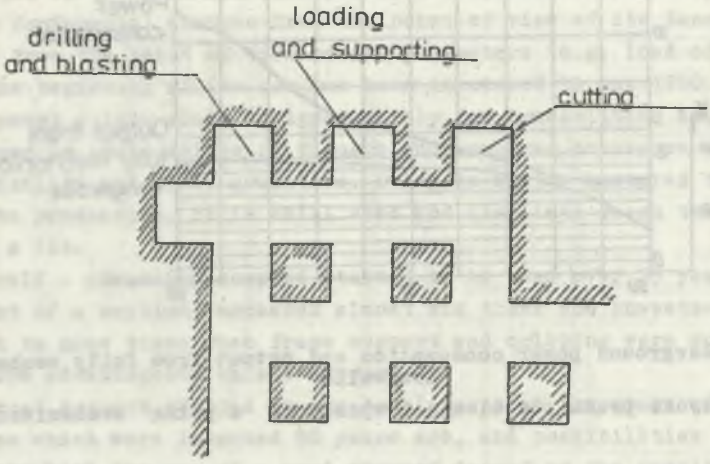


Fig. 5. Room and pillar system, conventional mining
Rys. 5. System "Room and Pillar" - metoda konwencjonalna

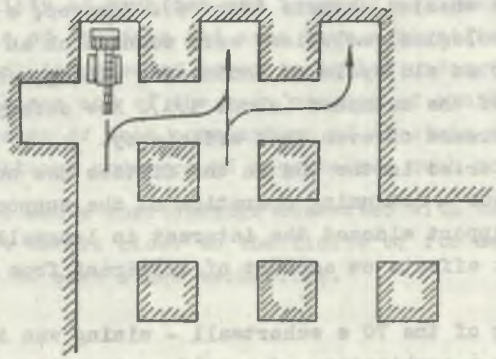


Fig. 6. Room pillar system, continuous mining
Rys. 6. System "Room and Pillar" - metoda wybierania ciągłego

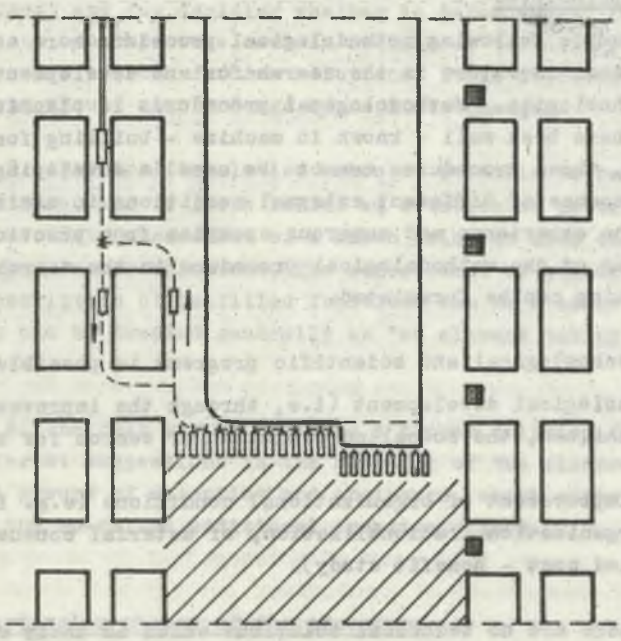


Fig. 7. Shortwall mining in the USA and Australia
Rys. 7. System "Shortwall - Mining" (USA i Australia)

It can be stated that the widely used in the USA and Australia the room and pillar system is at the same stage of exhaustion of its potential as longwall systems in Europe. It can be assumed that it is possible to suggest such a technology of mining which would meet both European and American requirements.

4. METHODOLOGICAL PROCEDURE IN DEVELOPING NEW MINING TECHNOLOGIES

The methodological procedure, aspecially useful in developing mining technologies, requires taking into account the following elements:

- basic principles (4.1),
- particular phases of the procedure (4.2),
- the degree of the connection of components (4.3),
- possibilities of putting together technologies from different stages of development (4.4),
- difficulties of further development of mining technologies (such difficulties occured in turning points in the past), (4.5).

