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Proactive management education for a technological breakthrough

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Abstract

The article reasons the need for changing the model of management education and corresponding tools and approaches to bring them in line with the challenges of a technological breakthrough and organisational transformations in the national economy that is going through an unprecedented overhaul of global economic ties and is restricted by sanctions. The authors suggest a paradigm of proactive training that is characterised by its focus on foreseeing changes by having a breakthrough research agenda, a quick conversion of research results into the educational content, research projects and activities, the flexibility of the content and formats of the educational process. The conceptual mechanism of a system for the anticipatory training of managers has been designed; potential methodologies have been identified for building educational modules for bachelor's and master's degree programs. By analysing the methodologies it was possible to develop a comprehensive approach to creating high-value educational products. The article describes some of the proprietary technologies that the authors use when implementing proactive education programs in practice.

The scientific novelty of the article lies in the formulation of the training concept for managers aimed at solving complex interdisciplinary tasks of a technological breakthrough. In terms of the practical value, the article presents a mix of educational technologies for the implementation of the concept. It includes electronic proactive leaning system, conveyor of continuous competence enhancement, digital modular architecture of the learning process, "module-in-module" technology.

Keywords: management education, proactive training, educational paradigm, technological breakthrough, proactive management, cross-disciplinarity, learning module.

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技术突破的积极主动管理培训

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摘要

当前，国民经济处于全球经济关系和制裁限制前所未有的变化模式。本文章证实了改变管理教育的模式、方法和工具的必要性，以应对经济中技术突破和组织变革的挑战。作者提出一种积极主动培训的范式，其特征是：通过突破性的科学议程来预先料到变化，将科学成果快速转化为教育内容，设计和研究积极性，教育过程内容和形式的灵活性。已制定管理人员积极主动培训系统的概念机制。强调了形成本科和硕士生课程培训模块的可能方法。在此基础上，开发了一种有助于创

造高价值教育产品的综合方法。描述了作者在积极主动培训的实际实施中使用的原始技术。
这篇文章的科学新颖性在于它提出了培训能够解决技术突破复杂跨学科任务的管理者的概念。实际意义在于为实施这一概念开发了教育技术系统，包括：用于积极主动培训的电子培训中心，管理专长持续发展的渠道，教育过程的模块的灵活架构，“模块中的模块”。
关键词：跨学科性、跨学科的专长、技术突破、管理教育、前馈控制、积极主动培训、系统工程，培训经理的方法论。

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Introduction

Big changes are taking place in business, and they are associated not only with digitalisation, the introduction of artificial intelligence technologies and smart industries [Trachuk, Linder, 2020; Bogachev et al., 2022], but above all, with the ongoing tectonic shifts in the architecture of economic systems, the energy crisis, changes in supply chains in world markets, sharply tightened requirements for ensuring the reliability and environmental friendliness of production, cybersecurity. Undoubtedly, at the same time, ties with continuously updated information technologies will be strengthened, and breakthroughs will occur, as a rule, at the intersection of new knowledge in the field of IT, engineering, social and natural sciences [Brenner, 2018; Savastano et al., 2019].

The ongoing changes are no longer described by a linear paradigm, and the total human intellect does not yet have time to comprehend their complex dynamics. In such conditions, science is on the cutting edge of a breakthrough, and the management paradigm must be flexible [Gitelman et al., 2017], opening up a choice of opportunities, and, of course, aimed at the future, at anticipatory strategies. The manager is forced to become a researcher not only of problems and trends, but of trends in context change and a developer of new production systems. He must analyse the organisation as a metasystem and the external and internal tendencies and forces acting on it. He, more than ever, needs to anticipate changes in the near future in various areas of activity, which only yesterday only indirectly affected the functioning of the business, and begin to immediately prepare for them [Senge, 2011].

Breakthrough technologies will continue to rapidly penetrate even into traditionally conservative industries, radically changing the industrial landscape, business models and economics of enterprises [International trends.., 2015; Can the universities.., 2018]. An illustration of this trend is the volume of the world market of “pure” information technologies (for example, software). According to IDC, CompTIA and Gartner estimates in 2019, it was $3.8-4.0 trillion, and taking into account converged solutions and so-called emerging technologies, today the market can be valued at about $5-5.5 trillion [Minton et al., 2018; IT Industry Outlook.., 2019; 2022].

The very concept of an “industry” is expanding – its boundaries are moving and significantly expanding, new sectors are emerging, and competition is shifting to an inter-industry level [Porter, Heppelmann, 2014; Bessonova and Gonchar, 2019]. The main competitive advantage is no longer products as such, but the innovative systems and technological platforms that connect them [Pereira et al., 2018].

In this regard, management education is designed to link scientific research, design, innovation and training into an integral system. The authors call this educational paradigm proactive learning, the main difference of which is the focus on anticipating changes through a breakthrough research agenda and the rapid transfer of scientific results into educational content.

A number of previous articles by the authors [Gitelman et al., 2019; Gitelman et al., 2020b; Gitelman et al., 2020c]. In this study, the emphasis is on the mechanism and original technologies for organising educational work, without which, in reality, advanced learning is impossible. These technologies should solve the main task of a technological breakthrough - a large-scale transformation of the country’s economy, providing in a short time to obtain results in various industries and areas of activity that are qualitatively superior to existing ones.

