DOI: 10.17747/2618-947X-2023-2-118-135

Innovation managers for the country's technological sovereignty

L.D. Gitelman[1]
A.P. Isayev[1]
M.V. Kozhevnikov[1]
T.B. Gavrilova[1]
[1] Ural Federal University named after the First President of Russia B.N. Yeltsin (Ekaterinberg, Russia)

Abstract

The article substantiates the authors' position, supported by empirical data, on the sharp increase in the intellectual intensity of managerial activities and on the transformation of the managerial profession into one of the most complex, gaining particular importance in the organisation of the innovation process for technological sovereignty. The increasing role of management science in understanding the ongoing turbulent changes, developing methodologies for proactive management and identifying competencies in demand in the economy is highlighted. The need for the introduction of advanced learning in these conditions is demostrated; the authors' experience in its development and implementation in terms of specific organisational models, content and teaching methods is presented. Within the framework of the proposed concept of further education, it is necessary to introduce a management specialisation focused on specific industries into the existing system of higher education. It will provide enhanced fundamental and applied training, a significant increase in the volume of practice and will enable students to master the engineering-economic and engineering-managerial knowledge necessary for taking into account interdisciplinary relationships between high technology, economics and finance when making management decisions.

Keywords: technological sovereignty, management education, interdisciplinarity, proactive management, systems engineering, advanced training, fundamental training, specialty.

For citation:

Gitelman L.D., Isayev A.P., Kozhevnikov M.V., Gavrilova T.B. (2023). Innovation managers for the country's technological sovereignty. *Strategic Decisions and Risk Management,* 14(2): 118-135. DOI: 10.17747/2618-947X-2023-2-118-135. (In Russ.)

Acknowledgment

The study was carried out with the financial support of the Ministry of Science and Higher Education of the Russian Federation within the framework of the Development Programme of the Ural Federal University of the first President of Russia B.N. Yeltsin in accordance with the Priority 2030 Strategic Academic Leadership Programme.

创新管理者于国家技术主权

L.D. Gitelman[1]
A.P. Isaev[1]
M.V. Kozhevnikov[1]
T.B. Gavrilova[1]
[1] 俄罗斯联邦首任总统叶利钦命名的乌拉尔联邦大学（俄罗斯叶卡捷琳堡）

摘要

该文章通过经验数据证实了作者的观点，即当今管理活动的智力密集度急剧上升。管理已成为最繁难的专业之一，这一点在组织技术主权的创新进程时尤为重要。管理科学在理解正在发生的动荡变化、制定积极管理方法和确定经济所需的专长方面发挥着越来越重要的作用。作者证明，在这些条件下有必要引入超前教育方法，而且从具体的组织模式、内容和教学方法等方面介绍了设计和实施该课程的经验。有必要在现有高等教育体系中引入管理专业，该专业将面向特定行业。这种教育包括加强基础培训和应用培训，大量增加实践经验。这将为学生提供在做出管理决策时考虑知识密集型技术、经济和金融的跨学科相互关系所需的工程-经济和工程-管理知识。

关键词： 技术主权、管理教育、跨学科、积极管理、系统工程、超前教育、基础培训、专家学位。

供引用:

Gitelman L.D., Isayev A.P., Kozhevnikov M.V., Gavrilova T.B. (2023). 创新管理者于国家技术主权。战略决策和风险管理。14(2): 118-135 (俄文). DOI: 10.17747/2618-947X-2023-2-118-135. (俄文。)

该研究得到了俄罗斯联邦教育与科学部的支持根据"优先2030"战略学术领袖计划在以叶利钦命名的乌拉尔联邦大学发展框架内。

Introduction

The task of ensuring Russia's technological sovereignty is strategic and is enshrined in the Concept of the country's technological development until 2030[1]. According to it, the share of domestic high-tech products should reach 75% and lead to the country's independence from imports in the context of increasing geopolitical risks and the threat of unfair market behaviour by foreign producers. Technological sovereignty implies the ability of a country to independently generate the latest scientific knowledge and create breakthrough innovations that determine the long-term sustainable development of the state [Crespi et al., 2021; Edler et al., 2023]. Its achievement depends on solving two interrelated problems: the development of effective production methods and subsequent replication of innovative technical solutions, business models, products and services that are critical for the economy; the implementation of new technologies and products in foreign markets to achieve global competitiveness[2]. Thus, technological sovereignty does not imply complete autonomy of the state from external actors. On the contrary, its presence gives it a strong negotiating position with economic partners in the exchange of know-how, access to which in turn further strengthens the state's technological leadership and economic security[3].

On the way to technological sovereignty, Russia is already facing the most acute problem of a shortage of qualified personnel. This problem is being raised quite actively in the professional community, but it has not yet been widely and meaningfully discussed.

The extent of this problem, which is already hampering the country's innovative development, is underestimated. Basically, the discussion boils down to the shortage of workers and engineers, IT specialists and the need to reformat the relevant educational programmes (abandoning the Bologna system and moving towards specialisation). This study raises an equally important aspect of the problem, namely the total lack of professional, competent managers to organise the innovation process - innovation managers - and the need for a radical modernisation of management education in this respect.

Today, revolutionary changes in the management of companies are literally taking place in front of our eyes. Proactive management is really coming to the fore - a set of technical, organisational, resource and economic measures carried out at all levels of an industry, a specific company and aimed at preventing the negative impact of internal and external factors that threaten sustainability, functionality, competitiveness, economic and environmental efficiency [Gitelman et al., 2017].

Proactive management aims to address the challenges and threats posed by general instability, as well as to identify emerging opportunities as a result of monitoring scientific and technological trends. The goal of proactive management is largely achieved through the inextricably linked advance preparation of the company for unexpected changes and planned innovations (5-10-15 years ahead), including R&D, building intellectual capital, introducing flexible organisational structures and creating a creative business environment.

Unfortunately, Russian science pays practically no attention to the issues of proactive management. In the Russian database of scientific publications eLibrary for the last ten years, it is possible to find a small number of serious publications on economics and management (for example, [Vaino et al., 2011; Zarochintsev, 2021]), which contain this concept in keywords. Considering that more than 10 thousand articles were published in economics and management during this period, the share of publications on proactive management is essentially negligible - less than 0.1%.

The inattention to this issue in academia is reflected in the current state of management education. It is still based on an outdated paradigm that corresponds to the ideas, principles and management practices of advanced countries thirty years ago. As a result, the gap between the tasks of technological sovereignty and the competencies of management personnel is widening and increasingly becoming a serious obstacle to the country's development.

The purpose of this article is to present and discuss the results of the authors' many years of research, which demonstrate:

(1) the rapid increase in the complexity of management tasks due to scientific and technological progress and the growth of the knowledge intensity of production;

(2) the urgent need for advanced management education that anticipates changes in the content of managers' activities;

(3) the need for a deep restructuring of the educational process, with a pronounced emphasis on promising industry technologies and best practices, which determines the relevance of the new learning paradigm and the replacement of bachelor's degrees with specialist degrees.

1. Research methodology

The study is based on a systematic approach in which the issues of achieving technological sovereignty, managing scientific and technological projects, modernising the national economy and industry are considered in a comprehensive manner, primarily in terms of the emergence of new types of activities that determine changes in the content of the tasks solved by managers. This methodological principle

[1] Decree of the Government of the Russian Federation dated 20 May 2023 ¹ 1315-r 'On Approval of the Concept of Technological Development for the Period up to 2030'. http://static.government.ru/media/files/KlJ6A00A1K5t8Aw93NfRG6P8OIbBp18F.pdf.
Decree of the Government of the Russian Federation dated 15 April 2023 ¹ 603 603 'On approval of Priority areas of projects of technological sovereignty and projects of structural adjustment of the economy of the Russian Federation and Regulations on conditions for classifying projects as projects of technological sovereignty and projects of structural adjustment of the economy of the Russian Federation, on providing information on projects of technological sovereignty and projects of structural adjustment of the economy of the Russian Federation and keeping a register of these projects, as well as requirements to organisations authorized to submit conclusions on compliance of projects with requirements for projects of technological sovereignty and projects of structural adjustment of the economy of the Russian Federation'. http://publication.pravo.gov.ru/Document/View/0001202304170025.
[2] Evtukhov V. (2023). Technological sovereignty is a story not only about critical, but also about advanced technologies. Kommersant, 11 July.https://www.kommersant.ru/doc/6081958.
[3] Peskov D. (2022). Why is technological sovereignty important for Russia? RBC, 9 June. https://www.rbc.ru/newspaper/2022/06/10/62a0e95b9a79472d8b713207.

determines the logic of the study, which involves the passage through several interrelated stages:

1) empirical justification for the radical increase in the complexity of management activities and the demand for proactive management;
2) formulation of requirements for advanced learning - an integral element of proactive management in conditions of dynamic change and uncertainty;
3) determination of organisational models to train management personnel for innovative activities and technological breakthroughs and their implementation in the shortest possible time.

The information base was formed by surveys of experts - managers and specialists of electric and thermal power engineering enterprises, telecommunications enterprises of the Russian Federation, professors and university teachers (more than 100 respondents in total); 150 students and graduates of management programmes were also recruited. The results of the expert assessments, combined with an analysis of the content of the curricula of management training programmes, allowed the authors to identify the characteristics of management activities that determine the reference structure of programmes and the composition of educational content. In addition, an analysis of more than 50 relevant scientific publications was carried out.

