

**ДИАЛОГ ПОКОЛЕНИЙ:  
ИЗУЧАЕМ, ОБУЧАЕМ, УЧИМСЯ**

**Материалы V Всероссийской  
научно-практической конференции  
с международным участием**

**Часть I**

**DIALOGUE OF GENERATIONS:  
LEARN. TEACH. STUDY**

**Proceedings of the V All-Russian  
Research and Practice Conference  
with International Participation**

**Part I**

**Санкт-Петербург  
2024**

Министерство науки и высшего образования Российской Федерации  
ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ БЮДЖЕТНОЕ ОБРАЗОВАТЕЛЬНОЕ УЧРЕЖДЕНИЕ ВЫСШЕГО ОБРАЗОВАНИЯ  
«Санкт-Петербургский государственный университет  
промышленных технологий и дизайна»  
Высшая школа технологии и энергетики

## **МАТЕРИАЛЫ**

**V Всероссийской  
научно-практической конференции  
с международным участием**

**«ДИАЛОГ ПОКОЛЕНИЙ:  
ИЗУЧАЕМ. ОБУЧАЕМ. УЧИМСЯ»**

Научное издание  
2024 • Часть I

*Под общей редакцией заведующего кафедрой иностранных языков,  
кандидата филологических наук, доцента В. В. Кирилловой*

Санкт-Петербург  
2024

УДК 378.4

ББК 81.2

Д 44

**Редакционная коллегия:**

кандидат филологических наук, доцент, заведующий кафедрой иностранных языков *В. В. Кириллова* (Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики);

кандидат филологических наук, доцент *К. А. Сечина* (Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики);

старший преподаватель *Т. С. Шарпа*

(Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики)

**Ответственный редактор**

старший преподаватель *А. М. Знаменская*

(Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики)

Д 44 Материалы V Всероссийской научно-практической конференции с международным участием «Диалог поколений: Изучаем. Обучаем. Учимся» (23-24 апреля 2024 г.). В 2-х частях / Минобрнауки РФ; ФГБОУ ВО «С.-Петерб. гос. ун-т промышленных технологий и дизайна»; под общ. ред. В. В. Кирилловой. — СПб.: ВШТЭ СПбГУПТД, 2024. — Часть I. — 103 с.

ISBN 978-5-91646-378-1

Сборник включает материалы V Всероссийской научно-практической конференции «Диалог поколений: Изучаем. Обучаем. Учимся» на трех иностранных языках: английском, немецком и французском. Актуальные вопросы педагогики, филологии, экономики, истории, технических и естественных наук представлены в 34 статьях 47 авторами, являющимися преподавателями, аспирантами, магистрантами и студентами различных высших учебных заведений России, Беларуси и Казахстана.

УДК 378.4  
ББК 81.2

ISBN 978-5-91646-378-1

© ВШТЭ СПбГУПТД, 2024  
© Коллектив авторов, 2024

**Ministry of Science and Higher Education of the Russian Federation**  
FEDERAL STATE BUDGETARY EDUCATIONAL INSTITUTION OF HIGHER EDUCATION  
**“Saint Petersburg State University of Industrial Technologies and Design”  
Higher School of Technology and Energy**

## **PROCEEDINGS**

**of the V All-Russian  
Research and Practice Conference  
with International Participation**

**“DIALOGUE OF GENERATIONS:  
LEARN. TEACH. STUDY”**

Scientific publication  
2024 • Part I

*Under the general editorship of the Foreign Languages Department Head,  
PhD in Philology, Associate Professor V. V. Kirillova*

Saint Petersburg  
2024

**UDC 378.4**  
**BBK 81.2**  
**D 44**

**Editorial board:**

PhD in Philology, Associate Professor, Head of the Department of Foreign Languages *V. V. Kirillova* (Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy);

PhD in Pedagogical Sciences, Associate Professor, *K. A. Sechina* (Saint Petersburg State University of Industrial Technologies and Design, Higher School of technology and Energy);

Senior Lecturer *T. S. Sharapa* (Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy)

**Responsible editor**

Senior Lecturer *A. M. Znamenskaia* (Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy)

**D44** Proceedings of the V All-Russian Research and Practice Conference with International Participation “Dialogue of Generations: Learn. Teach. Study.” (20-21 April 2024). In 2 parts / Ministry of Education and Science of the Russian Federation; FSBEI HE “Saint Petersburg State University of Industrial Technologies and Design”; under the general editorship of V. V. Kirillova. SPb.: HSTE SPbGUITD, 2024. Part I, 103 p.

ISBN 978-5-91646-378-1

The collection includes the proceedings of the V All-Russian Research and Practice Conference with International Participation “Dialogue of Generations: Learn. Teach. Study”, published in three foreign languages: English, German and French. Relevant issues of philology, pedagogy, economics, history, technical and natural sciences and are discussed in 34 articles by 47 lecturers, post graduate students, master’s students and students of different universities of Russia, Belarus and Kazakhstan.

UDC 378.4  
BBK 81.2

ISBN 978-5-91646-378-1

© HSTE SPbSUITD, 2024  
© Composite authors, 2024

## TABLE OF CONTENTS

### PEDAGOGICAL SCIENCES

---

<i>Semchuk E. V., Sergeeva K. Ya.</i> THE ROLE OF THE EDUCATIONAL PROCESS IN THE SPECIALIST TRAINING SYSTEM .....	9
<i>Stepanova N. N.</i> SUR LA QUESTION DU MÉCANISME CACHÉ DU TRANSFERT INTERLANGUES LORS DE L'ÉTUDE DU FRANÇAIS APRÈS L'ANGLAIS .....	13
<i>Stroganova M. S.</i> PROJECT «INTERNATIONAL ONLINE SCHOOLS» .....	19

### ENGINEERING SCIENCES

---

<i>Belousov V. N., Smorodin S. N.</i> UNCONVENTIONAL TECHNOLOGY FOR THE THERMAL TRANSFORMATION OF HIGHLY TOXIC SUBSTANCES IN A STATIONARY SHOCK WAVE .....	23
<i>Litvinova A. V.</i> INTERIOR DESIGN OF PASSENGER AIRCRAFT CABINS IN THE 60s OF THE USSR .....	29
<i>Marushchak Yu. I., Yasinskaya N. N.</i> ANALYSE COMPARATIVE DE L'ÉCO-CUIR MODERNE DE DIFFÉRENTS FABRICANTS .....	35
<i>Lapaev F. V., Makhotina L. G.</i> PERSPECTIVE OF THE SECONDARY FIBER BLEACHING PROCESS FROM WASTE PAPER OF GRADE MS-5B .....	42
<i>Ruzanova E. A.</i> ENERGY SAVING OF RESIDENTIAL BUILDINGS .....	47
<i>Ruzanova E. A.</i> ALTERNATIVE ENERGY SOURCES .....	50
<i>Mel'nichuk M. S., Dubovyi V. K.</i> DISSOLVING PULP. OBTAINING AND APPLICATION .....	53

### ECONOMIC SCIENCES

---

<i>Rakipov A. S.</i> , ON THE APPLICABILITY OF SPATIAL ECONOMICS METHODS TO THE PROBLEMS OF INTEGRATED DEVELOPMENT OF MINERAL RESOURCES OF THE ARCTIC ZONE OF RUSSIA.....	57
---	----

<i>Nazarova A. N., Viryacheva E. V.</i> PROBLEMS AND OPPORTUNITIES FOR THE FORMATION OF HUMAN RESOURCES POTENTIAL OF THE TRANSPORT AND LOGISTICS INDUSTRY AT THE PRESENT STAGE .....	63
<i>Vasiliev M. V., Nazarova A. N.</i> ECOLOGICAL AND ECONOMIC SUBSTANTIATION OF THE USE OF QUARRIES OF THE LENINGRAD REGION FOR UTILISATION OF CONSTRUCTION WASTE OF CLASS 5 .....	68
<i>Nikiforova V. D., Kovalenko A. V., Nikiforov A. A.</i> PREREQUISITES AND FOUNDATIONS FOR ECOSYSTEM DEVELOPMENT IN THE CONTEXT OF TECHNOLOGICAL TRANSFORMATION .....	74
<i>Zlotnitskaya T. S., Kotova A. Yu.</i> THE EVOLUTION OF PLANNING CONCEPTS .....	78
<i>Mushenko R. D., Malikhina O. V.</i> RUSSIAN MEDICAL EQUIPMENT LOCAL MANUFACTURING DEVELOPMENT STRATEGIES IN CONTEMPORARY HEALTHCARE CHALLENGING ENVIRONMENT .....	83
<i>Nuzhnaya K. G., Malikhina O. V.</i> POSSIBILITY OF USING THE ADAPTIVE MODEL IN TRANSPORT SYSTEM MANAGEMENT .....	90
<i>Freidkina E. M.</i> CURRENT PROBLEMS OF ECONOMIC THEORY .....	97
INFORMATION ABOUT AUTHORS .....	101

## СОДЕРЖАНИЕ

### ПЕДАГОГИЧЕСКИЕ НАУКИ

---

*Семчук Е. В., Сергеева К. Я.* РОЛЬ ВОСПИТАТЕЛЬНОГО ПРОЦЕССА  
В СИСТЕМЕ ПОДГОТОВКИ СПЕЦИАЛИСТА ..... 9

*Степанова Н. Н.* К ВОПРОСУ О СКРЫТОМ МЕХАНИЗМЕ  
МЕЖЪЯЗЫКОВОГО ПЕРЕНОСА ПРИ ИЗУЧЕНИИ ФРАНЦУЗСКОГО  
ЯЗЫКА ПОСЛЕ АНГЛИЙСКОГО ..... 13

*Строганова М. С.* ПРОЕКТ «МЕЖДУНАРОДНЫЕ ОНЛАЙН-ШКОЛЫ» ..... 19

### ТЕХНИЧЕСКИЕ НАУКИ

---

*Белоусов В. Н., Смородин С. Н.* НЕТРАДИЦИОННАЯ ТЕХНОЛОГИЯ  
ТЕРМИЧЕСКОГО ПРЕОБРАЗОВАНИЯ ВЫСОКОТОКСИЧНЫХ  
ВЕЩЕСТВ В СТАЦИОНАРНОЙ УДАРНОЙ ВОЛНЕ ..... 23

*Литвинова А. В.* ПРОЕКТИРОВАНИЕ ИНТЕРЬЕРОВ САЛОНОВ  
ПАССАЖИРСКИХ САМОЛЕТОВ В 60-е гг. В СССР ..... 29

*Марущак Ю. И., Ясинская Н. Н.* СРАВНИТЕЛЬНЫЙ АНАЛИЗ  
СОВРЕМЕННЫХ ЭКОКОЖ РАЗЛИЧНЫХ ПРОИЗВОДИТЕЛЕЙ ..... 35

*Лапаев Ф. В., Махотина Л. Г.* ПЕРСПЕКТИВА ПРОЦЕССА ОТБЕЛКИ  
ВТОРИЧНОГО ВОЛОКНА ИЗ МАКУЛАТУРЫ МАРКИ МС-5Б ..... 42

*Рузанова Е. А.* ЭНЕРГОСБЕРЕЖЕНИЕ ЖИЛЫХ ЗДАНИЙ ..... 47

*Рузанова Е. А.* АЛЬТЕРНАТИВНЫЕ ИСТОЧНИКИ ЭНЕРГИИ ..... 50

*Мельничук М. С., Дубовый В. К.* ЦЕЛЛЮЛОЗА ДЛЯ ХИМИЧЕСКОЙ  
ПЕРЕРАБОТКИ. ПОЛУЧЕНИЕ И ПРИМЕНЕНИЕ ..... 53

### ЭКОНОМИЧЕСКИЕ НАУКИ

---

*Ракипов А. С.* О ПРИМЕНИМОСТИ МЕТОДОВ ПРОСТРАНСТВЕННОЙ  
ЭКОНОМИКИ К ПРОБЛЕМАМ КОМПЛЕКСНОГО ОСВОЕНИЯ  
МИНЕРАЛЬНО-СЫРЬЕВЫХ РЕСУРСОВ АРКТИЧЕСКОЙ  
ЗОНЫ РОССИИ ..... 57

*Назарова А. Н., Вирячева Е. В.* ПРОБЛЕМЫ И ВОЗМОЖНОСТИ  
ФОРМИРОВАНИЯ КАДРОВОГО ПОТЕНЦИАЛА ТРАНСПОРТНО-  
ЛОГИСТИЧЕСКОЙ ОТРАСЛИ НА СОВРЕМЕННОМ ЭТАПЕ ..... 63



<i>Васильев М. В., Назарова А. Н.</i> ЭКОЛОГО-ЭКОНОМИЧЕСКОЕ ОБОСНОВАНИЕ ИСПОЛЬЗОВАНИЯ КАРЬЕРОВ ЛЕНИНГРАДСКОЙ ОБЛАСТИ ДЛЯ УТИЛИЗАЦИИ СТРОИТЕЛЬНЫХ ОТХОДОВ 5 КЛАССА .....	68
<i>Никифорова В. Д., Коваленко А. В., Никифоров А. А.</i> ПРЕДПОСЫЛКИ И ОСНОВЫ РАЗВИТИЯ ЭКОСИСТЕМ В КОНТЕКСТЕ ТЕХНОЛОГИЧЕСКОЙ ТРАНСФОРМАЦИИ .....	74
<i>Злотницкая Т. С., Котова А. Ю.</i> ЭВОЛЮЦИЯ ПРЕДСТАВЛЕНИЙ О ПЛАНИРОВАНИИ .....	78
<i>Мушенко Р. Д., Малихина О. В.</i> СТРАТЕГИИ РАЗВИТИЯ РОССИЙСКОГО ПРОИЗВОДСТВА МЕДИЦИНСКОГО ОБОРУДОВАНИЯ В УСЛОВИЯХ СОВРЕМЕННЫХ ВЫЗОВОВ СИСТЕМЫ ЗДРАВООХРАНЕНИЯ .....	83
<i>Нужная К. Г., Малихина О. В.</i> ВОЗМОЖНОСТЬ ИСПОЛЬЗОВАНИЯ АДАПТИВНОЙ МОДЕЛИ В УПРАВЛЕНИИ ТРАНСПОРТНЫМИ СИСТЕМАМИ .....	90
<i>Фрейдкина Е. М.</i> СОВРЕМЕННЫЕ ПРОБЛЕМЫ ЭКОНОМИЧЕСКОЙ ТЕОРИИ .....	97
ИНФОРМАЦИЯ ОБ АВТОРАХ .....	101

УДК 316.37

*Semchuk Elena Vladivirovna,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
Semchukelena@rambler.ru*

*Sergeeva Ksenia Yakovlevna,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
k.s.sergeeva@inbox.ru*

### THE ROLE OF THE EDUCATIONAL PROCESS IN THE SPECIALIST TRAINING SYSTEM

**Abstract.** The article deals with the connection between education and personality development, the role of the teacher, and the Russian Federation laws concerning educational system.

**Keywords:** upbringing, socio-pedagogical support for the formation and development of a highly moral, responsible, creative, initiative, competent citizen of Russia.

*Семчук Елена Владимировна,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
semchukelena@rambler.ru*

*Сергеева Ксения Яковлевна,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
k.s.sergeeva@inbox.ru*

### РОЛЬ ВОСПИТАТЕЛЬНОГО ПРОЦЕССА В СИСТЕМЕ ПОДГОТОВКИ СПЕЦИАЛИСТА

**Аннотация.** Статья посвящена связи образования и воспитания личности, роли педагога и законам Российской Федерации, касающимся образования и воспитания.

**Ключевые слова:** воспитание, педагогическая поддержка, формирование и развитие высокоморального, ответственного гражданина России.

The upbringing of a person, the formation of the properties of a spiritually developed personality, love for his country, the need to create and improve is the most important condition for the successful development of Russia.

In accordance with the Constitution of the Russian Federation, a person, his rights and freedoms are the highest value. At the same time, every citizen of the Russian Federation, possessing all rights and freedoms on its territory, bears equal responsibilities.

The modern national educational ideal is a highly moral, creative, competent citizen of Russia, accepting the fate of the Fatherland as his personal one, aware of responsibility for the present and future of his country, rooted in the spiritual and cultural traditions of the multinational people of the Russian Federation.

The most important goal of modern domestic education and one of the priorities of society and the state is the upbringing, socio-pedagogical support for the formation and development of a highly moral, responsible, creative, initiative, competent citizen of Russia.

The organization of a socially open space for the spiritual and moral development and upbringing of the personality of a citizen of Russia, the moral way of life of students is carried out on the basis of:

- the moral example of a teacher;
- social and pedagogical partnership;
- individual and personal development;
- the integrativity of spiritual and moral education programs;
- the social relevance of education.

Why do you need education at a university? The university serves to develop the reproduction of a special cultural layer, the most important element of which is the specialist himself. As a representative of a certain culture, he is characterized not only by a specific set of knowledge and skills, but also by a certain worldview, life attitudes and values, and features of professional behavior... We do not have the right to decide for a person what to be like, because he must live his own life without shifting responsibility to others for his choice, for the decisions that he has to make.

The uniqueness and uniqueness of each individual constitutes the wealth of the whole society, and any artificial restriction on the free manifestation and development of personality undermines its creative potencies, preventing its self-actualization.

The main task of the educator is to reveal to the educated a wide field of choices, which is often not opened by the child, teenager, or young man himself due to his limited life experience, lack of knowledge and lack of development of the entire wealth of culture.

Another task of education is to help the student develop an individual lifestyle, an individual style of activity and communication.

It is at the student age that not only physical, but also psychological properties and higher mental functions reach their maximum in their development: perception, attention, memory, thinking, speech, emotions and feelings. There should be no significant discrepancy between the self-assessment and the assessment taught by the

student from people who are important to him, to whom the teacher must necessarily relate.

Federal Law No 304-FZ dated 07/31/2020 "On Amendments to the Federal Law "On Education in the Russian Federation" on the education of Students" has made its own adjustments and plans for the implementation of the program [1].

In accordance with this, I would like to make separate theses:

*The first thesis.* Parenting today: new meanings are needed.

The concept of "education" in accordance with the Federal Law "On Education in the Russian Federation" is interpreted as education and upbringing.

*The second thesis.* To find yourself in a profession.

When forming the goals of education, it is impossible not to take into account the needs and requests of the student's personality. As a rule, our students are only at the beginning of their professional and life self-determination. The most important goal- the result of professional education and upbringing from this point of view will be the professional self-identification of a young person – identification with his chosen profession, the formation of a positive image of "himself in the profession", the adoption of a system of values characteristic of future professional activity.

*The third thesis.* About the transprofessional world of work, in which it is not easy for a graduate.

The uncertainty and variability of the modern world will only increase. The world of work speaks of trans professionalism (the integral ability to master and perform activities from various types and groups of professions) and multiprofessionalism (mastering labor functions from several types of professional activities). The risks of digital transformation highlight new human security issues.

How to foster professional mobility – the ability to flexibly respond to changes in society and the labor market and the willingness to change the professional and life trajectory?

Moreover, there is an increasing need to develop *the fourth Thesis. Professional education and self-determination?*

The definition of the concept of "education" (among other important components) includes "creating conditions for self-determination and socialization of students." It is a very difficult task to promote professional and personal development, to include young people in the system of social relations, in various types of social communities [2].

It is important here that professional education and self-determination, socialization are not multidirectional processes. It is necessary to create conditions for a young person to gain a variety of experience, including the experience of self-earning, obtaining economic results due to the fact that public organizations, the non-profit sector, social institutions are interested in his professional potential; experience that prepares for independent entrepreneurial activity [3]; stress tolerance, the ability to comply with the principle of "lifelong education".

*The fifth thesis (scientific and philosophical).* About patriotic education.

At the state level, emphasis is placed on patriotic education. Educational work is methodically provided not only by Federal Law No 304-FZ of 07/31/2020 and the action plan for the implementation of the Strategy for the Development of Education

in the Russian Federation for 2021-2025. There is also a federal project "Patriotic education of citizens of the Russian Federation" [4]. The position of the state is clear. And the educational process in an educational organization is, as it is written in textbooks on pedagogy, a purposeful process.

### **References:**

1. Bogdanova, A. I., Derenzhi, N. D., Stefanova, V. S. *Informaciya i obrazovanie v XXI v.* [Information and education in the XXI century] // Open education. 2001. № 1, pp. 29-32. (in Russian).
2. Glazer, G. D. *Novaya Rossiya: Obshhee obrazovanie i obrazuyushheesya obshchestvo* [New Russia: General education and the emerging society] // Pedagogy. 2000. № 6, pp. 3-12. (in Russian).
3. Sukhomlinsky, V. A. *Pis'ma k sy'nu* [Letters to his son]. M. : Enlightenment, 1979, 122 p. (in Russian).
4. Sukhomlinsky, V. A. *Kak vospitat' nastoyashhego cheloveka. E'tika kommunisticheskogo vospitaniya* [How to raise a real person. Ethics of communist education]. M. : Pedagogy, 1990, 288 p. (in Russian).

### **Список литературы:**

1. Богданова, А. И. Информация и образование в XXI в. / А. И. Богданова, Н. Д. Деренжи, В. С. Стефанова. – Текст : непосредственный // Открытое образование. – 2001. – № 1. – С. 29-32.
2. Глейзер, Г. Д. Новая Россия: Общее образование и образующееся общество / Г. Д. Глейзер. – Текст : непосредственный // Педагогика. – 2000. – № 6. – С. 3-12.
3. Сухомлинский, В. А. Письма к сыну. – М. : Просвещение, 1979. – 122 с. – Текст : непосредственный.
4. Сухомлинский, В. А. Как воспитать настоящего человека. Этика коммунистического воспитания. – М. : Педагогика, 1990. – 288 с. – Текст : непосредственный.

*Stepanova Natalia Nikolaïevna,  
Université de Saint-Pétersbourg technologies de gestion et économie,  
Saint Pétersbourg, Fédération de Russie  
n.stepanova.55@mail.ru*

## **SUR LA QUESTION DU MÉCANISME CACHÉ DU TRANSFERT INTERLANGUES LORS DE L'ÉTUDE DU FRANÇAIS APRÈS L'ANGLAIS**

**Annotation.** L'article est consacré aux phénomènes d'interférence et de transfert dans l'enseignement du français langue étrangère lors de l'apprentissage de l'anglais langue première. À partir d'une comparaison des systèmes phonétiques, lexicaux et grammaticaux de l'anglais et du français, les sources de transfert et d'interférence sont identifiées. Des recommandations méthodologiques sont données pour prédire et prévenir l'impact négatif des compétences déjà formées en anglais sur le développement des automatismes en français.

**Mots-clés:** interférence, transfert, le français, l'anglais.

*Stepanova Natalia Nikolaevna,  
Saint Petersburg University of Management technologies and Economics,  
Saint Petersburg, Russian Federation  
n.stepanova.55@mail.ru*

## **ON THE HIDDEN MECHANISM OF INTERLANGUAGE TRANSFER WHEN LEARNING FRENCH AFTER ENGLISH**

**Abstract.** The article is devoted to the phenomena of interference and transference in teaching French as a second foreign language with the first English. Based on a comparison of the phonetic, lexical, and grammatical systems of English and French, the sources of hyphenation and interference are identified. Methodological recommendations are given for predicting and preventing the negative impact of already formed skills in English language on the formation of automatism in French.

**Keywords:** interference, transfer, French, English.

*Степанова Наталия Николаевна,  
Санкт-Петербургский университет технологий управления и экономики,  
Санкт-Петербург, Российская Федерация  
n.stepanova.55@mail.ru*

## **К ВОПРОСУ О СКРЫТОМ МЕХАНИЗМЕ МЕЖЪЯЗЫКОВОГО ПЕРЕНОСА ПРИ ИЗУЧЕНИИ ФРАНЦУЗСКОГО ЯЗЫКА ПОСЛЕ АНГЛИЙСКОГО**

**Аннотация.** Статья посвящена явлениям интерференции и переноса при обучении французскому языку как второму иностранному при первом

английском. На основе сопоставления фонетической, лексической и грамматической систем английского и французского языков выделены источники переноса и интерференции. Даны методические рекомендации по прогнозированию и предупреждению отрицательного воздействия уже сформированных навыков на английском языке на становление автоматизмов на французском языке.

**Ключевые слова:** интерференция, перенос, французский язык, английский язык.

L'interférence est un processus d'interaction conflictuelle des mécanismes de la parole qui se manifeste dans la parole par un écart par rapport aux modèles d'une langue sous l'influence négative d'une autre. L'interférence linguistique provoque trop de difficultés pédagogiques sur les plans phonétique, morphologique, sémantique et syntaxique dans la classe des langues étrangères. Mais on maintient que ces difficultés rencontrées ne peuvent pas rendre impossible, l'apprentissage de la langue française. Dans la méthodologie, le transfert s'entend comme l'influence positive de la première langue étrangère sur la seconde. Le transfert positif peut être spontané (intuitif) et/ou contrôlé. Le transfert spontané se produit sans explications préalables de la part de l'enseignant, tandis que le transfert contrôlé n'est possible qu'après que l'enseignant a créé une base indicative appropriée et indiqué la corrélation des phénomènes corrélés.

La première langue étrangère agit généralement comme une source de transfert conscient. Le processus de transfert interlingue est influencé par un certain nombre de facteurs: la similitude du matériel, le degré de son assimilation, le niveau de maîtrise de la première langue étrangère, l'expérience linguistique et les caractéristiques psychologiques individuelles des étudiants, etc. Les résultats de nombreuses études confirment l'importance d'un niveau élevé de maîtrise de la première langue étrangère pour un transfert efficace lors de l'apprentissage d'une deuxième langue étrangère.

Le sujet de cet article est d'étudier les caractéristiques de la méthodologie de développement des compétences phonétiques, lexicales, grammaticales et des techniques de lecture des élèves en français dès la première année en anglais. La formation des compétences de prononciation et d'intonation rythmique chez les étudiants apprenant le français après l'anglais est soumise à l'influence perturbatrice des compétences phonétiques déjà formées dans la langue anglaise. Comme vous le savez, les interférences phonétiques se produisent en raison de:

- 1) divers degrés de spécialisation des caractéristiques phonémiques;
- 2) caractéristiques de la répartition de la tension articulaire;
- 3) variabilité différente et nombre de mouvements articulaires caractéristiques des langues précédemment étudiées.

L'influence de l'articulation anglaise sur la production de la prononciation française est associée à la répartition des tensions articulaires. En français, la labialisation des voyelles joue un rôle important; elle comporte également davantage de consonnes labiales. Ainsi, dans la langue française, les sons produits dans la partie antérieure de l'appareil vocal prédominent. En anglais, au contraire, les voyelles arrière prédominent. Lorsqu'ils apprennent le français après l'anglais, les élèves

prononcent les voyelles antérieures plus profondément qu'ils ne le devraient. Cette interférence est causée par l'habitude articulatoire formée par le discours en anglais, ainsi que par la tendance à diphtonguer les voyelles françaises et à réduire les voyelles non accentuées. Au stade initial de l'apprentissage du français après l'anglais, les élèves prononcent en français [t], [d], [p] avec une aspiration à l'anglais, c'est-à-dire qu'une interférence conduit à l'apparition dans l'élément linguistique de signes d'un élément corrélatif d'un autre système. Les élèves mettent l'accent sur chaque mot, et non sur le groupe rythmique; ne pas émettre le ton montant correct, etc.

Le transfert existe quand la faute commise n'aboutit pas au changement de la valeur sémantique des mots mal prononcés. Ce genre de situation dans la plupart du temps, s'effectue aux niveaux phonétique (à l'oral) et morphologique (à l'écrit). Par exemple:

1. Safois [safwa], au lieu de savoir [savwa].

2. Magnétophone [magnetofon], au lieu de magnétophone [mapetofon] La faute commise dans les deux exemples est ouvertement évidente.

Dans le premier, la consonne labio-dentale fricative sourde [f] est prise pour la consonne labio-dentale fricative sonore [v]. Dans le deuxième, la consonne medio-dorso palatale [ɲ] est mal prononcée comme la consonne dorso-vélaire sonore [g].

Il y a quelques phonèmes existents en anglais mais ils n'existent pas en français. Par exemple: Le phonème [θ], une consonne dentale fricative sourde, comme il se trouve dans le mot *thing* ou [ð], une consonne dentale fricative sonore, comme on le trouve dans le mot *that* en anglais simplement n'existent pas sur le tableau consonantique du français, ils sont donc remplacés par [t], une consonne apico-dentale sourde comme on le trouve dans les mots suivants: tête, torture, et tentativement. Ce procédé s'appelle la sous-différenciation.

Pour développer les compétences de prononciation, des exercices sont utilisés pour reproduire (répéter) à plusieurs reprises le son étudié dans la poésie, les chansons, les comptines et les virelangues. Pour développer les compétences rythmiques et intonationnelles, il est important de proposer aux élèves une écoute régulière d'un discours authentique.

Lors du développement de compétences techniques en lecture, le transfert depuis l'anglais est possible, puisque le français et l'anglais utilisent l'alphabet latin. La coïncidence de certaines règles de lecture dans deux langues facilite également l'apprentissage de la lecture:

1) la lettre **e** à la fin du mot n'est pas lisible. Par exemple, *little*, *live* (anglais) – *livre*, *chemise* (français);

2) la lettre **c** avant **e**, **i**, **y** se lit comme [s]: *civil*, *bicycle* (anglais), *milice*, *citadelle*, *bicyclette* (français), dans les autres cas comme [k]: *cube*, *cry* (anglais), *acte*, *cabine* (français);

3) la combinaison de lettres **ph** se lit comme [f]: *phrase*, *photo* (anglais) – *phrase*, *photo*, *alphabet* (français).