1. Technological breakthrough as an object of advanced learning

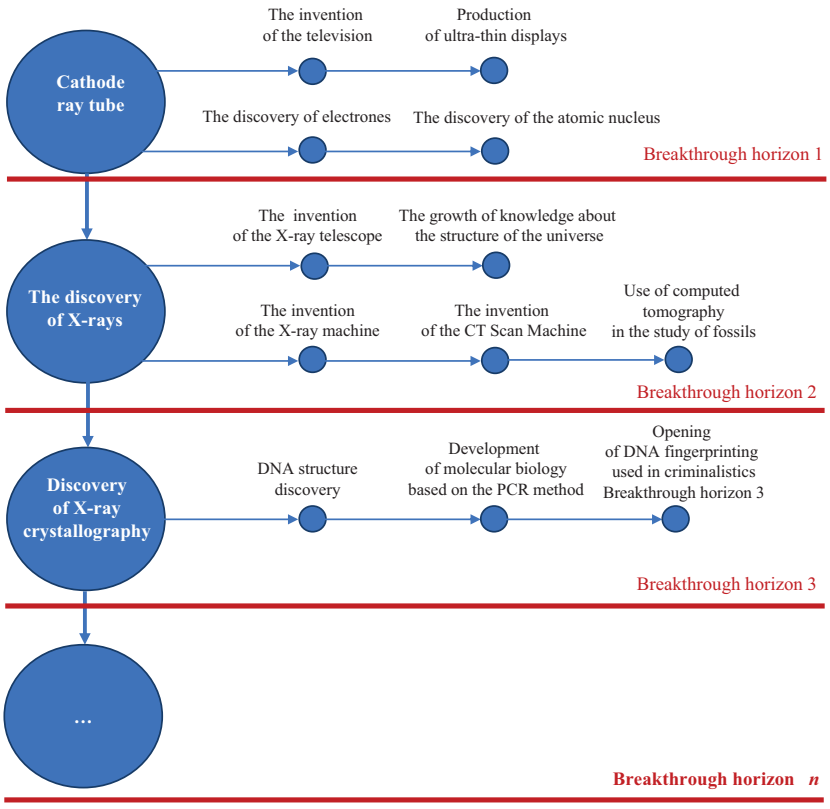
The authors understand a technological breakthrough as a systematically organised process of radical changes in the engineering and technical base of production based on the latest scientific and technological achievements. Of course, such a process can be carried out with accompanying transformations in the production, economic and social systems, that is, with an organisational breakthrough. A technological breakthrough implies the introduction of fundamentally new product, technological and organisational solutions, as well as the accelerated creation of the intellectual potential of a human resource for industries and sectors of the economy to enter the leading market positions, as a result of which the efficiency of activities is significantly increased: new markets are created, and existing industries are either transformed dramatically or disappear altogether [Edquist, Henrekson, 2006; Seba, 2009; 2014].

When a breakthrough is made, the role of science sharply increases, which should specify what the breakthrough will lead to (what new opportunities will open up), whether there are specific features of each of the stages of the breakthrough, how these features should be taken into account in engineering and management, and finally, what are the risks of uncontrolled development technologies and new systems leading to potentially negative socio-economic consequences [Falkenberg et al., 2022]. At the same time, science is called upon to perform three key functions:

1) to develop mechanisms for the search and selection of breakthrough innovative ideas;
2) to form methodologies for the implementation of a technological breakthrough;
3) to determine the most balanced format for the interaction of various areas of scientific knowledge in terms of their necessary proportions, organisation of their exchange, approbation of new solutions in practice [Brooks, 1994; Martinez, 2018; Byun et al., 2020].

The interdisciplinary nature of the technological breakthrough is illustrated in Fig. 1. So, X-rays, invented at the end of the 19th century and which became an undoubted breakthrough in medicine, are now widely used in non-invasive diagnostic methods, in particular in computed tomography, which, in turn, have found application in other

Fig. 1. A chain of technological breakthroughs caused by a sequence of scientific discoveries



Source: adapted from: Science and technology on fast forward. https://undsci.berkeley.edu/understanding-science-101/what-has-science-done-for-you-lately/science-and-technology-on-fast-forward/.

areas of science – archeology, paleontology , astronomy, physics. Another example is the discovery in the structure of DNA, which had a huge impact on the technological development of agriculture, biology, and ecology.

New scientific knowledge and technologies from different fields are thus deeply intertwined and feed off each other.

The creation of the concept and methodology of a technological breakthrough is the basis for the staffing of Russia's transition to the mode of accelerated innovative development. The problem under consideration has an extremely high social significance, which determines the state security of the country. Obviously, it is especially relevant for the basic infrastructure sectors of the economy and high-tech industries.

From a management standpoint, a technological breakthrough inherently requires proactive management actions, that is, proactive management [Gitelman et al., 2017]. Its organisation actualises a whole range of systemic problems, both in terms of technological and instrumental equipment, infrastructural innovations in terms of knowledge-intensive service, and, of course, profound changes in the training of managers – management education. This concerns, first of all, the increase in the role of fundamental knowledge and the flexibility of thinking [Gitelman et al., 2022b], interdisciplinarity [Gitelman et al., 2022a], and the introduction of anticipatory learning, which is significantly different from the traditional one.