2. Management is becoming an extremely complex profession

The factors determining the rapid growth of the intellectual intensity of the management profession are the following.

1. The ongoing technological revolution is generating an avalanche of scientific and technological achievements, the significance of many of which for business, the economy and society has yet to be grasped. New knowledge is required to introduce advanced technologies into production and management and to define the principles of their integration with technologies of previous and future generations, which means that science is moving to the forefront of innovation.

The manager becomes a researcher of problems, trends and contextual changes and a developer of fundamentally new production and technological systems [Senge, 2011]. He must analyse the organisation as a meta-system and the external and internal trends and forces acting on it, anticipate changes in a wide range of areas of activity and begin to prepare for them immediately.

2. Disruptive technologies are rapidly penetrating even traditionally conservative industries, radically changing the production landscape, business models and economics of companies. The very concept of 'industry' is expanding - its boundaries are changing and expanding significantly, new sectors are emerging, and competition is moving to the inter-industry level [Porter, Heppelmann, 2014; Bessonova, Gonchar, 2019]. The main competitive advantage is no longer the products themselves, but the innovative systems and technological platforms that connect them [Pereira et al., 2018; Trachuk, Linder, 2023].

As a result, the systems in which the manager works become much more complex. To manage the functioning and development of such systems, a manager needs a deep understanding of their structure and interrelated characteristics - engineering, technical, financial, economic, environmental, social. It requires knowledge of the latest methods for creating resilient and flexible systems that are resistant to unexpected external influences and disruptive factors. This is particularly true for critical infrastructure - life-sustaining and strategically important industries such as energy, aerospace, nuclear and electronics, oil and gas, telecommunications, fintech, heavy engineering.

3. In the context of technological sovereignty, it is necessary to solve a wide range of complex problems in the shortest possible time: import substitution, modernisation of existing and creation of new production facilities, formation of optimal supply chains, forecasting demand and development of new markets, advanced training of personnel, ensuring energy and information security. A deep understanding of the relationships between 'technology - engineering - ecology - economy and finance – management' is the imperative of a modern leader, and his activities acquire a pronounced interdisciplinary character [Rolstone, 2022; Gutiérrez-Iñiguez et al., 2023][4].

4. A manager's main 'product', a management decision, is made under conditions of relatively high uncertainty and often information chaos [Bledow et al., 2011]. There are virtually no ready-made algorithms for most decisions, and the cost of an error from a wrong choice increases many times over [Zhang, Parker, 2019]. Big data processing, predictive analytics, artificial intelligence, multi-factor scenario design methods, risk management tools and the latest systems engineering methods make it possible to set up control systems that are highly sensitive to weak signals and reduce the overall uncertainty of the future. Therefore, making strategic decisions with long-term consequences requires powerful analytical tools and expensive IT infrastructure, including cyber protection of critical data [Makarov, Makarov, 2021; Karikova, 2023].

5. The development of specific management thinking among managers, characterised by a fundamentally larger scale, is significantly updated: it includes systemic, cost, entrepreneurial, technical and conceptual thinking [Harju et al., 2021; Gratton, Gratton, 2022]. For different levels of management, these types of thinking are needed in different proportions: while for middle managers, systemic, entrepreneurial and technical thinking may be most important, for top managers, conceptual, systemic and cost thinking is a priority, shaping their visionary qualities [Kearney et al., 2019].

[4] Also refer to: Rolstone G. (2022). Why middle management is one of the most difficult jobs. Delphinium, 14 February. https://delphiniumcc.co.uk/why-middle-management-is-one-of-the-most-difficult-jobs/.

6. The shortage of highly qualified personnel, which some experts describe as catastrophic [Bondarenko, 2022][5], requires taking into account the factor of generational change, the values of young people, whose main motivators are not only career and money, but also intangible factors: trust and recognition in the team, interesting creative tasks, working in a team. Therefore, even in conservative industries, the importance of innovation, creativity, distributed leadership, self-development and learning opportunities is increasing.

In the empirical assessment of the complexity of the managerial profession, the authors used criteria formulated on the basis of the results of their own research [Professionals in Competition..., 2021; Gitelman et al., 2022a], generalisations of scientific publications [Sacramento et al., 2013; Shin et al., 2020; Bai et al., 2021][6], special rating techniques[7] and communication with experts. These criteria include:

- intellectual intensity: the need for versatile knowledge, systems thinking, the ability to use experience in the relevant field of activity; intensity of the work process and the number of decisions made in a given period of time;
- proactive decision making;
- the high social cost of errors: the damage caused by the consequences of the decisions taken for the company and the subjects of the external environment;
- lack of ready-made algorithms and uncertainty of conditions for solving problems, the need to search for non-standard approaches when making decisions;
- innovative activity: mastering advanced scientific and technical achievements, generating new ideas and knowledge for their implementation;
- professional working conditions: high physical and emotional stress (responsibility, frequent stressful situations);
- the need to work with large amounts of data;
- diversity of communication: the need to interact, use a common conceptual language and achieve mutual understanding with people from different professions, positions, viewpoints and experiences;
- multitasking: the need to deal with a large number of different issues simultaneously, requiring constant switching from one to another;
- adaptability to change: continuous restructuring of actions, tactics and behavioural strategies in response to changes in objectives, technologies and operating conditions.

Let us comment on some of the survey results. For example, management activities are already characterised by increasing complexity at the middle level (Fig. 1). Moreover, according to a number of criteria, the transition between the lower and middle levels of management is not linear but exponential in terms of complexity (Fig. 2).

At the same time, a survey of undergraduate and graduate students, future leaders, showed that most of the characteristics of activity, in which complexity increases most dynamically, are extremely poorly reflected in the corresponding educational programmes. Particularly negative is the low rating of students for the compliance of programmes with the criterion of innovative activity - a key factor in solving the problems of modernisation and achieving technological sovereignty - only 5.7 points out of 10. This situation correlates with the opinion of practising managers about the areas of activity in which there is the greatest deficit of relevant knowledge and skills (Fig. 3).

3. Management science will need to understand the changes that are taking place

In an environment where science does not provide answers to many of the questions that modern managers face, they have to search for answers and make decisions themselves, almost always with the risk of a high cost of error. In this context, the demands on managers' professional skills are increasing radically.

The reliance on experience in management decisions increases rather than reduces the risk of error, because its accumulation was linked to situations whose development was more predictable. Today, we have to rely on intuition, but it naturally involves considerable risks, since the concentrated experience of previous decisions in situations that are irrelevant today plays a significant role in its mechanisms [Myers, 2010].

According to the authors, managers need fundamentally different skills and tools to act successfully.

1. Organising and carrying out applied research on specific situations, highlighting current factors and relevant contexts. They are necessary because tasks for which there is insufficient existing knowledge (not found in reference books or even among experts) become critical.

2. Using the current structure of basic knowledge (anticipatory management methodology, scientific foundations of production and technologies of the future, vision of changes in professional activities) to analyse the nature of new processes, trends and identify the reasons for their emergence [Gitelman et al., 2022c].

3. Multidimensional flexible management thinking, including the ability to use, switch and integrate such types of thinking as strategic, systemic, critical, cost, conceptual and project, allowing to find hidden resources for effective solutions.

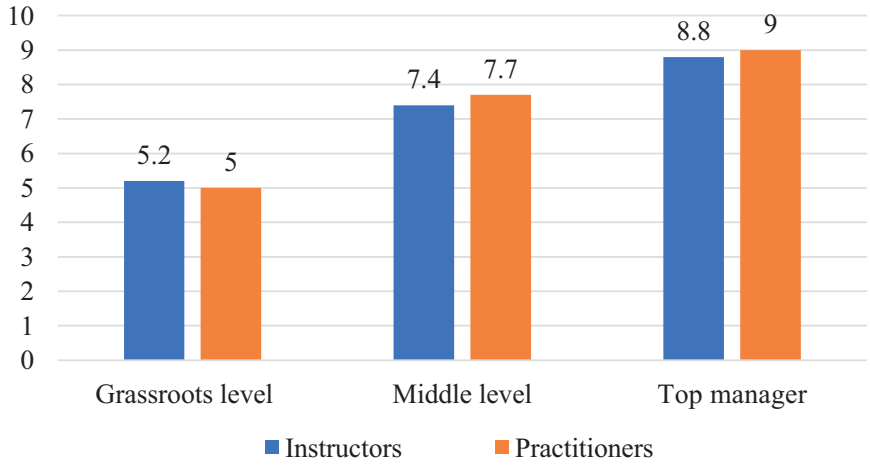
4. Using in-depth analysis of changing situations to carry out a calculative justification of the most appropriate alternative and make the right, least risky choice.

[5] Also refer to: Kozlov A., Grinkevich D. (2023). Personnel shortage and local unemployment: what awaits the labour market in 2023. Vedomosti, 18 January. https://www.vedomosti.ru/economics/articles/2023/01/18/959434-kadrovii-golod-i-lokalnaya-bezrabotitsa.

[6] Also refer to: Chin C. (2023). Why is management so difficult? Management for Startups. https://managementforstartups.com/articles/why-management-is-difficult/.

[7] Davis C. (2023). Hardest jobs in the world. ValiantCEO, 17 August. https://valiantceo.com/hardest-jobs-in-the-world/.
Zambas J. The 40 hardest jobs in the world (and what they pay) (2023). Careeraddict, 21 July. https://www.careeraddict.com/5-most-difficult-jobs-in-the-world.