Toutefois, le transfert n'exclut pas une assimilation négative dans la prononciation des mots français. Les étudiants font l'expérience d'un stéréotype créé lors de l'apprentissage de l'anglais: lorsqu'ils voient un mot écrit en latin et



graphiquement similaire à un mot anglais, ils le prononcent à la manière anglaise, c'est-à-dire qu'il y a un transfert direct de la prononciation de l'anglais vers le français. Comme le montre l'expérience, au stade initial, il existe de fortes interférences lors de la lecture de mots français contenant des combinaisons de lettres:

**er:** cercle, verbe, terme, traverse (les élèves prononcent [ə:] au lieu de [ɛ]);

**qu:** question, quatre (prononcé à tort [kw] au lieu de [k]).

Les élèves font aussi souvent des erreurs en lisant des mots avec la lettre **u**: ils prononcent l'anglais [ju] au lieu du son français [y]: musique, lune. Pour surmonter l'influence perturbatrice de la langue anglaise, il est recommandé d'utiliser des exercices spéciaux pour développer les techniques de lecture. Les propos doivent être enregistrés sur support audio.

Lors des cours d'une deuxième langue étrangère, un travail ciblé doit être réalisé pour reconnaître et analyser les correspondances de vocabulaire entre le russe et les langues étrangères étudiées. Il faut cependant souligner que la part du transfert positif n'est significative que lors de la perception et de la reconnaissance visuelle. L'écart entre la portée des sens des mots en français et en anglais donne lieu à des interférences tant dans la réception que dans la production. Les mots suivants ont également des significations différentes:

*journée* f день/*voyage* n путешествие; *caractère* m характер/*character* n герой произведения; *large* adj. широкий/*large* adj. большой; *rester* v оставаться/*to rest* v ОТДЫХАТЬ

Le choix des mots dans le discours dans une deuxième langue étrangère, c'est-à-dire dans les types productifs d'activité de parole, n'est influencé par la première langue étrangère que s'il existe une similitude formelle (par exemple, forme sonore et graphique) des mots de la première et deuxièmes langues étrangères. Ainsi, les correspondances de dictionnaire peuvent être divisées en deux groupes – sonores et graphiques, qui, à leur tour, peuvent être complets et incomplets. Les correspondances graphiques complètes comprennent:

*train* m/*train* n; *question* f/*question* n; *danger* m/*danger* n; *page* f/*page* n; *important* adj./*important* adj.; *moustache* f/*moustache* n; *admirer* v/*admirer*

Les élèves reconnaissent facilement ces mots lors de la lecture (avec perception visuelle d'un enregistrement graphique) et se souviennent de l'orthographe des mots, mais lorsqu'ils parlent et lisent à haute voix, des interférences phonétiques de la première langue étrangère sont possibles. Une analyse du vocabulaire des langues anglaise et française a montré la présence d'un nombre important de correspondances graphiques incomplètes dans les deux langues, qui sont source d'interférences à l'écrit:

*texte* m/ *text* n; *verbe* m/ *verb* n; *exercice* m/ *exercice* n ; *exemple* m/*example* n ; *adresse* f/*adresse* n; *répéter* v/*repeat* v; *participer* v/*participate* v; *calme* adj./ *calm* adj.

Il est recommandé de commencer par des correspondances complètes et, à mesure que les compétences de reconnaissance se développent, de passer au travail avec des correspondances incomplètes, en utilisant une technologie de recherche basée sur les problèmes pour conceptualiser les connaissances. On peut donner aux

élèves une série de mots en français et en anglais et leur demander de dresser un tableau de correspondance entre les suffixes et terminaisons anglais et français :

a) activité/activity, qualité/quality, société/society, université/university, cité/city;

b) forêt/forest, intérêt/interest, hôpital/hospital;

c) participer/participate, enluminer/illuminate, illustrer/illustrate.

Dans le processus de développement des compétences lexicales, il est important de familiariser les élèves avec les mécanismes de formation des mots de la langue française. Les travaux sur les méthodes pédagogiques de formation des mots doivent être réalisés en utilisant le matériel lexical de l'ensemble pédagogique et méthodologique de base. Les tâches de regroupement de mots par sujet, de compatibilité, de recherche de mots avec la même racine, d'antonymes, etc. sont également efficaces.

Le français et l'anglais étant des langues analytiques, en termes de grammaire, l'anglais sera source de transfert positif dans la maîtrise de la morphologie et de la syntaxe de la langue française. Les opportunités de transfert positif sont des points communs dans les grammaires de l'anglais et du français, à savoir:

- ordre direct des mots dans une phrase déclarative;
- former le pluriel des noms en ajoutant la terminaison – s ;
- la présence d'un article;
- l'usage obligatoire du verbe *être* au présent dans un prédicat nominal composé;
- la présence d'un grand nombre de formulaires temporaires;
- la présence de formes temporaires simples et complexes;
- la coordination des temps pour exprimer la simultanéité, la préséance ou la succession dans les plans du présent et du passé;
- la similitude dans la formation des degrés comparatifs et superlatifs des adjectifs français et dissyllabiques et polysyllabiques anglais;
- la similitude dans l'utilisation des expressions *il y a* et *there is \ are*.

En anglais, il n'existe que deux types de verbes en fonction formative sous les noms: regular et irregular. Ces termes s'interposent en français entre les trois groupes verbaux à savoir: verbes du 1er groupe, du 2e groupe et du 3e groupe.

On cite les exemples de la conjugaison au présent de l'indicatif (simple present tense) ainsi:

– Simple present → (to work–travailler) ← Present continuous I work We work I am working we are working You work You work You are working you are working He/she/it works They work He/she/it is working they are working

– Simple present → (to place–placer) ← Present continuous I place We place I am placing We are placing You place You place You are placing You are placing He/she/it places They place He/she/it is placing They are placing.

La distinction entre simple present et present continuous en anglais est claire, cette distinction de temps verbaux n'existe pas en français. Voilà pourquoi les deux verbes se conjuguent ainsi:

Travailler → To work Placer → To place Je travaille Nous travaillons Je place Nous plaçons Tu travailles Vous travaillez Tu places Vous placez Il/elle travaille Ils/elles travaillent Il/elle place Ils/elles placent.

C'est seulement à la 3e personne du singulier qu'on ajoute un s au verbe, le verbe reste invariable dans toutes les autres personnes. Par exemple, le verbe *to sing* en anglais, il est conjugué ainsi:

I/you/we/you/they sing. He/she/it sings.

En anglais, la fonction primaire du présent de l'indicatif est celle d'exprimer une action qui se déroule au moment où l'on parle. Un élève est confronté par cette difficulté interférentielle parce qu'il s'est déjà adapté à l'emploi du présent de l'indicatif en anglais. Ainsi, pour exprimer les phrases anglaises suivantes en français, ils sont tentés de faire une traduction directe de *am eating* et de *are dancing* en disant:

1. I am eating rice. Je suis mange du riz.

2. The students are dancing tango. Les étudiants sont dancent le tango.

Les deux phrases doivent correctement être écrites respectivement comme: "Je mange du riz" et "Les étudiants dansent tango".

Cependant, la source d'interférence peut être la coïncidence incomplète des conditions d'emploi de:

Imparfait\passé composé # Present perfect\past indefinite, etc. Les divergences dans le contrôle des verbes dans les langues étudiées donnent souvent lieu à des interférences. Par exemple, les verbes français regarder qn\qch (regarder quelqu'un, quelque chose), écouter qn (écouter quelqu'un), attendre qn (attendre quelqu'un) nécessitent l'utilisation d'un objet direct après eux, tandis que leurs équivalents en anglais *to look at smth*, *to listen to smb*, *to wait for smb* sont utilisés avec un objet indirect. A l'inverse, les verbes français répondre à qn, obéir à qn nécessitent l'utilisation d'un objet indirect, tandis que leurs équivalents anglais pour *to answer smb*, *to obey smb* nécessitent un objet direct. Après avoir identifié une divergence dans le contrôle de verbes spécifiques, l'enseignant doit proposer aux élèves des exercices spéciaux pour la formation.

La préposition de l'adjectif en anglais sert également de source d'interférence lors de l'apprentissage du français langue seconde étrangère à partir de l'anglais. A titre d'exemple, nous donnons les phrases suivantes:

une pomme verte/ a green apple; une robe rouge/a red dresse.

Il est donc nécessaire de conclure cette étude par des points qui se serviront comme solution aux problèmes d'interférence. Le bilinguisme est une situation où un homme possède la connaissance de deux langues au moins. La mise en œuvre d'une approche comparative dans l'enseignement d'une deuxième langue étrangère consiste à encourager les élèves à comparer les langues, à identifier les similitudes et les différences entre elles afin d'éviter les interférences et de réaliser un transfert positif. L'apprentissage de la langue française sera amélioré lorsque les professeurs sont capables d'expliquer les comportements des différentes langues dans le contexte grammatical, sémantique, syntaxique et phonétique.

*Stroganova Maria Sergeevna,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
masha199407@list.ru*

### **PROJECT «INTERNATIONAL ONLINE SCHOOLS»**

**Abstract.** «International online schools» is a vocational guidance project. The main objective of the project is internationalization of engineering Russian education in the world and attraction of students from foreign countries to the engineering specialties.

**Keywords:** international online school, engineering and technical specialties, vocational guidance project.

*Строганова Мария Сергеевна,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
masha199407@list.ru*

### **ПРОЕКТ «МЕЖДУНАРОДНЫЕ ОНЛАЙН-ШКОЛЫ»**

**Аннотация.** «Международные онлайн-школы» – это профориентационный проект. Основной целью данного проекта является интернационализация инженерного российского образования в мире и привлечение участников из иностранных государств на технические специальности.

**Ключевые слова:** международная онлайн-школа, технические специальности, профориентационный проект.

Today young people are not interested in engineering and technical specialties. In order to internationalize education and attract foreign applicants to technical and economic specialties, the idea of international online vocational guidance school for schoolchildren, college and technical school students, as well as students of university preparatory departments arose.

During studying foreign students from different countries try to adapt themselves in social and cultural environment of the city and university. International online school can help at adaptation to engineering classes and promote the main specialties of Higher School of Technology and Energy (HSTE).

International online school contains opening ceremony and welcoming speech by the Heads of HSTE, lectures and tests in the main education fields of HSTE,

including "Russian as a Foreign Language", student activities, culture and history of Saint Petersburg, the main migration issues for foreign students staying in Russia and closing ceremony as well as diplomas awarding.

The school's lecture platform consists of a technology class, an energy and automation class, and a management and economics class, correlating with the titles of the HSTE institutes. The topics presented by the lectures of the main education fields of HSTE were Environmental Engineering, General Chemistry, Pulp and Paper Chemistry, Mechanics, Electrical Power and Electrical Engineering, Industrial Heat and Power Engineering, Automation, Industrial Design, IT Technologies and Modeling, Economics and Management, Business Analytics, Logistics and Energy Management, etc. Young and promising teachers took part in recording of video-lectures and workshops and presented fascinatingly the main training fields of HSTE.

Students of the university presented various activities as sport clubs, science club "Bios-club", dancing club, social club of students, etc. [1].

During International online school participants can learn about culture and history of Saint Petersburg with photo and video provided by the Saint Petersburg Committee for Tourism Development.

In the block of important information for foreign students, participants learned about the status of a foreign student in Russia, norms and rules of migration legislation and issues they should pay attention to before arriving in Russia, as well as about university dormitory, how the new life will be arranged and what events are held in HSTE.

This year the First International online school 2024 was held from April 22 till April 26, 2024.

During 4 month 230 participants from 18 countries were registering at the First International online school.

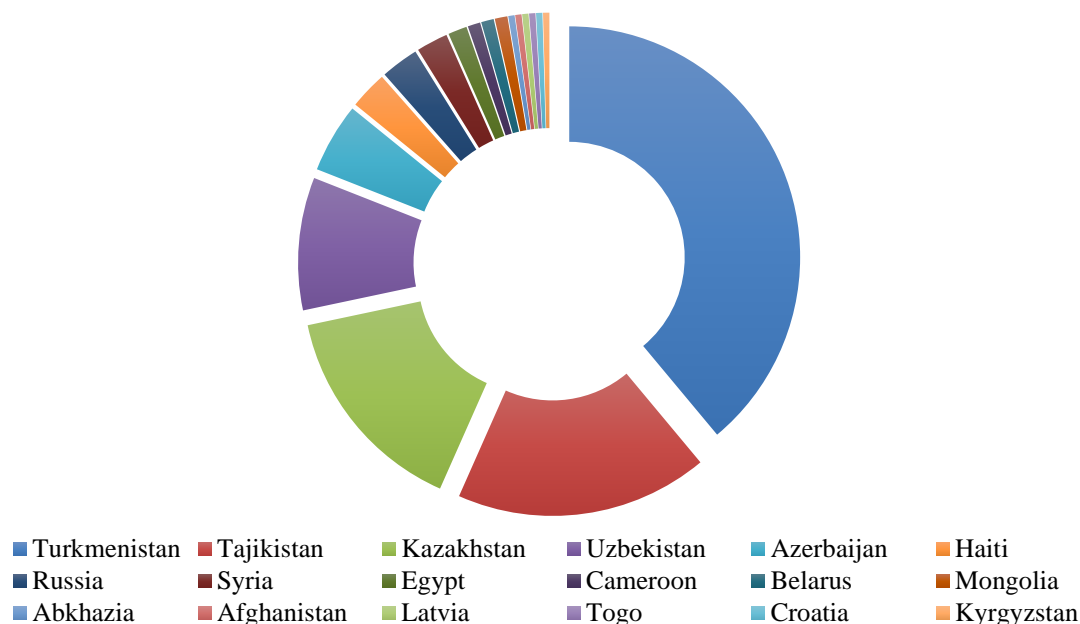


Figure – Statistics of participants from 18 countries at the First International online school

This year the main target group of the school is Russian-speaking and Russian-learning potential applicants, initially from the CIS countries. Work language of the school is Russian.

Participants from different countries were attracted through the Committees of Saint Petersburg and the Russian Houses in different countries at Embassies of Russian Federation.

Before the start of the international online school, the organizers held an introductory webinar, where participants learnt how to connect to the school's online platform and asked the question they were interested in.

Opening ceremony of International online school 2024 was at International Earth Day, April 22. At the opening of the online school, the event program was presented, participants learned about the training format, how to work at the online education platform "Moodle" and how to complete tasks.

During the school, the participants completed more than 150 tasks. The technology class and the management and economics class arouse the greatest interest, but the energy and automation class also turned out to be of interest to many students. The required number of tasks to get a diploma of successful completion of the International online school 2024 was completed by 30 participants in the class of technology, 22 participants in the class of management and economics, and 21 participants in the class of energy and automation. Also, many participants watched the video in the block about Saint Petersburg and in the block of important information.

The closing ceremony of the online school took place on April 26 at the online platform. At the closing ceremony, organizers summed the results of the online school and answered all questions of participants and their parents regarding admission to the university. At the end of International online school 2024, participants received diplomas of successful completion and certificates. 42 students successfully graduated from the International online school. 33 students were awarded with the diplomas of successful completion and 9 students – with the participation certificates.

The most active participants were from Azerbaijan, Kazakhstan, Mongolia, Tajikistan, Turkmenistan and Uzbekistan.

To develop the idea of "International Online Schools" further, the colleagues from International Administration of HSTE Department submitted an application for a grant of Federal Agency for Youth Affairs (Rosmolodezh) to hold the event in online and offline formats.

Colleagues from Education Online Technologies Department of our University was preparing the platform of the school and managing it during the school.

In collaboration with all structures of HSTE, the project can lead the university to success.

### **References:**

1. Stroganova, M. S. Development of the Russian BIOS – 2018 project / Stroganova, M. S. , Kushnerov, A. I. , Shishkin, A. I. // In the collection : *XXIII Mezhdunarodny`j Bios-forum i Molodezhnaya Bios-olimpiada 2018* [XXIII International Bios Forum and Youth Bios Olympiad 2018]. Collection of materials. 2019. pp. 250-258. (in Russian).

### **Список литературы:**

1. Строганова, М. С. Развитие российского проекта "БИОС-2018" / М. С. Строганова, А. И. Кушнеров, А. И. Шишкин. – Текст : непосредственный // XXIII Международный Биос-форум и Молодежная Биос-олимпиада 2018 : сборник материалов. – Санкт-Петербург, 2019. – С. 250-258.

УДК 620.1

*Belousov Vladimir Nickolaevich,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
srv56@mail.ru*

*Smorodin Sergej Nickolaevich,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
smorodin@inbox.ru*

**UNCONVENTIONAL TECHNOLOGY FOR THE THERMAL  
TRANSFORMATION OF HIGHLY TOXIC SUBSTANCES  
IN A STATIONARY SHOCK WAVE**

**Abstract.** In this paper, a methodology for conducting experiments and a calculation algorithm for the decomposition of toxic substances in a shock wave have been developed. Calculations of the decomposition and oxidation of mustard gas in a methane flame under shock tube conditions have been performed, taking into account the detailed kinetics and turbulent characteristics of the medium. A model setup has been prepared for experiments.

**Keywords:** stationary shock wave, supersonic nozzle, kinetics, turbulence, highly toxic substances.

*Белоусов Владимир Николаевич,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
srv56@mail.ru*

*Сморodin Сергей Николаевич,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
smorodin@inbox.ru*

**НЕТРАДИЦИОННАЯ ТЕХНОЛОГИЯ ТЕРМИЧЕСКОГО  
ПРЕОБРАЗОВАНИЯ ВЫСОКОТОКСИЧНЫХ ВЕЩЕСТВ  
В СТАЦИОНАРНОЙ УДАРНОЙ ВОЛНЕ**

**Аннотация.** В данной работе представлена методика проведения экспериментов и алгоритм расчета по разложению токсичных веществ в



ударной волне. Проведены расчеты разложения и окисления иприта в пламени метана в условиях ударной трубы с учетом детальной кинетики и турбулентных характеристик среды. Подготовлена модельная установка для экспериментов.

**Ключевые слова:** стационарная ударная волна, скачок уплотнения, сверхзвуковое сопло, кинетика, турбулентность, высокотоксичные вещества.

## **UNCONVENTIONAL TECHNOLOGY FOR THE THERMAL TRANSFORMATION OF HIGHLY TOXIC SUBSTANCES IN A STATIONARY SHOCK WAVE**

At the end of the twentieth century, a huge amount of highly toxic substances representing various types of chemical weapons accumulated in many countries of the world, including Russia: sarin, soman, phosgene, mustard gas, lewisite and others. According to official data, most of the chemical weapons were disposed of, which, however, does not correspond to reality.

Chemical transformations of various substances, including toxic ones, are carried out in reactors of various types under certain thermokinetic parameters (pressure, temperature, residence time, presence of by-products: catalysts, phlegmatizers). An important factor is the continuity of the process and the ability to withstand the residence time in the reactor.

For most chemical reactions, the rate obeys the Arrhenius law as a function of temperature. Therefore, in order to reduce the residence time of the initial components in the reactor and, accordingly, increase productivity, it is advisable to increase the process temperature.

One of the possible options to meet these requirements is the so-called ideal mixing reactor, into which the initial components are continuously fed and the reaction products are continuously removed. At the same time, certain concentrations of all components of the reacting mixture (initial, intermediate, final) are set in the reactor. Such a reactor has limited capacity, since when it is increased, mixing to a homogeneous level is not ensured for any technically achievable mixing method.

The implementation of a chemical reaction in a flow bounded by walls, with a separate supply of the initial components (mixing of jets in a pipe) does not ensure a uniform distribution of component concentrations over the cross section and length of the reactor, and therefore it is impossible to speak about the unambiguity of the parameters determining the process of chemical transformations.

The above disadvantages can be eliminated by carrying out the process in a jet reactor with strong mixing of the components in the area with the set values of thermokinetic parameters. Such conditions are met by conducting a reaction in a stationary shock wave formed in a supersonic flow of one of the reacting substances (usually an oxidizer) with an excess mass of inert components [1].

The stationary shock wave method is known as one of the methods for obtaining kinetic constants of chemical reactions. It ensures sufficient purity of the obtained chemical compounds from by-products.

The supply of one of the initial reagents, as a toxic substance, is carried out in the critical section of the supersonic nozzle in the form of a single jet in the center or

a system of jets along the periphery of the nozzle. Since the temperature in the critical section and further along the supersonic nozzle is significantly lower than the initial temperature of the oxidizer, no noticeable chemical reactions occur up to the shock wave zone. Upon entering the zone formed by one direct or several oblique shock waves, the temperature and pressure rise sharply, and the jets of the toxic component are intensively mixed in the oxidizer stream. Thus, a homogeneous reactor with certain temperature and pressure values is formed in the shock wave zone. By changing the initial values of temperature, pressure to the critical section, as well as forming the shock wave region, the parameters can be adjusted, this gives the opportunity to control the process of converting chemical compounds.

Toxic substances are supposed to be oxidized in the presence of methane. This will significantly change the temperature in the reactor core due to the thermal effect of oxidation of the latter and affect the oxidation process due to the additional formation of active particles.

Calculations of thermodynamic parameters in the reaction zone for various compositions of mixtures of air, methane and some toxic substances at different initial temperatures and Mach numbers from 2 to 5 are carried out.

In this paper, a method for neutralizing toxic substances is considered, using the example of *mustard gas* utilization.

Mustard gas is a chemical warfare agent of skin-abscess action. It is a colorless liquid with the smell of garlic or mustard. It has the following chemical formula  $S(CH_2CH_2Cl)_2$  and a lethal concentration of 0.03 mg/l.

We consider a method of mustard gas disposition based on incomplete gas oxidation in a homogeneous reactor formed by a stationary shock wave.

A shock wave is a thin transition region, beyond which there is a sharp change in the parameters of the medium, and which is formed under certain conditions: this can be an explosion, supersonic movement of a body in space, as well as supersonic flow of gas in any channel.

The experimental installation consists of three main parts: Laval nozzle, homogeneous reactor and gas cooler (Fig. 1).

The toxic substance is fed through the supply tube 2 and sprayed in the critical section of the Laval nozzle 8 on its axis. Fuel (methane) is supplied here through holes 3 along the periphery. The air supplied by the compressor through channel 1 is used as an oxidizer. In the expanding part of the nozzle, the gas mixture acquires supersonic velocity. Next, the flow encounters an obstacle in its path – tooth 11, which leads to the formation of a shock wave [2].

The toxic substance is fed through the supply tube 2 and sprayed in the critical section of the Laval nozzle 8 on its axis. Fuel (methane) is supplied here through holes 3 along the periphery. The air supplied by the compressor through channel 1 is used as an oxidizer. In the expanding part of the nozzle, the gas mixture acquires supersonic velocity. Next, the flow encounters an obstacle in its path – tooth 11, which leads to the formation of a shock wave [2].

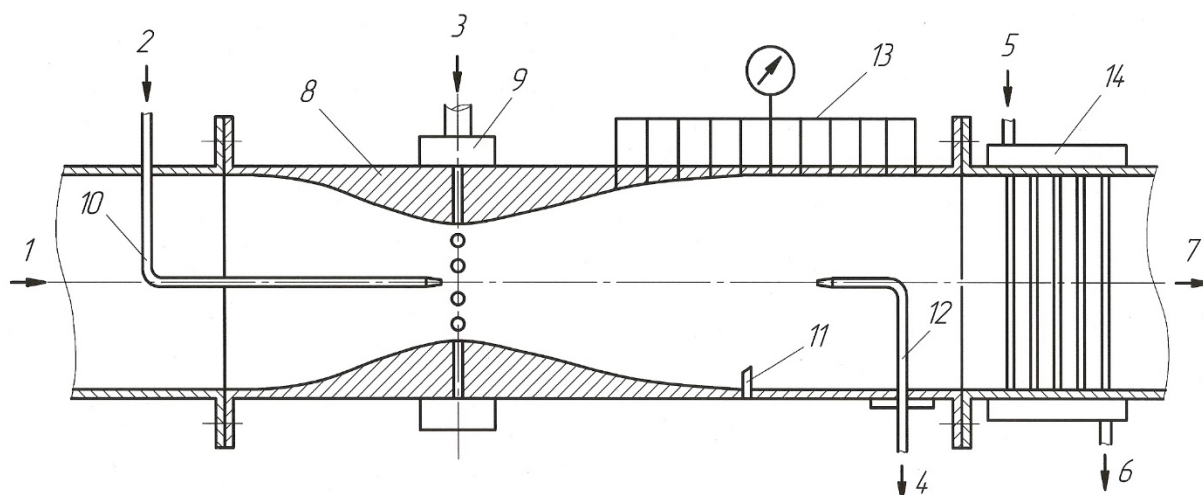


Figure 1 – Experimental installation

1 – oxidizer supply; 2 – toxic substance injection; 3 – fuel injection; 4 – selection of gases for analysis; 5 – supply of the cooling medium; 6 – removal of the cooling agent; 7 – removal of reaction products; 8 – supersonic nozzle; 9 – fuel injection collector; 10 – toxic substance supply tube; 11 – tooth for fixing the shock wave; 12 – sampling tube; 13 – pressure measurement system; 14 – heat exchanger

As a result, a homogeneous reactor with certain temperature and pressure values is formed after a seal jump, which makes it possible to obtain intermediate products, in particular ethylene oxide, hydrochloric acid and hydrochloric acid, rather than the final products of the oxidation reaction.

Thus, by changing the initial values of temperature and pressure to a critical section, as well as forming a shock wave region, it is possible to adjust the flow parameters behind the shock wave front, which in turn will allow controlling the process of converting chemical compounds, obtaining the necessary reaction products.

The cooling of the reaction products takes place in a regenerative gas-liquid heat exchanger consisting of a bundle of pipes arranged in a staggered manner, the cooling agent is water.

In addition, a pressure measurement system 13 is provided in the process unit, which allows monitoring the gas pressure before and after the seal surge. After a small stabilizing area, a tube 12 is installed for sampling gas for analysis.

A thermodynamic calculation algorithm has been compiled that allows us to investigate the dependence of the flow parameters, as well as the geometric dimensions of the nozzle on the initial pressure (Fig. 2, 3). The change in the initial pressure significantly affected the nozzle profile, in particular its expanding part.