2. The paradigm of advanced management education

Advanced education (training) is understood as an organised process of formation of knowledge and competencies to solve future problems that correspond to global trends and national development programs, taking into account modern realities: sanctions restrictions, breaking traditional economic ties, the need for import substitution, strengthening the security sector. The purpose of advanced training is to provide specialists with knowledge to work in the conditions of technical, organisational and economic systems created in the foreseeable future, based on new principles and functioning in an external environment characterised by increased turbulence and aggressive competition.

Anticipatory learning, unlike the traditional one, is focused on the formation of a different scale of vision, the ability to systematically take into account various industry, market and technological contexts, use tools for early diagnosis of threats and opportunities, apply interdisciplinary analysis and conceptual project synthesis, think and act strategically, preventing the emergence of crisis phenomena and ensuring the sustainable development of business, company and industry in the foreseeable future.

At the same time, the creation of an attractive research environment and an appropriate tool base for involving students in the full cycle of the innovation process is one of the first steps in building a system of advanced learning. Thus, advanced learning is impossible – and this should be emphasised – without a targeted research component integrated into the educational process: obtaining knowledge and competencies in context analysis, monitoring scientific and technological achievements, foresight forecasts of structural changes in the economy.

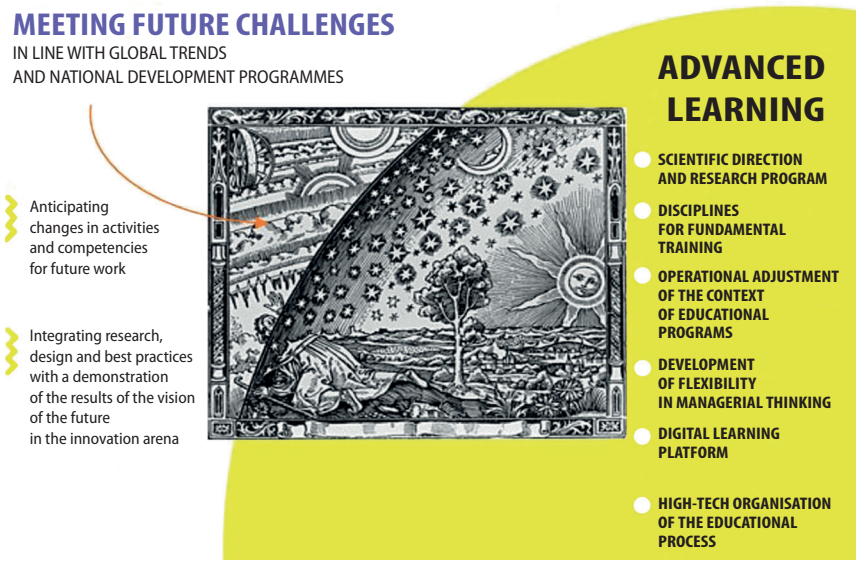
Advanced learning is carried out in an integrated scientific and educational circuit and sets the vector of knowledge aimed at creating a new image of the industry (company), embodying the advanced achievements of scientific and technological progress and organisational and economic innovations. An important emphasis in advanced training is placed on the mechanisms that protect the industry from external challenges and threats. Unlike the traditional training of managers to solve today's problems, advanced training aims to produce a new type of managers: innovative designers with the competencies of conceptual designers of new systems and their implementation in existing production. At the same time, it is important to emphasise that different categories of managers require different proportions of advanced and traditional training.

In this regard, anticipatory learning is focused on identifying the relationship between the current business situation, the prospect of its development and the image of the desired future. Without understanding these links, it is impossible to build a realistic picture of the future, and most importantly, without this, it is impossible to develop an effective plan for implementing a strategy to achieve it. The organised process of transforming a problematic and unstable situation into a qualitatively new one, organically integrated into the technological landscape being created, is one of the key clusters of abilities formed in advanced learning. The formation of such abilities presupposes the possession of skills for the priority use of intellectual and sociocultural resources in the systematic solution of innovative problems.

The objects of advanced learning are complex interdisciplinary problems that require the continuous generation of new knowledge. We will demonstrate them on the example of the electric power industry.

- Methodology for designing complex systems saturated with innovative elements: an electric power system with full automation of control and regulation up to the consumer, which has structural flexibility to introduce new elements based on the latest information technologies; a wholesale energy and capacity market with automatic protection against violations of the rules by market participants, with pricing mechanisms adequate to the efficiency of

Fig. 2. Visualisation of the proactive learning mechanism



generation, transmission and use of electricity, with a strong motivation to attract investment in new construction of energy facilities.