Fig. 1. Results of expert assessment of management complexity
(on a 10-point scale)



5. Using the resource of interdisciplinarity and teamwork to solve the most complex and time-consuming problems.

6. Knowing the principles, methods and tools of proactive management, not only to anticipate threats in the early stages of their emergence, but also to realise emerging opportunities for production development.

Each of these skills increases the effectiveness of management action in contingency situations, but none of them is universal, so they often need to be used in combination to solve management problems successfully.

Of particular importance today is the ability of managers to formulate multifactorial business development scenarios and to reduce uncertainty about the future, which can no longer be predicted simply by extrapolating from the past. In this respect, there are areas and methodologies that aim to solve this problem and are actively developed in the scientific community (Fig. 4). It should be noted that most of these areas of future research are interdisciplinary in nature and have emerged in the last two to three decades, reflecting well the exponential growth in the complexity of economic development problems and related activities, primarily management, on which their successful solution depends. Therefore, the new generation of managers must be able to navigate in new areas of knowledge and find in them

Fig. 2. Dynamics of the complexity level of activities according to specific criteria
(average assessment by practitioners and professors)

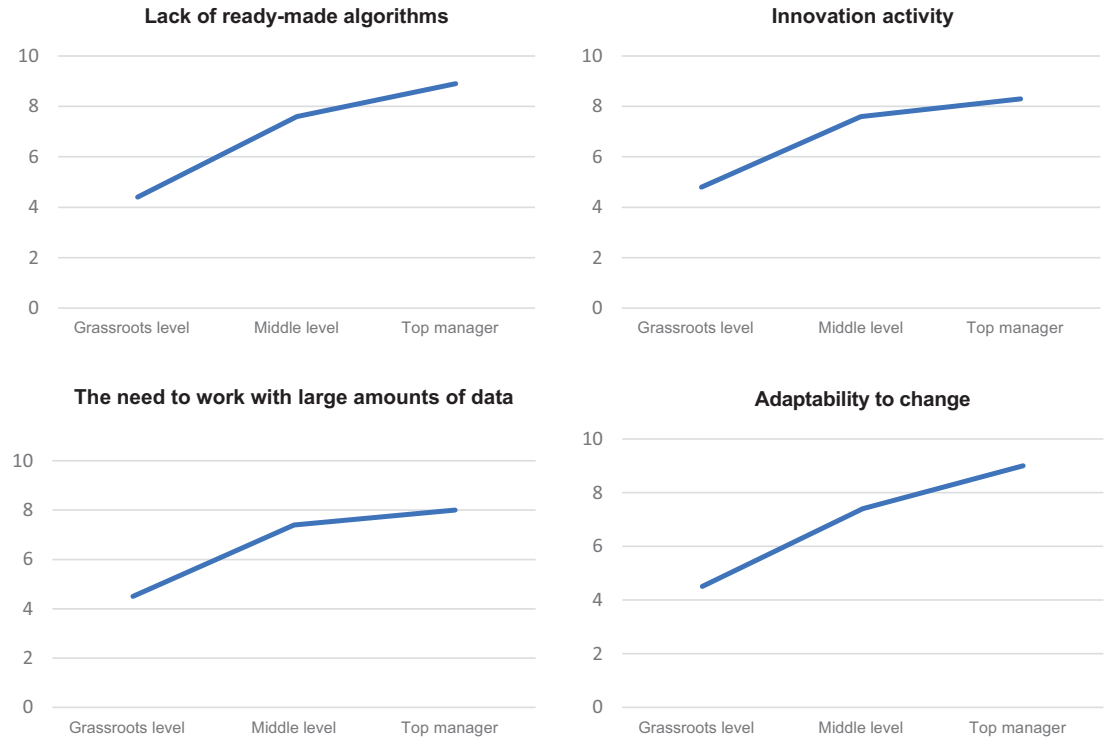
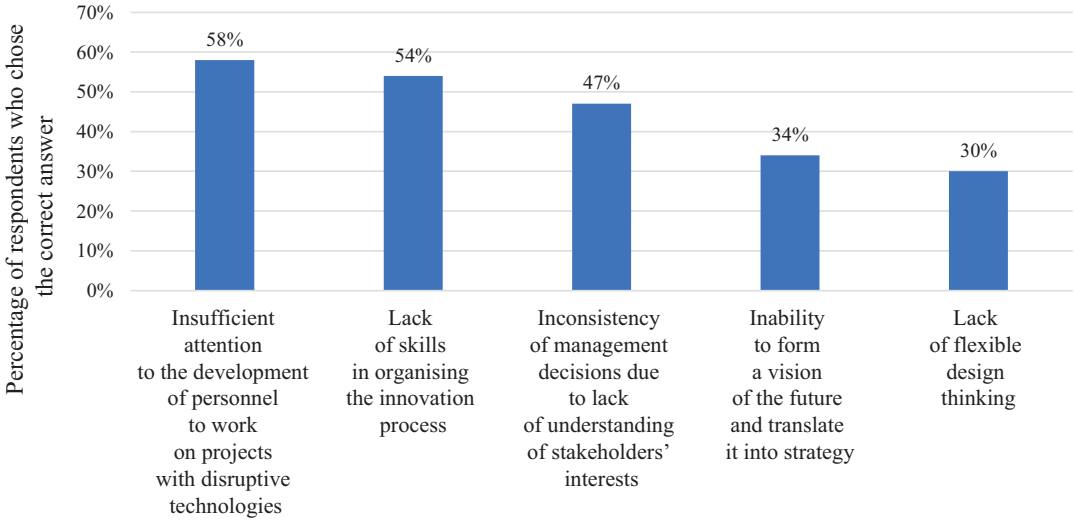


Fig. 3. Main disadvantages of high-tech business leaders

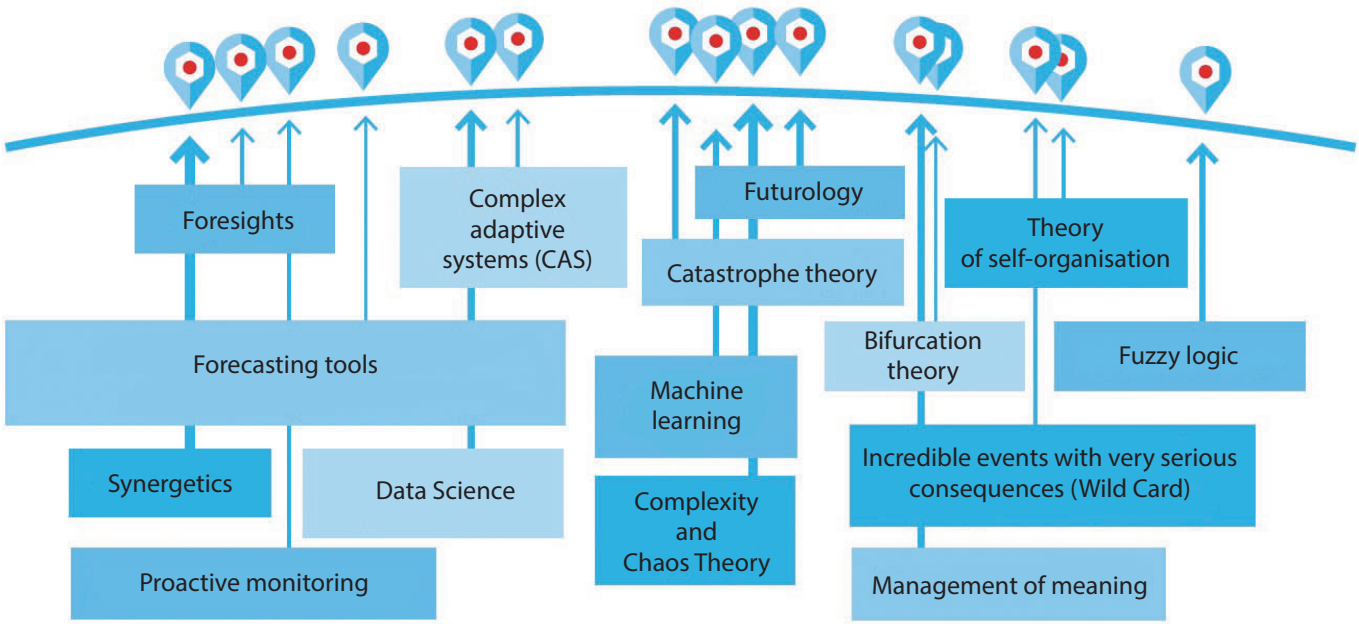


guidelines for solutions that are adequate to the content of the tasks and the conditions of current practice.

The ability to cope with increasing complexity will largely determine the success of innovation, which poses many multidimensional problems. In this context, research into the practical application of the systems approach - systems engineering - is of great interest [Bar-Yam, 2005]. The methods and tools developed on its basis are successfully used in practice for a wide class of objects, including socio-technical systems and systems of systems.