4.1. Basic principles

Groups of people following methodological procedure more and more often replace individual inventors in the search for and development of new techniques and technologies. Methodological procedures in planning, devising, and designing have been well - known in machine - building for over twenty years. However, those procedures cannot be used in developing new mining technologies because of different external conditions in mining.

Basing on the experience and numerous examples from practice, eight basic principles of the methodological procedure in the search for new concepts in mining can be formulated.

Principle 1. Technological and scientific progress is possible:

- through technological development (i.e, through the improvement of existing techniques, the so-called evolution or search for new technologies,
- through the improvement of organizational conditions (e.g. improvement of general organization, rationalization, of material consumption, data processing, and cost - benefit study).

Principle 2. There are no technical solutions which in their essence are absoluty new, but only combinations of new type of elements or assemblies of machines, or previously known technologies.

Principle 3. There is a necessity of systematic analysis of literature, and of analysis and estimation of already known solutions. Such an analysis should take into account conditions accompanying their coming into existence, and first of all review of all patent applications often not realized in the past because of the lack of technical possibilities.

Principle 4. There is a need for a deep analysis of actual possibilities of the realization of solutions known from the past and of possibilities of their improvement on the basis of new experience.

Principle 5. There is a need for a clear devision between a concept and construction. The concept-defines schematically a machine or a process, a way of its operation, and realized functions without details. The construction - defines the solution in details and can be a design of a certain kind, which after optimization of those details can be a basis for building a prototype.

Principle 6. There is a need for taking into account turning points in development and for deciding whether it makes sense, in the present conditions, to improve a certain machine or technology or whether it is necessary to look for new solutions. It is important that auxiliary equipment should also undergo appropriate changes.

Principle 7. Abstract formulation makes it possible to reach many new propositions, and to leave behind an established pattern, and to form a more accurate assessment of a known solution from the point of view of its use in new solutions. The replecement of standard terminology by a description of fulfilled functions can be a means for that, e.g., a stamp can be treated generally as "an element taking load from the roof".

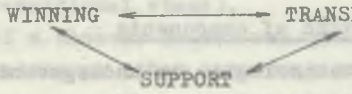
Principle 8. The best way of choosing a proper solution from a big number of different suggestions is the adoption of the planned procedure by a small groups of scientist and engineers, which gives a possibility to use the so-called additional creative effect.

4.2. Particular phases of the procedure

Porticular phases of the procedure always occur in the following sequence:

PLANNING - DEVISING - DESIGNING - FINAL ELABORATION

Planning - comprises mainly the process of determination of the scope of the operation, and thus the boundary conditions of the operation of a machine. The search for new mining technologies requires separation of rigid dependences in the system:



Equally, finding a new technology in road drivage requires a deep analysis of suitability of all currently used machines and systems.

Devising - the aim of this phase is to ensure the expected functions.

It is a typically creative stage, which can be described as follows

1 - detailed explanation of a given task,
2 - description of imposed requirements,

3 - rough estimation of costs,
4 - abstract thinking,
5 - determination of a main function,
6 - devision into component functions,
7 - search for solutions fulfilling component functions (using improved solutions from the past),
8 - finding optimum combination of solutions for fulfilling the main function,
9 - work on alternative concepts,
10 - technical and technological assessment of alternative concepts and the choice. It is worth noting that activities 4-9 constitute the creative phase of the whole process.

Designing and final elaboration have been well - known for years and are characterized by a certain constant sequence of activities.

Designing -

- elaboration of a design keeping proper proportions,
- technical and economic assessment of a design,
- elimination of weak points of a solution,
- determination of a final form of a design.

Final elaboration

- optimization of a shape and details,
- elaboration of documentation,
- construction and trial of a prototype,
- repeated analysis of costs.