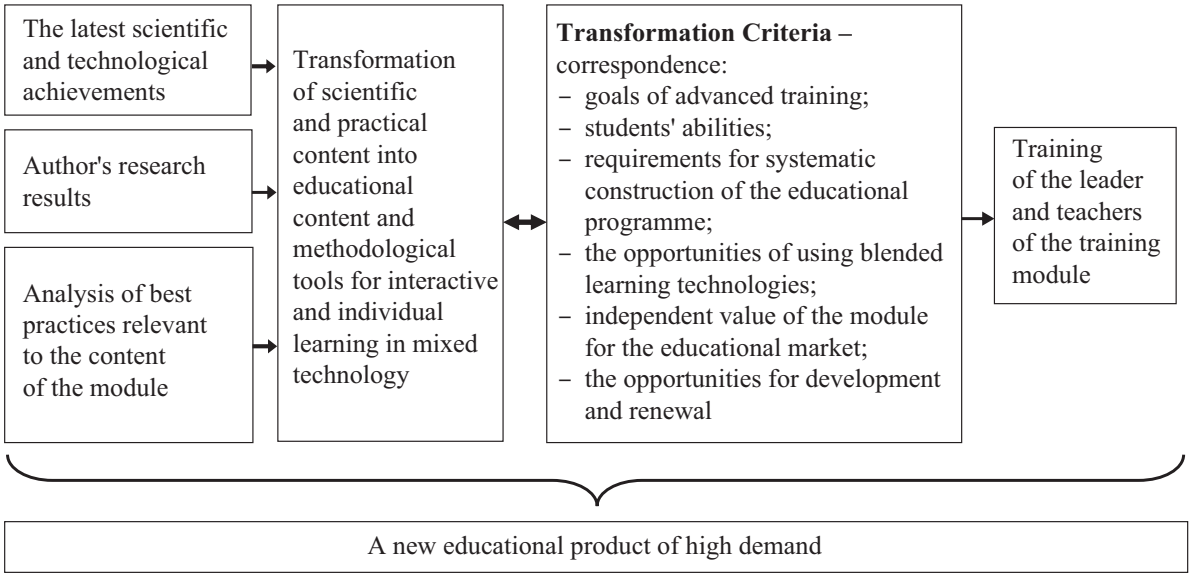
- Changes in the industry context, primarily in terms of global trends in scientific and technological progress and, of course, world-class problems - energy transition in the context of the global energy crisis and the necessary transformation of the electric and thermal power industry to fulfill the climate agenda: distributed generation, smart grids, safe nuclear power plants, economically competitive RES, polymodel concept of wholesale and retail electricity markets, interdisciplinary criteria (environmental, economic, energy) when making decisions on the development of energy systems.
- Forecasts of resource constraints and environmental turbulence: personnel, fuel, technology, financial and currency volatility, etc.
- Proactive management methods that neutralize the turbulence of the external environment, overcome resource and environmental constraints and stabilise the competitiveness (financial and economic efficiency) of the business.
- The quality of the human resource and its readiness for change.
- Leadership development, which sees a general shift from outstanding individuals to distributed leadership and collective intelligence that contributes to high results, as well as increasing the importance of a visionary approach based on global thinking and consideration of a wide context.
- Interdisciplinary teamwork involving specialists from different subject areas of science and practice in solving problems of increased uncertainty and complexity, including on the basis of virtual communications.

It is important to emphasise that the introduction of innovative management competencies into the educational programme of monitoring trends in technological and organisational development, foresight analysis, designing the future, strategic planning, the introduction of smart technologies and systems with artificial intelligence is not enough to create the effect of advanced learning.

The basis of advanced learning is a new significant component, namely the integration of research, design, best practices. In this regard, in order to create an integral system of advanced training for managers, it is necessary to:

- an educational and research complex based on a scientific direction and a research programme aimed at anticipating changes in strategy, organisational activities and competencies for future work;
- a block of disciplines for fundamental training, contributing to the formation of a systematic vision of changes in professional activity, understanding of upcoming changes;
- regulations for the operational adjustment of the content of educational programs in connection with the emergence of new knowledge;
- restructuring the methodological arsenal of all forms of training sessions and especially independent work to develop the flexibility of managerial thinking;
- a digital educational platform for the operational management of constant changes in educational content and the formation of individual learning trajectories;

Fig. 3. Organisational and methodological scheme for the development of training modules



- high-tech organisation of the educational process, updating educational products "to the task" (scientific and educational platform, conveyor technology, network of communication platforms, training complex with electronic courses, modular architecture) (Fig. 2).

3. Organisation of advanced (proactive) training

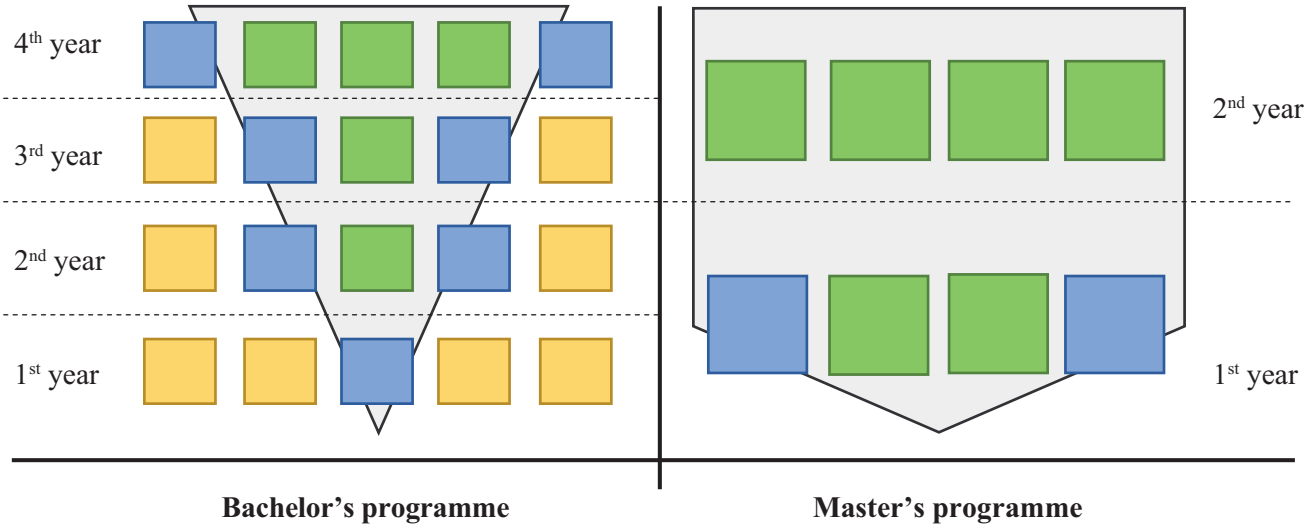
An important element of advanced learning is the modular architecture of educational products, which responds to the growing market demand in terms of customisation and flexibility of the educational process. It should be emphasised here that the formation of training modules in educational programmes is a certain methodological task that can be solved on the basis of different approaches and principles.