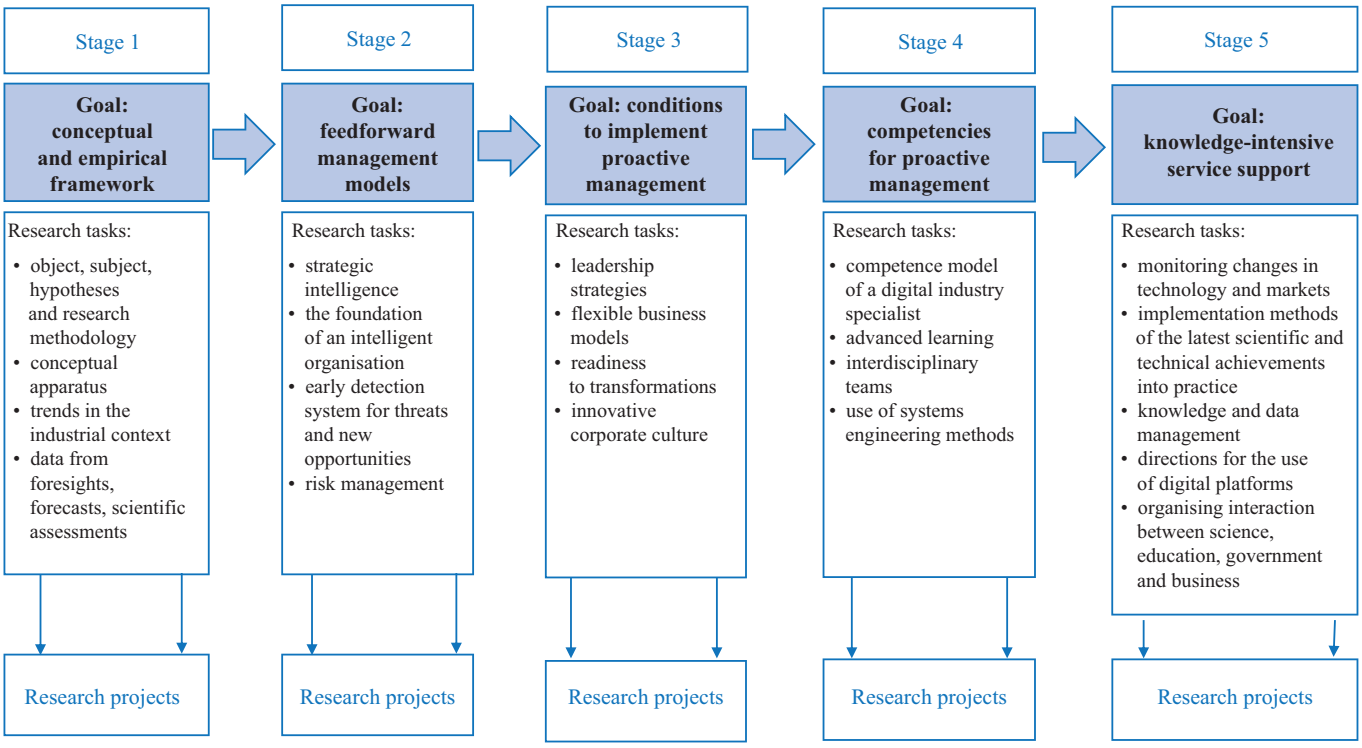
Analysis tools use fuzzy logic, neural networks, Markov chains and social network analysis methods. Diagnostic tools are based on Monte Carlo methods, algorithmic complexity, fractal dimensions and graph theory. Modelling tools include game theory, cellular automata, system dynamics and multi-scale models. Architectural frameworks, genetic algorithms, multi-agent systems and adaptive networks are used to synthesise solutions [Shalizi, 2006]. It is worth pointing out that these areas are not adequately represented in the corresponding areas of mathematics studied at universities, a science that is of high value to management as a fundamental basis for professional training (as confirmed by the experience of some of the world's top universities [LeSage et al., 2021][8]).

Fig. 4. Relevant future research areas



[8] Also refer to: Why do managers need advanced mathematics? (2022). St. Petersburg State University, 25 May. https://english.spbu.ru/news-events/news/why-do-managers-need-advanced-mathematics.

Fig. 5. Creation of topics in the scientific field of 'Proactive management in actively developing industries and sectors of the economy'



Systems engineering is by nature interdisciplinary. Interdisciplinarity implies the synthesis of knowledge from different fields of science and practice, the identification of new relationships between them, allowing us to obtain qualitatively new solutions to complex problems.

Research aims to solve management problems, not engineering problems [Calvo-Amodio, 2019]. Particular attention is paid to the problem of increasing the flexibility and adaptability of systems - giving them properties that protect them from the adverse effects of unpredictable factors and increase the stability of their functioning. Thus, the methodology of elasticity (resilience) is being actively developed in various fields (ecology, sociology, psychology, organisation and engineering) [Stevenson et al., 2015].

System resilience is defined as the ability to cope with adverse conditions and events through preparation (planning), resistance to disruption, recovery from failure and successful adaptation to change and disruptive influence[9]. Elasticity implies the ability of a system to:

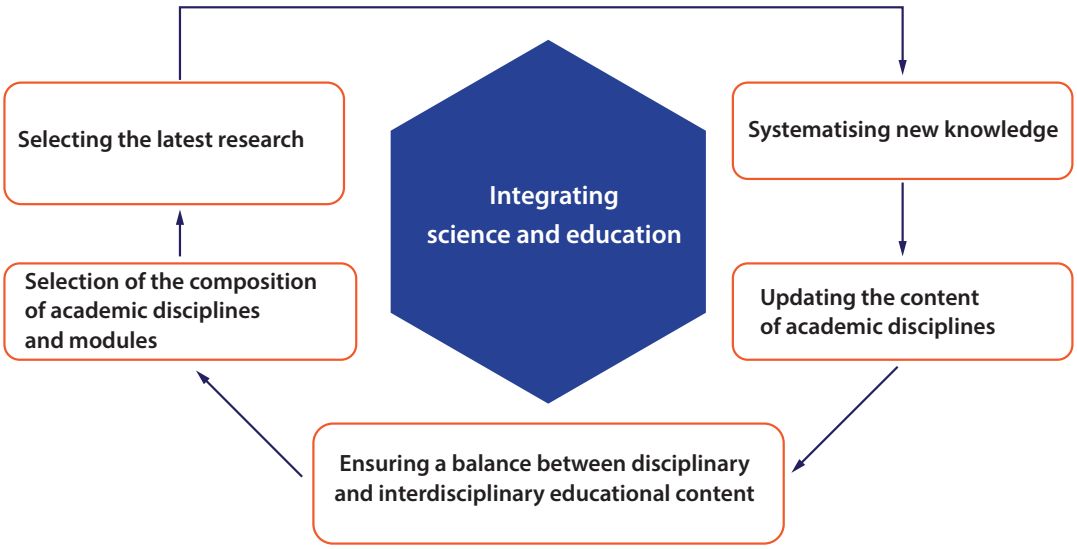
- anticipation - anticipating impending dangers in order to start adapting earlier and reduce the risk of decompensation;
- synchronisation - managing the coordination of activities at different levels to respond to rapidly changing events and reduce the risk of conflicting objectives;
- responsiveness - developing the ability to respond to future 'surprises' and reducing the risk of unreliability;
- proactive learning - learning to understand the signs, causes and sources of unreliability and improving the ability to withstand them (resilient performance) before a large-scale breakdown occurs by learning from the experience of monitoring and resolving unexpected situations [Hollnagel, Woods, 2006].

Another actively developing area of systems engineering is methodologies aimed at ensuring the flexibility of complex systems designed to operate under conditions of high instability and to perform critical functions where failure is unacceptable or very costly (agile methodologies). Such systems require a special approach to design and development. The techniques and tools developed by agile systems engineering for the design and development of such systems are described by the authors in [Gitelman et al., 2020].

The FuSE Agility project [Willett, 2021], which is one of the research projects initiated by the Future of Systems Engineering working group, is currently underway. The project considers four aspects of the Agile methodology.

[9] National research council. Disaster resilience: A national imperative (2012). Washington, The National Academies Press.

Fig. 6. Structure of the block for rapid updating of educational content



1. Agile systems engineering (processes): the application of agile tactics, technologies and procedures throughout the system lifecycle.

2. Agile systems engineering (technology): ensuring the adaptability of the system to both predictable and unpredictable change.

3. Operational flexibility (external environment): providing the ability to configure (flexibly configure) work processes to maintain efficiency in adverse conditions.

4. Flexibility in Performance (People): High adaptability to change, skills, knowledge and personal effectiveness.

In general, it can be said that the scientific issues of technological breakthroughs are increasingly moving into the realm of interdisciplinarity, taking into account engineering, technical and organisational-economic relationships as drivers of management development. This should, of course, be taken into account in the professional training of managers when developing their ability to quickly navigate a changing environment and find non-standard solutions to emerging problems [Pan, Sun, 2018; Anderson et al., 2023].

As a result of the conclusion on the special role of science in solving the problem of technological sovereignty, attention is drawn to the fact that the passport of the Higher Attestation Commission for the scientific speciality 5.2.6 'Management' does not sufficiently reflect the problems that have been relevant for the last decade. Among them are digital transformation, use of artificial intelligence in decision-making, big data management, knowledge management, proactive management). Therefore, we must admit that this document, which defines the main vector of development of all management science in the country, does not fully reflect the dynamics of modern trends and requires adjustments.