The methodological procedure, which not only help to look for new solutions but also to assess existing solutions, are useful both at university institutes and, especially, design offices and producers.

4.3. Degree of the connection of components

Machines, equipment, and technologies in underground mining compose a system which is full of interdependences. If we want to use "the methodological procedure" within the framework of such a system we must, at the very beginning, determine the degree of interdependences of particular components E.g., three such types of dependences can be distinguished within a longwall system:

1. Connection: putting together elements of winning, transport, and support of different origin (from different producers).

2. Harmonization - forecasting co-operation of components already at the stage of designing.

3. Integration - as the highest degree of connections forecasts optimization of a system, and the essence of this optimization is possibly most advantegeous distribution of constituent functions to particular elements of a system.

4.4. Possibilities of putting together technologies from different stages of development

Putting together elements of mining technologies characteristic for different stages of development leads to considerable problems. This statement refers also to machines, equipment and even to particular components. In mining practice a lot of examples of the simultoneous use of equipment at different level of technological development, especially during the transition period from technology I to II and II to III have been stated. Problems of this type were encountered outside mining, too. A lot of examples can be given for mounting new technique on an old base; e.g the development of the car, the pneumatic hammer, attempts at winning coal by means of high - pressure water jet.

The discussed tendency can be observed in the discussion about possibilities of the use of computers and microprocessors in mining. This discussion is conducted in the Fed. Rep. of Germany under the title "the coal - mine of the futhre".

4.5. Difficulties in further development of mining technologies, which occurred in turning points in the past

A lot of examples can be given to prove that new solutions have always been accompanied by intermediate solutions which delayed the development of mining technologies.

For instances:

- full mechanization of cutting by means of shearer loaders (shearers were used at the transitional stage),
- the movable arm of a shearer loader was proceeded by a cutting drum fastened rigidly although other constructions with movable arms were known earlier,
- the hydraulic prop came into being through the improvement of a prop spraged hydraulicly, but having a wedge yoke where hydraulics fulfilled only an auxiliary function,
- used over a 100 years ago prop filled with output and with a wooden piston was a remote predecessor of a hydraulic prop,
- the curved conveyor which is derived from conveyors, curvilinearity of which resulted from the subordination to the functions of a coal plough,
- the hydraulic hammer on an arm with a self - propelled chassis which was used 5-8 years after the first concept of such a solution was presented,

- the self - advancing support which had its predecessor in a support with removable props, the idea of which was put forward at the turn of the 19th and 20th centuries.

5. EXAMPLES OF THE SUCCESSFUL USE OF THE METHODOLOGICAL PROCEDURE IN THE SEARCH OF NEW CONCEPTS OF TECHNICAL SOLUTIONS

5.1. Shield support for thin seams

At first shield supports were used in the USSR and Hungary and next in Fed. Rep. of Germany in mean and thick seams. The used solutions failed in the conditions of thin seams because elements of the support were blocked by the output on the side of a caving. Special packing was invented to eliminate this obstacle by the way of the methodological procedure. The present construction of shield supports is more suitable for thin seams than any other support.

5.2. Articulated swivel shoes

It results from the kinematics of the support that most of the load is transferred to the floor by the base. The indentation of the base into the floor leads to the burial of the support while moving.

Following the methodological procedure main functions and components of the support were determined and next, it was stated that the end of the base can be treated as a joint analogous to the joint between the roof - bar and the support. As a result the base was equipped with an articulated swivel shoes which improve the distribution of loads. Underground tests proved the efficiency of this solution, which turned out to be very useful in the conditions of thin seams which very often have a soft floor.

5.3. Steering of the coal - plough

The development of the technique of coal winning brought a need for steering the coal - plough from the side of the support. A machine with hydraulic serwo-motors on an armoured conveyor used by Westfalia Lünen showed a lot of advantages but limited the section of a gangway for the miners.