An analysis of the literature and the experience of educational activities allows us to identify three possible methodologies [Baranov et al., 2020; Gitelman et al., 2020a; Chantarasombat, Rooyuenyong, 2020].

1. Competence-based, currently implemented in federal state educational standards. The competencies that students need to master as part of the educational programme are grouped into the so-called learning outcomes. Each module corresponds to one or more learning outcomes. The disadvantages of the approach are its excessive rigidity and focus on fixing current rather than promising competencies.
2. Market. Based on the needs of the market and specific customers. Competences are important here, but they are secondary – promising areas of knowledge come to the fore, often in short supply, actually not represented in the educational landscape and in need of new teaching methods. This methodology requires constant interaction with practice, involvement of business representatives and qualified practitioners in the educational process. It has more novelty and relevance, it is more attractive from a commercial standpoint. Its shortcomings are the difficulty in finding highly qualified teachers and creating an educational project team.
3. Research. Modules are formed based on the scientific direction in which the project team works. Such an approach can be implemented if there is a strong scientific background and a mechanism for the rapid transfer of scientific results into educational content. This is the most difficult methodology to implement, but also the most in demand for preparing managers for the economy of the future. Among the advantages are a high degree of elaboration of the issues under study, a variety of options for project work, and an orientation towards breakthrough scientific and technological achievements. Cons – the research agenda does not always correlate with the current requests of the customer and the needs of employers.

For advanced learning, the most adequate approach to the formation of training modules is a comprehensive one, combining all three of these methodologies. The key elements of an integrated approach are shown in Figure 1. 3. These include: (1) authoritative research results on the profile of the module, available to its authors; (2) knowledge, competencies and scientific and

Fig. 4. Modular structure of educational programs
(triangle and pentagon designate areas of proactive learning content)



methodological groundwork for the transformation of scientific and practical content into educational content, the availability of proven tools for advanced learning. The first condition is ensured by the presence in the structural unit (it the department of learning, division) of breakthrough scientific areas and experience in their implementation for five or more years. The second condition is formed in the process of creating innovative educational products of a new generation, including digital learning technologies.

When developing and implementing a training module in the educational process, the following requirements are taken into account:

- interdisciplinarity, providing integration with other modules in the educational programmes of master's and MBA programmes;
- flexibility – the ability to adapt modules to different programmes and consumers;
- constant updating of content based on monitoring the scientific and educational environment, as well as the results of our own research;
- continuous improvement of technological and methodological tools for work in the module, increasing its relevance;
- instrumental and methodological equipment, which allows to adapt the educational work in the module to the needs and individual characteristics of the trainees.

The specifics of the modular approach in advanced learning ensures a dramatic increase in the quality of educational services due to the correspondence of training

Table 1
Examples of modules in educational programs implemented by the authors

Type of module	Bachelor's degree (programme "Management in energy and high-tech industries")	Master's degree (Programme "Innovation Management in the Digital Economy")
1	"Ideological foundations of professional activity", "Organisational and managerial decisions in professional activity"	—
2	"Strategic management of the organisation", "Fundamentals of energy business"	"Digital Economy Management", "Digital Revolution"
3	"Energy business development management"	"Management of the development of digital systems", "Consulting and engineering in the industry of the future"