4. Proactive learning becomes imperative

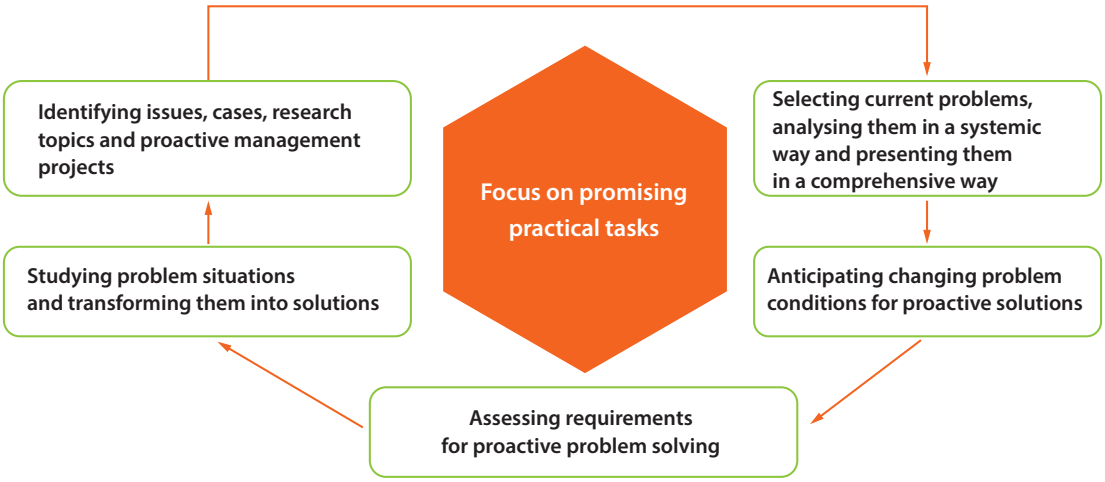
Thus, the need for significant changes in the training of managers for the tasks of technological breakthrough and technological sovereignty is obvious. It is proposed to conduct such training within the framework of the concept of advanced learning with a strong emphasis on design and research work [Gitelman et al., 2022b]. In this regard, the authors have formulated and are implementing a groundbreaking scientific direction 'Proactive management in actively developing industries and sectors of the economy', in which they have been working for more than ten years [Professionals in Competition.., 2021]. The logic of its application in current research projects is shown in Fig. 5.

It should be emphasised that feedforward learning generates knowledge for feedforward management; these two concepts are inextricably linked and define a new model for managing the evolution of any complex system [Gitelman et al., 2022b]. Examples of other features of feedforward learning are:

- interdisciplinary links with emerging trends and scientific and technological advances. The result is the development of skills to anticipate change, neutralise threats, exploit new opportunities and develop anti-crisis measures;
- intensive research and design work according to the real agenda of the company (region, territory), its strategy and development priorities;
- formation of constructive management thinking to implement breakthrough transformations, create innovative business models, leadership management systems.

The authors have created a self-developing educational system of advanced learning, which includes a number of blocks that perform certain functions and are in a state of

Fig. 7. Structure of the problem-focused block of the educational programme



active interaction with each other to ensure the flexibility of the educational process. It includes problem-orientation of the educational programme; rapid updating of educational content; systematisation and integration of learning outcomes; types and methods of educational activities; support for self-study services.

Let us comment on the blocks that directly perform the functions of developing competencies in students for proactive action.

The block for rapid updating of educational content is the key to advanced learning (Fig. 6). It creates conditions for the flexibility of educational modules: (1) their composition makes it possible to create different learning pathways according to students' objectives and priorities; (2) the composition of educational modules and disciplines is regularly updated with developments corresponding to the emergence of new knowledge and technologies; (3) the content of modules is updated on the basis of research and the prompt transfer of its results into educational content.

The block of problem-oriented focus of the educational programme (Fig. 7) is intended to determine the practical component of advanced learning in the form of current problems, the solutions to which should become the object of independent analytical, research and project activities of students.

The block of types and methods of educational activities characterises the methodological complex for the formation of universal and professional competences and shows the variety of cognitive and practical activity of students (Fig. 8). Together they form in students a holistic perception of the organisational and managerial context, an understanding of the possibility of analysing problems and tasks from different angles, as well as the ability to find relations between different processes and events.

Fig. 8. Structure of the block of types and methods of educational activities

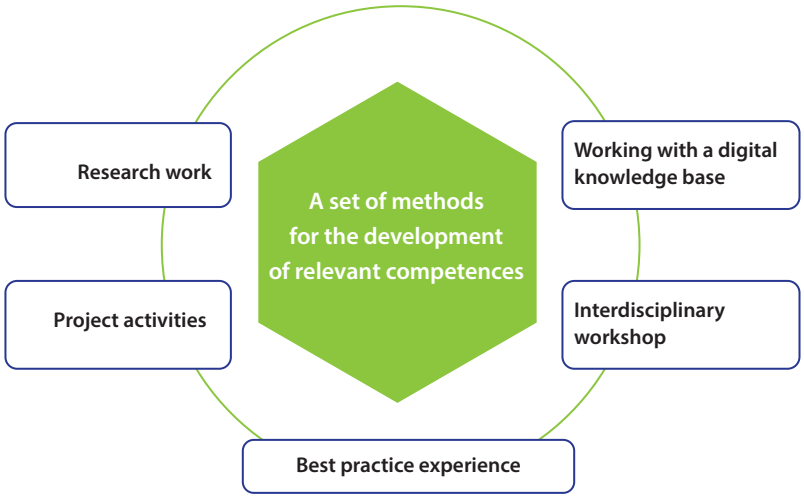
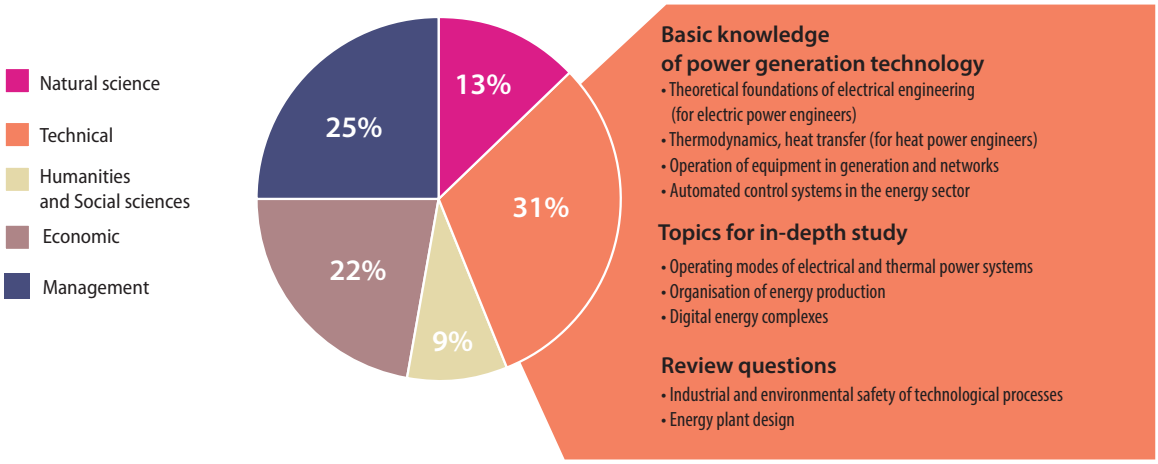


Fig. 9. Reference structure of the educational programme for energy managers (%)

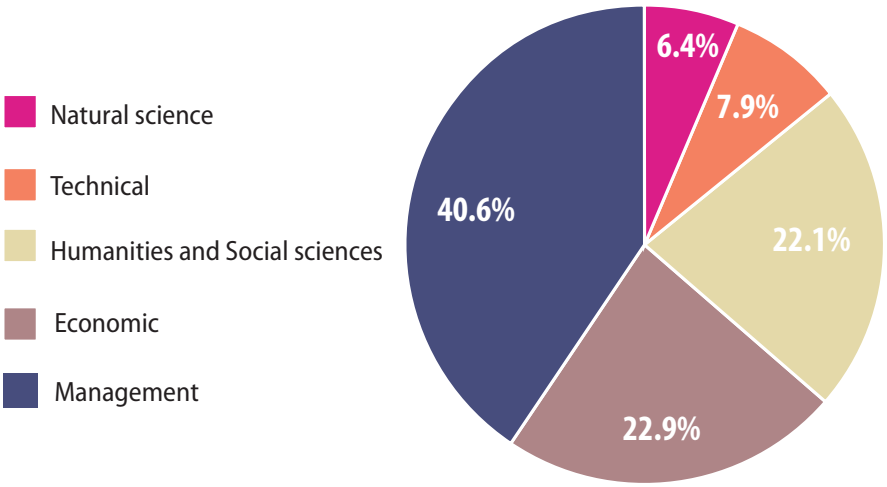


Thus, the main function of interdisciplinary education programmes of advanced learning is to form a holistic vision of the interrelations of processes and action algorithms from different scientific fields and academic disciplines.