The minimum gangway of $h = 400$ m x $b = 600$ mm is required in the Fed. Rep. of Germany. It was especially defficult to meet this condition in the conditions of thin seams. Heinzmann undertook methodological research, as the result of which a very interesting constructional solution was found. The elements of a device steering the plough were placed between bases leaving the gangway free. The practice proved big usefulness of this solution.

5.4. Minihydraulics

The use of hydraulic props in the longwall support required the introduction of a big amount of hydraulic hoses which connect neighbouring sections of the support, and which, however, make the passage for workers much more difficult. Methodological analysis of functions of particular elements led to significant reduction of troublesome hoses. Steering from the neighbouring section was realized by the introduction of the so-called minihydraulics. In the new solution velves and hoses of minimum intersection were used for the realization of processes of a small demand for the medium.

5.5. Super Advance Full Extraction System in the USA

The previously discussed room and pillar system of coal extraction has undergone methodological and gradual improvement. The shortwall mining system has been developed. The initially used unidirectional continuous miner winning with the web of 3,2 m - 3,5 m has been replaced by a two-directional winning machine of 1,6 - 1,8 m web. Such big webs require a support with especially long roof-bar proped near the face by an anchor prop to 350 kN.

5.6. Self - advancing support for the face end

Problems encountered in the region of the face end were analysed in a methodological way and a lot of new solutions, among other things, connecting elements of the road support in an uncovered section of the gangway were suggested.
As a further development the hydraulic self - adwancing support for protecting the face edge area the region of the face end was introduced. The results of experiments with that type of support were published in "Glückauf" in 1981 together with a lot of recommendations necessary for solving this problem.

5.7. System of gangway drivage with slotted contour

A methodological search for new systems of gangway drivage which would enable to conduct jobs connected with winning and supporting at the same time led to the elaboration of some solutions in this field. There are two main methods of acting in this field:

- elaboration of a new technology based on the currently used road header,
- elaboration of a completely new technique not connected with methods used at present.

One of the more interesting solutions is the gangway drivage with slotted contour and the introduction of the road support before winning the shole section of the gangway. A lot of suggestions of ways of the imple-

mentation ot this idea were presented and one of concepts was presented at a mining exhibition in Düsseldorf in 1976.

5.8. Baldachin - Verbundausbau (Conopy road support)

A deep analysis of solutions of road supports was carried out in Institut für Bergbaukunde II RWTH, Aachen. The carried out analysis took mainly into account all requirements to which supports are subject. It was stated that a new support should connect properties of the roof bolting, flexible arches with joints and must be bound with the rock mass. After many trials and corrections introduced to the original concept, the so-called "conopy road support" was suggested, Fig. 8. Properties of this support make possible full mechanization of working and of conducting working while winning in the face.