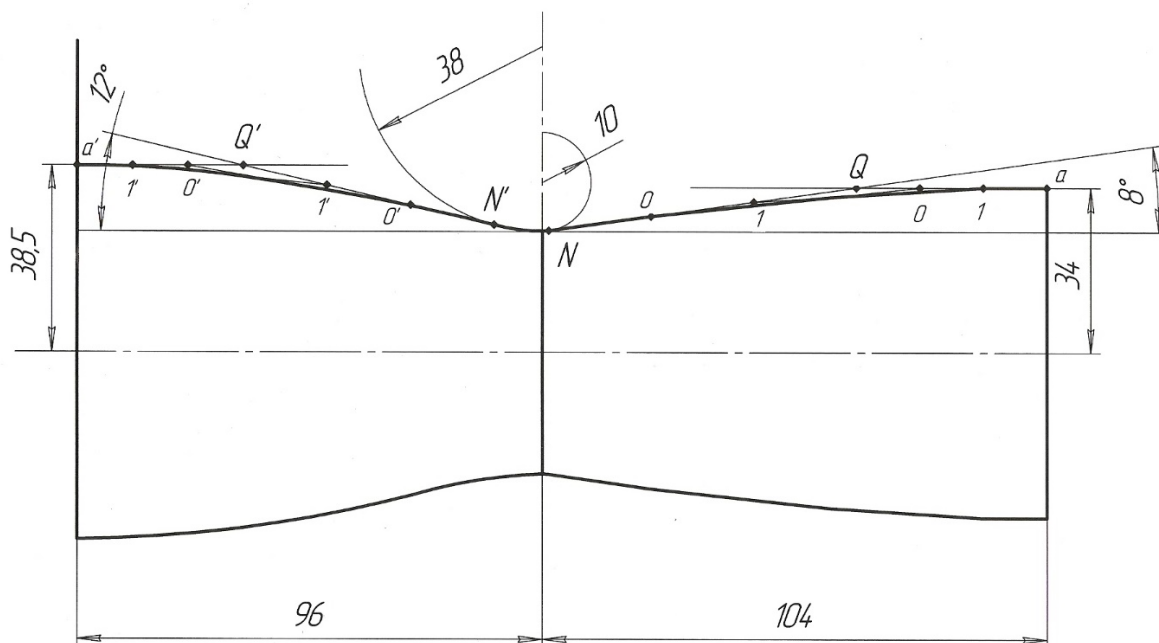


Figure 2 – Nozzle profile at an initial pressure of 0.9 MPa

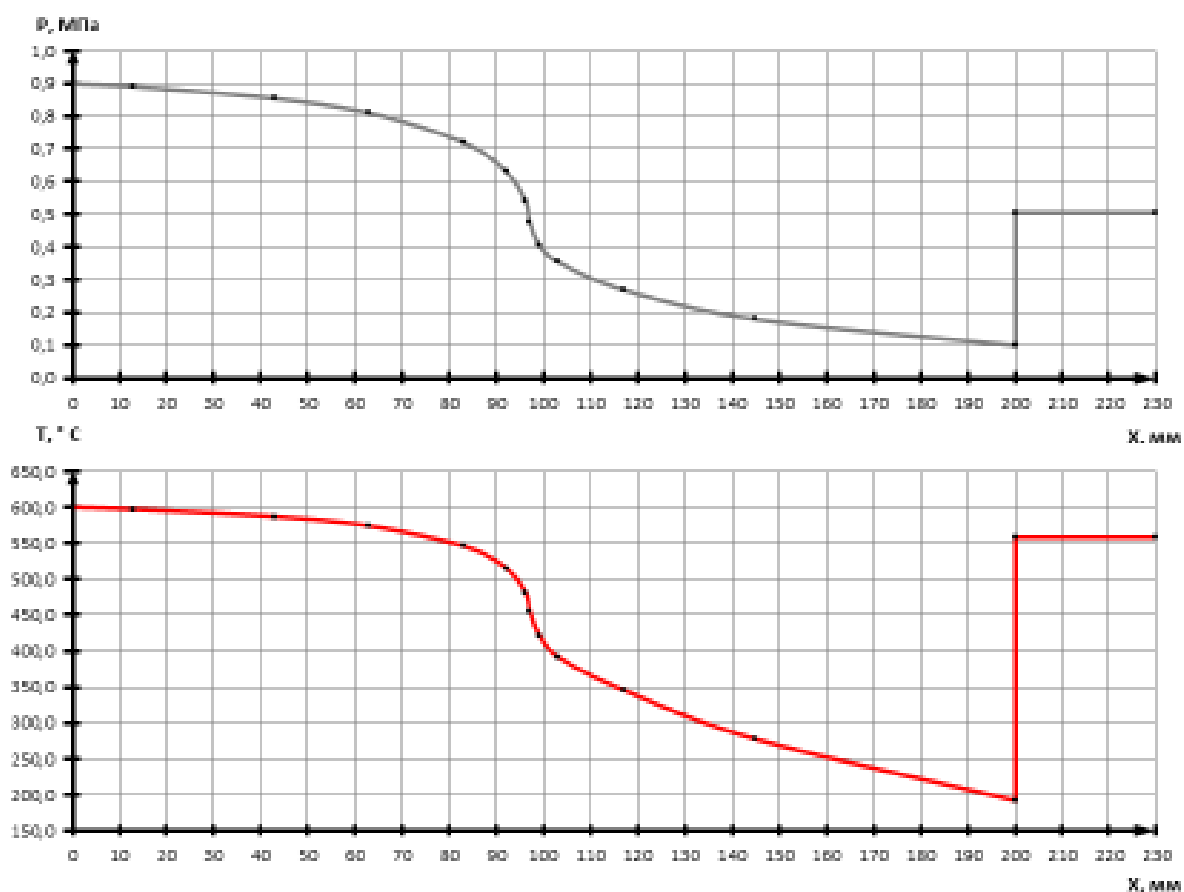


Figure 3 – Pressure and temperature changes along the nozzle length and behind the shock wave front

The mechanism of mustard gas oxidation has been compiled based on general ideas on the oxidation of organochlorine sulfides. In this scheme, it is assumed that the limiting reaction is the decomposition reaction of ethyl chloride, accompanied by the rupture of C-Cl bonds. The values of the kinetic constants for this reaction are

known. Including this and subsequent reactions of mustard gas oxidation into the methane oxidation scheme, a general kinetic scheme of 106 components (atoms, radicals, molecules) was compiled [3].

An algorithm has been developed for solving the problem of oxidation of the above mixture under conditions of a system of shock waves, taking into account the aerodynamic characteristics of the system (turbulence, etc.).

Calculations have shown that under certain conditions (residence time, pressure and temperature) it is possible to obtain significant concentrations of valuable products such as ethylene oxide, formaldehyde, and hydrogen chloride. If the reaction breaks down at this stage, valuable products can be released for subsequent separation.

Research in this area needs experimental verification. The result of this check should be the determination of the optimal parameters of the technological units of the installation.

### References:

1. Tulpanov, R. S., Belousov, V. N., Vitiazeva, E. A., Leble, M. O., Michalchuk, S. A. Influence of turbulence on the chemical reactions, NO<sub>x</sub> synthesis included, in the diffusion turbulent flames. 24<sup>th</sup> International symposium on combustion, Sydney, 1992. (in Russian).
2. Tulipov, R. S., Belousov, V. N., Grigoriev, L. N., Mikhalchuk, S. A., Shnurova, N. V. *Преобразование токсичных веществ методом стационарной ударной волны. Высшая школа и конверсия* [Transformation of toxic substances by the stationary shock wave method. Higher school and conversion] // Тез. докл. All-Russian Conference. Moscow, 1993. (in Russian).
3. Tulipov, R. S., Belousov, V. N., Ivanov, A. N. *Опыт эксплуатации системы утилизации вредных газовых выбросов. Проблемы экономии топливно-энергетических ресурсов на предприятиях и ТЭС* [System operation experience disposal of harmful gas emissions. Problems of fuel economy-energy resources at industrial enterprises and thermal power plants] // interuniversity collection scientific tr. / St. Petersburg, St. Petersburg State Technical University RP. 2001, pp. 277-282. (in Russian).

### Список литературы:

1. Tulpanov, R. S., Belousov, V. N., Vitiazeva, E. A., Leble, M. O., Michalchuk, S. A. Influence of turbulence on the chemical reactions, NO<sub>x</sub> synthesis included, in the diffusion turbulent flames. 24<sup>th</sup> International symposium on combustion, Sydney, 1992.
2. Тюльпанов, Р. С. Преобразование токсичных веществ методом стационарной ударной волны. Высшая школа и конверсия / Р. С. Тюльпанов, В. Н. Белоусов, Л. Н. Григорьев, С. А. Михальчук, Н. В. Шнурова. – Текст : электронный // Тез. докл. Всероссийской конф. – Москва, 1993.
3. Тюльпанов, Р. С. Опыт эксплуатации системы утилизации вредных газовых выбросов. Проблемы экономии топливно-энергетических ресурсов на предприятиях и ТЭС / Р. С. Тюльпанов, В. Н. Белоусов, А. Н. Иванов. – Текст : непосредственный // Межвуз. сб. науч. тр. – СПб., 2001. – С. 277-282.

*Litvinova Alexandra Vladimirovna,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
shura\_litvinova@bk.ru*

## **INTERIOR DESIGN OF PASSENGER AIRCRAFT CABINS IN THE 60s OF THE USSR**

**Abstract.** This article explores and analyzes the design aspects of creating passenger aircraft interiors during the Soviet Union. The design, materials used, technologies and designs of Soviet aircraft are considered. The purpose is to study and describe the process of designing passenger aircraft interiors in the Soviet Union, to identify the features and basic design principles that were used in the aviation industry of the USSR.

**Keywords:** aviation industry, passenger aircraft, design, salon, interior, design, Soviet Union, technology.

*Литвинова Александра Владимировна,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
shura\_litvinova@bk.ru*

## **ПРОЕКТИРОВАНИЕ ИНТЕРЬЕРОВ САЛОНОВ ПАССАЖИРСКИХ САМОЛЕТОВ В 60-е гг. В СССР**

**Аннотация.** В данной статье исследуются и анализируются дизайнерские аспекты создания интерьеров пассажирских самолетов во времена Советского Союза. Рассматривается дизайн, используемые материалы, технологии и конструкции советских самолетов. Цель – изучить и описать процесс проектирования интерьеров пассажирских самолетов в Советском Союзе, выявить особенности и основные принципы дизайна, которые применялись в авиационной индустрии СССР.

**Ключевые слова:** авиационная индустрия, пассажирский самолет, дизайн, салон, интерьер, проектирование, Советский Союз, технологии.

In the 60s in the Soviet Union, interior design of passenger aircraft cabins was one of the key tasks of the aviation industry. At that time, citizens of the Soviet Union began to travel actively, and in order to ensure comfortable transportation of passengers, it was necessary to create modern and functional interiors. The development of the interior of a passenger aircraft is associated with the general

development of aircraft construction as one of the most advanced industries in scientific and technical terms.

The USSR design artists solved a variety of technical problems related to ensuring the reliability and safety of flight, did not neglect the creation of comfortable conditions for passengers, especially with the advent of multi-seat aircraft and the colossal branching of the lines of the civil air fleet [1].

Comfort is the result of a thoughtful architectural and artistic interior design and high – quality technical and household equipment. During the development of the interior of the aircraft cabins at the first stage of design, it was not possible without the participation of architects, design artists, decorators, etc. In the 60s, many design bureaus still had few specialists, and they hardly dealt with technical aesthetics issues there. As a result, there were planes whose appearance contrasted sharply with the interior. An example of a clear violation is some samples of passenger aircraft TU (104-124). Reliability, power and other technical advantages of the aircraft were hardly noticeable as soon as the passenger entered the aircraft: the interior was designed in an old-fashioned manner, heavy, eclectic. In the AN-10 and IL-18 aircraft, the interiors were more modest and strict, but many elements (bathrooms, armchairs, ceiling lights, etc.) are far from ideal [2].

During this period, it was believed that comfort and a sense of security could be ensured by creating a "home environment" in the cabin of the aircraft. Developing this trend, the interior was decorated with "heavy", "massive" chairs made of "expensive wood", "powerful" lamps made of "stone" and "forged gilded metal", pilasters and capitals at the windows. It was a prop, since all the items were made from new, lightweight aviation materials. Such "finds" were condemned both abroad and in the USSR.

The USSR design artist had to solve the following issues: variability of layout, placement and arrangement of seats for passengers, equipment of personal service facilities, lighting, air conditioning, arrangement of luggage racks, partitions, buffet kitchen, utility rooms, bathrooms, etc.

To create a variable interior, the designer painstakingly studied many options before determining the right number and optimal placement of entrance and loading doors, lobbies, closets, bathrooms, buffet kitchens, as well as the location of windows and personal service facilities (air supply, lighting, radio, alarm), the size of the luggage rack, general lighting etc.

It was necessary to obtain the desired interior design with minimal effort and time. The design artist had to provide for easily removable, interchangeable, mobile equipment in his project. At the same time, lightweight, fire-resistant, hygienic, durable materials were used to finish the main equipment, partitions and walls, which can be easily and quickly given a fresh look. Neutral colors and patterns were used for these materials, as they were in harmony with various color schemes. When arranging seats in the cabins of the aircraft, they sought to ensure the relative equivalence of passenger seats in terms of comfort. The issue of the density of the seating arrangement, i.e. in tourist or economic variants, was particularly acute. The optimal seating arrangement in terms of the number of rows and the number of seats in a row is related to the length and width of the cabin. The designers faced a serious

task: to find the most convenient and beautiful shape of the opening from all points of view, to successfully fit the window into the interior. While working on the interior of the aircraft, the designer took into account that the frequent arrangement of high-backed seats, low window placement and significant thickness of the structure would give the cabin a "blind" look. The expansion of the window panel edges, highlighting them with material and color helped to get rid of this feeling. The solid ribbon of windows forced the abandonment of soft curtains. On many Soviet aircraft of the 60s, including the IL-62, rigid curtains moving vertically were adopted.

The comfort of the cabin was largely determined by the comfort of the seat. In the beginning, no scientific experiments were carried out, since there were no experienced specialists either. Therefore, the first chairs turned out to be not only bulky and ugly, but also contradicted the requirements of anthropology and medicine. Soon, research institutes took control of the design. Seat tests were widely practiced in various flight conditions, and feedback from passengers was collected.

The designers' efforts were aimed at designing mainly tourist-class seats, the cheapest for mass passenger transportation. The designers had to reconcile conflicting requirements: the density of the seating arrangement, maximum comfort for passengers, strict weight restriction (up to 10-11 kg per passenger) [3].

It was necessary to choose the general contour of the chair on a scientific basis, find the optimal design of the frame, seats, backrest, armrests, and suitable materials. Abroad in the 60s for a long time there were companies for the equipment of passenger aircraft and for providing airlines with passenger seats. Examples of such companies: Microsoft, Rumbold, Aircraft Manufacturing, TESO, etc.

The comfort of the passenger seat was also determined by the means of individual maintenance, the number of which depended on the class of the aircraft. This included individual lighting, fresh air supply, signal communication with flight attendants, radio broadcasting, individual oxygen devices, etc. The placement of personal service facilities on the lower part of the luggage rack panel was considered the most rational [4].

Lighting is a necessary element of the interior of a passenger aircraft (Fig. 1).

Solving the issues of lighting – general, duty, night, emergency, the designer had to take into account a number of structural and operational requirements. Lightness, simplicity and ease of maintenance must be combined with reliability in operation.

In the passenger plane, much attention was paid to the equipment of auxiliary services – buffet kitchen, wardrobe, bathrooms, lobbies. For these services, space was allocated in areas inconvenient for passenger seats – at the entrance doors, where free space was used only during boarding and loading, in areas of increased noise, in the tail section, where the narrowing of the volume complicated the placement of seats.

In the buffet kitchen, it was necessary to place quite a lot of equipment for storing all kinds of containers (containers for food, water and dishes, universal boilers and ovens, etc.). Shelving equipment had to be carefully thought out for the rational placement of all these containers. The key to the tireless work of flight attendants and fast passenger service is the convenient location of work and auxiliary tables, their additional lighting, the placement of containers and appliances, eliminating



unnecessary movements, rational choice of a place for washing, containers for dirty dishes and garbage, etc.

In the 60s, there were no specialized organizations designing and manufacturing equipment for buffet kitchens. The equipment of that time was developed by various organizations and did not have a single style.

There were companies abroad specializing in the equipment of airplane kitchens: General Electric, Field Aircraft Services, Ergally, Hanshell, Taylor, etc. These companies supplied many airlines with complete sets of kitchen equipment, from cutlery and glassware to napkins, taking into account not only the specifics of the aircraft, but also the specific needs of the airlines (the nature of transportation, national characteristics and traditions, etc.).

The arrangement of bathrooms requires no less attention. Their number was determined by the norm at the rate of one bathroom per 40 people. Their location was supposed to exclude the passage of passengers through other lounges and the buffet kitchen. The bathrooms were equipped with a flush toilet, a washbasin, containers for garbage and water. The water supply and sewerage scheme used on domestic aircraft was based on the use of a re-circulating liquid. In the beginning, the toilet rooms on Soviet planes had the most unattractive appearance. Then the attitude towards their equipment changed dramatically. Cold and warm water in the washbasin, a thermos of drinking water and individual cups, containers for soap, garbage, shelves for personal belongings, sockets for electric shavers, hooks for clothes, soft, uniform lighting, convenient location of buttons and pedals – a toilet room on an airplane was unthinkable without these attributes [4].

The correct selection of finishing materials and decorative processing of structures was of great importance. Fabric materials with PVC coating (pavinol) have become the most widely used for interior decoration of aircraft (Fig. 2). With low weight, they are quite durable, diverse in color and texture. These materials were convenient for pasting and covering panels, partitions and structures, and practical in operation. Pavinols imitating leather were used in the decoration of chairs. For a long time, interior designers did not have successful floor covering materials at their disposal.

Then the industry mastered, by order of aviation, the production of synthetic nylon carpets on a spongy (latex) basis. Carpets of monophonic colors or with free-form patterns were used in the interior of the aircraft.

In order to reduce weight, reduce raw material consumption and reduce cost, lightweight fabrics with strong fibers and various strengthening treatments (latex, acrylic, vinyl, etc.) were used. There were some trends in the interior design. Curved and small panels that emphasize the "tunneling" and cramped interior and give it a "tram" look have long outlived themselves, as well as handrails, lighting shades, luggage racks. Ribbon ceiling or concealed fluorescent lighting combined with soft illumination of wall panels at the shelves and individual lighting made the interior more cozy and spacious.

The composition of the interior, household equipment, and the selection of colors for finishing materials depended on many factors: the type of aircraft and class of transportation, the area and route of operation, the size of passenger cabins, special

customer requirements, etc. It was unacceptable to use one successful idea for all aircraft without taking into account their specifics.

For example, for large passenger aircraft making long-distance flights, the interior was designed in a soft, calm, strict manner, without sharp contrasts in color and texture of materials. This style helped aircraft builders to create confidence in flight safety among passengers.

Small-capacity aircraft with a short range, frequent stops and a constant change of passengers were preferably finished in bright, contrasting colors, highlighting interior elements with color and pattern.

Passenger aircraft of the USSR were not inferior to similar foreign models in terms of technical characteristics. The interiors of passenger aircraft cabins in the 60s were distinguished by simplicity and functionality. The furniture was made in a minimalistic style, which made it possible to use the interior space as efficiently as possible. The chairs and tables were made of durable and lightweight materials, providing comfort for passengers and durability of the furniture. One of the key aspects of designing passenger aircraft interiors was safety. Special attention was paid to the development of comfortable and safe seats, as well as the placement of emergency exits in the cabin. In addition, the ideology of socialism was taken into account in the design of the interiors of passenger aircraft cabins. The design artists sought to create interiors reflecting the ideals of communism and well-being. This was manifested in the choice of colors, the use of symbols of Soviet symbols, as well as in the design of public areas of the aircraft.



Figure 1 – For the first time, fluorescent lighting, blind luggage racks and rigid blinds moving vertically were used on the IL-62



Figure 2 – For the first time, the IL-18 used a panel wall construction with a lightweight laminate covering, foam rubber instead of spring structures for chairs. The IL-18 is the first domestic passenger aircraft equipped with individual lighting and air conditioning (these devices are located in the luggage rack structures)

But in terms of comfort, Soviet aircraft in the 60s did not yet reach the level of the best world standards. This situation was the result of aircraft builders underestimating the role of technical aesthetics. Too few specialists in artistic design

were involved in the design of aircraft interiors, and the role of the artist was often reduced to decoration.

The interiors of passenger aircraft in the USSR differed from modern Russian ones in many aspects. Firstly, in Soviet times, interiors were more functional, with a simple and convenient design. Modern Russian aircraft have a more advanced and stylish design, more advanced materials and technologies are used.

In addition, in Soviet times, less attention was paid to passenger comfort, and almost all aircraft had the same type of seats, while modern aircraft are equipped with more comfortable and individual adjustable seats and other amenities

Also, Soviet aircraft were less automated and equipped than modern Russian aircraft, which makes flights safer and more comfortable for passengers.

In modern conditions of designing such facilities, new advanced materials and technologies are of great importance. Therefore, modern interiors of passenger aircraft cabins differ favorably from their predecessors.

### **References:**

1. *Stanovleniya i razvitiya dizajna v SSSR* [Formation and development of design in the USSR] // Journal : [website]. 2020. Jan 10. URL: <https://cyberpedia.su/13xab70.html> (date accessed: 03.25.2024). (in Russian).
2. Ryzhikov, S. S. *Opyt raboty nad intererom i okraskoj samoletov tipa AN* [Experience of working on the interior and coloring of aircraft of the AN type], Technical aesthetics No 9 September 1965 : [Bulletin; Magazine]. Moscow, I-223, VNIITE, pp. 11-14. (in Russian).
3. Koskov, M. A., Alekseev, P. G. *Liki dizajna* [Faces of design] : illustrated monography/scientific ed. prof. M. A. Koskov. St. Petersburg: LSU named after A. S. Pushkin, 2021. – 400 p. (in Russian).
4. *Texnicheskaya estetika №12 dekabr` 1965* [Technical aesthetics No 12 December 1965] : [Bulletin; Journal]. Moscow, I-223, VNIITE. p. 36. (in Russian).

### **Список литературы:**

1. Становления и развития дизайна в СССР. – URL: <https://cyberpedia.su/13xab70.html> (дата обращения: 25.03.2024). – Текст: электронный.
2. Рыжиков, С. С. Опыт работы над интерьером и окраской самолетов типа АН / С. С. Рыжиков. – Текст: непосредственный // Техническая эстетика. – 1965. – № 9. – С. 11-14.
3. Коськов, М. А. Лики дизайна: иллюстрированная монография / М. А. Коськов, П. Г. Алексеев. – СПб: ЛГУ им. А. С. Пушкина, 2021. – 400 с. – Текст: непосредственный.
4. Техническая эстетика : бюллетень / Всесоюзный научно-исследовательский институт технической эстетики Государственного комитета СССР по науке и технике. – Москва, 1965. – № 12. – 36 с. – Текст: непосредственный.

*Marushchak Julia Igorevna,  
Université technologique d'état de Vitebsk,  
Vitebsk, République Du Bélarus  
tonk.00@mail.ru*

*Yasinskaya Natalia Nikolaevna,  
Université technologique d'état de Vitebsk  
Vitebsk, République Du Bélarus  
yasinskaynn@rambler.ru*

## **ANALYSE COMPARATIVE DE L'ÉCO-CUIR MODERNE DE DIFFÉRENTS FABRICANTS**

**Annotation.** L'article reflète les résultats d'une recherche sur la résistance des éco-cuirs aux effets mécaniques (abrasion, étirement, adhérence) en vue de leur utilisation dans la production de couture. Les facteurs d'usure sont analysés. La perméabilité à la vapeur et à l'air des éco-cuirs de différents fabricants a été étudiée. L'échantillon avec le revêtement en polyuréthane microporeux le plus épais a montré la meilleure résistance à l'abrasion. L'échantillon avec un support tricoté a montré la meilleure extensibilité. Il est prouvé que les éco-cuirs biélorusses ne sont pas inférieurs en qualité aux analogues étrangers et qu'ils remplaceront avec succès les cuirs d'origine naturelle.

**Mots-clés:** Revêtement polyuréthane, respirabilité, perméabilité à la vapeur, résistance à l'abrasion, revêtement microporeux, qualité.

*Marushchak Yulia Igorevna,  
Vitebsk State Technological University,  
Vitebsk, Republic of Belarus  
tonk.00@mail.ru*

*Yasinskaya Natalia Nikolaevna,  
Vitebsk State Technological University,  
Vitebsk, Republic of Belarus  
yasinskaynn@rambler.ru*

## **COMPARATIVE ANALYSIS OF MODERN ECO-LEATHER FROM DIFFERENT MANUFACTURERS**

**Abstract.** The article reflects the results of a study of the resistance of eco-leathers to mechanical influences (abrasion, stretching, adhesion) with the aim of using them for the production of clothing. Wear factors are analyzed. The vapor and air permeability of eco-leathers from various manufacturers was studied. The sample with the greatest thickness of microporous polyurethane coating has the greatest resistance to abrasion. The sample with a knitted fabric base has the best

stretchability. It has been proven that Belarusian eco-leathers are not inferior in quality to foreign analogues and will successfully replace leather of natural origin.

**Keywords:** polyurethane coating, breathability, vapor permeability, abrasion resistance, microporous coating, quality.

*Марущак Юлия Игоревна,  
Витебский государственный технологический университет,  
г. Витебск, Республика Беларусь  
tonk.00@mail.ru*

*Ясинская Наталья Николаевна,  
Витебский государственный технологический университет,  
г. Витебск, Республика Беларусь  
yasinskaynn@rambler.ru*

## **СРАВНИТЕЛЬНЫЙ АНАЛИЗ СОВРЕМЕННЫХ ЭКОКОЖ РАЗЛИЧНЫХ ПРОИЗВОДИТЕЛЕЙ**

**Аннотация.** В статье отражены результаты исследования стойкости экокож к механическим воздействиям (истираемость, растяжение, слипаемость) с целью применения их для производства одежды. Проанализированы факторы износа. Исследованы паро- и воздухопроницаемость экокож различных производителей. Наибольшей устойчивостью к истиранию обладает образец с наибольшей толщиной микропористого полиуретанового покрытия. Лучшей растяжимостью обладает образец с трикотажным полотном в основе. Доказано, что белорусские экокожи не уступают по качеству зарубежным аналогам и успешно заменяют кожи натурального происхождения.

**Ключевые слова:** полиуретановое покрытие, воздухопроницаемость, паропроницаемость, устойчивость к истиранию, микропористое покрытие, качество.

Le cuir naturel a longtemps été considéré comme le meilleur matériau pour la production de vêtements. La qualité du vêtement fini est largement déterminée par les propriétés hygiéniques du matériau textile, car c'est ce matériau qui détermine le confort du vêtement. Les cuirs naturels présentent un niveau élevé de propriétés hygiéniques, mais en raison de leur rareté et de leur coût élevé ces dernières années, les cuirs artificiels sont devenus de plus en plus populaires. La plupart des cuirs artificiels ont une très faible perméabilité à l'air et à la vapeur, en raison du faible taux de diffusion de la vapeur d'eau, puisqu'un film polymère continu est formé à la surface [1]. Aujourd'hui, les technologies de production de cuir artificiel s'améliorent et un groupe de matériaux à base de polyuréthane – les éco-cuirs avec revêtement en polyuréthane microporeux – devient de plus en plus populaire [1, 2]. Ces matériaux ressemblent au cuir naturel par leur apparence, s'en rapprochent par un ensemble d'indicateurs de propriétés hygiéniques et offrent un confort maximal lorsqu'ils sont utilisés comme matériaux pour la production de vêtements.

En République du Belarus, l'éco-cuir est importé de Chine et de Turquie. Dans le cadre du projet commun, les auteurs et les représentants de l'entreprise ont maîtrisé la technologie et produit des lots pilotes de cuir artificiel pour l'habillement avec des indicateurs élevés de perméabilité à la vapeur et de perméabilité à l'air (éco-cuir) [1]. La présence de pores dans la couche de polymère de surface est due au pré-moussage de la composition polymère avant l'application, ce qui permet d'améliorer la qualité du produit, de lui conférer de nouvelles propriétés opérationnelles et d'obtenir un effet économique significatif.

Afin d'évaluer objectivement la qualité des éco-cuirs, la perméabilité à l'air, la perméabilité à la vapeur et la résistance aux influences mécaniques des éco-cuirs de différents fabricants, déclarés comme matériaux pour l'habillement, ont été étudiées.

Les caractéristiques des objets de recherche sont présentées dans le tableau 1.

Tableau 1 – Caractérisation des objets de recherché

Chiffre	Composition du matériau Matériau de la couche de base/face	Densité de surface, g/m <sup>2</sup>	Fabricant
№1R	Coton, tissu à armure toile/ Polyuréthane microporeux	300	Bélarus
№2Z	Coton, tissu à armure toile/ Polyuréthane microporeux	260	Bélarus
№3Ch	Coton, tissage sergé/ Polyuréthane microporeux	390	Bélarus
№4Ch	Coton, tissu à armure toile/ polyuréthane	430	Chine
№5B	Polyester, support tricoté/ Polyuréthane	265	Chine

Au cours des processus de fabrication, de transport, de lavage et de nettoyage, ainsi que directement au cours du fonctionnement, le matériau et les produits qui en sont constitués sont soumis à un impact complexe de facteurs externes, ce qui conduit au vieillissement du matériau, qui affecte négativement les propriétés physiques et mécaniques et conduit à une réduction de la durée de vie du produit [3]. On distingue les facteurs d'usure suivants : - mécanique (déformations répétées d'étirement, de flexion, d'abrasion); - physico-chimique (action de la lumière, de la température, de l'humidité, des produits chimiques); - biologique (destruction par les micro-organismes et les insectes); - complexe (action de l'abrasion, des intempéries légères, du lavage, du nettoyage à sec, de l'usure) [3].

L'analyse des sources bibliographiques a montré qu'une grande partie de l'usure mécanique est attribuée à l'abrasion, et une plus petite partie aux déformations répétées par traction et par flexion [3]. L'abrasion est due au frottement externe du matériau textile contre d'autres surfaces, qui s'accompagne d'un effritement progressif du revêtement polymère et, par conséquent, d'une perte de masse, d'une réduction de l'épaisseur et, enfin, d'une destruction du matériau. La résistance à l'abrasion a été réalisée sur l'appareil DIT-M. Les tissus enduits ont été testés à une vitesse de rotation de la tête de l'appareil de 100 tr/min. La charge de rupture et l'allongement de

rupture ont été déterminés conformément à la norme GOST ISO 1421 "Matériaux enduits de caoutchouc ou de plastique. Détermination de la charge de rupture et de l'allongement à la rupture". Pour évaluer l'adhérence des tissus enduits de polymère, GOST R 5978 "Tissus enduits de caoutchouc ou de plastique. Méthode de détermination de la résistance à l'adhésion". Pour étudier la perméabilité à l'air, nous nous sommes inspirés de la norme GOST 12088-77 "Matériaux textiles et produits textiles. Méthode de détermination de la perméabilité à l'air".

Pour mesurer l'épaisseur de la couche de polymère des échantillons étudiés, une microscopie transversale a été réalisée en lumière réfléchie à l'aide d'un microscope de recherche Altami MET 5T.

Pour étudier la perméabilité à la vapeur des matériaux, nous avons choisi la méthode gravimétrique mise en œuvre à l'aide de l'analyseur d'humidité Radwag M-50. Cette méthode est une variante de la méthode de Taylor et est basée sur la mesure de la perte d'humidité par évaporation d'un récipient hermétiquement fermé avec le matériau étudié. La température dans la chambre de l'appareil est contrôlée pendant toute la durée de l'expérience et est de 40 °C. La durée de l'essai est de 1 heure. Le coefficient de perméabilité à la vapeur est déterminé par la méthode de calcul comme le rapport de la masse de vapeur d'eau passant à travers l'échantillon de matériau à la surface de l'échantillon de matériau et à la durée de l'essai.