In order to implement and develop the concept of advanced training, a new methodology for the training of managers is being created, using the best practices of traditional training and developing new organisational and methodological tools, which are clearly still insufficient. In this direction, the authors have developed a number of technologies used in the training of managers and breakthrough teams in large energy and industrial companies and universities. Among them are:

- electronic education and training complex for advanced learning is a system that integrates for the users educational content, methods, information and service support for advanced learning. It focuses on the study of development problems and the anticipation of management decisions for non-standard situations of the future; a promoter of continuous competence building, which implements the idea of lifelong learning in compliance with the continuity of different levels of education, ensured on the basis of re-evaluation of the material completed at previous levels. At the same time, personal professional and company interests, the student's planned position are taken into account, and the content and formats of the training can be changed flexibly according to the specifics of the tasks to be solved. The technology is the basis for the design of educational programmes that involve the mastering of several educational levels in a short period of time (Bachelor + Master, Master + MBA, Master + Postgraduate), which corresponds to the practice of the world's leading universities;

Fig. 10. Relevant structure of educational programmes in management (%)



- 'module within a module' is a technology that represents the integration within a block of academic disciplines of different activities, the proportions of which vary directly during the training according to the preferences of the students;
- digital knowledge base, including more than 50 textbooks, teaching aids, monographs and 300 articles written by the faculty of the Department of Energy and Industrial Management Systems of Ural Federal University;
- project repertoir 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 are: organising a strategic process in a digital environment; strategic intelligence of the organisation; readiness for systemic change based on designing the future; asset management under conditions of uncertainty; environment and competencies for a breakthrough in the markets of the future; breakthrough teams and systems for growing talents and leaders.

5. An interdisciplinary approach requires an understanding of the technological underpinnings of production

Technology has a decisive impact on business performance. Therefore, the engineering and economic competences and the engineering and management competences of managers come to the fore, ensuring the functioning and development of the company, its technical, technological and economic systems as a whole, from the point of view of increasing reliability, safety, environmental and economic efficiency. These competences are required to justify and make management decisions in almost all areas of activity (logistics, finance, marketing, strategic management, etc.) [Gitelman et al., 2022a].

For example, in the power industry, in the process of fuel supply to power plants, it is necessary to understand that the boiler runs on fuel of a certain quality, with strictly defined suppliers and prices. In financial activities, when planning the budget of an energy company, it is necessary to know the relationship between the efficiency of power units and business results. Energy marketing presupposes the rational behaviour of an active consumer on the energy and power market - a customer who orders the necessary services from the energy system. It is not without reason that a survey of experts conducted by the authors revealed the particular importance of engineering and technical disciplines in the training of energy managers. According to the respondents, it is precisely these disciplines, which are organically linked to the economic and management disciplines, that should come to the fore in training and should account for more than 30% of the teaching load (Fig. 9).

At the same time, the analysis of the curricula of undergraduate management programmes carried out in various universities of the Russian Federation shows that engineering and technical education is given extremely little attention. Thus, in the standard structure of 'management' education shown in Fig. 10, which the authors created based on the analysis of the curricula of domestic universities from various regions (MSU, HSE, NSU, TSU, St Petersburg State Polytechnic University, Plekhanov Russian University of Economics, Gubkin Russian State University, Far Eastern Federal University, etc.), the predominance of humanities and social sciences over natural sciences and engineering is clearly reflected.

A completely different principle and, of course, a different set of disciplines can be seen in management training programmes for knowledge-intensive industries at the best foreign universities. An example of one of these is given in Table. 1.

The practice of individual Russian universities focused on complex high-tech industries (e.g. MEPhI, MSTU named after N.E. Bauman, ITMO and a number of others) indicates an increased interest in engineering, management and business education. At the same time, programmes in so-called general management, which are in no way linked to the specifics of production, continue to be the most popular in domestic universities. As a result, the content and methods of management training at most universities are not much different for a trading company, a clothing factory, an energy company or a metallurgical plant. However, outside of specific technologies, business processes and the specifics of industrial markets, it is impossible to use teaching methods aimed at studying the latest scientific and technical achievements, their impact on competitiveness, introducing digital solutions and analysing the best practices in organising innovative activities. Moreover, the question of a strong increase in the role of science in the educational process loses its practical meaning.

6. Discussion

The professional training of the new generation of managers requires fundamental organisational decisions to change existing training practices. The most important of these is a change in the format of training - a move towards specialisation, implemented in long-cycle programmes (5 years).

In contrast to a bachelor's degree, a specialisation offers the possibility of organising a more comprehensive education, both in terms of theory and practical skills. The structure of the specialisation is based on pre-established criteria for the complexity of management activities, includes basic and applied training, specialised industry practice and develops students' readiness for innovative activities.

Let us take the example of designing a specialised programme to train managers in the electricity industry.

1. 1. The programme provides a thorough grounding in understanding the patterns of economic, scientific and technological development, mastering the skills of systems thinking and forming a holistic view of modern management activities, taking into account industry specifics.

Table 1
Master Programme 'Management and Engineering in the Electric Power Industry' of the University of Aachen (Germany) in cooperation with the Maastricht Business School (The Netherlands)

Term	University	Key disciplines
1	Aachen	Electrical Machines (part 1); Testing and Diagnostics in the Engineering of Complex Systems; Theory and Analysis of Energy Transformations; Electricity Storage and Accumulation Systems; Entrepreneurial Strategy; Technology Development Strategy
2	Aachen	Electrical Machines (Part 2); High Voltage Equipment in Main and Distribution Electrical Networks; Automation in Complex Power Systems; Accidents and Stability of Power Systems; Energy Economics; Architecture of Energy Markets; Finance and Accounting; Power Storage and Accumulation Systems - Laboratory Practice
3	Maastricht School of Management	Global Trends and Sustainable Business Competitiveness; Organisational Development and Transformation; Managing International Network Projects; Business Economics; Supply Chain Management; Human Capital Management
4	Aachen / Maastricht School of Management	Preparation of a Master's thesis

2. Already in the first third of the education cycle, the emphasis is on technical and economic training, which solves two problems:

- - to give an idea of energy technologies and production complexes as highly complex and responsible management objects;
- to teach students to analyse the interdisciplinary relationships between engineering - technology - ecology - economics - management in order to make informed decisions about the development of the energy industry and to improve individual business processes and areas of activity of energy companies.

3. An increased number of internships are planned in companies and events that introduce students to energy production and involve them in solving operational and innovative problems.

4. YThe curriculum is based on the idea of having one or two key disciplines in each semester - majors and short minors that enrich and thematically complement the majors. In this way the problem of redundancy of disciplines in the curriculum is solved and it becomes more focused on specialised knowledge and skills.

5. A teaching method in which the design and research work of the students comes to the fore becomes fundamentally important. Its volume may be small in junior courses, while in senior years it may reach 70-80% of academic work. It is also important to instil in students a culture of self-development, self-learning and creative exploration. As our analysis has shown, these components largely determine not only the complexity of management activities, but also, in principle, the effectiveness of a manager's work in conditions of unpredictable change and increased risk.

An example of the content of the specialist's degree programme is given in Table. 2.

We emphasise that the proposed model of specialisation does not contradict the requirements of the federal state educational standards, which establish obligatory modules on the ideological foundations of professional activity, the foundations of Russian statehood and military training. The authors' proposals concern the part of the specialist's degree programme directly related to the profession.

Let us look at some important conditions for the implementation of this model.

First, it is necessary to overcome the 'identification' of management and business education. In terms of content, these types of professional training no longer coincide, although a significant part of the educational programmes have common content. Today, the understanding of business management has a different emphasis - it is no longer only about solving economic problems (with an understanding of their importance), but also about environmental and climate agendas, social responsibility, working conditions and personal self-realisation, which are becoming increasingly important. The high dynamics of change in production technologies, the digitalisation of all aspects of business, the activation of geopolitical factors, the general unpredictability of the external environment and market conditions require managers to have systemic knowledge of the interrelationships between engineering, computer science, geopolitics and psychology as much as knowledge of new economic approaches.

The development of economic and management science and practical activity is going in very different directions. For managers, the multidimensionality of tasks is increasing sharply and the possibility of their algorithmisation is decreasing; economists, on the contrary, have more opportunities to use intellectual means of calculation and analytical work by transferring a part of routine operations to machines. In general, the content of real practical problems solved by managers changes every year and the share of economic knowledge in it decreases. All this leads to an increasing differentiation of management and economic professions. This issue is discussed in more detail by the authors in [Gitelman et al., 2020].

Fundamental changes are needed in the organisation and content of student placements. It is much more difficult for a management student to choose a placement in a company than in any other field. 70-80% of management activity consists of interaction and communication with other people: subordinates, colleagues, managers, experts, employees in various fields of activity. At the same time, the content of these interactions is predominantly interdisciplinary. In addition, it varies considerably depending on the area of activity, even within the same management level. For this reason, functional units are preferable for those involved in organising student placements - future managers. They have less communication, fewer decision-making procedures and less organisation of their implementation, but more analysis with well-known algorithms for preparing decisions.

It is much more difficult to organise a management practice in the production sector. The activity of a line manager is not only to make operational decisions and communicate with other people, but often to direct the implementation of the decisions made, to prepare orders and instructions for carrying out the necessary actions. It is difficult, if not impossible, to organise this kind of practice by the manager delegating some of his functions to the trainee. Here another form of practice is needed, for example in the form of the trainee's participation in the work of a manager. Even in this form of production practice there are many limitations to the acquisition of the necessary experience in management activities.

The problem of a radical increase in the volume of practice for students of management specialities requires an urgent response. Today, graduates of Management major are actually deprived of the opportunity to fully acquaint themselves with real production - the volume of hours allocated to them for practice is less than 4% of the curriculum [Gitelman, Kozhevnikov, 2023], and should be at least three to four times more, as shown in the proposed design of the management specialist programme.