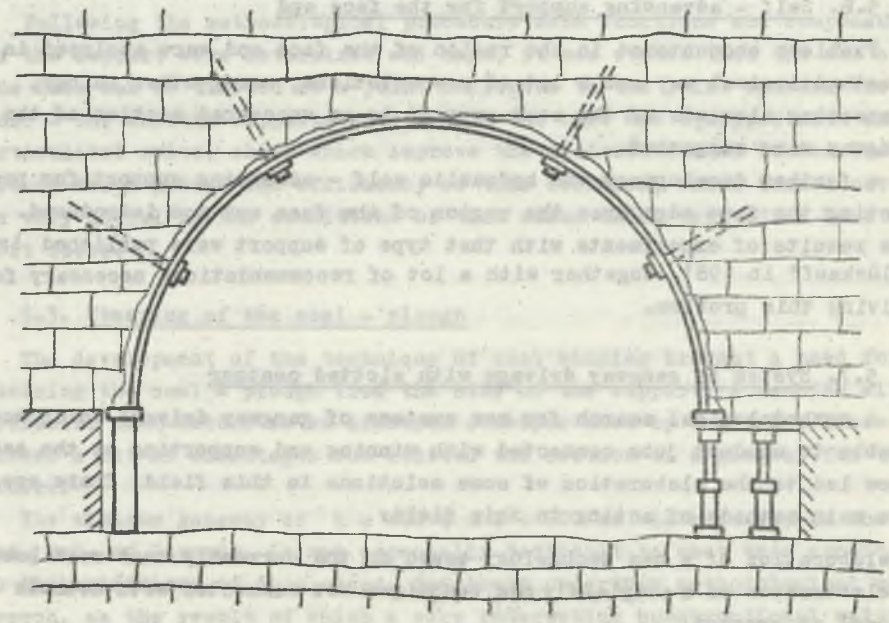


Fig. 8. Verbundausbau (conopy shield support)
Rys. 8. Obudowa baldachimowo-wiążąca (Baldachin-Verbundausbau)

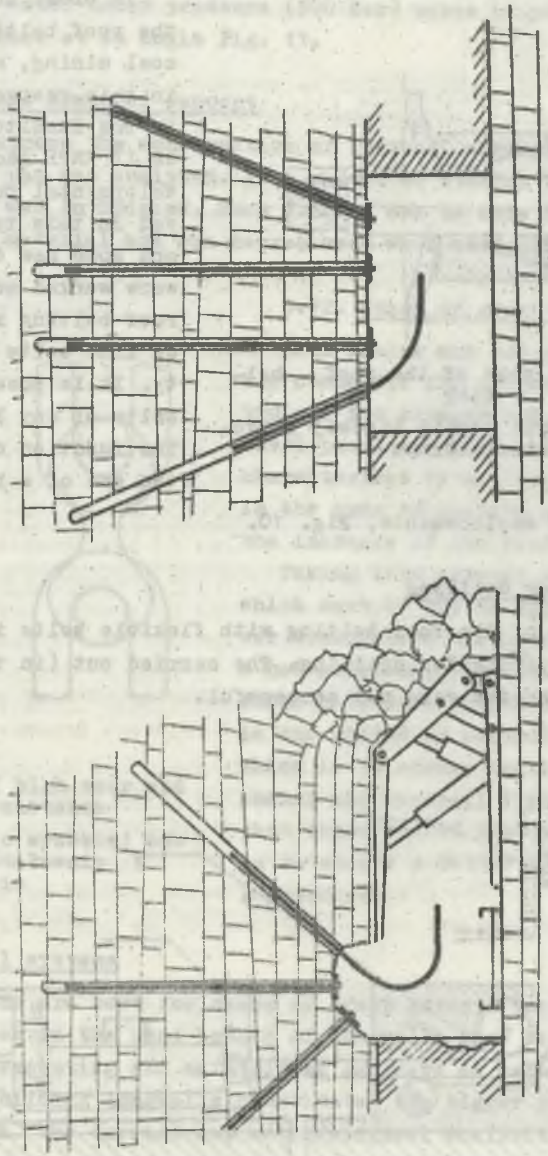


Fig. 9. Roof - bolting with flexible bolts
a) in the longwall, b) in the road-gate
Rys. 9. Obudowa kotwiowa z kotwiami giętkimi
a) w wyrobisku ścianowym, b) w wyrobisku przyścianowym

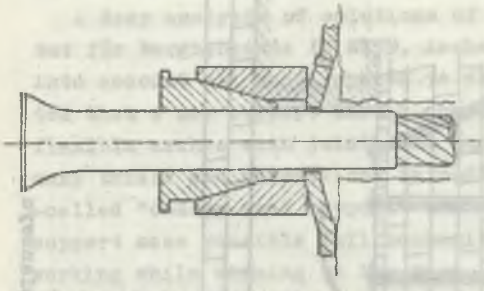


Fig. 10. Wedge yoke of the roof - bolting

Rys. 10. Końcówka kotwii linowej z zamkiem ciernym

5.9. Roof bolting

In order to widen the use of the roof bolting in European coal mining, a detailed analysis in this respect was carried out in the Institut für Bergbaukunde II RWTH Aachen. Enormous developmental potential was proved in this type of a support and some new detailed solutions were worked out. The use of the roof bolting requires the use of line bolts of big flexibility. It is possible to use such bolts of any length, Fig. 9. The function of a wedge yoke at the end of a bolt is to take over rock mass deplacements, Fig. 10.