Lors de l'examen de la résistance à l'abrasion du revêtement polymère, le nombre de cycles que l'échantillon supporte avant la rupture visuelle de l'intégrité de la structure du polymère a été évalué. Les données obtenues sur la résistance à l'abrasion sont présentées dans le tableau 2.

Tableau 2 – Échantillons après l'essai d'abrasion

				
Nombre de cycles: 327	Nombre de cycles: 498	Nombre de cycles: 128	Nombre de cycles: 78	Nombre de cycles: 45
№1R	№2Z	№3Ch	№4Ch	№5B

D'après les données obtenues (tableau 2, échantillons № 1 à 3), l'hypothèse selon laquelle le nombre de cycles que l'échantillon peut supporter pendant l'abrasion augmente de manière significative avec l'épaisseur du revêtement polymère. En comparant les échantillons d'éco-cuir avec des valeurs similaires d'épaisseur de revêtement polymère (échantillons № 1 et № 4, échantillons № 3 et № 5), nous pouvons conclure que le plus grand nombre de cycles est supporté par les échantillons № 1 et № 3, qui possèdent un revêtement polyuréthane microporeux. L'échantillon № 2 de production biélorusse est le plus résistant à l'abrasion, avec une épaisseur de revêtement en polyuréthane microporeux de 700-720 microns.

Selon les résultats de l'étude de l'adhérence des échantillons, il a été établi : échantillons № 1,3,4 – 1 point ("pas d'adhérence" : les surfaces revêtues sont séparées

sans aucun signe d'adhérence), échantillons № 2,5 – 2 points ("légère adhérence": pendant la séparation, il y a une adhérence séparée des surfaces revêtues sans destruction de l'enrobage).

La figure 1 montre les courbes cinétiques du coefficient de perméabilité à la vapeur des éco-cuirs étudiés.

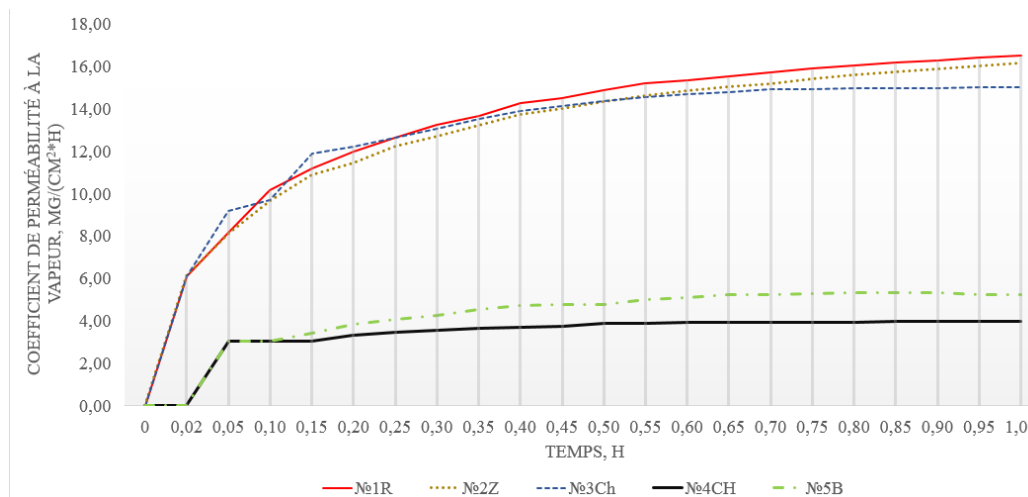


Figure – Courbes cinétiques du coefficient de perméabilité à la vapeur

Le tableau 3 montre les résultats de la mesure de la charge de rupture et de l'allongement de rupture des échantillons testés. Le tableau 4 présente les résultats des études menées sur les indicateurs d'hygiène.

Tableau 3 – Charge de rupture et allongement des échantillons à la rupture

Chiffre	Charge de rupture, N		Allongement à la rupture, mm	
	chaîne	trame	chaîne	trame
№1R	661,5	357,7	21	31
№2Z	568,4	441	24	36
№3Ch	772,2	254,8	27	32
№4Ch	548,8	436,1	37	38,5
№5B	754,6	642	65	125

Tableau 4 – Résultats des mesures

Chiffre	№1R	№2Z	№3Ch	№4Ch	№5B
Épaisseur du revêtement, $\mu\text{m}$	395-410	700-720	90-105	405-415	190-205
Perméabilité à l'air, $\text{dm}^3/(\text{m}^2 \cdot \text{s})$	62,4	39,4	32,4	6	0
Perméabilité à la vapeur, $\text{mg}/(\text{cm}^2 \cdot \text{h})$	16,50	15,02	16	3,97	5,25



Les produits textiles enduits acquièrent les propriétés des matériaux à partir desquels ils sont fabriqués. La résistance d'un tissu enduit est principalement fonction de la caractéristique force-extension des fils individuels. Bien que les fils de chaîne et de trame aient la même densité, les caractéristiques du tissu sont différentes dans les deux directions mutuellement perpendiculaires. Cela est dû au degré de déformation différent des fils de chaîne et de trame dans le système de tissage du tissu, en raison de leur tension inégale à la fois dans le processus de tissage et dans le processus d'enduction. Ainsi, le tissu traité se caractérise par des allongements différents dans le sens de la chaîne et de la trame. Les mêmes raisons technologiques sont également à l'origine de l'anisotropie de la résistance du tissu : les fils de trame subissent des forces transversales plus importantes en tension, ce qui réduit légèrement leur résistance effective par rapport aux fils de chaîne. L'échantillon № 5 présente l'allongement à la rupture le plus élevé en raison de l'utilisation d'un tissu tricoté comme matériau de chaîne. Les échantillons 2 et 3, dont la structure est constituée d'un tissu, ont un allongement relatif plus faible, mais la limitation du mouvement des fibres par le type de tissage augmente la charge de rupture du matériau.

L'analyse des graphiques obtenus (Figure) permet de conclure qu'avec l'augmentation de l'épaisseur du revêtement polymère et de la densité du tissu, on observe une diminution de la perméabilité à la vapeur de l'ensemble du matériau. Pour les échantillons №1R, №2Z, №3Ch, la première période du test (20 minutes) se caractérise par une augmentation du coefficient de perméabilité à la vapeur, au cours de laquelle la structure poreuse du matériau se remplit intensément de vapeur d'eau. Dans la période suivante, l'augmentation du coefficient de perméabilité à la vapeur est moins dynamique et les différences entre les coefficients de perméabilité à la vapeur des différents échantillons sont moins prononcées. L'analyse des données (tableau 2) montre que les échantillons expérimentaux №1R, №2Z, №3Ch avec un revêtement en polyuréthane microporeux ont une meilleure perméabilité à la vapeur que les échantillons avec un film monolithique en polychlorure de vinyle ou en polyuréthane (imperméable).

Les valeurs de perméabilité à l'air les plus élevées sont inhérentes aux cuirs artificiels avec revêtement en polyuréthane microporeux produits au Belarus (échantillons №1R, №2Z, №3Ch). L'échantillon №4Ch présente des valeurs de perméabilité à l'air réduites (moins de  $10 \text{ dm}^3/(\text{m}^2\text{c})$ ), et les échantillons №5B – zéro. L'échantillon №1R présente la perméabilité à l'air la plus élevée, ce qui est dû au revêtement en polyuréthane microporeux utilisé comme couche de surface et au tissu à armure toile de la base. La perméabilité à l'air des échantillons №2Z et №3Ch est inférieure à celle de l'échantillon №1R, ce qui s'explique par l'utilisation d'un tissu plus dense comme matériau de base que celui de l'échantillon №1R à armure sergée.

Les valeurs de perméabilité inférieures des échantillons sont dues à la structure du revêtement de surface qui, dans la plupart des cas, ne possède pas de porosité. Selon les résultats obtenus, les échantillons №4Ch, №5B peuvent être recommandés comme matériaux pour l'ameublement, car les indicateurs d'hygiène sont inacceptables pour les matériaux destinés à l'habillement. Les échantillons №1R, №2Z, №3Ch surpassent leurs analogues importés en termes d'indicateurs hygiéniques (perméabilité à la vapeur, perméabilité à l'air), ce qui leur confère un avantage par

rapport à d'autres types de cuirs artificiels lorsqu'ils sont utilisés comme matériaux pour l'habillement.

### **Références:**

1. Maruschak, Yu. I., Yasinskaya, N. N., Petyul, I. A. Development of nomenclature of quality indicators and assessment of the properties of eco-leather // *Izvestiya vysshee obrazovaniya vysshee obrazovaniya*. TTP. № 2 (404), pp. 103-111. (en russe).
2. Pavutnitsky, V. V. Développement de la théorie et de la pratique de l'obtention et de l'application de mousses à faible épaisseur dans les processus technologiques de la production textile. Résumé de la thèse de doctorat en sciences techniques sur la spécialité 05.19.02 "Technologie et traitement primaire des matériaux textiles et des matières premières", Saint-Pétersbourg, 2004, 44 p. (en russe). – URL: <https://www.dissercat.com/content/razvitie-teorii-i-praktiki-polucheniya-i-primeneniya-nizkokratnykh-pen-v-tekhnologicheskikh-read>.
3. Zulkharnaeva, K. A., Zhilisbaeva, R. O. Research of resistance of different types of leather to abrasion / *Bulletin of ATU*. № 4 (100), 2013, pp. 22-26. (en russe). – URL: <https://sciup.org/140204676>.

### **References:**

1. Marushchak, Yu. I. Yasinskaya, N. N., Petyul, I. A. *Razrabotka nomenklatury pokazatelej kachestva i ocenka svojstv ekokozh* [Development of a nomenclature of quality indicators and assessment of the properties of eco-leathers] // *News of Higher Educational Institutions*. TTP. No 2 (404), pp. 103-111. (in Russian).
2. Pavutnitsky, V. V. *Razvitie teorii i praktiki polucheniya i primeneniya nizkokratnykh pen v tekhnologicheskikh processah tekstil'nogo proizvodstva* [Development of the theory and practice of obtaining and using low-expansion foams in technological processes of textile production]. Abstract of a dissertation for the degree of Doctor of Technical Sciences in specialty 05.19.02 "Technology and primary processing of textile materials and raw materials", St. Petersburg, 2004, 44 p. (in Russian). URL: <https://www.dissercat.com> (date accessed: 12.02.2024).
3. Zulharnaeva, K. A. , Zhilisbaeva, R. O. *Issledovanie stojkosti razlichnykh vidov kozhi k istiraniyu* [Study of the resistance of various types of leather to abrasion] / *Bulletin of ATU* No 4 (100), 2013, pp. 22-26. (in Russian). URL: <https://sciup.org/140204676> (date accessed: 15.02.2024).

### **Список литературы:**

1. Марущак, Ю. И. Разработка номенклатуры показателей качества и оценка свойств экокож / Ю. И. Марущак, Н. Н. Ясинская, И. А. Петюль. – Текст: непосредственный // *Известия высших учебных заведений*. ТТП. – № 2 (404). – С. 103-111.
2. Павутницкий, В. В. Развитие теории и практики получения и применения низкократных пен в технологических процессах текстильного производства: специальность 05.19.02 «Технология и первичная обработка текстильных материалов и сырья»: автореферат дис. доктора технических наук / Вячеслав Васильевич Павутницкий; С.-Петербург. гос. ун-т технологии и дизайна. – Санкт-Петербург, 2004. – 44 с. – URL: <https://www.dissercat.com> (дата обращения: 12.02.2024). – Текст: электронный.
3. Зулхарнаева, К. А. Исследование стойкости различных видов кожи к истиранию / К. А. Зулхарнаева, Р. О. Жилисбаева. – Текст: электронный // *Вестник АТУ*. – № 4 (100), 2013. – С. 22-26. – URL: <https://sciup.org/140204676> (дата обращения: 15.02.2024).

*Lapaev Filipp Valer'evich,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
filipp.lapaev@inproec.com*  
*Makhotina Lyudmila Gertsevna,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
lusi\_makhotina@mail.ru*

## **PERSPECTIVE OF THE SECONDARY FIBER BLEACHING PROCESS FROM WASTE PAPER OF GRADE MS-5B**

**Abstract.** In this paper, the most perspective methods of bleaching secondary fiber from waste paper grade MS-5B were studied in order to use it in production of a liner with a white cover layer.

**Keywords:** secondary fiber, waste paper, bleaching, old corrugated cardboard, hydrogen peroxide, dithionite sodium.

*Лапаев Филипп Валерьевич,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
filipp.lapaev@inproec.com*  
*Махотина Людмила Герцевна,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
lusi\_makhotina@mail.ru*

## **ПЕРСПЕКТИВА ПРОЦЕССА ОТБЕЛКИ ВТОРИЧНОГО ВОЛОКНА ИЗ МАКУЛАТУРЫ МАРКИ МС-5Б**

**Аннотация.** В данной работе изучены наиболее перспективные способы отбеливания вторичного волокна из макулатуры марки МС-5Б с целью дальнейшего использования его при производстве лайнера с белым покровным слоем.

**Ключевые слова:** вторичное волокно, макулатурная масса, отбеливание, МС-5Б, перекись водорода, дитионит натрия.

Recycled raw material – waste paper is a used product or printed product made from paper and cardboard and waste from their production and processing [1].

The main reason of the increase in the use of waste paper is environmental policy. Its goal is to preserve natural resources, reduce the amount of solid waste and utilization of cardboard and paper waste.

According to "GOST 10700-97 Paper and cardboard waste paper", waste paper grade MS-5B is a waste of production and usage of corrugated cardboard and paper (without black and white and color printing) [2]. Corrugated cardboard consists of flat layers (liner) and corrugated paper (fluting) (Figure) [3].

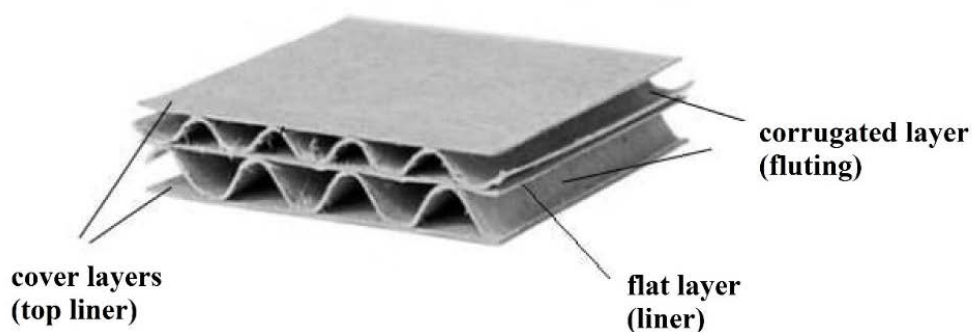


Figure – Corrugated cardboard

Cardboard for flat layers usually is multilayer and divided into kraft liner and test liner.

Kraft liner consists of virgin fibers – sulfate unbleached pulp, semi-chemical pulp, wood (mechanical) pulp. A test liner is a cardboard which composition includes secondary fibers. In the production of the test liner, secondary fiber obtained mainly from used cardboard containers.

Kraft liner can be produced with a white cover layer, named white top liner and with a coated cover layer white top liner. Bleached softwood or hardwood pulp or their mixture is used as a semi-finished product for the cover layer.

The liner should be with high rigidity and high printing properties. It usually consists of several layers connected to each other on a board machine. The top layer has increased strength, smoothness and porosity, provides the necessary properties for the package production [4].

Fluting is a layer of corrugated cardboard that protects against damage and softens shocks, so fluting paper must be stiff and elastic, as well as elastic to form a wavy shape [5]. Unlike a liner, fluting is usually made in a single layer.

Depending on the used raw materials, corrugation paper is divided into two types – semichemical and waste paper (recycled). In both cases, virgin fibers, mainly softwood sulphate fibers, may be added to the composition.

Since waste paper grade MS-5B mainly consists of old corrugated cardboard made from unbleached semi-finished products, a yellow-brown tint is given to the secondary fiber by chromophoric groups that are formed as a result of the oxidation

of phenolic hydroxyl groups of lignin to quinone during the production of these fibrous semi-finished products.

The purpose of this paper is to determine the most perspective methods of bleaching secondary fiber from waste paper grade MS-5B for usage it in the production of a white top liner instead of bleached sulfate pulp, which is currently used.

In pulp bleaching, the main goal is to complete the delignification process started during cooking by using chemicals that completely destroy the residual lignin, increase whiteness and give the fiber certain physicochemical properties. Currently, Russia mainly uses Elemental Chlorine Free (ECF) bleaching by chlorine dioxide, which prevents the formation of dioxin-like compounds.

When bleaching mechanical pulp, the main goal is to remove only chromophores – groups that cause color. Modern mechanical pulp bleaching systems make it possible to obtain a semi-finished product with a whiteness of ISO 80...82% from softwood and 85...87 % from hardwood [6].

Higher brightness and stability can be achieved with lignin removal, but hemicellulose losses will also occur, which will affect the strength of the raw material.

Our analysis of the literature made it possible to determine the most perspective method for bleaching secondary fiber from waste paper grade MS-5B. This is lignin-preserving bleaching by decolorizing chromophore groups. This type of bleaching is less energy consuming, since delignification is not required.

The main advantage of decolorizing bleaching: it refers to the Total Chlorine Free (TCF) process, which completely eliminates the use of chlorine-containing bleaching reagents, which has a positive effect on the environment. The yield reaches 95-100%, since the removal of lignin and hemicelluloses does not occur, and due to the preservation of hemicelluloses, there is less effect on the decrease in the physical and mechanical properties of the fiber.

Hydrogen peroxide and dithionite natrium are the most common bleaching agents for decolorizing secondary fibers.

Hydrogen peroxide is an oxidizing reagent. It used together with auxiliary reagents – NaOH, Na<sub>2</sub>SiO<sub>3</sub>, MgSO<sub>4</sub> and DPTA or EDTA complexing agents, which serve to increase the efficiency of the bleaching process.

The use of a reducing agent dithionite natrium, is characterized by a higher bleaching rate and lower reagent consumption in comparison with the use of hydrogen peroxide. The main difficulty in carrying out bleaching is the need for no air in the system, since dithionite natrium degrade in the presence of air in a relatively short time [7].

The disadvantage of the decolorizing process, in comparison with delignification, is unstable brightness, because of some types of chromophores after bleaching with reagents can again be oxidized and restore their color, which leads to yellowing after some time. But for the final product, a white top liner, considered in this paper, stable brightness for a long time is not needed.

After analyzing the literature, we can note the sufficient perspective for using waste paper grade MS-5B to production bleached fiber:

- 1) waste paper without printing ink, which eliminates the process of deinking (flotation);
- 2) bleaching can be carried out in the absence of chlorine by decolorizing the chromophore groups of lignin;
- 3) the purpose of further work is to determine the optimal technological parameters of the bleaching process and which high strength parameters of bleached secondary fiber are maintained.

### References:

1. Puzyrev, S. S. *Pererabotka makulatury* [Waste paper processing] / Puzyrev, S. S., Kovaleva, O. P., Tsvetkova G. N.; Saint Petersburg State Forest Technical University. Saint Petersburg : SPbSFTU, 2003, 44 p. (in Russian).
2. GOST 10700-97. *Makulatura bumazhnaya i kartonnaya, Tehnicheskiye usloviya* [Waste paper and board, Specifications]. – Minsk : IPK Standards publisher, 2003. – III, 7 p. (in Russian).
3. Smolin, A. S., Komarov, V. I., Duboviy, V. K., Beloglazov, V. I. *Tehnologiya gofrokartona* [Corrugated cardboard process]. In 3 parts. Part 2 / A. S. Smolin, V. I. Komarov, V. K. Duboviy, V. I. Beloglazov ; Saint Petersburg : SPbSTURP, 2014, 98 p. (in Russian).
4. GOST R 53207-2008. *Karton dlya ploskih sloev gofrirovannogo kartona, Tehnicheskiye usloviya* [Paper for corrugated cardboard flat layers. Specifications]. Moscow: Standartinform, 2009, III, 16 p. (in Russian).
5. GOST R 53206-2008. *Bumaga dlya gofrirovaniya, Tehnicheskiye usloviya* [Paper for corrugating. Specifications]. Moscow: Standartinform, 2009, III, 7 p. (in Russian).
6. *Tehnologiya cellyulozno-bumazhnogo proizvodstva* [Pulp and paper processing] : in 3 volumes. V. 1, Part 3. Raw materials and semi-finished production / Puzyrev, S. S., Vorilaynen, E. V., Polyakov, Y. A., Kryazhev, A. M. Saint Petersburg : Politahnika, 2004, 316 p. (in Russian).
7. Vanchakov, M. V. *Tehnologiya i oborudovaniye pererabotki makulatury* [Technology and equipment of waste paper processing]. In 3 parts. Part 3 / Vanchakov, M. V., Kuleshov, A. V., Aleksandrov, A. V., Gauze, A. A. Saint Petersburg : HSTE SPbSUITD, 2019, 145 p. (in Russian).

### Список литературы:

1. Пузырев, С. С. Переработка макулатуры : учебное пособие / С. С. Пузырев, О. П. Ковалева, Г. Н. Цветкова ; Министерство образования Российской Федерации, Санкт-Петербургская государственная лесотехническая академия. – Санкт-Петербург : СПбГЛТА, 2003. – 44 с. – Текст : непосредственный.
2. ГОСТ 10700-97. Макулатура бумажная и картонная. Технические условия = Waste paper and board. Specifications : межгосударственный стандарт : издание официальное : принят Межгосударственным Советом по стандартизации, метрологии и сертификации (протокол № 11 от 23 апреля 1997 г.) : Постановлением Государственного комитета Российской Федерации по стандартизации и метрологии от 23 августа 2002 г. № 311-ст межгосударственный стандарт ГОСТ 10700-97 введен в действие

непосредственно в качестве государственного стандарта Российской Федерации : дата введения 2003-01-01 / разработан Украинским государственным научно-исследовательским институтом целлюлозно-бумажной промышленности (УкрНИИБ). – Минск : ИПК Издательство стандартов, 2003. – III. – 7 с. – Текст : непосредственный.

3. Смолин, А. С. Технология гофрокартона. Учебное пособие. В 3 частях. Часть 2 / Смолин А. С., Комаров В. И., Дубовый В. К., Белоглазов В. И. – Санкт-Петербург : СПбГТУРП, 2014. – 98 с. – Текст : непосредственный.

4. ГОСТ Р 53207-2008. Картон для плоских слоев гофрированного картона. Технические условия : национальный стандарт Российской Федерации : издание официальное : утвержден и введен в действие Приказом Федерального агентства по техническому регулированию и метрологии от 25 декабря 2008 г. № 695-ст : введен впервые : дата введения 2009-01-01 / разработан Открытым акционерным обществом «Центральный научно-исследовательский институт бумаги» (ОАО «ЦНИИБ»). – Москва: Стандартинформ, 2009. – III – 16 с. – Текст : непосредственный.

5. ГОСТ Р 53206-2008. Бумага для гофрирования. Технические условия : национальный стандарт Российской Федерации : издание официальное : утвержден и введен в действие Приказом Федерального агентства по техническому регулированию и метрологии от 25 декабря 2008 г. № 694-ст : введен впервые : дата введения 2009-01-01 / разработан Открытым акционерным обществом «Центральный научно-исследовательский институт бумаги» (ОАО «ЦНИИБ»). – Москва : Стандартинформ, 2009. – III – 7 с. – Текст : непосредственный.

6. Технология целлюлозно-бумажного производства : справочные материалы. В 3 томах. Т. 1, часть 3 : Сырье и производство полуфабрикатов / С. С. Пузырев, Э. В. Виролайнен, Ю. А. Поляков, А. М. Кряжев ; Всероссийский научно-исследовательский институт целлюлозно-бумажной промышленности (ВНИИБ). – Санкт-Петербург : Политехника, 2004. – 316 с. – Текст : непосредственный.

7. Ванчаков, М. В. Технология и оборудование переработки макулатуры : учебное пособие. В 3 частях. Часть 3 / Ванчаков, М. В., Кулешов, А. В., Александров, А. В., Гаузе, А. А.; Министерство науки и высшего образования Российской Федерации, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики. – Санкт-Петербург : Высшая школа технологии и энергетики СПбГУПТД, 2019. – 145 с. – Текст : непосредственный.

*Ruzanova Ekaterina Aleksandrovna,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
ruzanova15@mail.ru*

## ENERGY SAVING OF RESIDENTIAL BUILDINGS

**Abstract.** The article deals with energy saving of residential buildings, the main directions of energy saving are considered.

**Keywords:** energy saving, energy passport, dew point.

*Рузанова Екатерина Александровна,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
ruzanova15@mail.ru*

## ЭНЕРГОСБЕРЕЖЕНИЕ ЖИЛЫХ ЗДАНИЙ

**Аннотация.** В статье рассматривается энергосбережение жилых зданий, представлены основные направления энергосбережения.

**Ключевые слова:** энергосбережение, энергетический паспорт, точка росы.

In the Russian Federation, the issue of energy conservation is acute. This is one of the main directions of the country's economy. Tariffs for thermal energy, which the consumer uses for heating and hot water supply, are increased annually. But at present there is a serious deterioration of residential and public buildings, heating networks, and there is also no desire to solve energy saving issues among housing companies and consumers. These factors complicate the development of energy saving in Russia.

Energy surveys are conducted to develop measures to improve energy efficiency. There are many scientific papers devoted to the problems of energy conservation. Some of them are aimed at improving sources for the production of thermal energy, others at minimizing losses during transportation, as well as reducing consumer losses [1].

The main areas of energy saving include [2]:

- Conducting energy surveys of organizations;
- Implementation of energy accounting systems in industrial enterprises, residential and public buildings;



- Conducting energy surveys of residential buildings with assigning them an energy efficiency class based on the survey;
- Solving issues of thermal protection of buildings;
- Modernization of the heat supply system;
- Development of small and unconventional energy.

Energy saving in an apartment building begins with an energy survey. It allows you to find out accurate data on the amount of resources consumed, determine the potential for energy saving and increasing energy efficiency. Having received such information, it is possible to develop energy-saving measures that are recorded in the energy passport of the house.

The energy passport of residential and public buildings is intended to confirm the compliance of energy efficiency indicators and thermal engineering indicators of the building with the indicators established in regulatory documents.

The energy passport should be developed for reconstructed and erected buildings. Energy saving classes are "A", "B", "C", "D", "E", and for buildings under construction, the energy saving class cannot be lower than "C", and for buildings built before 2000, classes "D", "E" are set for the purpose of prioritizing the development of measures for reconstruction.

The walls of the house can be insulated both from the inside and from the outside (Figure). However, external insulation is used more often than internal.

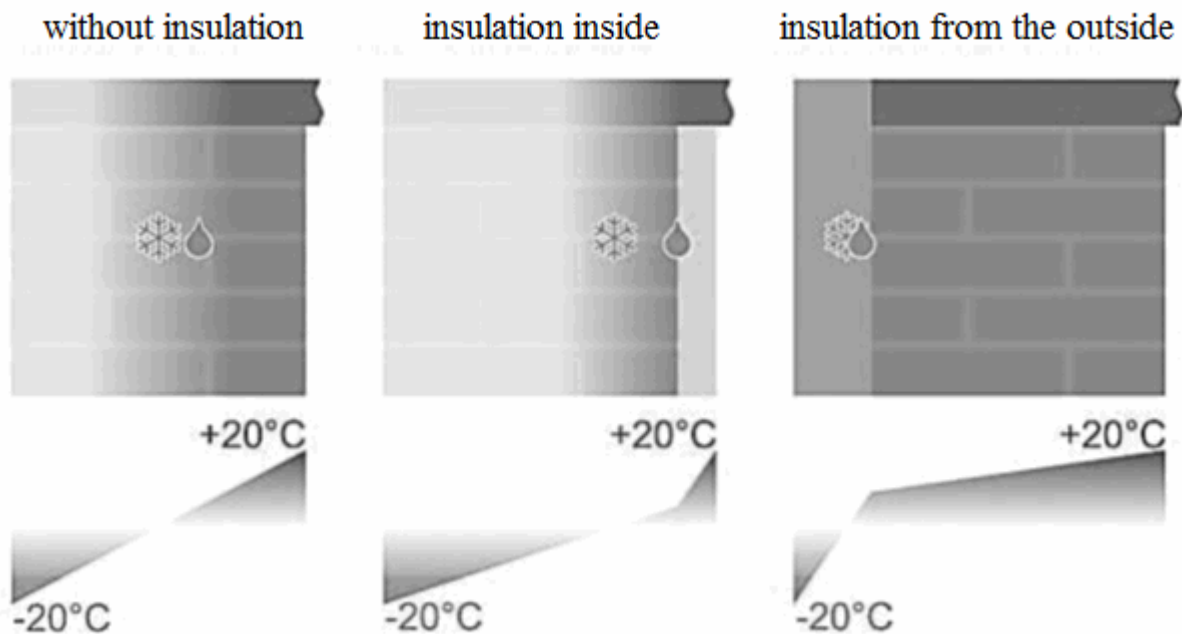


Figure – Dew point for a wall without insulation, with internal insulation, with external insulation

The dew point is the temperature at which condensation falls (moisture from the air turns into water). The point with this temperature is located in a certain place (on the wall outside, somewhere in the thickness of the wall or on the wall inside) [3].