In this regard, it is appropriate to cite the experience of foreign universities, where practice is usually organised in two forms: an internship in a company, which can last a whole semester, or, which is more often implemented, an intensive project literally from the first year. Moreover, the last year of study can be entirely devoted to students carrying out projects under the guidance of mentors from the university and the company [Matzembacher et al., 2019]. This approach is used, for example, at Stanford University (USA), Dalhousie Research University (Canada), University College London (UK) [Gitelman et al., 2022a]. Student placements account for at least 20-25% of the curriculum, and the more innovative the student's future field of work, the more placements are included in the curriculum.

They should also pay attention to the general problems that impede the implementation of advanced learning and the viability of the proposed design of the specialised programme.

For example, it is no secret that in the last decade many universities have actively adopted the so-called mass education approach to the implementation of their educational programmes. Its characteristic features are:

- a significant increase in the general theoretical block of disciplines in the total volume of the educational programme, with a simultaneous decrease in its professional block;
- large-scale 'clustering' of students in classrooms, even for specialised courses (often 200-300 people each), to minimise programme costs;
- a sharp decrease in the threshold of points obtained by applicants in the Unified State Examination, which is necessary for admission to management programmes (to enter, it is enough to pass exams with weak C grades) - even in the leading universities of the Russian Federation, priority is given to the number of students over the quality of their input knowledge;
- the design of curricula based on the principle of throwing dozens of disciplines into a 'single pot', unrelated or duplicating each other, in order to preserve the teaching load of the teams to which it was 'historically' assigned.

In terms of management training, Russian universities today tend to favour the training of general managers, the content and methods of which are little different for the service, trade and high-tech sectors. Such training promotes the importance of 'soft skills' and ignores the importance

Table 2
Design of the management degree programme for the electric power industry

	Learning cycle				
	1st year	**2nd year**	**3rd year**	**4th year**	**5th year**
Key academic disciplines	Introduction to specialty Patterns of scientific and technological development General Mathematics Economics and Market Architecture	Organisation of energy production Modern Information and Digital Technologies Advanced Mathematics and Statistics	Industry Economics Industrial Economics (Energy Markets) Financial Mathematics Investment and Risk	Management system for energy companies Strategic management under uncertainty Investment Project Management Human Resource and Team Development Methods	Research and Business Analysis in Management Business Process Engineering
Basic active learning methods	Intellectual business games Innovative company tours Professional quests	Public pre-defence of diploma projects in energy companies	Public pre-defence of diploma projects in energy companies Расчетно-аналитические кейсы	Public pre-defence of diploma projects in energy companies Management cases	Internships in companies Public proposal defense of diploma projects in energy companies
Scope of design and research work	20%	40%	60%	60%	80%
Type and duration of internship	Academic internship at the department (2 weeks)	Technological practical training in the workplace (2 weeks)	Business practical training in a specialised division of an energy company (4 weeks)	Internship with the management of an energy company (8 weeks)	Pre-diploma placement combined with on-the-job training (16 weeks)

of knowledge of the latest advances in engineering and technology. The training process in these programmes does not usually involve the use of specialised laboratory equipment or experimental production sites, so the profitability of training 'generalist' managers is much higher than that of training engineers or scientists. And for many applicants with a very average level of preparation, management education is an attractive option: it is easy to enrol in programmes, especially contract programmes, it is prestigious, and studying does not require much effort. This 'system' of selecting applicants for management programmes leads to a situation where less than 20% of students have expressed professionally important qualities for management activities [Isaev, 2010; Professionals in competition.., 2021].

Students themselves often believe that they will work as sales or purchasing managers when they graduate, which shows the discrediting of the management profession and a complete lack of understanding of its complexity and responsibility.

What makes the problems identified particularly acute in the context of this article is the fact that in many universities the departments of sectoral economics and management have essentially been liquidated (or placed in conditions that impede normal work and development): mechanical engineering, energy, metallurgy, petrochemistry, construction - unique and highly sought-after centres of competence. This is done in order to meet the requirements of the so-called managerialisation of training and cost reduction.

However, this insignificant saving leads to a significant loss in the quality of trained managers for the real sector of the economy and creates a serious shortage of them in high-tech industries. There is also an acute shortage of teachers in engineering-economics and engineering-management programmes. According to the authors, it will take at least 5-10 years to eliminate this shortage.

Conclusion

The achievement of the country's technological sovereignty, together with the development of scientific and technological breakthroughs, the introduction of the latest production, digital and organisational solutions into the economy, is determined by the ability to organise the innovation process at all stages of its life cycle (from R&D to the operation of new equipment) and to manage the creation and development of complex integrated systems. Success is largely achieved through management. After all, it is innovative managers who implement transformations and must effectively solve problems of the highest intellectual intensity. The job of a manager is thus becoming more responsible, more knowledge-intensive, more interdisciplinary and filled with fundamentally new content.

At the same time, management science, and therefore the management education system, is seriously lagging behind the understanding of established realities and continues to propagate paradigms that were relevant decades ago. Moreover, neither science nor education has fully grasped the challenges facing management. This problem essentially blocks the implementation of a technological breakthrough, and its solution is therefore of great national importance.

Today, proactive management and the inextricably linked anticipatory learning are coming to the fore in management - concepts that involve an early response to future events and the creation of flexible management systems that take advantage of new opportunities. In practice, these concepts are embodied in a certain logic, according to which first a broad research agenda is established, generating the latest knowledge, and then an accelerated transfer of this knowledge into educational content is carried out. An important role will be played by a knowledge-intensive service infrastructure, including tools for monitoring changes in markets, platforms for knowledge management and communication, technologies for the continuous updating of educational products based on the results of the latest research.

The reform of management training in the country should be implemented immediately and include a number of priority organisational measures:

- transition to specialist's degree programmes for training innovative managers in high-tech industries;
- adaptation of the regulatory framework (mainly federal educational standards) in terms of greater attention to fundamentals, interdisciplinarity, actively developing scientific fields (anticipatory management methodology, systems engineering, data science, artificial intelligence, etc.), as well as work placement internship;
- creation of a system for accelerated training of university teachers with engineering, business and engineering and management skills to revitalise relevant industrial departments as centres of unique competence.

References

Bondarenko A. (2022). Problems of staffing in the fuel and energy sector. *Energy Policy.* November 14. https://energypolicy.ru/problemy-kadrovogo-obespecheniya-otraslej-tek/neft/2022/15/14/. (In Russ.)

Vayno A.E., Kobyakov A.A., Saraev V.N. (2011). Proactive management of complex systems. *Economic Integration Bulletin,* 11(1): 7-21. (In Russ.)

Gitelman L.D., Isaev A.P., Kozhevnikov M.V. (2022). *Advanced management education for the industry of the future.* Ekaterinburg, Ural University Press. (In Russ.)

Gitelman L.D., Isaev A.P., Kozhevnikov M.V., Gavrilova T.B. (2022a). Interdisciplinary competencies of managers for technological breakthrough. *Strategic Decisions and Risk Management,* 13(3): 182-198. DOI: 10.17747/2618-947X-2022-3-182-198. (In Russ.)

Gitelman L.D., Isaev A.P., Kozhevnikov M.V., Gavrilova T.B. (2022b). Advanced management education for technological breakthrough. *Strategic Decisions and Risk Management,* 13(4): 290-303. DOI: 10.17747/2618-947X-2022-4-290-303. (In Russ.)

Gitelman L.D., Isaev A.P., Kozhevnikov M.V., Gavrilova T.B. (2022c). Fundamental knowledge and flexibility of thinking - priorities of management education for a technological breakthrough. *Strategic Decisions and Risk Management,* 13(2): 92-107. (In Russ.)

Gitelman L.D., Kozhevnikov M.V. (2023). Radical changes are needed in the training of managers and engineers. *Energy Specialist,* 10. (In Russ.)

Zarochintsev S.V. (2021). Proactive governance and national security risk assessment. *Issues of State and Municipal Administration,* 3: 200-218. (In Russ.)

Isaev A.P. (2010). *Fundamentals of management of professionalization of managers of industrial enterprises.* Ekaterinburg, Ural University Press. (In Russ.)

Karikova A.S. (2023). Overcoming the barriers to the digital transformation of industrial enterprises through the business model selection mechanism. *Strategic Decisions and Risk Management,* 14(1): 74-85. DOI: 10.17747/2618-947X-2023-1-74-85. (In Russ.)

Mayers D. (2010). *IIntuition. Opportunities and dangers.* St. Petersburg, Piter. (In Russ.)

Makarov A.Yu., Makarov A.A. (2021). *Digital economy. Technologies that change management.* Moscow, SOLON-Press. (In Russ.)

Professionals in competition for the future. Advanced training for leadership in the digital industry (2021). Moscow, SOLON-Press. (In Russ.)

Senge P.M. (2011). *The fifth discipline.* Moscow, OLIMP-Business. (In Russ.)

Trachuk A.V., Linder N.V. (2023). Introduction of digital platforms by industrial companies as a source of competitive advantages. *Strategic Decisions and Risk Management,* 14(1): 18-32. DOI: 10.17747/2618-947X-2023-1-18-32. (In Russ.)

Andersone N., Nardelli G., Ipsen C., Edwards K. (2023). Exploring managerial job demands and resources in transition to distance management: A qualitative Danish case study. *International Journal of Environmental Research and Public Health,* 20: 69. DOI: 10.3390/ijerph20010069.