Fig. 5. The device of the educational and training complex

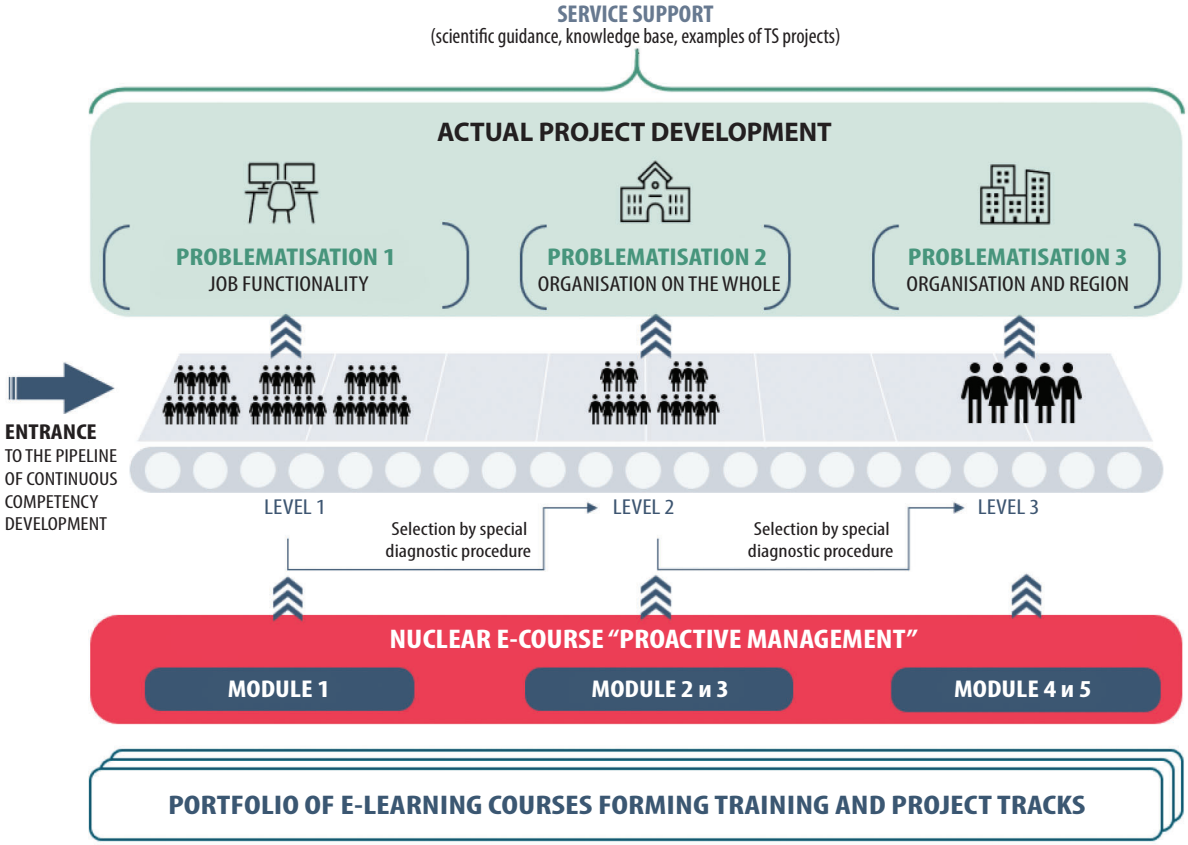
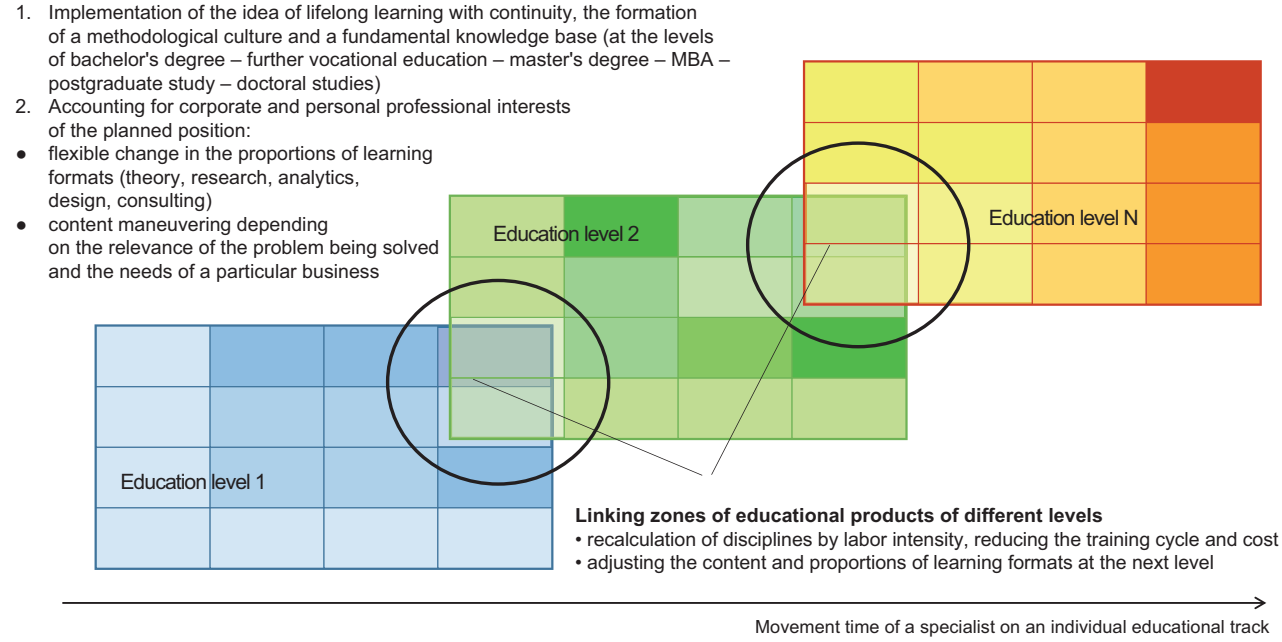


Table 2
Assessments of competencies by importance in practice

Competence	Average score	Rank
To implement proactive management actions based on early diagnosis of threats and opportunities	4.56	**1**
Ability to adapt and achieve results in a dynamic and uncertain environment	4.54	**2**
To assess the costs, risks and efficiency of resource use in the implementation of innovative projects	4.44	**3**
To perform multi-criteria assessments of design solutions and complex analytics of the problems being solved	4.38	**4**
To develop leadership strategies and organise proactive staff training	4.36	**5**
To develop integrated solutions at the intersection of management, engineering, economics, IT technologies and other areas of knowledge	4.33	**6**
The ability to adequately self-assess one's professionalism for solving non-standard tasks and continuous self-learning	4.31	**7**
To apply special methods to develop the company's vision for the future and business models	4.28	**8**
Ability for interpersonal communication, productive collaboration and teamwork in a digital environment	4.28	**9**
To organise technological modernisation processes and manage project portfolios	4.23	**10**

Fig. 6. The essence of the pipeline technology for continuous development of competencies



modules to current market needs, advanced scientific and technological achievements, and a greater ability to meet the interests of consumers of services through original tools. At the same time, an educational programme that implements advanced learning may contain three types of modules, the share of which in the total volume of the programme differs depending on the level of education (Fig. 4).