Compared with internal insulation, external insulation has more advantages and fewer disadvantages. Consider them.

The advantages include the following:

- A layer of insulation and decorative finishes protect the walls of the house, which means it prolongs the service life;
- Preservation of the useful volume of the building;
- A larger selection of insulation materials and design solutions;
- With external wall insulation, when the insulation completely covers the outer surface of concrete elements, the problem of the formation of "cold bridges" is solved.

The disadvantages include the fact that the work can be done with the help of either industrial mountaineering or with the installation of scaffolding.

European countries have been actively developing in the field of energy efficiency for a long time. Houses are designed that not only do not consume energy, but also generate it themselves, as well as buildings that accumulate solar energy during the day and give it to the house at night, due to a special coating applied to the walls. Structures are being built with effective insulation, located depending on the cardinal directions. These buildings not only have low energy consumption, but also use solar energy for heating. All these measures can reduce the volume of energy purchases. Therefore, in order for Russia to remain a competitive country, it is necessary to adopt the experience of abroad.

### **References:**

1. Komkov, V. A., Timakhova, N. S. *Jenergoberezhenie v zhilishhno-kommunal'nom hozjajstve* [Energy saving in housing and communal services]. 2nd ed. Moscow: INFRA-M, 2014, 204 p. (in Russian).
2. Akimova, E. V. *Strategija snizhenija zatrat* [Cost reduction strategy] // Planning and Economic Department, 2018, № 2. (in Russian).
3. *Obshhie cherty bol'shoj raboty – iz chego sostoit tehnologija po utepleniju fasada* [Common features of a lot of work – what is the technology for facade insulation]. URL: <https://x-teplo.ru/uteplenie/fasady/texnologiya-utepleniya-fasada.html> (accessed 10 April 2024). (in Russian).

### **Список литературы:**

1. Комков, В. А. Энергосбережение в жилищно-коммунальном хозяйстве / В. А. Комков, Н. С. Тимахова. – 2-е изд. – М. : ИНФРА-М, 2014. – 204 с. – Текст : непосредственный.
2. Акимова, Е. В. Стратегия снижения затрат / Е. В. Акимова. – Текст : непосредственный // Планово-экономический отдел. – 2018. – № 2. – С. 42-57.
3. Общие черты большой работы – из чего состоит технология по утеплению фасада. – URL: <https://x-teplo.ru/uteplenie/fasady/texnologiya-utepleniya-fasada.html> (дата обращения: 10.04.2024). – Текст : электронный.

*Ruzanova Ekaterina Aleksandrovna,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
ruzanova15@mail.ru*

## ALTERNATIVE ENERGY SOURCES

**Abstract.** The article considers the types of alternative energy sources, and their comparative analysis is carried out.

**Keywords:** alternative energy sources, power plants, comparative analysis.

*Рузанова Екатерина Александровна,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
ruzanova15@mail.ru*

## АЛЬТЕРНАТИВНЫЕ ИСТОЧНИКИ ЭНЕРГИИ

**Аннотация.** В статье рассмотрены виды альтернативных источников энергии, проведен их сравнительный анализ.

**Ключевые слова:** альтернативные источники энергии, электростанции, сравнительный анализ.

Every year in Russia, an increasing number of people are wondering about the organization of autonomous energy supply to their homes based on alternative energy sources. These sources are represented by wind farms, solar power plants, micro hydroelectric power plants and installations powered by local fuels of various types.

For optimal selection of the type of autonomous source, it is necessary to make a comparative analysis of the devices, their technical characteristics and operating conditions.

As a rule, the following types of alternative energy sources recommended for autonomous power supply are compared with each other:

- solar power plants powered by solar cells and systems that convert solar energy into thermal and then into electrical energy using Stirling engines;
- wind farms with vertical and horizontal axes of rotation.

Let's consider the principles of operation of various power plants operating on the basis of non-traditional energy sources. The most common are solar power plants. Solar photovoltaic panels generate electricity using silicon cells due to exposure to solar radiation. Solar collectors heat the coolant by absorbing solar radiation and are able to generate both thermal and electrical energy by installing a Stirling engine. The

efficiency of such installations can reach 25 %, and the service life is 20 years, while the efficiency of photovoltaic power plants account for 15 % [1], and the service life is 15 years with the same occupied areas [2]. However, both of these systems depend on the weather and occupy large areas.

Wind farms with horizontal and vertical axes of rotation have the same principle of operation: they generate electricity when exposed to wind on the blades connected to the generator shaft. The difference is that a wind turbine with a vertical axis of rotation is capable of operating at a wind speed of 0.5 m/s, while a wind turbine with a horizontal axis of rotation is capable of operating at 1-1.2 m/s. The service life of each type of power plant is 20 years [3].

Power plants using local fuels are represented by solid fuel and gas power plants. They are capable of generating both thermal and electrical energy, so their efficiency is about 80 %. But the principles of their work are different. Solid fuel boilers are capable of operating on any local solid fuel, which is burned in a special way in the combustion chamber with the release of pyrolysis gas. It is used to operate a gas generator that generates electricity. The heat after burning wood in the boiler is removed and used for heating and hot water supply. Such installations they are quite compact and capable of burning on a single stack of firewood for up to 12 hours [4].

Biogas power plants use biogas, which is obtained from the fermentation of organic waste in special tanks, to operate a gas generator. It generates electrical energy, and thermal energy during the cooling of the generator. Such installations occupy a large area and require a large amount of household waste to generate biogas. The service life of these installations is 30 and 40 years, respectively.

During the comparative analysis, various types of autonomous power plants operating on different principles and from different primary energy sources were considered. The most promising ones include: a solid-fuel power plant using local fuel, a derivational micro A hydroelectric power station, a wind farm with a vertical axis of rotation and a collector solar power plant. These power plants are the most efficient in each of their groups, however, when choosing them for autonomous power supply, it is necessary to take into account the specifics of the area in order to obtain the most optimal result.

### **References:**

1. *Shema ustrojstva solnechnoj batarei i princip raboty* [Renewable energy sources]: URL: <http://www.agencynau.tj/energo/solnechnaya.html> (accessed 7 April 2024). (in Russian).
2. *Shema ustrojstva solnechnoj batarei i princip raboty* [The scheme of the solar battery device and the principle of operation]. URL: <http://termoframe.ru/sxemaustrojstva-solnechnoj-batarei-i-princip-raboty.html> (accessed 7 April 2024). (in Russian).
3. Khavronichev, S. V., Soshinov, A. G., Galushchak, V. S. *Netradicionnye vozobnovljaemye istochniki jenerгии* [Non-traditional renewable energy sources]. Volgograd : VolgSTU, 2015, 91 p. (in Russian).

4. *Pechi i sistemy otoplenija* [Furnaces and heating systems]. URL: <http://stroyday.ru/stroitelstvo-doma/pechi-i-sistemyotopleniya/kotel-na-otoplenie-svoimi-rukami.html> (accessed 7 April 2024). (in Russian).

#### **Список литературы:**

1. Возобновляемые источники энергии. – URL: <http://www.agencynau.tj/energo/solnechnaya.html> (дата обращения: 07.04.2024). – Текст : электронный.
2. Схема устройства солнечной батареи и принцип работы. – URL: <http://termoframe.ru/skhemaustrojstva-solnechnoj-batarei-i-princip-raboty.html> (дата обращения: 07.04.2024). – Текст : электронный.
3. Хавроничев, С. В. Нетрадиционные возобновляемые источники энергии / С. В. Хавроничев, А. Г. Сошинов, В. С. Галуцк. – Волгоград : ВолгГТУ, 2015. – 91 с. – Текст : непосредственный.
4. Печи и системы отопления. – URL: <http://stroyday.ru/stroitelstvo-doma/pechi-i-sistemyotopleniya/kotel-na-otoplenie-svoimi-rukami.html> (дата обращения: 07.04.2024). – Текст : электронный.

*Mel'nichuk Mariya Sergeevna,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
mariya.melnichuk@inproec.com*  
*Dubovyi Vladimir Klimentevich,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
dubovy2004@mail.ru*

## DISSOLVING PULP. OBTAINING AND APPLICATION

**Abstract.** This paper analyzes literature sources related to the production of dissolving pulp, as well as investigates the prerequisites and possibilities of creating the production of dissolving pulp in Russia.

**Keywords:** Dissolving pulp, alpha-cellulose, viscosity, viscose fiber, cellulose acetates, cellulose ethers.

*Мельничук Мария Сергеевна,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
mariya.melnichuk@inproec.com*  
*Дубовый Владимир Климентьевич,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
dubovy2004@mail.ru*

## ЦЕЛЛЮЛОЗА ДЛЯ ХИМИЧЕСКОЙ ПЕРЕРАБОТКИ. ПОЛУЧЕНИЕ И ПРИМЕНЕНИЕ

**Аннотация.** В данной работе анализируются литературные источники, касающиеся производства целлюлозы для химической переработки, а также исследуются предпосылки и возможности создания в России производства целлюлозы для химической переработки.

**Ключевые слова:** целлюлоза для химической переработки, альфа-целлюлоза, вязкость, вискозное волокно, ацетаты и эфиры целлюлозы.

Dissolving pulp is a bleached pulp characterized by a high degree of chemical purity, containing more than 90 % alpha-cellulose.

The main characteristics of dissolving pulp are presented in Table.

Table – The main characteristics of dissolving pulp

Characteristic	Unit	Value
Whiteness ISO	%	88-92
Viscosity	ml/g	400-600
Alpha-cellulose content	%	93-95
Ash content	%	<0,1

The most common products which are obtained in the production of dissolving pulp are:

- Viscose fiber – used in the production of textiles and non-woven special materials for industrial purposes (health care, automotive industry, etc.).
- Microcrystalline cellulose – used in the pharmaceutical industry as a binder, and in the food industry as a thickener and in the paint and varnish industry.
- Cellulose acetates – used in the textile industry, in the production of high quality plastics and in the chemical industry (varnishes, paints, etc.).
- Cellulose ethers – consumed in the food, pharmaceutical and chemical industries.

Dissolving pulp is mainly used for the production of viscose fiber, which is used in the textile industry.

In addition to the degree of purity, a significant quality criterion of pulp for viscose fiber production is its viscosity, which should be in the range of 400-600 ml/g (and reduced to 200-250 ml/g during the viscose production process). Too low viscosity value may cause the viscose solution to gel swell, which can make filtration difficult, and can also adversely affect the physical strength of the resulting cellulose fiber, while too high viscosity value will cause inhomogeneity of the cellulose during processing.

The main factors that influence the physical and mechanical properties of dissolving pulp are fiber length and shape, fiber roughness, and fiber length distribution. The type of fiber, as well as the processing methods used to produce dissolving pulp, are determinants of the final type of product.

Generally, the quality of the final products from dissolving pulp depends on the raw material used (hardwood or softwood). Since the lignin content of softwood is higher compared to hardwood, the residual lignin content of softwood pulp after cooking is higher and the brightness is lower [1]. However, hardwoods are characterized by a higher content of hemicellulose, which need to be removed in the production of pulp for chemical processing by pre-hydrolysis [2].

Depending on the intended purpose of dissolving pulp, the method of pulp production is chosen. There are two main methods of dissolving pulp production:

1. Sulphite cooking.

The production process of dissolving pulp by sulfite cooking is similar to that of pulp production for papermaking. Sulfite dissolving pulp has higher reactivity and a higher and more uniform degree of polymerization than kraft pulp has. Low-resin woods (spruce, fir) are the preferred raw materials for the sulfite cooking process.

## 2. Kraft cooking with pre-hydrolysis (steam or water).

The difference from sulphite cooking is the depolymerization and dissolution of hemicellulose, which takes place in the hydrolysis before the cooking stage. By adjusting the intensity of the hydrolysis process, the residual hemicellulose content can be reduced to a low level. The process results in a mass containing 96 % of alpha cellulose.

Aqueous pre-hydrolysis is more commonly used. The role of a catalyst accelerating the hydrolysis of hemicellulose is played by organic acids, mainly acetic and formic acids, formed during aqueous cooking due to the cleavage of acetyl and formal groups from glycans.

Steam pre-hydrolysis is a variation of aqueous pre-hydrolysis. It eliminates the need to withdraw the hydrolysate and dispose of the sugars which have passed into solution. The wet steaming method produces pulp with a slightly lower alpha-cellulose content and a higher amount of pentosans compared to the water pulping method. In addition, due to the absence of liquid circulation at the pre-hydrolysis stage, the inhomogeneity of pulp over the digester volume increases [3].

The main advantage of the kraft method of cooking is the possibility of using any kind of wood as raw material.

Literature analysis has shown that the production of dissolving pulp is a very important industry in the modern world.

Large-scale production of dissolving pulp in Russia has stopped with the closure of Baikalsk Pulp and Paper Mill in 2013.

The Russian market of dissolving pulp products is mainly covered by imports from other countries. Availability of raw material base, absence of major players in the product market, need for import substitution, high export potential and annual growth in demand create favorable conditions for the production of dissolving pulp in Russia. In the current state of the Russian pulp and paper industry it may be interesting to carry out the stage of enrichment to accelerate the process of obtaining of dissolving pulp, using as feedstock technical hardwood pulp from enterprises in Russia (market pulp).

## References:

1. Terentyeva, E. P. *Himija drevesiny, celljulozy i sinteticheskikh polimerov* [Chemistry of wood, cellulose and synthetic polymers] / In 2 parts. Part 2 / E. P. Terentyeva, N. K. Udovenko, E. A. Pavlova – Saint Petersburg : SPbSTURP, 2015, 83 p. (in Russian).
2. Lipin, V. A. *Tehnologicheskie osobennosti proizvodstva rastvorimoy celljulozy iz listvennyh porod drevesiny* [Process Features of Dissolving Hardwood Pulp Production] / V. A. Lipin, E. D. Sofronova, A. P. Mihaylovskaya, S. F. Grebennikov, O. Y. Leyman. // Light Industry Technology, 2018, № 1, p. 112. (in Russian).



3. *Technologiya cellyulozno-bumazhnogo proizvodstva* [Pulp and paper processing] : in 3 volumes. V. 1, Part 2. Raw materials and semi-finished production. Semi-finished production / G. L. Akim, R. B. Belodubroskiy, A. V. Burov, E. I. Germer and other. Saint Petersburg : Politehnika, 2003, 633 p. (in Russian).

#### **Список литературы:**

1. Терентьева, Э. П. Химия древесины, целлюлозы и синтетических полимеров: учебное пособие. В 2 частях. Часть 2 / Э. П. Терентьева, Н. К. Удовенко, Е. А. Павлова. – Санкт-Петербург : СПбГТУРП, 2015. – 83 с. – Текст : непосредственный.
2. Липин, В. А. Технологические особенности производства растворимой целлюлозы из лиственных пород древесины / В. А. Липин, Е. Д. Софронова, А. П. Михайловская, С. Ф. Гребенников, О. Ю. Лейман. – Текст : непосредственный // Технология легкой промышленности. – 2018. – № 1. – С. 112.
3. Технология целлюлозно-бумажного производства. В 3 томах. Т. 1, часть 2: Сырье и производство полуфабрикатов. Производство полуфабрикатов / Г. Л. Аким, Р. Б. Белодубровский, А. В. Буров, Э. И. Гермер и др. ; – Санкт-Петербург : Политехника, 2003. – 633 с. – Текст : непосредственный.

УДК 332.13

*Rakipov Antony Sergeevich,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
physic26@yandex.ru*

**ON THE APPLICABILITY OF SPATIAL ECONOMICS METHODS  
TO THE PROBLEMS OF INTEGRATED DEVELOPMENT OF MINERAL  
RESOURCES OF THE ARCTIC ZONE OF RUSSIA**

**Abstract.** The article is devoted to the application of spatial economics methods in the organisation and planning of mining enterprises in the Arctic zone of Russia.

**Keywords:** regional development, spatial economy, mineral and raw materials complex.

*Ракипов Антоний Сергеевич,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
physic26@yandex.ru*

**О ПРИМЕНИМОСТИ МЕТОДОВ ПРОСТРАНСТВЕННОЙ  
ЭКОНОМИКИ К ПРОБЛЕМАМ КОМПЛЕКСНОГО ОСВОЕНИЯ  
МИНЕРАЛЬНО-СЫРЬЕВЫХ РЕСУРСОВ АРКТИЧЕСКОЙ ЗОНЫ  
РОССИИ**

**Аннотация.** Статья посвящена применению методов пространственной экономики в организации и планировании деятельности горнодобывающих предприятий в Арктической зоне России.

**Ключевые слова:** региональное развитие, пространственная экономика, минерально-сырьевой комплекс.

As of 2019, Russia ranks 17th in the world in terms of geological potential, while geological information is scattered, and the relevant agencies do not have time to reproduce reserves by discovering new deposits [1]. From the available information on the reserves of strategic raw materials in geological funds, we can conclude that it is unlikely that Russia's national interests will be secured without the integrated development of the Arctic zone (AZRF). The share of the AZRF in the structure of reserves by key minerals is shown in the table below.

Table – Main types of minerals of the Arctic zone of the Russian Federation the share of their reserves and production in the volume of reserves and production in the Russian Federation for 2021 [2].

<b>Group and type of mineral resource</b>	<b>% of Russian Federation reserves</b>	<b>% of Russian Federation production</b>
Oil	20,8	13,2
Combustible gases (free gas)	76,3	87,4
Condensate	58,0	71,4
Chrome ores	37,0	43,9
Titanium	30,3	100
Copper	41,1	46,2
Rare earth metals	71,4	100
Platinoids	78,6	96,1
Gold	12,6	7,4
Apatite ores	67,6	99,2
Diamonds	29,3	39,8

\*1 The composition of the land territories of the Arctic zone of the Russian Federation is determined by the Decree of the President of the Russian Federation dated 02.05.2014 N 296 (ed. 05.03.2020) "On the land territories of the Arctic zone of the Russian Federation" (as amended by the Decrees of the President of the Russian Federation dated 27.06.2017 N 287, dated 13.05.2019 N 220).

It has been said many times that the key to the development of the economy of hard-to-reach regions of the Russian Federation is the wealth of subsoil resources [3], [4]. At the same time, it is necessary to understand that in the real-world picture, to ensure economically efficient subsoil development, without which reserves remain only figures on paper, it is necessary to solve a number of fundamental issues, which include:

1. Transport and Logistics.
2. Climatic features.
3. Low population density and the consequent issue of replenishing human resource capacity.
4. Ecology and conservation of natural potential.
5. Geopolitics.

In accordance with the issues identified, researchers categorise the Arctic economy into three segments:

1. Generally accepted economy built on invariant principles and laws.
2. Non-commodity economy, economic activity of indigenous peoples, the basis of which is human interaction with nature to the extent of providing for their own needs.
3. Transfer economy – fulfilment of state functions with the provision of social services to the citizens of the country regardless of their place of residence.

All these activities and services generate a certain demand and form specific financial and economic flows and linkages in the Arctic economy [5].

The most important feature of the system of norms and rules (or "resource regime") adequate to the new conditions of Arctic natural resources development is the creation, development, and expansion of co-operative forms of interaction between participants in economic processes. The interaction of companies with different levels of competence and approaches to the development of natural objects allows not only to reduce individual risks, but also to ensure an effective exchange of experience and best practices. [6]

It is unlikely to build cooperation to effectively address the issues of strategic development of the Arctic regions without using the methods of spatial economics, i.e. without taking into account the mutual influence of factors belonging to different groups and segments of the economy, sociology, geography, etc., i.e. what is called "by naivety".

Examples of failed and postponed regional development projects, including those based on economic models with a lack of co-operation, include:

*Transpolar Railway* – a railway project from the shores of the Barents Sea to the coast of the Sea of Okhotsk and to Chukotka. The railway was not completed; the sections built were connected to the country's railway network via the Pechora railway. As of 1 January 1954, 870 km of the main line had been built at a total cost of 4 billion rubles [7].

In the modern history there have been several attempts to revive the project in the northern latitudinal passage since 2003 and, the possibility of the project will be confirmed only after taking into account the integration with the Northern Sea Route, which shows that it is impossible to realise such a large project without cooperation [8].

In the early 1990s, uncertainty reigned in Svalbard settlements, both Russian and Norwegian, due to dwindling coal reserves and poor market conditions. Norway restructured companies and partially privatised and demonopolised state-owned enterprises in the archipelago. In 1993, the Norwegian settlement of Longyear was sold to the government, which began to establish a scientific and tourist centre. Russia retained the Soviet approach to the development of Svalbard, whereby the areas isolated from the "big land" operated under the model of monocities ("city-enterprise"). Despite the openness of the archipelago, Russian business on Svalbard is virtually non-existent, state property is used extremely inefficiently and requires expenditures both to maintain and to preserve the jurisdiction. Proposals for the development of the Russian part of the archipelago in one form or another boil down to the need for an increase in permanent subsidies, their detailed elaboration is lacking, and the amount of proposed investments is unclear. Russia continues to focus on coal mining in the archipelago, and there are no other development strategies besides mining. This is largely a consequence of Russia's lack of a clear strategy for the development of Svalbard in recent decades [9].

### **Vorkuta**

Vorkuta was the coal capital of the Russian North-West for seventy years. Today it has the sad fame of being the fastest dying out city in Russia. Over the past thirty years, Vorkuta has lost 67 per cent of its population. In Russia, it is perhaps Vorkuta that could be the first city to transform itself from a large hundred-thousand-

tonne city into a small urban settlement. There are two main reasons for this. Firstly, it is an Arctic city, and secondly, it is a center of coal mining, which will sooner or later come to naught. [10].

The concept of long-term development of the region did not envisage cooperation and diversification; this mistake should be corrected on the basis of spatial economy methods adapted to domestic realities.

Based on the above examples, for the AZRF, as a macro-region, the most important issues of its economic management are the problems of practical territorial organisation.

The result of applied research of the previous fifteen years was the conclusion that there is no need to prove the need to identify and take into account the spatial factor in the regional economy of Russia, it obviously arises from the size of the country and the extreme heterogeneity of conditions on its territory. But the uniform and consistent theoretical and methodological basis for the study of the spatial factor has not yet been developed.

The level of complexity of spatial organisation and spatial interactions in the modern economy has already exceeded the theoretical and experimental capabilities of regional economics. At the same time, regional economic policy still constructs a system of incentives and restrictions oriented to an isolated region rather than to a system of regions, economic equilibrium within a certain economic region is considered without the use of long-term planning tools. These circumstances indicate the incompleteness of the process of theoretical and methodological design of the scientific system describing economic dynamics. The spatial aspect of multi-dimensional economic systems in modern conditions cannot be adequately described by the existing approaches within the framework of regional economics.

In order to develop a methodology for long-term planning and development of regions, a synthesis of spatial methods and approaches of the Soviet school in terms of artificial creation and functioning with the principles of sustainable development through cooperation, including the organisation of diversified economic zones, clusters, etc., the transition from the models of single-industry towns through their gradual filling with other industries, services, science – to fully functioning and economically developed administrative units should be considered.

### **References:**

1. *O Strategii razvitija Arkticheskoj zony Rossijskoj Federacii i obespechenija nacional'noj bezopasnosti na period do 2035 goda* [On the Strategy for the development of the Arctic zone of the Russian Federation and ensuring national security for the period up to 2035] : Decree of the President of the Russian Federation of 26.10.2020 № 645. URL: [publication.pravo.gov.ru/Document/View/00012020103](http://publication.pravo.gov.ru/Document/View/00012020103) (accessed 20 October 2023). (in Russian).
2. *Jekonomika sovremennoj Arktiki: v osnove uspešnosti jeffektivnoe vzaimodejstvie i upravlenie integral'nymi riskami* [Economy of the modern Arctic: the basis of success is effective interaction and management of integral risks] : a monograph / edited by V. A. Kryukov, T. P. Skufyina, E. A. Korchak. Apatity: FIC KSC RAS, 2020. 245 p. (in Russian).

3. Golubev, A. A. *Proekt Transpoljarnoj magistrali: istorija i sovremennost'* [Transpolar Railway Project: History and Modernity] // *Uchenye zapiski Petrozavodskogo gosudarstvennogo universiteta* [Scientific Notes of Petrozavodsk State University]. 2020. No 2. URL: <https://cyberleninka.ru/article/n/proekt-transpolyarnoy-magistrali-istoriya-i-sovremennost> (accessed 20 October 2023). (in Russian).
4. Evdokimov, A. N., Sirotkin, A. N., Kryukov, Y. V. *Rossija na Shpicbergene: istorija izuchenija, problemy osvoenija nedr i perspektivy na budushhee* [Russia on Spitsbergen: history of study, problems of subsoil development and prospects for the future] // *ECO*. 2018. No 4 (526). – URL: <https://cyberleninka.ru/article/n/rossiya-na-shpitsbergene-istoriya-izucheniya-problemy-osvoeniya-nedr-i-perspektivy-na-budushee> (accessed 20 October 2023). (in Russian).
5. Minakir, P., Demyanenko, A. *Prostranstvennaja jekonomika: jevoljucija podhodov i metodologi* [Spatial economics: evolution of approaches and methodology]. // *ENSR*. 2010. No 3 (50). (in Russian).
6. *Spravka o sostojanii i perspektivah ispol'zovanija mineral'no-syr'evoj bazy arkticheskoy zony RF na 15.03.2021* [Information about the state and prospects of using the mineral resource base of the Arctic zone of the Russian Federation as of 15.03.2021] VSEGEI. URL: [www.rosnedra.gov.ru/data/Fast/Files/202104/45bb8bcc7b844220954744c0149a86f4.pdf](http://www.rosnedra.gov.ru/data/Fast/Files/202104/45bb8bcc7b844220954744c0149a86f4.pdf) (accessed 20 October 2023). (in Russian).
7. *Gosudarstvennyj doklad o sostojanii i ispol'zovanii mineral'no-syr'evyh resursov Rossijskoj Federacii v 2021 godu* [State report on the state and use of mineral resources of the Russian Federation in 2021]. URL: [vims-geo.ru/en/documents/714/Book\\_GD-2021\\_web\\_2023.01.18\\_8.pdf](http://vims-geo.ru/en/documents/714/Book_GD-2021_web_2023.01.18_8.pdf) (accessed 20 October 2023). (in Russian).
8. *Parlamentskaya gazeta* [Parliamentary newspaper]. URL: <https://www.pnp.ru/social/rossiya-zanimaet-17-e-mesto-v-mire-po-geologicheskomu-potencialu.html> (accessed 20 October 2023). (in Russian).
9. Rossiyskaya Gazeta. URL: <https://rg.ru/2021/04/01/reg-szfo/stanet-li-shahterskaia-vorkuta-gorodom-prizrakom.html> (accessed 20 October 2023). (in Russian).
10. Glomsrod, S. The Economy of the North / S. Glomsrød, G. Duhaime, I. Aslaksen (eds.) // *Statistical Analyses*. 151. Statistisk sentralbyrå: Statistics Norway Oslo - Kongsvinger. 2015, 168 p.

### **Список литературы:**

1. О стратегии развития Арктической зоны Российской Федерации и обеспечения национальной безопасности на период до 2035 года : Указ Президента Российской Федерации от 26.10.2020 № 645. – URL: <http://publication.pravo.gov.ru/Document/View/00012020103> (дата обращения: 20.10.2023). – Текст : электронный.
2. Экономика современной Арктики: в основе успешности эффективное взаимодействие и управление интегральными рисками : монография / под научной редакцией В. А. Крюкова, Т. П. Скуфьиной, Е. А. Корчак. – Апатиты : ФИЦ КНЦ РАН, 2020. – 245 с. – Текст : непосредственный.

3. Голубев, А. А. Проект Трансполярной магистрали: история и современность / А. А. Голубев. – Текст : электронный // Ученые записки Петрозаводского государственного университета. – 2020. – № 2. – URL: <https://cyberleninka.ru/article/n/proekt-transpolyarnoy-magistrali-istoriya-i-sovremennost> (дата обращения: 20.10.2023).
4. Евдокимов, А. Н. Россия на Шпицбергене: история изучения, проблемы освоения недр и перспективы на будущее / А. Н. Евдокимов, А. Н. Сироткин, Я. В. Крюков. – Текст : электронный // ЭКО. – 2018. – № 4 (526). – URL: <https://cyberleninka.ru/article/n/rossiya-na-shpitsbergene-istoriya-izucheniya-problemy-osvoeniya-nedr-i-perspektivy-na-budushee> (дата обращения: 29.10.2023).
5. Минакир, П. А. Пространственная экономика: эволюция подходов и методология / П. А. Минакир, А. Н. Демьяненко. – Текст : непосредственный // ЭНСР. – 2010. – № 3 (50).
6. Справка о состоянии и перспективах использования минерально-сырьевой базы арктической зоны РФ на 15.03.2021 ВСЕГЕИ – URL: <https://www.rosnedra.gov.ru/data/Fast/Files/202104/45bb8bcc7b844220954744c0149a86f4.pdf> (дата обращения: 20.10.2023). – Текст : электронный.
7. Государственный доклад о состоянии и использовании минерально-сырьевых ресурсов Российской Федерации в 2021 году. – URL: [vims-geo.ru/ru/documents/714/Книга\\_ГД-2021\\_web\\_2023.01.18\\_8.pdf](https://vims-geo.ru/ru/documents/714/Книга_ГД-2021_web_2023.01.18_8.pdf) (дата обращения: 20.10.2023). – Текст : электронный.
8. Парламентская газета. – URL: <https://www.pnp.ru/social/rossiya-zanimaet-17-e-mesto-v-mire-po-geologicheskomu-potencialu.html> (дата обращения: 20.10.2023). – Текст : электронный.
9. Российская газета. – URL: <https://rg.ru/2021/04/01/reg-szfo/stanet-li-shahterskaia-vorkuta-gorodom-prizrakom.html> (дата обращения: 20.10.2023). – Текст : электронный.
10. Glomsrod, S. The Economy of the North / S. Glomsrød, G. Duhaime, I. Aslaksen (eds.) // Statistical Analyses. 151. Statistisk sentralbyrå: Statistics Norway Oslo – Kongsvinger, 2015, 168 p.