Bai J.Y., Tian Q., Liu X. (2021). Examining job complexity on job crafting within conservation of resources theory: A dual-path mediation model. *Frontiers in Psychology,* 12: 737108. DOI: 10.3389/fpsyg.2021.737108.

Bar-Yam Y. (2005). *Making things work: Solving complex problems in a complex world.* New England, Knowledge Press.

Bessonova E., Gonchar K. (2019). How the innovation-competition link is shaped by technology distance in a high-barrier catch-up economy. *Technovation,* 86-87: 15-32. DOI: 10.1016/j.technovation.2019.01.002.

Bledow R., Schmitt A., Frese M., Kühnel J. (2011). The affective shift model of work engagement. *Journal of Applied Psychology,* 96: 1246-1257. DOI: 10.1037/a0024532.

Calvo-Amodio J. (2019). Using principles as activity drivers in human activity systems. *Systems Research and Behavioral Science,* 36(5): 678-686. DOI: 10.1002/sres.2625.

Crespi F., Caravella S., Menghini M., Salvatori C. (2021). European Technological Sovereignty: An Emerging Framework for Policy Strategy. *Intereconomics,* 56(6): 348-354. DOI: 10.1007/s10272-021-1013-6.

Edler J., Blind K., Kroll H., Schubert T. (2023). Technology sovereignty as an emerging frame for innovation policy. Defining rationales, ends and means. *Research Policy,* 52(6): 104765. DOI: 10.1016/j.respol.2023.104765.

Gitelman L.D., Gavrilova T.B., Gitelman L.M., Kozhevnikov M.V. (2017). Proactive management in the power industry: Tool support. *International Journal of Sustainable Development and Planning,* 12: 1359-1369. DOI: 10.2495/SDP-V12-N8-1359-1369.

Gitelman L.D., Gavrilova T.B., Kozhevnikov M.V. (2020). Methodologies for managing complex systems under uncertainty. *WIT Transactions on Ecology and the Environment,* 241: 91-103. DOI: 10.2495/SDP200081.

Gratton G., Gratton L. (2022). Managers can't do it all. *Harvard Business Review,* March-April. https://hbr.org/2022/03/managers-cant-do-it-all.

Gutiérrez-Iñiguez Á., Collado-Agudo J., Rialp-Criado J. (2023). The role of managers in corporate change management: A bibliometric review. *Sustainability,* 15: 10811. DOI: 10.3390/su151410811.

Harju L.K., Kaltiainen J., Hakanen J.J. (2021). The double-edged sword of job crafting: The effects of job crafting on changes in job demands and employee well-being. *Human Resource Management,* 60(6): 953-968. DOI: 10.1002/hrm.22054.

Hollnagel E., Woods D.D. (2006). Epilogue: Resilience engineering precepts. In: Hollnagel E., Woods D.D., Leveson N. (eds.) *Resilience engineering: Concepts and precepts.* Aldershot, UK, Ashgate, 21-34.

Kearney E., Shemla M., van Knippenberg D., Scholz F.A. (2019). A paradox perspective on the interactive effects of visionary and empowering leadership. *Organizational Behavior and Human Decision Processes,* 155: 20-30. DOI: 10.1016/j.obhdp.2019.01.001.

LeSage A., Friedlan J., Tepylo D., Kay R. (2021). Supporting at-Risk University Business Mathematics Students: Shifting the Focus to Pedagogy. *International Electronic Journal of Mathematics Education,* 16(2): em0635. DOI: 10.29333/iejme/10893.

Matzembacher D.E., Gonzales R.L., Nascimento L.F.M. (2019). From informing to practicing: Students' engagement through practice-based learning methodology and community services. *The International Journal of Management Education,* 17(2): 191-200. DOI: 10.1016/J.IJME.2019.03.002.

Pan W., Sun L.-Y. (2018). A self-regulation model of Zhong Yong thinking and employee adaptive performance. *Management and Organization Review,* 14: 135-159. DOI: 10.1017/mor.2017.33.

Pereira G.I., Specht J.M., Silva P.P., Madlener R. (2018). Technology, business model, and market design adaptation toward smart electricity distribution: Insights for policy making. *Energy Policy,* 121: 426-440. DOI: 10.1016/j.enpol.2018.06.018.

Porter M.E., Heppelmann J.E. (2014). How smart, connected products are transforming competition. *Harvard Business Review,* November. https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition.

Sacramento C.A., Fay D., West M.A. (2013). Workplace duties or opportunities? Challenge stressors, regulatory focus, and creativity. *Organizational Behavior and Human Decision Processes,* 121: 141-157. DOI: 10.1016/j.obhdp.2013.01.008.

Shalizi C.R. (2006). Methods and techniques of complex systems science: An overview. In: *Complex Systems Science in Biomedicine.* New York, Springer, 33-114.

Shin Y., Hur W.-M., Park K., Hwang H. (2020). How managers' job crafting reduces turnover intention: The mediating roles of role ambiguity and emotional exhaustion. *International Journal of Environmental Research and Public Health,* 17: 3972. DOI: 10.3390/ijerph17113972.

Stevenson J.R., Kwok A., Skurak H.H., Davies A., Hatton T., Sajoudi M., Codling M., Bowie C. (2015). Multi-capital resilience annotated bibliography. *National Sciences Challenges,* 6. https://resorgs.org.nz/wp-content/uploads/2017/07/rnc_annotated_resilience_benchmarking.pdf.

Willett K.D., Dove R., Chudnow A., Eckman R., Rosser L., Stevens J.S., Yeman R., Yokell M. (2021). Agility in the future of systems engineering (FuSE) - A roadmap of foundational concepts. *Proceedings International Symposium.* International Council on Systems Engineering, Honolulu, HI, July 17-22. DOI: 10.1002/j.2334-5837.2021.00831.

Zhang F., Parker S.K. (2019). Reorienting job crafting research: A hierarchical structure of job crafting concepts and integrative review. *Journal of Organizational Behavior,* 40: 126-146. DOI: 10.1002/job.2332.

About the authors

Lazar D. Gitelman
Doctor of economic sciences, professor, professor of the Department of Energy and Industrial Management Systems, Ural Federal University named after the first President of Russia B.N. Yeltsin (Ekaterinburg, Russia). WOS Research ID: AHB-8473-2022; Scopus Author ID: 55806230600.
Research interests: proactive management, organizational transformations, sustainable energy, management education.
ldgitelman@gmail.com

Alexander P. Isayev
Doctor of economic sciences, associate professor, professor of the Department of Energy and Industrial Management Systems, Ural Federal University named after the first President of Russia B.N. Yeltsin (Ekaterinburg, Russia).
Research interests: managerial professionalism, design of educational systems, programs and technologies, innovative leadership.
ap_isaev@mail.ru

Mikhail V. Kozhevnikov
Doctor of economic sciences, associate professor, head of the Department of Energy and Industrial Management Systems, Ural Federal University named after the first President of Russia B.N. Yeltsin (Ekaterinburg, Russia). WOS Research ID: AAB-6693-2020; Scopus Author ID: 55805368400; ORCID: 0000-0003-4463-5625.
Research interests: knowledge-intensive service, innovative industrial development, management education.
m.v.kozhevnikov@urfu.ru

Tatyana B. Gavrilova
Candidate of economic sciences, associate professor, associate professor of the Department of Energy and Industrial Management Systems, Ural Federal University named after the first President of Russia B.N. Yeltsin (Ekaterinburg, Russia). Scopus Author ID: 57190430748.
Research interests: systems engineering, business analytics, information technology in management.
ems_2005@mail.ru

作者信息

Lazar D. Gitelman
经济学博士，教授，能源和工业企业控制系统教研室主任，俄罗斯联邦首任总统叶利钦命名的乌拉尔联邦大学（俄罗斯叶卡捷琳堡）。
WOS Research ID：AHB-8473-2022；Scopus Author ID：55806230600。研究领域：电力、热力行业能源业务，前馈控制，组织变革、管理教育。
ldgitelman@gmail.com

Alexander P. Isaev
经济学博士，能源和工业企业控制系统教研室教授，俄罗斯联邦首任总统叶利钦命名的乌拉尔联邦大学（俄罗斯叶卡捷琳堡）。研究领域：管理职业性，教学系统、程序和技术设计，创新领导力。
cap_isaev@mail.ru

Mikhail V. Kozhevnikov
经济学副博士，能源和工业企业控制系统教研室副教授，俄罗斯联邦首任总统叶利钦命名的乌拉尔联邦大学（俄罗斯叶卡捷琳堡）。
WOS Research ID：AAB-6693-2020；Scopus Author ID：55805368400；ORCID：0000-0003-4463-5625。
研究领域：知识密集型服务业，产业创新，管理培训。
m.v.kozhevnikov@urfu.ru

Tatyana B. Gavrilova
经济学副博士，能源和工业企业控制系统教研室副教授，俄罗斯联邦首任总统叶利钦命名的乌拉尔联邦大学（俄罗斯叶卡捷琳堡）。Scopus Author ID：57190430748.
研究领域：系统工程，商业分析，管理中的信息技术。
ems_2005@mail.ru

The article was submitted on 10.05.2023; revised on 26.05.2023 and accepted for publication on 01.06.2023. The authors read and approved the final version of the manuscript.
文章于 10.05.2023 提交给编辑。文章于 26.05.2023 已审稿，之后于 01.06.2023 接受发表。作者已经阅读并批准了手稿的最终版本。