Modules of the first type (in Fig. 4 they are colored yellow) are aimed at the goals of educational standards that are not related to advanced learning. Modules of the second type (blue) are associated with both educational standards and advanced learning. Modules of the third type (green) are fully associated with proactive learning.

Thanks to this composition of modules, students develop knowledge of approaches to solving problems

Fig. 7. Examples of author's programs implemented in the pipeline logic

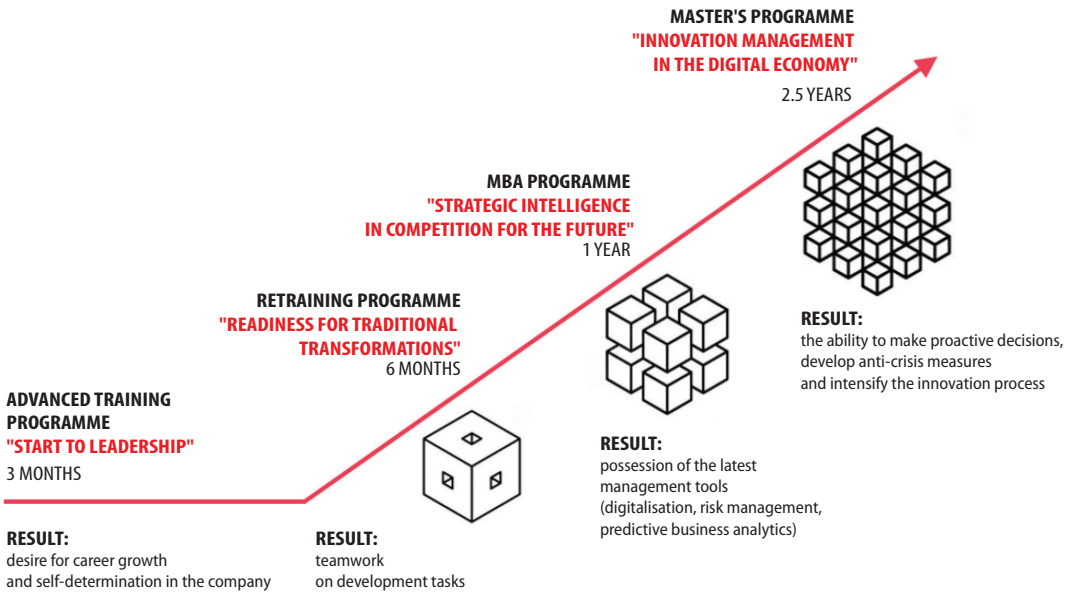
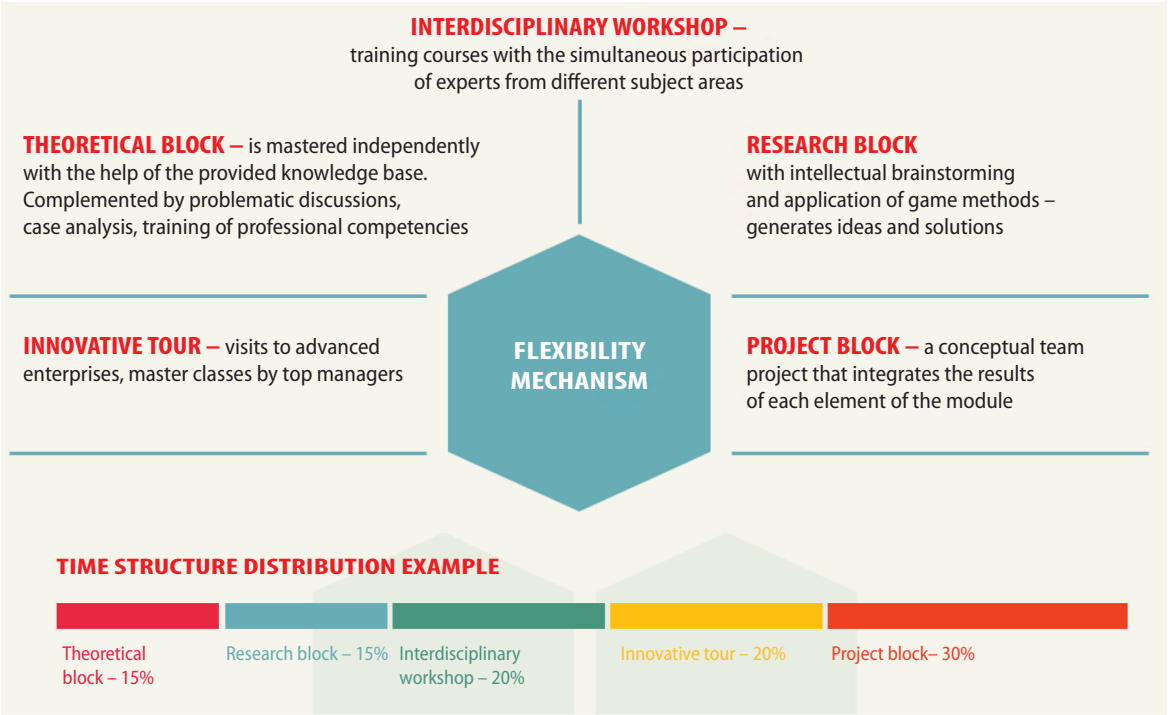


Fig. 8. "Module-in-module" technology



of current activities, the ability to explore and create a picture of the future, an understanding of the relationships and dependencies between the problems of today and the possibilities of implementing plans to achieve the future in accordance with its built image. Examples of modules of each type are given in Table. 1.