*Nazarova Anna Nikolaevna,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
spb.anna.nazarova@yandex.ru*

*Viryacheva Evgenia Valeryevna,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
viryacheva@mail.ru*

## **PROBLEMS AND OPPORTUNITIES FOR THE FORMATION OF HUMAN RESOURCES POTENTIAL OF THE TRANSPORT AND LOGISTICS INDUSTRY AT THE PRESENT STAGE**

**Abstract.** The article evaluates the current situation in the field of formation of personnel potential of transport and logistics sector, analyses the problems and possibilities of their solution from the point of view of representatives of higher educational institutions to increase the practical orientation of the educational process through various forms of interaction with representatives of government and business.

**Keywords:** transport and logistics industry, human resources potential, effective ways to attract personnel, vocational guidance activities of higher education institutions, practice-oriented educational process, case championship LogisticsUM.

*Назарова Анна Николаевна,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
spb.anna.nazarova@yandex.ru*

*Вирячева Евгения Валерьевна,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
viryacheva@mail.ru*

## **ПРОБЛЕМЫ И ВОЗМОЖНОСТИ ФОРМИРОВАНИЯ КАДРОВОГО ПОТЕНЦИАЛА ТРАНСПОРТНО-ЛОГИСТИЧЕСКОЙ ОТРАСЛИ НА СОВРЕМЕННОМ ЭТАПЕ**

**Аннотация.** В статье оценивается сложившаяся ситуация в области формирования кадрового потенциала транспортно-логистического сектора,



анализируются проблемы и возможности их решения с точки зрения представителей вузов по повышению практико-ориентированности учебного процесса за счет различных форм взаимодействия с представителями власти и бизнеса.

**Ключевые слова:** транспортно-логистическая отрасль, кадровый потенциал, эффективные способы привлечения персонала, профориентационная деятельность вузов, практико-ориентированность учебного процесса, кейсовый чемпионат ЛогистикУМ.

The current geopolitical situation in the world has led to the increasing role of logistics in general and, as a consequence, the need to improve the level of formation of human resources for the logistics industry.

The best universities in the world produce personnel for the logistics industry, allowing the industry to operate effectively in the face of global changes. Here is the rating of world educational institutions, which, according to experts, are the leading ones for the analysed area.

Table – Top 10 Best Universities for Logistics Professionals [1]

Positions	University	Country
1	Centre for Transport and Logistics, Massachusetts Institute of Technology	USA
2	Vienna University of Economics and Business	Austria
3	Ross School of Business, University of Michigan	USA
4	Erasmus University Rotterdam School of Management	Netherlands
5	Marshall School of Business at the University of Southern California	USA
6	Trinity College	Ireland
7,8	Manchester Business School	United Kingdom
9	School of Management, Politecnico di Milano	Italy
10	University of Washington School of Business	USA

As can be seen from the table below, not a single domestic higher education institution (HEI) was included in this list. There are a number of objective and subjective reasons for this. But it is the Russian representatives of the logistics industry who, starting from 2022, are faced with the task of rethinking and redistributing forces in logistics chain management in the shortest possible time under the unprecedentedly tight conditions of global sanctions and their consequences.

Interaction with business representatives, in particular within the framework of extended meetings of the Transport and Logistics Committee of the St. Petersburg Chamber of Commerce and Industry; meetings, organised by the St. Petersburg Committee for Science and Higher Education and in general vocational guidance activities of higher education institutions shows that due to a number of the above-

mentioned circumstances, a huge shortage of personnel in the logistics sector has now become apparent.

According to the statistics of the Ministry of Science and Higher Education of the Russian Federation in our country there are 1024 HEIs registered in 2024. They are scattered in 266 cities of our country. There are 853 state universities and 171 non-state universities available to applicants [2]. At the same time, universities that graduate students in the direction of "Logistics and supply chain management" only 74 educational institutions. Among them are such universities as National Research University Higher School of Economics (in Moscow and St. Petersburg); St. Petersburg State University of Economics, St. Petersburg State University of Economics and Technology; State University of Economics; RUT (MIIT); MADI; UGATU (Ufa); TOGU (Khabarovsk); TSU (Togliatti); VGTU (Voronezh); ChelGU; UrSEU; Pskov State University and others. [3]

In order to solve personnel problems in the logistics industry, one of the main challenges of the new time for universities is the possibility of effective formation of not only theoretical, but also practice-oriented skills and abilities of students of different forms of education.

In this regard, the involvement of business representatives in the educational process, who understand and largely determine the competitive competences of graduates, becomes a necessity.

As an example of such a promising interaction we can cite the conclusion of a long-term cooperation agreement between Higher School of Technology and Energy SPbUPTD and the leader of domestic software developers for automation of supply chain management processes AXELOT company has moved to a new level of formation of quality human resources for logistics.

As part of this co-operation, AXELOT-LAB was created in the walls of the Higher School of Economics and Technology. Acquired equipment and software products of the laboratory will allow bachelors, masters and even postgraduate students, receiving education related to logistics to learn rational management of warehouse processes (WMS), as well as automation of transport logistics on the basis of TMS solutions AXELOT.

It is important that by training with these software products students will master the technology of so-called "seamless" integration with other components of the AXELOT SCM platform, which will certainly increase their demand in the labour market in the field of supply chain management.

In order for the interaction between the university and the supply chain software developer to be most effective, the Department of Marketing and Logistics at the Higher School of Technology and Energy has made changes to the curriculum in advance, introducing specialised disciplines such as "Software for Logistics Processes" and "Digital Technologies in Logistics and Marketing". Moreover, the format of practical classes in such disciplines as "Warehouse Logistics", "Transportation Management in Supply Chains", "Inventory Management in Supply Chains", etc. was changed, implying the practice of necessary skills in a specialised laboratory.

Another equally important event that promotes the collaboration of universities and representatives of the business community in the process of forming human resources potential, in particular for the transport and logistics industry, is the holding of specialised case championships. They can be held in different formats (online/offline), time ranges (from a few hours to a year), the composition of participants can be from one industry, as well as inter-industry, etc. But the essence of them lies in the students' need to solve actual tasks set before them, so-called cases for an industry, a business or even a single organisation. In the process of doing this work, students have the opportunity to immerse themselves in the profession as much as possible, demonstrate the knowledge and skills they have acquired, while potential employers can choose their employees.

This form of improving the quality of practice-oriented educational process has been implemented by the Department of Marketing and Logistics of the Higher School of Technology and Energy. We brought the format of 4-hour case championship from Moscow, but in St. Petersburg it was HSTE that was the first to hold such an event, having organised it taking into account the specifics of the labour market of the North-West region and focusing on graduates of universities and secondary vocational schools of St. Petersburg.

As a confirmation of the fact that this is the most successful format of interaction between graduates of profile universities and logistics business, we, the organisers, have seen the response to the first game in 2023, and especially how our project will be scaled up in the new season.

Understanding the needs of the labour market and graduates of secondary vocational schools in St. Petersburg, we organised the LogisticUM-SOFT game in December 2023. Teams from five colleges that graduate students in logistics specialities fought for the right to demonstrate their competitive advantages to employers. In addition to prizes and gifts, which, according to the terms of the game, all participants of the event receive, the teams that won prizes are offered discounts on admission to the Higher School of Technology and Energy under the special programme "College-university" implemented in SPbUPTD.

The upcoming LogisticUM-BACKGROUD event at the end of April is distinguished by the expanded business community of the logistics industry, the interest shown in the case championship by such structures as the St. Petersburg Chamber of Commerce and Industry; the Committee on Transport and Logistics; the use of innovative technologies in the submission of cases solved by teams, as well as the receipt of special conditions for admission to the new Master's programme "Logistics and Supply Chain Management", which will be opened by the Department of Marketing and Logistics of the Higher School of Technology and Energy from 2024.

In the foreseeable future it is planned to organise intermediate qualifying rounds in online format, which will allow teams from other cities of the North-West region to exchange experience with colleagues, expand their professional horizons, gain knowledge about the latest trends and innovations in logistics, and most importantly compete for a career start.

The special significance of LogisticUm events is distinguished by the high degree of involvement in the organisation process of students, postgraduates, as well as those who have already completed the process of studying at HSE and stayed at the university to work.

We would like to additionally note the positive experience of the Department of Marketing and Logistics of the Institute of Management and Economics of the Higher School of Technology and Energy in introducing changes in the format of coursework for 2nd, 3rd and 4th year students. Cooperation agreements have been signed with a number of profile enterprises for the fulfilment of term papers according to their requests and enquiries in the format of project activities. This allows students to understand different areas of logistics in detail and choose the one that will determine their professional path and, in some cases, career start.

Thus, the systematic and versatile work of the profile department, aimed at increasing the practical orientation of the educational process, will progressively contribute to the request of the transport and logistics industry to expand the opportunities for the formation of human resources.

### **References:**

1. *Ministerstvo nauki i vysshego obrazovaniya RF* [Ministry of Science and Higher Education of the Russian Federation]. URL: <https://minobrnauki.gov.ru/> (accessed 1 April 2024). (in Russian).
2. *Special'nost' Logistika v vuzah Rossii 2024* [Specialty Logistics in Russian universities 2024]. URL: <https://edunews.ru/universities-base/spisok/vuzy-logistiki.html> (accessed 1 April 2024). (in Russian).
3. *Luchshie universitety logistiki v Rossii* [The best universities of logistics in Russia]. URL: <https://logistics.by/blog/top-10-luchshih-universitetov-dlya-polucheniya-obrazovaniya-v-oblasti-logistiki-sravnitelnyj-analiz-rejting-i-preimushhestva> (accessed 1 April 2024). (in Russian).

### **Список литературы:**

1. Министерство науки и высшего образования РФ. – URL: <https://minobrnauki.gov.ru/> (дата обращения: 01.04.2024). – Текст : электронный.
2. Специальность Логистика в вузах России 2024. – URL: <https://edunews.ru/universities-base/spisok/vuzy-logistiki.html> (дата обращения: 01.04.2024). – Текст : электронный.
3. Лучшие университеты логистики в России. – URL: <https://logistics.by/blog/top-10-luchshih-universitetov-dlya-polucheniya-obrazovaniya-v-oblasti-logistiki-sravnitelnyj-analiz-rejting-i-preimushhestva> (дата обращения: 01.04.2024). – Текст : электронный.

*Vasiliev Mikhail Vladimirovich,  
Saint Petersburg State University of Industrial Technologies and Design,  
Saint Petersburg, Russian Federation  
9418988@bk.ru*

*Nazarova Anna Nikolaevna,  
Saint Petersburg State University of Industrial Technologies and Design,  
Saint Petersburg, Russian Federation  
spb.anna.nazarova@yandex.ru*

## **ECOLOGICAL AND ECONOMIC SUBSTANTIATION OF THE USE OF QUARRIES OF THE LENINGRAD REGION FOR UTILISATION OF CONSTRUCTION WASTE OF CLASS 5**

**Abstract.** The article evaluates the current situation in the Leningrad region in terms of utilisation of construction waste of class 5 (FKCO code 8 11 100 01 49 5), the share of which in the total mass of waste is 54 %. At the present moment in the territory of the Leningrad region there is an acute problem of construction waste utilisation due to the lack of capacity for its reception at the existing landfills, as well as due to the transport remoteness of landfills from the places of waste generation.

The authors of the article propose to use the capacity of previously worked out quarries, which are in close proximity to construction projects. Involvement of quarries in the activity on treatment and utilisation of construction waste will allow to reduce the financial burden on the waste generator due to the reduction of transport costs, and the subsoil user will be able to perform the liquidation of the mine workings, as well as the reclamation of lands disturbed earlier by mining operations.

**Keywords:** Leningrad region, waste disposal sites, class 5 construction waste, FKCO code 8 11 100 01 49 5, waste quarries, treatment and utilisation, product, mining liquidation, reclamation, soil transport, economic feasibility.

*Васильев Михаил Владимирович,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Санкт-Петербург, Российская Федерация  
9418988@bk.ru*

*Назарова Анна Николаевна,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Санкт-Петербург, Российская Федерация  
spb.anna.nazarova@yandex.ru*

## **ЭКОЛОГО-ЭКОНОМИЧЕСКОЕ ОБОСНОВАНИЕ ИСПОЛЬЗОВАНИЯ КАРЬЕРОВ ЛЕНИНГРАДСКОЙ ОБЛАСТИ ДЛЯ УТИЛИЗАЦИИ СТРОИТЕЛЬНЫХ ОТХОДОВ 5 КЛАССА**

**Аннотация.** В статье оценивается сложившаяся ситуация в Ленинградской области в части утилизации строительных отходов 5 класса

(код ФККО 8 11 100 01 49 5), доля которых в общей массе отходов составляет 54 %. На сегодняшний момент на территории Ленинградской области имеется острая проблема утилизации строительных отходов ввиду отсутствия емкостей для их приема на действующих полигонах, а также из-за транспортной удаленности полигонов от мест образования отходов. Авторами статьи предлагается использовать емкости ранее отработанных карьеров, находящихся в непосредственной близости от объектов строительства. Вовлечение карьеров в деятельность по обработке и утилизации строительных отходов позволит снизить финансовую нагрузку на образователя отходов за счет сокращения транспортных расходов, а недропользователю выполнить ликвидацию горной выработки, а также рекультивацию земель, нарушенных ранее горными работами.

**Ключевые слова:** Ленинградская область, полигоны по размещению отходов, строительные отходы 5 класса, код ФККО 8 11 100 01 49 5, отработанные карьеры, обработка и утилизация, продукт, ликвидация горной выработки, рекультивация, транспортирование грунтов, экономическая целесообразность.

The Strategy of Environmental Security of the Russian Federation for the period until 2025, approved by the Decree of the President of the Russian Federation No 176 dated 19 April 2017, lists internal challenges to environmental security, which, among others, include an increase in the volume of production and consumption waste generation with a low level of recycling (paragraph D, item 20 of the Strategy).

In accordance with paragraph 25 of the Strategy, in order to achieve the goals of the state policy in the field of environmental safety, the task of efficient use of natural resources and increasing the level of production and consumption waste utilisation should be solved.

At present, there is an acute problem of construction waste utilisation on the territory of the Leningrad region due to the lack of capacity for its reception at the existing landfills, as well as due to the transport distance of landfills from the places of waste generation. At the same time, the commissioning of new waste processing complexes (WPC) is delayed due to the long and complicated procedure for approval of project documentation, as well as due to the high social tension of the population regarding the construction of such facilities [1].

Construction waste includes waste generated in excess during the production of construction works and not used on the territory of the object of formation, therefore classified by the owner as waste (FKCO code 8 11 100 00 00 00 0 0), even if by all indicators their further use and application in terms of environmental and sanitary-epidemiological safety is possible.

At the same time, the largest volume of waste is generated during excavation works during construction of facilities, which are classified as class 5 waste according to 8 11 100 01 49 5. According to the Territorial Waste Management Scheme of the Leningrad Region for 2022, the volume of such waste amounted to

3.97 million tonnes, which in the volume of all waste is 53.7 % and significantly exceeds the volume of solid waste (2.9 million tonnes) [2].

Thus, for example, only in the south-western part of the Leningrad Region during the construction of new power units of LNPP-2 in Sosnovy Bor in 2023, the volume of construction waste of class 5 in the form of soils generated during excavation works is not less than 5 million tonnes. At the same time, the only nearest working landfill (Novy Svet-Eco) is located 110 km away from the construction site and technically has no reserve capacity to even accept it.

In turn, said waste is essentially the same soil, which is sand, sandy loam, loam or other type of soil that was previously deposited in nature on the plot of land where construction is planned, and after excavation turned into "waste" due to the lack of need for its use by the owner, which in accordance with current legislation must be taken to a landfill and disposed of.

The solution to the problem may be the involvement of previously worked-out quarries, located in the immediate vicinity of construction sites, in the activities for processing and utilisation of soils for the purpose of reclamation and restoration of lands disturbed by previous mining operations.

Based on the analysis of the current legislation, the impossibility of further use for economic and other purposes indicates that this material belongs to the category of waste, and in the presence of useful (consumer) properties (possibility of further use, demand, interested party) the waste ceases to be a waste and becomes a commodity, raw material or material (product).

The main obstacle to the implementation of the proposed solution is the fact that the majority of quarries for the extraction of common minerals are located on forest lands, which according to the Forest Code of the Russian Federation are subject to protection from pollution and other negative impacts, as well as the prohibition on the use of waste production and consumption of rocks during reclamation.

The way out of the situation is the preliminary accumulation of waste at an equipped technological site, its treatment and subsequent utilisation to produce a product that can be used to fill the excavated space of the quarry, which, in turn, does not violate the current legislation.

To solve this problem, the Technological Regulation "Technology of production of the product "Ecosmash" on the basis of waste soils and overburden rocks" was developed, which provides the principle technology of obtaining the product "Ecosmash" on the basis of waste soils of class 5 by processing and recycling.

Processing means preliminary selection of waste fractions: glass, polymeric materials and metal. Selection of waste fractions is carried out both manually and mechanised by means of excavators. The recyclable fractions are accumulated in containers at separate sites and, as they are filled, are transferred for further disposal or recycling to a licensed organisation under a contract.

After processing, the feedstock is recycled, either by screening or by mixing, depending on the product grade.

When utilising the screening method, a mobile screen is used, a tracked sorting

equipment used to separate the feedstock into separate fractions. It can be of vibrating, drum or grate type. The specific type of screen is selected based on the properties of raw materials, requirements for the final product and the volume of its output. Large-medium lumpy wood inclusions separated at the screen inlet are to be disposed of by shredding in a mulcher (shredder) at a separate site. Large-medium lumpy inclusions represented by stones, boulders can be disposed of by crushing by various mobile crushing and screening units at a separate site.

During utilisation by the mixing method, the feedstock is repeatedly re-excavated in order to reduce the concentration of pollutants in it through dilution. The degree of dilution of pollutant concentrations depends on the quantity and parameters of the feedstock.

The result of utilisation of the initial raw material is obtaining the product "Ecosmixture" of various types and grades, meeting the requirements of TU 23.99.19-001-35758845-2019 (with all changes), by-products and waste fractions.

The Technological Regulations stipulate a mandatory requirement to carry out in addition to the mandatory laboratory tests of the initial raw material, studied as waste, additionally to carry out incoming laboratory control of waste for compliance with the requirements of TU 23.99.19-001-35758845-2019 for the soil-product. In case the initial soil-waste according to the results of research fully complies with the requirements of TU, it is recognised as a soil-product directly at the object of generation without additional operations on its processing, such as sorting and mixing, thus the process of utilisation by the method of comparison is implemented.

This method of utilisation fully fits into the main principles and priority directions of the state policy reflected in the regulatory documents: "Fundamentals of state policy in the field of ecological development of the Russian Federation for the period up to 2030" (approved by the President of the Russian Federation on 30.04.2012), as well as in the Federal Law dated 10.01.2002 N 7-FZ "On Environmental Protection" and in the Federal Law dated 24.06.1998 N 89-FZ "On Production and Consumption Waste", namely the principle of "scientifically justified combination of environmental and economic interests of society in order to ensure sustainable development of society".

Let's consider the economic effect from implementation of these design solutions on the example of the construction site of power units No 3, 4 of LNPP-2. The volume of waste generated during the construction of excavations for new power units – class 5 soils is about 3 million m<sup>3</sup> or 4.5 million tonnes.

Table shows the nearest landfills and KPOs planned for commissioning with indication of the cost of delivery and utilisation of these soils.



Table – Summary cost indicators of soils transportation from LNPP-2 to the nearest disposal facilities

Name of polygon /landfill	Distance from the place of waste generation, km	Cost of transport with utilisation rub./m <sup>3</sup>	Cost of utilisation rub./m <sup>3</sup>	Total costs rub./m <sup>3</sup>	Cost of transportation and utilisation of the entire volume of soil (3 million m <sup>3</sup> ) bln. rub.
KPO Novoselki *	90	900	100**	1000	3,0
KPO Kingisepp *	89	890	100**	990	2,97
Polygon Novy Svet-EKO	114	1100	100**	1200	3,6
Nearest Quarry	34	400	120	520	1,56

- Planned KPOs to be commissioned in 2024-25 according to open source data
- Soil utilisation costs are assumed to be similar to other operating landfills.

As can be seen from Table 1, how important is the logistical factor of the location of the waste generation site and the final disposal site. In the final price of disposal transport costs are not less than 76 % and with the increase of transport shoulder reaches 92 % (on the example of the landfill "Novy Svet-EKO").

The economic effect from the implementation of solutions for disposal of waste soils, using the example of using the excavated space of the quarry, can reach at least 1.4 billion of budget money.

The change in the cost of Class 5 waste carriage and disposal depending on the length of transportation is shown in Figure.

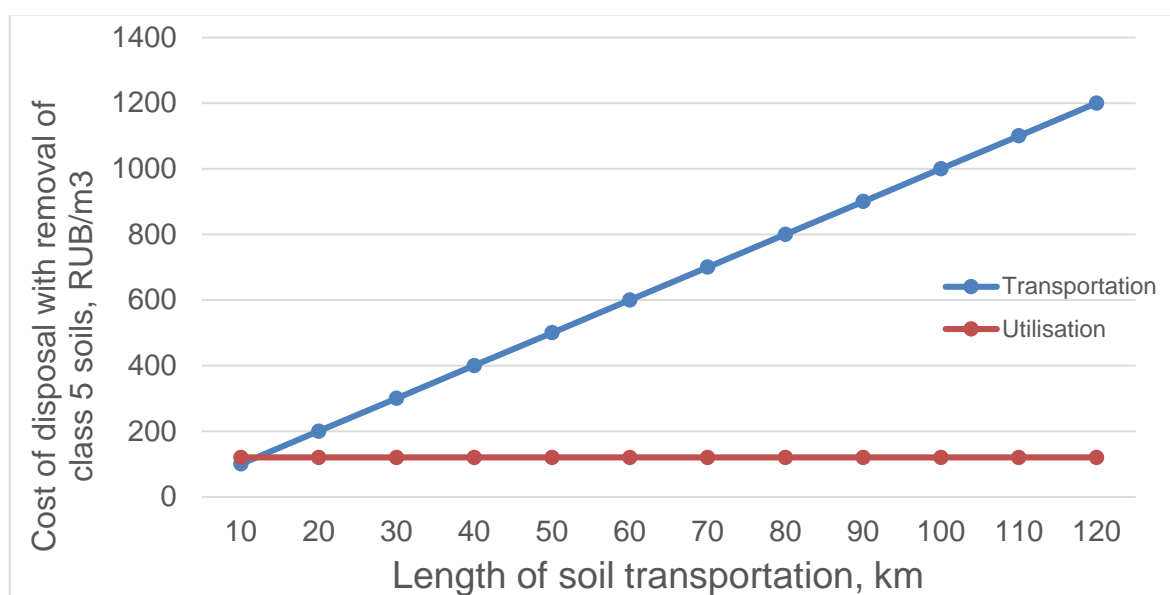


Figure – Change in the cost of Class 5 waste carriage and disposal depending on the length of transportation

As can be seen from Diagram 1, the cost of the disposal process itself is generally in the range of 100-150 RUB per m<sup>3</sup>, does not depend on the transportation shoulder and does not actually have a significant impact on the final cost of the service.

The key value is determined by the transportation shoulder, which means the place of utilisation and its logistical accessibility.

In addition, the shorter length of transportation will reduce both the load on the road bed of public roads and social tension due to the reduced intensity of dump truck traffic in the vicinity of settlements on the way of transporting such a volume of cargo, will solve the issue of the subsoil user in terms of the liquidation of the mining operation and subsequent reclamation of lands disturbed by mining operations.

Thus, the involvement of quarries in the activity on treatment and utilisation of construction waste will allow to reduce the financial burden on the waste generator due to the reduction of transport costs, and the subsoil user will be able to perform the liquidation of the mine workings, as well as the reclamation of lands disturbed earlier by mining operations.

#### **References:**

1. Delovoj Peterburg [Business Petersburg]. URL: <https://www.dp.ru/a/2023/12/07/zapusk-kompleksov-po-pererabotke> (accessed 2 April 2024). (in Russian).
2. RBK: Srok pererabotki bol'shej chasti othodov Lenoblasti [RBC: The processing period for most of the Leningrad Region's waste]. URL: [https://www.rbc.ru/spb\\_sz/](https://www.rbc.ru/spb_sz/) (accessed 2 April 2024). (in Russian).

#### **Список литературы:**

1. Деловой Петербург. – URL: <https://www.dp.ru/a/2023/12/07/zapusk-kompleksov-po-pererabotke> (дата обращения: 02.04.2024). – Текст : электронный.
2. РБК: Срок переработки большей части отходов Ленобласти. – URL: [https://www.rbc.ru/spb\\_sz/](https://www.rbc.ru/spb_sz/) (дата обращения: 02.04.2024). – Текст : электронный.

***Nikiforova Vera Dmitrievna,**  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
ver.niko2011@yandex.ru*

***Kovalenko Anna Vladimirovna,**  
Saint Petersburg State University of Chemistry and Pharmacy  
Saint Petersburg, Russian Federation  
lav85@mail.ru*

***Nikiforov Alexander Alexandrovich,**  
Saint Petersburg Mining University,  
Saint Petersburg, Russian Federation  
naaket@yandex.ru*

## **PREREQUISITES AND FOUNDATIONS FOR ECOSYSTEM DEVELOPMENT IN THE CONTEXT OF TECHNOLOGICAL TRANSFORMATION**

**Abstract.** The article deals with the topical issues of ecosystems related to the transformation of technological infrastructure and the increasing complexity of the business environment. The authors focus their attention on the peculiarities of functioning of industrial ecosystems and substantiate the need to create mechanisms of state regulation of their activities.

**Keywords:** industrial ecosystems, self-organization, state regulation.

***Никифорова Вера Дмитриевна,**  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики  
Санкт-Петербург, Российская Федерация  
ver.niko2011@yandex.ru*

***Коваленко Анна Владимировна,**  
Санкт-Петербургский государственный  
химико-фармацевтический университет,  
Санкт-Петербург, Российская Федерация  
lav85@mail.ru*

***Никифоров Александр Александрович,**  
Санкт-Петербургский горный университет,  
Санкт-Петербург, Российская Федерация  
naaket@yandex.ru*

## **ПРЕДПОСЫЛКИ И ОСНОВЫ РАЗВИТИЯ ЭКОСИСТЕМ В КОНТЕКСТЕ ТЕХНОЛОГИЧЕСКОЙ ТРАНСФОРМАЦИИ**

**Аннотация.** В статье рассматриваются актуальные вопросы экосистем, связанные с трансформацией технологической инфраструктуры и усложнением

бизнес-среды. Авторы сосредотачивают свое внимание на особенностях функционирования промышленных экосистем и обосновывают необходимость создания механизмов государственного регулирования их деятельности.

**Ключевые слова:** промышленные экосистемы, самоорганизация, государственное регулирование.

The 2020-2022 pandemic empirically confirmed the thesis that industry is the core element of the economy, and in difficult times, manufacturing sectors can be a catalyst and a major source of recovery. It was the manufacturing sector that, during the lockdown, enabled millions of people to access basic necessities while preserving jobs.

The UNIDO Industrial Development Report 2022 shows that countries with high industrial capacity and the most diversified manufacturing sectors are the ones that bore the brunt of the pandemic. Industrial sectors of the economy also play the role of multipliers, creating additional value in other sectors.

The modern period and the entire history of mankind show that the rate of change of technological cycles is constantly increasing. If earlier technologies changed once every few hundred years, today the rate of technology change has reached a ten-year cycle, and the frequency of technology change will only increase further.

The formation of diverse types of ecosystems can also be considered a distinctive feature of modernity. Industrial ecology, innovation ecosystems, business ecosystems, technological ecosystems, multi-actor networks and entrepreneurial ecosystems are the main directions of understanding the ecosystem essence. It can be concluded that a distinctive feature of the current stage of ecosystem development is the significant role of digital technologies, on the basis of which digital platforms and digital ecosystems are formed [1].

In the beginning, the concept of "ecosystem" was applied to nature. A natural ecosystem is a set of organisms living together in close relationship with the environment, which is characterised by a continuous process of substance and energy exchange.

Moore J. Moore was one of the first to use the analogy with a natural ecosystem in economics. He introduced the term "business ecosystem" ("Business Ecosystem"). Business ecosystems are "dynamic and co-evolving communities of diverse actors creating and gaining new content through interaction and competition".