5.10. Angular drilling

Realization of the roof bolting with flexible bolts is connected with the necessity of angular drilling. The carried out (in the USA) tests with flexible shafts were not successful.

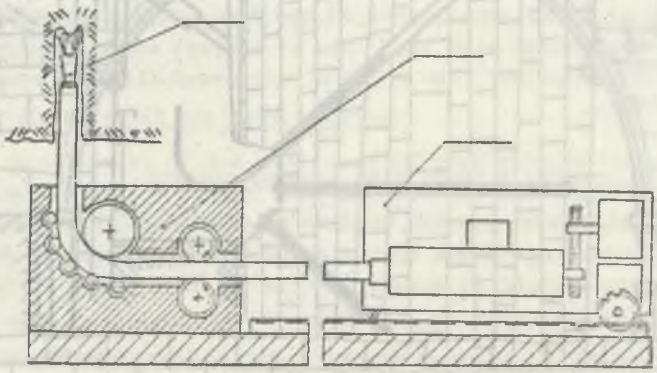


Fig. 11. Machine for angular hole drilling with the help of water jet under high pressure

Rys. 11. Urządzenie do wiercenia "zza węgła" wysokociśnieniowym strumieniem wody

As a result of the methodological procedure a drilling technique by means of high pressure water jet was accepted as a optimum solution. A specially guided hose with water under pressure (900 bar) makes it possible to approach a drilling place at an angle Fig. 11.

5.11. Pan of the armoured support

In order to improve the construction of longwall conveyors, the construction of the pan was analysed. As a result of studies the pan with replacable liner was introduced. Such a liner can be made from an abrasion - resisting material and can be replaced when need arises.

5.12. Chain of great durability

Link chains are not a proper flexible connector for transmitting loads typical for ploughs and conveyors. The development of those chains has been characterized by an improvement only in the area of quality of work and in the increase of the size of links.

Taking into account requirements which must be met by the chain for power transission the authors put forward a new solution, Fig. 12. Horizontal links have more favourable conditions in the places of contact with sprocket which is to ensure smaller wear. Horizontal and vertical links are of different shape and of high rigidity which is to ensure a better interaction with a sprocket.

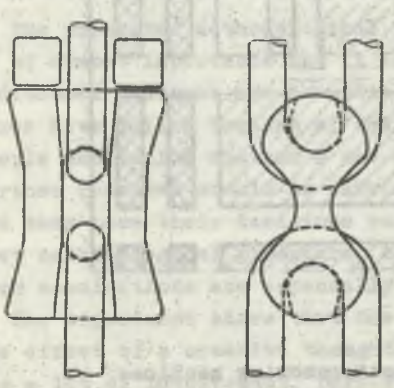


Fig. 12. Chain of high wear and deformation resistance

Rys. 12. Łańcuch o wysokiej odporności na odkształcenie i zużycie

5.13. Shortwall systems

Longwall systems are best for seams of great extent. Recently, considerable differences in the used length of longwalls have been noticed. At present costs of executing and maintaining gangways as well as costs of equipping and rebuilding longwalls constitute the bigger part of costs of coal extraction. The carried out methodological analysis proved that in order to reduce the above - mentioned costs the most favourable solution would be the possibly biggest distance from headings and conducting extraction in the direction perpendicular to them. Winning front in this system would have about 50 m. i.e. 20-25% of the length of present longwalls.