In addition, proactive training is a mechanism for the formation of a new self-awareness of managers, which is characterised by responsibility for their professional readiness to solve new problems and proactive actions in situations of emerging threats and new opportunities. As our research shows, achieving such a result is a difficult task for traditional training programmes. The results of a survey of qualified managers of a high-tech company with work experience and potential for professional growth showed that almost all of them verbally well understand the need for continuous (lifelong) training, but only 15% of them implement this understanding in specific plans and actions that reflect the internal need and level of professional consciousness. Students of the Master's Degree in Management, who are studying for the second year in an educational program with an integrated advanced training circuit, demonstrate higher rates in a similar survey – at the level of 54%.

In general, the experts we interviewed (both practitioners and master's students, 60 people in total) in the process of comparing the significance of different competencies for their professional activities on a 5-point scale give particular preference to the competencies of proactive training – predictive management, engineering, economic and engineering and management (Table 2).

To implement and develop the concept of advanced training, a new methodology for training managers is being formed, which uses the best practices of traditional training and develops new organisational and methodological tools, which are clearly insufficient so far. In this direction, the authors have developed a number of technologies used in the training of managers and breakthrough teams in large energy, industrial enterprises, and universities.

Electronic educational and training complex of advancing training. This is a system that integrates for users educational content, methods, information and service support for advanced learning, focused on the study of development problems and early management decision-making for non-standard situations of the future (Fig. 5).

Conveyor of continuous growth of competencies. The technology makes it possible to realise the idea of lifelong learning with the observance of the continuity of different levels of education, which is provided on the basis of re-credits of the material covered at the previous stages (Fig. 6, 7). At the same time, personal professional and

corporate interests, the planned position of the student are taken into account, and the content and formats of training can be flexibly changed in accordance with the specifics of the tasks being solved. Technology is the foundation for designing curricula that involve the development of several educational levels in a short time (bachelor's + master's, master's + MBA, master's + postgraduate), which corresponds to the practice of the world's leading universities.

"Module-in-module" is a technology that is an integration within one block of academic disciplines of various activities, the proportions of which vary directly in the course of training depending on the preferences of the students (Fig. 8).

The uniqueness of the technology also lies in the fact that it cannot be implemented without powerful service support. For example, to master the theoretical block, a digital knowledge base has been developed, which includes more than 50 textbooks, manuals, monographs and 300 articles by our team's teachers. As part of the project block, a special project repertoire has been created for students, which, in turn, is closely related to the research agenda of the breakthrough scientific direction "Proactive management in actively developing industries and sectors of the economy". Among the topics of the project repertoire there is an organisation of the strategic process in the digital environment, strategic intelligence of the organisation, readiness for systemic changes based on the design of the future, asset management under conditions of uncertainty, environment and competencies for a breakthrough to the markets of the future, breakthrough teams and systems for cultivating talented people and leaders.

Conclusion

The proactive learning paradigm has a significant potential for a variety of approaches and concepts for its implementation. It meets the new requirements for high-tech business leaders focused on technological breakthroughs and the creation of proactive management systems. The faster and more unpredictably the changes occur, the more acute the need for radical changes, the higher the demand for advanced training in the training of managers. In this regard, the relevance of advanced learning is so high that, in fact, it becomes a task of extreme national importance.

The transition from the traditional educational process to the advanced learning system is a complex and time-consuming task that requires:

1) expanding the range of goals for training graduates, including a qualitatively new composition of competencies and personal qualities;
2) creating educational programmes with an integrated contour of advanced training, providing a balance of the ability to solve current problems and promising problems of the development of the organisation in an unstable environment;
3) determining the content of training modules and disciplines based on an integrated approach that combines competence, market and research, to create a balanced composition of modules, taking into account their intended purpose;
4) development of a methodology for advanced learning, including the modernisation and adaptation of known methods to new educational content and the goals of preparing for proactive management, as well as the creation of special tools for organising educational, research and project work of students;
5) the introduction of a digital educational environment that increases the dynamism and flexibility of the educational process, its content and methodological development.

To successfully solve these problems, an innovative research environment with a baggage of significant scientific achievements and experience in organising search and conceptual design activities is required, in which students, interns, young scientists are easily involved, as well as a platform for partnerships with businesses interested in a breakthrough. All this requires considerable effort and creativity, but the intellectual and physical costs are fully justified, because, as the experience of the authors shows, a graduate of the advanced training programme is able to:

- quickly adapt to solving a variety of tasks of the management of the company's current activities;
- engage in the development of programs and projects for the vision of the future of the organisation and strategic planning for their implementation;
- be responsible for your level of professionalism and increase your readiness to solve new managerial tasks in line with development trends.

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