In an industrial environment, innovation can provide additional impulses for economic growth. In its essence, the innovation ecosystem (IES) is a highly organised combination of two systems: research and development and commercial (including industry). The main task of the state is to ensure optimal conditions and stimulate the flow of investments from the commercial sector into R&D. The task of creating an ecosystem of innovative development is to create conditions for the dominance of self-initiated R&D by the commercial sector. This will be fundamentally different from the current situation where the state is the main initiator of R&D activities.

With regard to the meso-level, an ecosystem can be regional, defined by territorial boundaries, or sectoral, defined by the sectoral affiliation of elements. The value of any ecosystem is formed on the basis of the principles of openness, the principle of decentralisation is used, based on self-organisation, self-development and self-control. Digital technologies and the transition to a digital economy ensure an increase in the speed of interaction between ecosystem participants and an increase in its quality [2].

The distinctive features of industrial ecosystems are:

- 1) its main elements – large enterprises and SME companies of the same or related industry, state institutions, sectoral educational institutions and profile research centres, elements of industrial infrastructure;
- 2) the key objective is to create favourable conditions for technology transfer and commercialisation of R&D results by stimulating interaction between business (industry representatives) and science;
- 3) has no territorial boundaries, is determined by the pronounced geographical concentration of industry representatives.

The prospects for the development of Russian ecosystems depend entirely on government regulation. Until recently, this area was not regulated in any way, but the strengthening of ecosystems and their entry into new verticals is forcing the state to pay attention to this area [3].

The introduction of regulation can create constraints in the market. Much will depend on the chosen concept of restrictions and mechanisms for implementing the measures in practice, and on the extent to which the opinion of business, which actively participates in the discussion of regulation, will be heard.

### References:

1. Kobylko, A. A. *Jekosistemnye kompanii: granicy i jetapy razvitija* [Ecosystem companies: boundaries and stages of development] // *Jekonomicheskaja nauka sovremennoj Rossii* [Economic Science of Modern Russia]. No 4 (87). С. 126-136. DOI: 10.33293/1609-1442-2019-4(87)-126-136. (in Russian).
2. Kuzovkova, T. A. *Obosnovanie setevoj jeffektivnosti i sinergeticheskogo haraktera razvitija infokommunikacij v uslovijah cifrovoj jekonomiki* [Justification of network efficiency and synergetic nature of infocommunications development in the conditions of digital economy] / T. A. Kuzovkova, A. D. Kuzovkov, I. M. Sharavov // *Jekonomika i kachestvo sistem svjazi* [Economics and quality of communication systems]. 2019. No 4(14), pp. 10-20. (in Russian).
3. Mesropyan, V. Digital platforms – new market power // Faculty of Economics of Moscow State University. URL: <https://www.econ.msu.ru/sys/raw.php?o=46781&p=attachment> (accessed 2 March 2024). (in Russian).

### Список литературы:

1. Кобылко, А. А. Экосистемные компании: границы и этапы развития / А. А. Кобылко. – Текст : непосредственный // *Экономическая наука современной России*. – 2019. – № 4 (87). – С. 126–136. DOI: 10.33293/1609-1442-2019-4(87)-126-136.

2. Кузовкова, Т. А. Обоснование сетевой эффективности и синергетического характера развития инфокоммуникаций в условиях цифровой экономики / Т. А. Кузовкова, А. Д. Кузовков, И. М. Шаравов. – Текст : непосредственный // Экономика и качество систем связи. – 2019. – № 4(14). – С. 10-20.
3. Месропян, В. Цифровые платформы – новая рыночная власть / В. Месропян. – Текст : электронный // Экономический факультет МГУ: [сайт]. – URL: <https://www.econ.msu.ru/sys/raw.php?o=46781&p=attachment> (дата обращения: 02.03.2024).

*Zlotnitskaya Tatyana Sergeevna,  
Kotova Anastasia Yurievna,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
tekz@mail.ru*

## THE EVOLUTION OF PLANNING CONCEPTS

**Abstract.** The article considers how for several centuries the views of different economic schools have shaped the idea of the necessity, role and tools of planning. It analyses trends in planning at macro-, meso- and micro-levels.

**Keywords:** economic theory, economic schools, evolution of planning views, market, demand, supply, pricing mechanism, planning.

*Злотницкая Татьяна Сергеевна,  
Котова Анастасия Юрьевна,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
tekz@mail.ru*

## ЭВОЛЮЦИЯ ПРЕДСТАВЛЕНИЙ О ПЛАНИРОВАНИИ

**Аннотация.** В статье рассматривается, как в течение нескольких веков взгляды разных экономических школ формировали представление о необходимости, роли и инструментах планирования. Проанализированы тенденции в планировании на макро-, мезо- и микроуровнях.

**Ключевые слова:** экономическая теория, экономические школы, эволюция взглядов на планирование, рынок, спрос, предложение, механизм ценообразования, планирование.

Planning in economics is a very broad concept. In a general sense, planning is the activity of economic agents in establishing the proportionality of economic development. In this case, economic development is considered not as an stand-alone objective, but as a mean of social development.

Classical economic theory, represented, for example, by J. B. Say, did not see planning as a necessary element of a market economy. The basic argument is that a competitive market economy tends to macroeconomic equilibrium. For the economy as a whole, this means that the aggregate demand for goods (the sum of paid income) equals the aggregate supply of products. That is why the situation of general overproduction is not possible [1]. In these conditions, it makes no sense for the

seller to study the demand and plan the production of goods, since its sales are initially guaranteed. This point of view for many decades was the basis of the idea of a state unregulated market.

Even in the 19th century, many economists, such as R. T. Malthus, pointed out the untenability of this approach. The plans of buyers and sellers may not correspond to each other. As a result, there are fluctuations in: output, incomes, employment levels and prices. Meanwhile, the coordination of these parameters should be the basis for planning at all levels. Observations of scientists have proved that there is no actual matching of supply and demand in the markets. And this is a condition for the planning necessity.

Representatives of the marginalist theory (K. Menger, L. Walras) at the beginning also shared the opinion of the classics, that perfect competition eliminates the need for planning. Competition provides all market participants with complete and reliable information and reduces market uncertainty. After the discovery of methods of functional analysis and mathematical modelling, the second stage of development of marginalism began. During this period, the laws of supply and demand in individual markets were defined. A. Marshall proved that the interaction of supply and demand leads to the mechanism of establishing the equilibrium market price. Shifts in the demand and supply curves are the result of the impact of relevant non-price factors. This dependence was considered as universal and became the basis for planning at macro- and meso-economic levels.

Further researches of the problems of general economic equilibrium have shown that the profit of an individual producer cannot be described by a simple linear dependence. The change in the production volume depends on a variety of external factors. All these factors must be taken into account in planning. That is why such a fundamental concept as 'expectations of an economic agent' was introduced into the scientific turnover. A new requirement to planning appeared – to consider such expectations, to use them as a basis for forecasting and future actions.

Classical, and following it, neoclassical economic theories assume that the rational behavior of a company in the market is aimed at extracting the highest possible profit. The profit maximisation is the result of planning by using economic and mathematical models. To maximise profit, it is necessary to produce such a volume of goods that marginal revenue equals marginal cost. At that, the output volume should correspond to the point of zero marginal revenue on the industry demand line. And the average rate of profit should be equal to the marginal rate of profit. All these equations can be the result of calculations and search for the optimal combination of the quantity of the produced goods and the prices for them. For this purpose, it is necessary to know the supply function and the demand function in a certain market segment, which requires its measurement, estimation and forecasting.

The economic crisis of 1929-1933 finally proved the incorrectness of the idea of the 'invisible hand of the market' self-sufficiency, which was stated by classical economic theory. The necessity of planning was proved by J. M. Keynes. In his concept, macroeconomic equilibrium is only a special case of the general non-equilibrium state of the market economy. Keynes determined the reasons for economic crises and proved that there is no 'automatic regulation'. Economic agents



tend to save, so consumption grows much slower than incomes. Therefore, incomes are not necessarily spent in full. Consequently, part of the produced goods will be unrealised, the output will fall and unemployment will rise [2].

In contrast to the classics, Keynesianism is based on the assumption that demand creates supply. The satisfaction of needs is the only purpose for economic activity and production. Both production and demand are constantly growing, but there is no automatic co-ordination of them either at the micro- or macro-levels. A special mechanism such as planning is necessary in order to reduce deviations of the supply from the real demand.

J. M. Keynes substantiated the extremely important role of state planning as a way to align supply and demand, to correct the actions of spontaneous market forces. At the micro level, in accordance with Keynes' ideas, marketing tools applied in planning [3].

Over many years of studying various aspects of economics, scientific ideas about the uncertainty of markets have finally developed. This uncertainty determines the economic feasibility of planning. Market participants are always not sufficiently aware of the market state of affairs. Producers should initially have an understanding of the market real needs in order to justify their strategic objectives, forecast expected costs and profits, make managerial decisions.

In the 21st century, the concept of planning as an organic element of the market mechanism was further developed. In 2001 the Nobel Prize was awarded to the studies that proved that market information is fundamentally incomplete and asymmetric. The corporate management has much more accurate information about the prospects of their company than outside investors, but keeps it in secret. The producers of a goods have much better information about its quality than the buyers. Buyers make their choice not only from rational economic considerations, but also under the influence of their own psychology and emotions. So companies are forced to predict market demands when developing strategies, to use more than just price information. Of particular importance is the forecasting of shifts in technology, the emergence of alternative technologies in other industries and competitors, shifts in income and in the structure of needs.

In the post-industrial, information economy, competitiveness is determined not by economic freedom, but by innovation potential, human capital and the efficiency of its use. The speed of technological and organizational changes and the quality of strategic management and planning are in key importance [4].

Modern economic theory denies the confrontation between the plan and the market. The market economy, as it develops, increases the need for planning. And the main planning subject becomes the large corporation, that integrates the inter-industry cycle of final products creation.

Modern marketing is oriented not on the distribution of final goods, but on the production of new ones through prospective forecasting of their consumption structure. Therefore, it is reasonable to consider functional planning as the basis for an organized market economy. And the elements of marketing (information gathering, development of new goods, price planning, designing channels of goods realization) act as planning tools.

Sustainable development of post-industrial economy at all levels is thus impossible without planning. Modern researchers focus on new issues: changing the methodology and methods of planning, transition from rigid planning to flexible planning, increasing the accuracy of planning due to the use of mathematics tools, etc.

It is important to realise that the development of economic and managerial ideas about planning is still ongoing. Modern researches have not yet formed into concepts, but can be identified as trends.

So as part of our work on this article, we identified several key trends in the modern view of planning. Such as:

1. *Change the scale/level of planning.* A multi-level planning system has been built from the global level to a specific household.

2. *Change in the planning horizon.* We can note, that the planning horizon of both the state and individual companies increases and decreases depending on the economic situation.

3. *Influence of the external environment uncertainty.* The growing degree of uncertainty of the external environment is one of the global modern trends. The higher the uncertainty, the less specific there are plans at all levels.

4. *Increase in the number of factors that are considered in planning.* The increasing degree of uncertainty in the external environment means that more and more different factors have to be taken into account in planning.

5. *Increase in complexity of planning tools.* Today, companies use a wide variety of tools from the Gantt chart to scenario methods. At the macro level planning tools also become more complex.

6. *Increase in the number of planning process participants.* The trend is that all market players have to plan based on the information coming from the performers. Therefore, the number of participants in the planning process is increasing

It is interesting to continue to observe the changes in planning its methodology and tools. To trace the transition from rigid planning from a single state center to multi-variant, flexible and multi-level planning. We assume that flexible planning of the future will involve the state, vertically integrated companies and other economic actors.

### **References:**

1. Borisov, G. V., Sutyurin, S. F., Shishkin, M. V. *Istorija jekonomicheskikh uchenij* [The history of economic studies]. Saint Petersburg, 2003, p. 384. (in Russian).
2. Knysh, V. A. *Marketingovaja koncepcija upravljenja gosudarstvennymi zakazami* [Marketing concept of government order management]. Saint Petersburg, 2003, p. 270. (in Russian).
3. Volkova, E. Yu. *Transformation of instruments of state regulation of the economy: from non-interference to strategic management* [Transformation of the instruments of state regulation of the economy: from non-interference to strategic management] // *Jekonomika i menedzhment* [Economics and Management]. 2022. No 1. (in Russian).
4. Kholikulov, A. N., Faizullaev, U. *Osnovnye ponjatija pronozirovanija, strategicheskogo upravljenja i programirovanija v sisteme gosudarstvennogo*

*regulirovanija rynochnoj jekonomiki* [Basic concepts of pronominating, strategic management and programming in the system of state regulation of market economy]. // JMBM. 2024. No 11. (in Russian).

**Список литературы:**

1. Борисов, Г. В. История экономических учений / Г. В. Борисов, С. Ф. Сутырин, М. В. Шишкин. – Санкт-Петербург: Изд. дом "Сентябрь", 2003. – 384 с. – Текст: непосредственный.
2. Кныш, В. А. Маркетинговая концепция управления государственными заказами / В. А. Кныш. – Санкт-Петербург: СПбГПУ, 2003. – 270 с. – Текст: непосредственный.
3. Волкова, Е. Ю. Трансформация инструментов государственного регулирования экономики: от невмешательства к стратегическому управлению / Е. Ю. Волкова. – Текст : непосредственный // Экономика и управление. – 2022. – № 1. – С. 92-104.
4. Холикулов, А. Н. Основные понятия прогнозирования, стратегического управления и программирования в системе государственного регулирования рыночной экономики / А. Н. Холикулов, У. Файзуллаев. – Текст: непосредственный // JMBM. – 2024. – № 11. – С. 22-27.

***Mushenko Roman Dmitriyevich,***  
*Federal State Budgetary Educational Institution of Higher Education*  
*“Saint-Petersburg State Institute of Technology (Technical University)”*,  
*Saint Petersburg, Russian Federation*  
*roman.mushenko@mail.ru*

***Malikhina Olesya Vladimirovna,***  
*Federal State Budgetary Educational Institution of Higher Education*  
*“Saint-Petersburg State Institute of Technology (Technical University)”*,  
*Saint Petersburg, Russian Federation*  
*lesya265@gmail.com*

## **RUSSIAN MEDICAL EQUIPMENT LOCAL MANUFACTURING DEVELOPMENT STRATEGIES IN CONTEMPORARY HEALTHCARE CHALLENGING ENVIRONMENT**

**Abstract.** The present study elucidates the dynamics of the Russian public Medical Devices and Diagnostics (MD&D) market by employing state tender analytics spanning the years 2019 to 2023. A discernible adverse trend is identified in both the monetary value and the quantity of medical equipment procured. This trend prompts an exploration of growth strategies for domestic MD&D entities, which entail the strategic utilization of J. Gans and H. Stern's "Entrepreneur Compass" framework. These strategies are tailored to navigate the prevailing geopolitical and economic landscape, as well as the complex challenges inherent within the Russian healthcare system. Of particular relevance are the prioritized pillars delineated in Government Decree No 2161 of November 29, 2022, which serve as guiding principles for strategic decision-making and resource allocation within the sector.

**Keywords:** medical equipment, entrepreneurship compass, healthcare solutions, healthcare, innovations, medical services.

***Мушенко Роман Дмитриевич,***  
*ФГБОУ ВО «Санкт-Петербургский государственный*  
*технологический институт (технический университет)»,*  
*Санкт-Петербург, Российская Федерация*  
*roman.mushenko@mail.ru*

***Малихина Олеся Владимировна,***  
*ФГБОУ ВО «Санкт-Петербургский государственный технологический*  
*институт (технический университет)»,*  
*Санкт-Петербург, Российская Федерация*  
*lesya265@gmail.com*

## СТРАТЕГИИ РАЗВИТИЯ РОССИЙСКОГО ПРОИЗВОДСТВА МЕДИЦИНСКОГО ОБОРУДОВАНИЯ В УСЛОВИЯХ СОВРЕМЕННЫХ ВЫЗОВОВ СИСТЕМЫ ЗДРАВООХРАНЕНИЯ

**Аннотация.** В статье рассматривается динамика рынка медицинского оборудования в государственных профильных учреждениях за 2019-2023 гг. Выявлена отрицательная динамика в общем объеме как в штучном, так и в стоимостном выражении. Даны стратегические ориентиры по дальнейшему развитию российского производственного комплекса в области медицинских технологий, оборудования и расходного инструмента с опорой на ключевые направления развития здравоохранения, указанные в Постановлении Правительства № 2161 от 29.11.2022 г.

**Ключевые слова:** медицинское оборудование, стратегический компас предпринимателя, решение современных проблем в здравоохранении, применение инновационных подходов в отечественной медицине, медицинские услуги, здравоохранение.

The contemporary landscape of global healthcare is undergoing substantial evolution and adaptation to meet the evolving needs of society. Over the past three decades, a rapid transformation of healthcare systems across nations has occurred, driven by various prevailing trends and challenges within this sphere of societal engagement. Prominent among these factors are:

- *Resource Constraints:* There exists limited access to and an uneven distribution of natural, material, financial, and human capital resources worldwide [1].

- *Demographic Shifts:* A noteworthy increase in global life expectancy, coupled with declining birth rates in developed nations, has reshaped population demographics. While the average global life expectancy has risen from 32 years at the onset of the 20th century to 72 years in 2021, demographic aging has led to alterations in disease prevalence, with a surge in chronic and mental health conditions. Mental disorders, for instance, are witnessing a steady rise, with depressive disorders and dementias accounting for significant disability-adjusted life years (DALYs) [2].

- *Escalating Risks in Medicine Development:* The landscape of global medicine development is fraught with burgeoning legal, resource, and compliance risks, necessitating agile management and response strategies. This trajectory is expected to foster widespread adoption of disease prevention measures, thereby enhancing medical care quality and reducing per-patient healthcare costs.

- *Increasing Patient Engagement:* Patients are becoming increasingly involved in their treatment and disease prevention efforts [3].

- *Rapid Digitalization:* Various sectors, including healthcare, are witnessing a surge in digitalization initiatives.

- *Complex Regulatory Environment:* The regulatory landscape governing healthcare, particularly access to local markets, is becoming more intricate. For instance, regulatory changes in the European Union have imposed barriers to the accessibility of medical equipment, necessitating compliance with stringent safety

standards. Similarly, in Russia, the registration process for medical devices entails significant financial and temporal investments.

- *Impact of COVID-19 Pandemic:* The COVID-19 pandemic has highlighted for healthcare systems importance of systematic flexibility in response to rapidly changing external conditions, while ensuring overall system resilience [4].

- *Integrated Social Policy Approach:* Recognizing healthcare as an integral component of social policy, effective healthcare operation necessitates systematic collaboration among governmental bodies, medical institutions, officials, and healthcare practitioners. This synergy aims to prevent mortality and disorders while fostering human potential development.

The healthcare system in Russia, in accordance with the strategic goals set by the government, aims to achieve various objectives including increasing life expectancy, decreasing mortality and disability rates, preventing illnesses, enhancing the quality and availability of medical services, encouraging healthy habits, and strengthening infrastructure and surveillance systems for public health. [5].

Aggregate indicators such as average life expectancy and mortality rates serve as informative metrics for evaluating the efficacy of healthcare systems (Figure). However, it is essential to recognize that these metrics are influenced not only by healthcare system performance but also by broader socio-economic, climatic, and historical factors. In the contemporary paradigm of managing human capital well-being, the duration and quality of life serve as pivotal determinants, reflecting the effectiveness of healthcare systems and the alignment of societal standards and regulations.

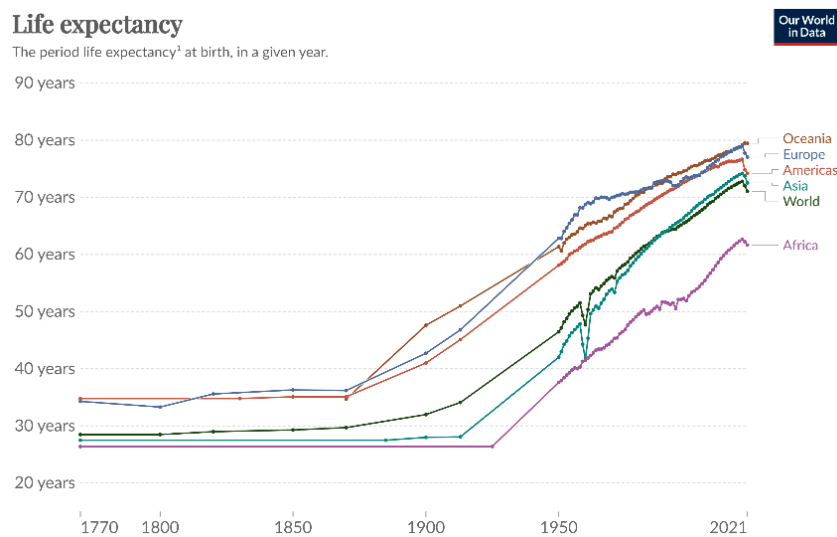


Figure – Dynamics of life expectancy according to UN data [6]

The medical industry assumes a pivotal role in driving the evolution of healthcare systems by furnishing cutting-edge developments and technologies to both managerial and clinical echelons. It serves as a linchpin across the entire spectrum of human health, spanning from preventative measures and diagnostic interventions to therapeutic modalities and post-discharge support. In the face of sanctions-induced pressures, the landscape of the Russian medical equipment market is witnessing

profound shifts, exerting direct ramifications on the accessibility, quality, and timeliness of healthcare services [7].

Within years 2022 and 2023, approximately 92 % of the aggregate public medical equipment landscape comprised Computed Tomography (CT) scanners, Magnetic Resonance Imaging (MRI) machines, X-ray diagnostic equipment, Mobile and stationary X-ray systems (C-arms and angiography units), Ultrasound devices, Ventilators, Patient Monitors (PM), Defibrillators (DF).

Medical equipment represents a critical technological and innovative factor facilitating preventive, diagnostic, therapeutic, and resuscitative interventions, thereby witnessing heightened demand in recent decades. Nonetheless, the absence of major manufacturers of full-cycle medical equipment within Russia necessitates reliance on foreign procurement, thus rendering the market susceptible to external influences, including political and economic determinants.

The onset of the Special Military Operation has ushered in a new phase of sanctions pressure on various sectors of the Russian Federation's foreign economic activities. Although the medical sector has not been directly affected by embargoes, many foreign vendors have opted to curtail or cease their operations within Russia. Notably, organizations engaged in warranty and post-warranty servicing of medical equipment have encountered acute challenges due to embargo restrictions on spare parts imports.

A meticulous examination of public tenders at <http://zakupki.gov.ru>, spanning the period from 2019 to 2023, has unveiled several concerning indicators impeding the realization of the Russian Federation Government's healthcare transformation plans within the current milieu. These include:

- Pronounced reliance of the medical equipment market on targeted federal funding programs.
- Substantial dependency of the Russian market on foreign medical technologies and products. Russian manufacturers were presented by 16.8 % in value; it is aligned with imports constituting approximately 85 % of public procurements based on Ros Business Consulting reports [8].

Diminishing market volume in both monetary and unit terms, attributed to the tapering effects of heightened state expenditures during the COVID-19 pandemic and the scaling back of certain initiatives within the national healthcare project, including cardiac and cardiac surgery segments. The findings from the initial 10 months of 2023 underscore the reinforcement of this trend, manifesting in an additional decline of 16.4 % in comparison to the corresponding period in 2022. Disregarding the impact of the SARS-CoV-2 pandemic, juxtaposing the data of state procurement for the first 10 months of 2019 reveals a market expansion in 2023, amounting to 7.4 % in monetary terms. Nevertheless, factoring in inflation and currency exchange rate fluctuations during the same period, the genuine investment dynamics within the examined segments exhibit negativity.

Disparities in regional expenditure dynamics, highlighting skewed distribution patterns and varying procurement strategies across different administrative entities. The notable surge in the acquisition of CT scanners during 2019-2020, with increases of +195 % and +110 % year-on-year, respectively, was succeeded by a marked

downturn in both 2021 and 2022. Procurement volumes during the initial 10 months of 2023 amounted to nearly half of the total for 2019. Despite considerable year-on-year fluctuations throughout the 2019-2023 period, the ultrasound machine market exhibits overall stable demand. Procurement figures in absolute monetary terms stood at 20.07 billion rubles in 2019, 31.97 billion rubles in 2020, 24.41 billion rubles in 2021, 22.52 billion rubles in 2022, and 17.44 billion rubles for the first 10 months of 2023, with a projection to at least match the 2019 level by the conclusion of 2023. These disparate trends are attributable to both external factors, such as prevailing clinical guidelines and epidemiological conditions, and the reallocation of governmental funds across various subprograms of the national healthcare initiative.

Shifting market dynamics with fluctuations in the prevalence of leading manufacturers and the ascendancy of domestic and Chinese entities amidst ongoing sanctions pressures. In 2019, acquisitions within Moscow and the Moscow region collectively represented 32.7 % of the total state procurement in the nation, while the Central Federal District (CFD) accounted for 10.9 %, and the Northwestern Federal District (NWFD) for 9.2 %. By 2021, these figures shifted to 20 % for Moscow and the Moscow region, 17.7 % for CFD, and 11.2 % for NWFD. Subsequently, in 2022, expenditures across these three regions – Moscow and the Moscow region, CFD, and NWFD – nearly converged, with the predominant share remaining with the first two entities. Consequently, only two constituents of the Russian Federation allocate more resources toward upholding and modernizing the technological facets of medical care than entire federal districts, each comprising over 10 entities.

The structure of manufacturers in the Russian Federation market has undergone notable changes. In 2019, the collective market share of the top three global vendors of "heavy" equipment, namely General Electric, Siemens, and Philips, in state procurement was 52.4 %. However, by 2020, it declined to 40 %, as Russian and Chinese companies gained traction. In 2021, these giants showed a resurgence, capturing 44.9 % of the market. Nevertheless, by 2022, their combined share dropped to 41.4 %, further decreasing to 35.1 % by the end of the first 10 months of 2023 due to recent sanctions imposed by the U.S. Bureau of Industry and Security against the medical sector in May 2023. Despite General Electric maintaining its position as the market leader, the market share of Chinese and domestic manufacturers is steadily rising. This trend includes projects involving the localization of products by global vendors, such as CT scanners manufactured at Rusatom Healthcare facilities. It is noteworthy that despite the absence of formal bans on the import of medical equipment, sanctions pressure significantly impacts local manufacturers, as the main component base is sourced from abroad and is subject to direct or indirect sanctions.

Despite the Government's delineation of key objectives aimed at preserving human capital and enhancing life expectancy, there persists a consensus among experts regarding the imperative for substantial restructuring of the material and technical infrastructure of medical institutions. This necessitates a paradigm shift in management approaches to enhance service quality, patient satisfaction, and optimize healthcare workforce efficiency.

Amidst prevailing economic and geopolitical realities, further augmentation of the Russian Federation's healthcare financing calls for meticulous strategy



formulation, innovative technologies, and recalibration of the state's role in shaping healthcare policies and ancillary domains. The envisaged transformation of the healthcare system anticipates significant investment inflows in material, technical, and equipment domains over the forthcoming 5-10 years.

In line with the exigencies of innovation endeavors, restructuring initiatives must be underpinned by coherent strategies that encompass distinct developmental phases, risk assessment protocols, and proactive risk mitigation strategies. Leveraging frameworks such as the "Entrepreneur's Compass" devised by Hans and Stern facilitates the strategic navigation of innovative enterprises and regional authorities seeking to galvanize healthcare system transformations [9]. This model, predicated on the evaluation of innovation strategies along two axes, namely collaboration versus competition with existing market players, and niche expansion versus market penetration, offers invaluable insights for navigating the intricate healthcare landscape and fostering sustainable advancements therein.

The application of Hans and Stern's theoretical framework to the contemporary landscape of the Russian medical equipment and consumables market delineates several viable strategies for domestic manufacturers and policymakers shaping regional industrial policies.

The main strategies articulated by Hans and Stern encompass:

- “Intellectual Property” Protection Strategy
- “Value Chain”: Integration into the Existing Value Chain and Value Addition Strategy
- “Disruptive“ Strategy
- “Architectura“ Strategy

In essence, embracing the "entrepreneur's compass" framework empowers local enterprises in the medical equipment and consumables sector to navigate the intricacies of strategic formation and growth effectively. By aligning strategies with prevailing economic, political, and informational landscapes, enterprises can foster rapid, multifaceted technological advancements in the healthcare domain, thus facilitating the realization of governmental targets pertaining to life expectancy, quality of life, and human capital preservation in the Russian Federation.

### References:

1. Life Expectancy. URL: <http://hdl.handle.net/10622/LKYT53> (accessed 5 April 2024).
2. *Analiz rynka medicinskogo oborudovanija v Rossii-2023. Pokazateli i prognozy* [Analysis of the medical equipment market in Russia-2023. Indicators and forecasts] / TEBIZ group, 2022, 136 p. URL: <https://marketing.rbc.ru/research/issue/75566/> (in Russian).
3. EUR-Lex. Regulation of the European Parliament and of the Council. URL: <https://eur-lex.europa.eu/legal-content/> (accessed 5 April 2024).
4. The NHS constitution. URL: <http://www.nhs.uk/> (accessed 5 April 2024).
5. *O vnesenii izmenenij v gosudarstvennuju programmu Rossijskoj Federacii «Razvitie zdavoohranenija»: Postanovlenie Pravitel'stva Rossijskoj Federacii ot 29 nojabrja 2022 g. № 2161* [On amendments to the State program of the Russian

Federation "Development of Healthcare": Decree of the Government of the Russian Federation dated November 29, 2022, No 2161] // *Sobranie zakonodatel'stva* [Collection of legislation]. 2022, pp. 154-169. (in Russian).