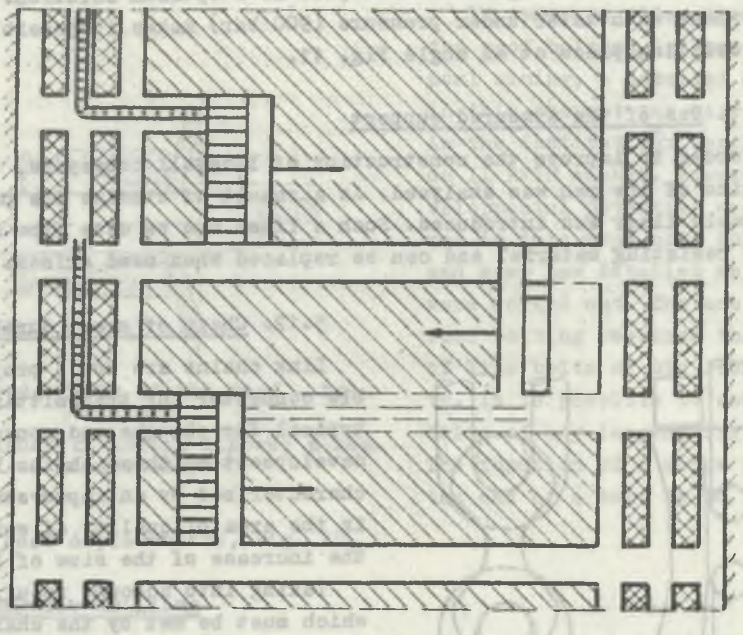


Fig. 13. Shortwall system without removing machines
Rys. 13. System krótkościanowy bez konieczności przemieszczania maszyn

It is much easier to automate short - walls because they are less dependent on geological conditions. One of suggestions for shortwall extraction worked out at the Institut für Bergbaukunde II RWTH Aachen is shown in Fig. 13. The problem of shortwalls should be understood as a different solution and not as a reduction of the length of longwalls currently used.

The author took part in the research on the discussed examples of the use of the methodological procedure in the search of new solutions in underground coal - mining: problems presented in 5.1, 5.2, 5.4, 5.6, 5.7 at Heinzmann research section and in 5.8, 5.9, 5.11, 5.12, 5.13 as a director of Institut für Bergbaukunde II RWTH Aachen.

6. FINAL RECOMMENDATIONS FOR THE USE OF THE METHODOLOGICAL PROCEDURE IN THE SEARCH FOR NEW TECHNOLOGICAL SOLUTIONS

Given examples show a need and suitability of the methodological procedure in solving important mining problems. A lot of problems connected with underground coal extraction require constant development. There is

a need for working out problems of winning, transport in a longwall, extraction of thick seams, reduction of costs of developmental work, new solutions of drives for mining machines of difficult starting conditions etc. For example:

- winning can be understood as a process of cutting coal from the floor and from the roof after which solid coal can be extracted in the most required assortment,
- finding a completely new transporting machine for longwalls (it would be possible after installing a loader near a winning machine),
- improving the drive of mining machines of difficult starting requires research on the whole driving system with simultaneous reduction of costs of those machines.

The presented methodological procedure in the search for new solutions is of utmost importance but it is not sufficient. For the implementation, additional measures are essential. A lot of logical in their course procedures have failed because of small mistakes. It should be remembered that people who decide whether a new solution can be implemented or whether further research should be carried out are very often not professionals and they base their decisions on opinions of advisers. None, even the best methodological procedure, can avoid a risky prototype examination. Such examinations are especially difficult to conduct underground.

The experience shows that the achievement of any final goal is not the effect of a creative thought or a methodological procedure but requires a lot of involvement, persistence and ability to forecast.

Lucjan Gajda prepared the paper basing on the published lectures on methodological procedures presented at RWTH Aachen (1981, '82, '83, '84), at Mining Academy of XUZHOU, China (1984) and at Silesian Technical University (1985).

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GRANICE DALSZEGO ROZWOJU TECHNOLOGII EKSPLOATACJI WĘGLA W GÓRNICTWIE PODZIEMNYM ORAZ POSTĘPOWANIE METODYCZNE W SYSTEMATYCZNYM POSZUKIWANIU NOWYCH TECHNOLOGII

S t r e s z c z e n i e

W opracowaniu omówione zostały zagadnienia metodycznego poszukiwania nowych rozwiązań technicznych i technologicznych w górnictwie podziemnym węgla kamiennego.

Przedstawione zostały zasady postępowania zapewniające osiągnięcie optymalnego celu.

W postępowaniu metodycznym istotna jest określona kolejność działania.

Podjęcie zadania wymaga przeprowadzenia dogłębnej analizy literaturowej, przeglądu zgłoszeń patentowych i zweryfikowania rozwiązań znanych w przeszłości - nie zrealizowanych wtedy ze względu na bariery technologiczne - pod kątem ich przydatności obecnie.

Postępowanie metodyczne pozwala uniknąć wielu błędów powodujących opóźnienie postępu, jak to było niejednokrotnie w przeszłości. Autor przytacza przykłady występowania punktów zwrotnych w historii rozwoju mechanizacji górnictwa i technologii górniczych.

Każde rozwiązanie posiada pewną granicę możliwości dalszego ulepszenia, po osiągnięciu której konieczne jest zastąpienie go rozwiązaniem innym - zupełnie nowym. Niezwykle ważne jest rozpoznanie zbliżania się do takiej granicy, aby dostatecznie wcześnie podjąć poszukiwanie tych nowych rozwiązań.

Autor stwierdza, że wiele stosowanych obecnie w górnictwie techniki i technologii stoi na granicy wyczerpania możliwości dalszego rozwoju. Konieczne jest więc podjęcie już teraz poszukiwania rozwiązań zupełnie nowych. Konieczność taka dotyczy, np. systemów eksploatacji węgla, techniki drążenia wyrobisk korytarzowych, napędów do maszyn górniczych o ciężkim rozruchu i inne.

W opracowaniu omówione są też liczne przykłady pomyślnego stosowania postępowania metodycznego odnotowanych w dziedzinie mechanizacji górnictwa.

ГРАНИЦЫ ДАЛЬНЕЙШЕГО РАЗВИТИЯ ТЕХНОЛОГИИ УГЛЯ В ПОДЗЕМНОМ ГОРНОМ ДЕЛЕ И МЕТОДИЧЕСКИЕ ПРОЦЕДУРЫ В СИСТЕМАТИЧЕСКОМ ПОИСКЕ НОВЫХ ТЕХНОЛОГИЙ

Р е з ю м е

В работе говорится о проблемах методического поиска новых технических и технологических решений в угледобывающей промышленности. Представлены правила действия, обеспечивающие достижение оптимальной цели.

В методическом развитии существенным является последовательность действия.

Постановка задачи требует проведения основательного глубокого анализа литературы, просмотра патентов и проверки решений, известных в прошлом, но не реализованных в своё время из-за технологического барьера, под углом зрения их пригодности в данный момент.

Методическое развитие позволяет избежать многих ошибок, вызывающих задержку прогресса, как это неоднократно бывало в прошлом.

Автор приводит примеры мёртвых точек в истории развития механизации горного дела и горных технологий.

Каждое решение обладает определенной границей возможности дальнейшего улучшения, после достижения которой необходимо заменить его решением другим - абсолютно новым. Необыкновенно важным является определение приближения к этой границе, чтобы заранее начать поиск новых решений.

Автор утверждает, что многие применяемые сейчас в горном деле техники и технологии находятся на границе возможностей дальнейшего развития.

Необходимо уже сейчас начать поиски совершенно новых решений. Такая необходимость касается, например, систем эксплуатации угля, техники проходки коридорных выработок, приводов горных машин с тяжелым запуском и др.

В работе предлагаются многочисленные примеры удачного применения методического развития в области механизации горного производства.