6. World Population Prospects 2022. URL: <https://population.un.org/wpp/> (accessed 4 April 2024).

7. Medicinskie tehnologii [Medical technologies]. URL: <https://www.mtl.ru/presscenter/news/> (accessed 5 April 2024). (in Russian).

8. Mushenko, R. D. Modern problems of the development of the medical equipment market in the Russian Federation in the context of economic crises. In: *Perspective fundamental research and scientific methods: a collection of articles of the international scientific conference* (Vyborg, December 2023). St. Petersburg: Lomonosov MIPI, 2023, pp. 69-73.

9. Gans, J. S., Stern, S. Managing ideas: Commercialization strategies for biotechnology. *ICFAI Journal of Intellectual Property Rights*. 2003. No 2, pp. 17-28.

### **Список литературы:**

1. Life Expectancy. – URL: <http://hdl.handle.net/10622/LKYT53> (дата обращения: 05.04.2024). – Текст : электронный.

2. Анализ рынка медицинского оборудования в России-2023. Показатели и прогнозы // *TEBIZ group*, 2022. – 136 с. – URL: <https://marketing.rbc.ru/research/issue/75566/> (дата обращения 05.01.2024). – Текст : электронный.

3. EUR-Lex. Regulation of the European Parliament and of the Council. – URL: <https://eur-lex.europa.eu/legal-content/> (дата обращения: 05.04.2024). – Текст : электронный.

4. The NHS. – URL: <http://www.nhscareers.nhs.uk/> (дата обращения: 05.04.2024). – Текст : электронный.

5. О внесении изменений в государственную программу Российской Федерации «Развитие здравоохранения»: Постановление Правительства Российской Федерации от 29 ноября 2022 г. № 2161 // *Собрание законодательства*. – 2022. – С. 154-169. – URL: <http://publication.pravo.gov.ru/Document/View/0001202212010021> (дата обращения 05.01.2024). – Текст : электронный.

6. World Population Prospects 2022. – URL: <https://population.un.org/wpp/> (дата обращения 05.04.2024) – Текст : электронный.

7. Медицинские технологии. – URL: <https://www.mtl.ru/presscenter/news/> (дата обращения: 05.04.2024). – Текст : электронный.

8. Мушенко, Р. Д. Современные проблемы развития рынка медицинского оборудования в Российской Федерации в условиях экономических кризисов / Р. Д. Мушенко. – Текст : непосредственный // *Перспективные фундаментальные исследования и научные методы: сборник статей международной научной конференции*, Выборг, 23 декабря 2023 г. – СПб.: МИПИ им. Ломоносова, 2023. – С. 69-73.

9. Gans, J. S., Stern, S. Managing ideas: Commercialization strategies for biotechnology. – Текст : непосредственный // *ICFAI Journal of Intellectual Property Rights*. – 2003. – № 2. – С. 17-28.

*Nuzhnaya Ksenia Gennadievna,  
Federal State Budgetary Educational Institution of Higher Education  
“Saint-Petersburg State Institute of Technology (Technical University)”,  
Saint Petersburg, Russian Federation  
nugnaya\_ks@mail.ru*

*Malikhina Olesya Vladimirovna,  
Federal State Budgetary Educational Institution of Higher Education  
“Saint-Petersburg State Institute of Technology (Technical University)”,  
Saint Petersburg, Russian Federation  
lesya265@gmail.com*

## **POSSIBILITY OF USING THE ADAPTIVE MODEL IN TRANSPORT SYSTEM MANAGEMENT**

**Abstract.** The main models of transport systems are considered in this paper. Theoretically, the question of application of one of the classical theories of automatic control to modelling of transport systems, i.e. transition from optimisation models of specific transport problems to models of optimal and, further, adaptive control of the whole transport system, is studied.

**Keywords:** model, optimisation model, optimal model, adaptive model, adaptive control.

*Нужная Ксения Геннадьевна,  
ФГБОУ ВО «Санкт-Петербургский государственный  
технологический институт (технический университет)»,  
Санкт-Петербург, Российская Федерация  
nugnaya\_ks@mail.ru*

*Малихина Олеся Владимировна,  
ФГБОУ ВО «Санкт-Петербургский государственный  
технологический институт (технический университет)»,  
Санкт-Петербург, Российская Федерация  
lesya265@gmail.com*

## **ВОЗМОЖНОСТЬ ИСПОЛЬЗОВАНИЯ АДАПТИВНОЙ МОДЕЛИ В УПРАВЛЕНИИ ТРАНСПОРТНЫМИ СИСТЕМАМИ**

**Аннотация.** В работе рассматриваются основные модели транспортных систем. Теоретически изучен вопрос приложения одной из классических теорий автоматического регулирования к моделированию транспортных систем, т. е. переход от оптимизационных моделей конкретных транспортных задач к моделям оптимального и далее адаптивного управления всей транспортной системой.

**Ключевые слова:** модель, оптимизационная модель, оптимальная модель, адаптивная модель, адаптивное управление.

In Russia, transport is one of the largest basic sectors of the economy. Due to the length of territories, the importance of the industry for the country is even more significant than in other countries, the transport complex should provide not only geographical connection between all parts of the country, but also economic connection between the sectors of the economy. In this regard, the development of not only transport, but also transport management systems is becoming important not only for companies, but also for the state. Digitalisation and informatisation have entered our lives so rapidly that today it is impossible for any industry to operate without it. Moreover, the directions of its sectoral and inter-sectoral development have already been determined, which leads to their ever-increasing importance and the need to develop software to solve specialised tasks and manage transport systems.

When creating programmes, the formal description of elements and tasks of the transport system is carried out, first of all, by means of mathematical modelling. The most widespread is modelling of the following tasks of the transport system:

- forecasting of transport volumes and technical and operational indicators;
- justification of the vehicle fleet structure;
- search for the shortest distances between the points of the transport network;
- optimisation of resource allocation;
- transport routing;
- selection of vehicles and transport schemes;
- assignment of transport routes to transport enterprises;
- allocation of vehicles to transport objects;
- development of schedules and timetables, coordination of the work of vehicles and terminals.

Table – Classification of transport system models

Types of models	Purpose	Purpose of modelling	Input conditions (input data)	Output data (modelling result)
Optimisation	Search for optimal solutions	Creation of development scenarios	Development objectives and constraints	Development scenarios
Forecasting	Forecast of transport infrastructure	Selection of optimal development scenarios	Formed development scenarios	Effective development scenarios.
Simulation	Parameter estimation and visualisation of transport processes	Project evaluation	Traffic flow parameters	Efficient traffic management project

Forecasting models are used in solving problems of transport planning and assessing the efficiency of modernisation projects of various transport systems [1]. The essence of building a forecast model is to calculate the average characteristics to determine the result of changes. Predictive models are realised under the following conditions, such parameters are known as:

- transport network configuration;
- transport network parameters;
- location of facilities;
- production parameters of the facilities;

Predictive models are created on the basis of:

- observations of a particular system;
- statistical processing of information.

The purpose of simulation models is to recreate the traffic flow and its features as well as its change in time. [2]

It all depends on the detail of the model. They can be macroscopic, where vehicles are considered in a general way. Namely by singling out each specific vehicle. And there are microscopic ones, when each vehicle will be considered separately taking into account their interactions.

Finally, the most extensive class is represented by optimisation models, which are used in solving most of the individual and general problems of transport system management.

An optimisation model is a model whose characteristic feature is the presence of one (single-criteria model) or several (multi-criteria model) target functions that allow finding the best solution from among the alternatives under consideration. [3]

Optimisation model considers different options for organising the process allocating resources (variables) taking into account their constraints in order to choose the best option for them. In general, the optimisation model is described by the following system:

$$\text{Target function: } K = f(x_1, \dots, x_j, \dots, x_n; a_1, \dots, a_k, \dots, a_l) \rightarrow \text{extr},$$

$$\text{Restrictions: } g_i = g_i(x_1, \dots, x_j, \dots, x_n; a_1, \dots, a_k, \dots, a_l) \begin{cases} \leq \\ \geq \\ = \end{cases} b_i,$$

$$\text{Variables: } X = (x_1, \dots, x_j, \dots, x_n),$$

where K is the optimality criterion;

f – target function;

$g_i$  – formulated constraints,  $i = \overline{1, m}$ ;

$x_j$  – variables,  $j = \overline{1, n}$ ;

$a_k$  – given parameters for variables,  $k = \overline{1, l}$ ;

$b_i$  – given values of the constraints.

The solution is to find the set of optimal values of the variables:

$$X^* = (x_1^*, \dots, x_j^*, \dots, x_n^*),$$

leading the target function to the extremum of its value (depending on the task) and satisfying the constraints on the specified parameters.

The target function is a mathematical expression, which includes all indicators and specified parameters of the model (in some cases can be excluded). The optimal solution is obtained by constructing the specified constraints, from which the area of acceptable solutions is found, which makes it possible to find all acceptable values of the variables of the parameters and, consequently, solutions in the obtained conditions.

The model variables are the model parameters whose values need to be optimised. As you can see the model does not take into account the change of parameters in time, and works exclusively in certain conditions - , i.e. there should be only a linear dependence of the solution on the variables, which leads to the use of these models only in specific cases, and to build a system of carrying out it is necessary to model all variants of specific tasks, which makes the system cumbersome and slows down its work. These problems are solved by transition to the optimal control model.

The optimal control problem includes not only the calculation of the optimal control programme (i.e., finding the optimal parameters), but also the synthesis of optimal control (i.e., tracking the state of the system at a point in time and selecting the optimal parameters for that point in time). The control programme is calculated in the form of the solution of the boundary value problem for the system of differential equations, and the synthesis of the control system is calculated in the form of a nonlinear programming problem in function spaces[4].

The mathematical model for the optimal control problem includes:

- a target function, in the form of a control quality criterion;
- a system of differential equations describing the possible change of the control object;
- a system of constraints in the form of equations or inequalities[4].

The mathematical model of the optimal control problem can be represented as follows:

Model:  $\dot{x}=F(x(t),u(t),t)$ .

Defined conditions:  $x(t_0)=x_0, x(t_1)=x_1 \dots$

Target function (management objective):  $u = u \left\{ \underset{u \in U}{\text{ext}} J_1(x, u, t) \right\}$

The problem of optimal control is to find the state functions  $x$  and control functions  $u$  at time  $t$ , at which the extremum is reached according to the given criteria of the system.

With the development of the transport industry, engineering and technology, the number of objects that need to be taken into account in control and, consequently, modelling increases. Each additional control object has its own characteristics and principles of functioning, which leads to the emergence of perturbing influences that were not put into the model and under the influence of which the model loses its optimality, i.e. there is a need to adapt the system to new conditions. Therefore, a separate direction in the informatisation of transport systems can be the development of adaptive (self-adjusting) models, which are the most universal.

Adaptation is the process of changing parameters, systems structure or control actions on the basis of information obtained during control in order to achieve

optimal control quality under initial uncertainty and/or changing operating conditions. [5]

The difference between adaptive systems and optimal systems is as follows. In optimal systems, the achievement of the target function is ensured by enumerating various variants of parameter combinations; in adaptive systems, the system parameters change in accordance with the perturbing influence, i.e., the system is changed rather than its variant is selected.

In modelling, the differences between adaptive models and optimal models begin at the stage of problem formulation.

The problem of adaptive control in a general form is written as a system of equations [6]:

$$\begin{aligned}\dot{x} &= F(x, u, f, \xi, t), \\ x(t_0) &= x_0, \\ x &\in H_x, u \in H_u.\end{aligned}$$

As mentioned earlier, parameter perturbations are added to the conditions of the adaptive model. Parametric perturbations can be referred to input parameters that affect the system for a long time, but have a damping effect. In this case, there is no linear dependence of the target function on the perturbing influence and the perturbing influence does not depend on time. Thus, the conditions of nonstationarity (1) and nonlinearity (2) are added:

- 1)  $\xi = \xi(t) \Rightarrow \dot{x} = A(\xi(t))x + B(\xi(t))u + f(t),$
- 2)  $\xi = \xi(x, t) \Rightarrow \dot{x} = A(\xi(x, t))x + B(\xi(x, t))u + f(t).$

Consequently, the model of the adaptive control problem taking into account perturbations can be written in the form:

$$\begin{aligned}\dot{x} = F(x, u, f, \xi, t) \Rightarrow (A[\xi(t)] + a(x, \xi))x + (B[\xi(t) + b(x, \xi)]u + f(t) = A_0x + B_0u + \\ [F(x, u, f, \xi, t) - A_0x - B_0u] = A_0x + B_0u + \sigma_\phi,\end{aligned}$$

where A and B are time-independent (non-stationary) parts;

a and b are nonlinear parts;

$(A_0x + B_0u)$  – desired change of the control object;

$A_0$  – Hurwitz matrix (otherwise the system is not stable).

Two additional conditions must be met:

- the object must be minimum-phase (i.e., stable);
- $(A_0, B_0)$  is a fully controlled system.

To define control, it is necessary to describe the quality of change of the object, i.e. to specify the rate, multiplicity and non-linearity of change.

$$\text{Rate of change of parameters: } \max_{i,j} [|\dot{a}_{i,j}|, |\dot{b}_{i,j}|] \leq \varepsilon,$$

where ( $a$  and  $b$ ) is the rate of change of the parameters.

The following cases are possible:

$\varepsilon \approx 0$  – quasi-stationary case (parameters practically do not change or change discontinuously and again and are constant on some interval);

$\varepsilon > 0$  – parameters change by jumps due to changing conditions;  
 Multiplicity of parameter changes:

$$\left| \max_{i,j} (a_{i,j}) - \min_{i,j} (a_{i,j}) \right| / \min_{i,j} |a_{i,j}| \leq \alpha, \quad \min_{i,j} |a_{i,j}| \neq 0,$$

$$\left| \max_{i,j} (b_{i,j}) - \min_{i,j} (b_{i,j}) \right| / \min_{i,j} |b_{i,j}| \leq \beta, \quad \min_{i,j} |b_{i,j}| \neq 0;$$

Nonlinearity of parameter variation:

$$\max_{i,j} \left| \frac{\partial a_{i,j}}{\partial x} \right| \leq \alpha_H; \quad \max_{i,j} \left| \frac{\partial b_{i,j}}{\partial x} \right| \leq \beta_H.$$

In contrast to the optimal control problem, the solution conditions of the adaptive control problem have qualitative indicators, i.e., they are limited not only by time and parameter characteristics.

Then the goal of adaptive control is to find the extremum of the system criteria linearity of parameter changes  $J_1$ :

$$u = u \left\{ \text{ext}_{u \in U} J_1(x, K, z, g, \hat{f}, \xi, t) \right\},$$

where  $g$  – input influences (or initial setpoints);

$K$  – matrix of adjustable parameters;

$z$  – vector of additional influences (corrective action to compensate for deviations).

Adaptation of the control system is carried out through the transformation of the matrix of adjustable parameters, and the formation of the vector of additional influences is the adjustment of the control system. As a result, the problem of solution search is divided into two:

- a)  $\text{ext } J_1$  at fixed  $K$  and  $Z$ , i.e., finding the optimal value of ;
- b)  $K$  &  $z$  that:  $[K, z] = \text{ext}_{K,z} J_2(x, [K, z], g, \hat{f}, \xi, t)$ .

The speed of adaptive systems is such that the processes in the model are faster than the real change in the parameters of the object and the environment, so when operating, the system has time to track changes in the tuning parameters of the object. The result of such a process is the fact that the system changes in time much less than from changes in the tuning parameters.

This paper is a theoretical attempt to apply one of the classical theories of automatic control to a transport system modelling system. Since the paper considered a general mathematical model of adaptive control, such modelling moments as data collection, analysis and processing of the modelled system were considered. The conducted analysis showed that the possibility of further algorithmisation of adaptive control of the transport system as a whole, solving not one, but several problems simultaneously and allowing control of parameters' output beyond the limits of permissible values.



### References:

1. Yakimov, M. R. *Transportnoe planirovanie: sozdanie transportnyh modelej gorodov* [Transport planning: creating transport models of cities]. 2013, 188 p. (in Russian).
2. Evseev, O. V., Yakimo, M. R. *Matematicheskie modeli v formirovanii jeffektivnyh transportnyh sistem* [Mathematical models in the formation of effective transport systems] // "Transport of the Russian Federation". No 6 (79). 2018. (in Russian).
3. Babina, O. I. *Razrabotka optimizacionnoj imitacionnoj modeli dlja podderzhki processov planirovanija skladskih sistem, Kompjuternye issledovanija i modelirovanie* [Development of an optimisation simulation model to support warehouse system planning processes, Computer Research and Modelling]. 2014. Vol. 6, Issue 2, pp. 295-307. (in Russian).
4. Rachkov, M. Y. *Optimal'noe upravlenie v tehniceskikh sistemah: uchebnoe posobie dlja vuzov* [Optimal control in technical systems: textbook for universities]. – 2024, 120 p. (in Russian).
5. Smorodin, V. S., Prokhorenko, V. A. *Adaptivnaja sistema upravlenija tehnologicheskim processom proizvodstva* [Adaptive control system for technological process of production] // *Problemy fiziki, matematiki i tehniki* [Problems of Physics, Mathematics and Technology]. No 3 (48), 2021. (in Russian).
6. Reshetnikova, G. N. *Adaptivnye sistemy* [Adaptive systems]. Tomsk. 2016, 112 p. (in Russian).

### Список литературы:

1. Якимов, М. Р. Транспортное планирование: создание транспортных моделей городов: монография / М. Р. Якимов. – М. : Логос, 2013. – 188 с. – Текст : непосредственный.
2. Евсеев, О. В. Математические модели в формировании эффективных транспортных систем / О. В. Евсеев, М. Р. Якимов. – Текст : непосредственный // Транспорт Российской Федерации. – 2018. – № 6 (79). – С. 30-34.
3. Бабина, О. И. Разработка оптимизационной имитационной модели для поддержки процессов планирования складских систем / О. И. Бабина. – Текст: непосредственный // Компьютерные исследования и моделирование. – 2014. – Т. 6, Вып. 2. – С. 295-307.
4. Рачков, М. Ю. Оптимальное управление в технических системах: учебное пособие для вузов / М. Ю. Рачков. – 2-е изд., испр. и доп. – Москва: Издательство Юрайт, 2024. – 120 с. – Текст : непосредственный.
5. Смородин, В. С. Адаптивная система управления технологическим процессом производства / В. С. Смородин, В. А. Прохоренко. – Текст : непосредственный // Проблемы физики, математики и техники. – 2021. – № 3 (48). – С. 96-102.
6. Решетникова, Г. Н. Адаптивные системы : учеб. пособие / Г. Н. Решетникова. – Томск: Издательский Дом Томского государственного университета, 2016. – 112 с. – Текст : непосредственный.

*Freidkina Elena Mikhajlovna,  
Saint Petersburg State University of Industrial Technologies and Design,  
Higher School of Technology and Energy,  
Saint Petersburg, Russian Federation  
freidi@gmail.com*

## CURRENT PROBLEMS OF ECONOMIC THEORY

**Abstract.** The article considers the main schools of economic theory, the peculiarities of the market of the XXI century, the problems of economic research of the laureates of the Alfred Nobel Memorial Prize in Economics.

**Keywords:** Economic theory, classical school, neoclassical school, supranational structures, market, Nobel Memorial Prize laureates in Economic Sciences.

*Фрейдкина Елена Михайловна,  
Санкт-Петербургский государственный университет  
промышленных технологий и дизайна,  
Высшая школа технологии и энергетики,  
Санкт-Петербург, Российская Федерация  
freidi@gmail.com*

## СОВРЕМЕННЫЕ ПРОБЛЕМЫ ЭКОНОМИЧЕСКОЙ ТЕОРИИ

**Аннотация.** В статье рассмотрены основные школы экономической теории, особенности рынка XXI века, проблематика экономических исследований лауреатов премии по экономике памяти Альфреда Нобеля.

**Ключевые слова:** экономическая теория, классическая школа, неоклассическая школа, наднациональные структуры, рынок, лауреаты премии по экономике памяти Альфреда Нобеля.

Modern economic theory, as well as most of the humanities, is in crisis. The crisis in science means that the current paradigm ceases to explain the known phenomena and the formation of a new theoretical framework is required.

The key concept of economic theory is the market. The classical school describes the market as a self-regulating mechanism based on the interaction of supply and demand. The key conditions of the market are commodity-money relations and competition. In the early stages of economic development there were two economic actors: seller and buyer. With the emergence of the state in the classical paradigm found for it the functions of protecting the "invisible hand of the market" without direct intervention in market processes.

With the development of industry and strengthening of the state, three subjects appear within the neoclassical school; the household, the firm, and the state. In this

case, the state becomes a full-fledged participant of market processes with unique functions: creating and providing a legal framework for the market system, protecting competition, redistributing income and producing public goods.

Further development of trade and industry leads to the merger of industrial and financial capital, which accelerated economic development many times over. V. I. Lenin in his work "Imperialism as the highest stage of capitalism" pointed out five signs of this stage of capitalism: the concentration of production and capital, creating monopolies; the merger of banking capital with industrial capital; the greater importance of the export of capital compared to the export of goods; the formation of international monopolistic unions; the end of the territorial division of the world. In the initial stage of imperialism, market mechanisms of regulation were still in place.

The development of the imperialist economic order in the twentieth century was characterised by numerous military conflicts over territories, markets, and sources of raw materials through the economic and political subjugation of weaker states.

In the twenty-first century, the market has little in common with its classical understanding. In addition to the three known subjects of economic relations, a vast group of supranational structures is added. First of all, these are transnational corporations. For example, the five largest smartphone manufacturers have a market share of 70 per cent;[1] the five largest manufacturers of hybrid cars - 58.5 per cent; electric cars - 42.8 per cent.[2] Exceptionally concentrated are the markets for air travel, banking services, pharmaceuticals, metals, mineral fertilisers, etc. The market is also extremely concentrated.

In addition to the industrial component, supranational structures include financial institutions (IMF, World Bank, Bank for International Settlements, etc.), regulatory organisations (UN, WTO), stock exchanges (commodity, stock, currency), standardisation organisations (ISO), military alliances (NATO), political alliances (EU, EAEU), and a large number of less significant structures such as rating and consulting agencies.

Supranational structures exert a powerful influence on market processes in the direction of ensuring the dominance of certain industrial, financial and service organisations, destroying healthy competition, distorting information and imposing their products and services. The activities of these structures often contradict state and national interests.

The table below shows the problems of the most famous economic studies.

Table – Problematics of studies that have won the Nobel Prize in Economics [3]

Year	Laureate	Key problems
000	James Heckman, Daniel McFadden	Analysis of the labour market and social programmes
001	George Akerlof, Michael Spence, Joseph Stiglitz	Information asymmetry
002	Daniel Kahneman, Vernon L. Smith	Lack of rationality in decision-making
003	Robert F. Engle, Robert F. Engle	Mathematical analysis of time series
004	Finn E. Kydland, Edward C. Prescott	Business cycles
005	Robert J. Aumann, Thomas C. Schelling	Analysing conflict and co-operation using game theory
006	Edmund S. Phelps	Intertemporal exchange in macroeconomic policy
007	Leonid Hurwicz, Eric S. Maskin, Roger Myerson	Incentive and resource allocation mechanisms
006	Paul Krugman	Analysing the structure of trade and the location of economic activity
009	Elinor Ostrom, Oliver E. Williamson	Transaction cost theory and collective action theory
010	Peter A. Diamond, Dale T. Mortensen, Christopher A. Pissarides	The theory of search and selection of goods and services in the market, the impact of search and selection on market efficiency, information asymmetry
011	Thomas J. Sargent, Christopher A. Sims	Impact of economic policy on macroeconomic indicators (inflation, unemployment, economic growth)
012	Alvin E. Roth, Lloyd S. Shapley	Use of auctions, tenders, competitions, etc. for equitable distribution of resources and benefits
013	Eugene F. Fama, Lars Peter Hansen, Robert J. Shiller	Unpredictable fluctuations in asset prices, factors affecting asset prices
014	Jean Tirole	Factors of market power and instruments of its regulation
015	Angus Deaton	Inequality and poverty, social security and welfare
016	Oliver Hart, Bengt Holmström	Behaviour of economic agents under conditions of incomplete contracts and imperfect information
017	Richard Thaler	Influence of psychological factors on economic decisions
018	William Nordhaus, Paul Romer	Sustainable development, long-term economic analysis, green economy

019	Abhijit Banerjee, Esther Duflo, Michael Kremer	Economic policy instruments for escaping the poverty trap
020	Paul Milgrom, Robert B. Wilson	Auction theory and new auction formats
021	David Card, Joshua Angrist, Guido Imbens	New methods for identifying cause-effect relationships
022	Ben Bernanke, Douglas Diamond, Philip H. Dybvig	A study of banks and financial crises
023	Claudia Goldin	Women's labour market research

Unfortunately, the sphere of scientific interests of Nobel Prize laureates in economics does not yet include complex problems such as the structure of the modern market, crisis phenomena, new economic models, problems and contradictions of globalisation, the place of the state in modern economic conditions, prospects for economic growth, globalisation processes, uncertainty in the economy, economic conditions of military conflicts, etc. This is probably a matter for future research.

#### References:

1. Leonov, E. P. *Rejting proizvoditelej smartfonov 2021* [Ranking of smartphone manufacturers 2021]. URL: <https://basetop.ru/rejting-proizvoditelej-smartfonov-2021/> (accessed 10 April 2024). (in Russian).
2. Razin, A. K. *6 iz 10 krupnejshikh proizvoditelej elektromobilej – kitajskie kompanii* [6 out of 10 largest electric car manufacturers are Chinese companies]. URL: <https://3dnews.ru/1082293/kitayskie-kompanii-zanimayut-shest-iz-desyati-pozitsiy-v-reytinge-krupneyshih-proizvoditeley-elektro> (accessed 10 April 2024). (in Russian).
3. *Spisok laureatov premii po jekonomike pamjati Al'freda Nobelja* [List of Nobel Memorial Prize laureates in Economic Sciences]. URL: [https://ru.wikipedia.org/wiki/List\\_of\\_Nobel\\_Memorial\\_Prize\\_laureates\\_in\\_Economic\\_Sciences](https://ru.wikipedia.org/wiki/List_of_Nobel_Memorial_Prize_laureates_in_Economic_Sciences) (accessed 10 April 2024). (in Russian).

#### Список литературы:

1. Леонов, Е. П. Рейтинг производителей смартфонов 2021 / Е. П. Леонов. – URL: <https://basetop.ru/rejting-proizvoditelej-smartfonov-2021/> (дата обращения: 10.04.2024). – Текст : электронный.
2. Разин, А. К. 6 из 10 крупнейших производителей электромобилей – китайские компании / А. К. Разин. – URL: <https://3dnews.ru/1082293/kitayskie-kompanii-zanimayut-shest-iz-desyati-pozitsiy-v-reytinge-krupneyshih-proizvoditeley-elektromobilej> (дата обращения: 10.04.2024). – Текст : электронный.
3. Список лауреатов премии по экономике памяти Альфреда Нобеля. – URL: [https://ru.wikipedia.org/wiki/List\\_of\\_Nobel\\_Memorial\\_Prize\\_laureates\\_in\\_Economic\\_Sciences](https://ru.wikipedia.org/wiki/List_of_Nobel_Memorial_Prize_laureates_in_Economic_Sciences) (дата обращения: 10.04.2024). – Текст : электронный.

## INFORMATION ABOUT AUTHORS / ИНФОРМАЦИЯ ОБ АВТОРАХ

<p><b>Semchuk Elena Vladimirovna,</b> Senior Lecturer, Department of Foreign Languages, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy</p>	<p><b>Семчук Елена Владимировна,</b> старший преподаватель, кафедра иностранных языков, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики</p>
<p><b>Sergeeva Ksenia Yakovlevna,</b> Senior Lecturer, Department of Foreign Languages, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy</p>	<p><b>Сергеева Ксения Яковлевна,</b> старший преподаватель, кафедра иностранных языков, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики</p>
<p><b>Stepanova Natalia Nikolaevna,</b> Docent, PhD in Philological Sciences, Saint Petersburg University of Management Technologies and Economics</p>	<p><b>Степанова Наталия Николаевна,</b> доцент, кандидат филологических наук, Санкт-Петербургский университет технологий управления и экономики</p>
<p><b>Stroganova Maria Sergeevna,</b> Senior lecturer of the department OOS and RIPR, PhD in Technical Sciences, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy</p>	<p><b>Строганова Мария Сергеевна,</b> старший преподаватель кафедры ООС и РИПР, кандидат технических наук, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики</p>
<p><b>Belousov Vladimir Nikolaevich,</b> PhD in Engineering, Associate Professor, Department of Industrial Heat Power Engineering, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy</p>	<p><b>Белоусов Владимир Николаевич,</b> кандидат технических наук, доцент, кафедра промышленной теплоэнергетики, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики</p>
<p><b>Smorodin Sergej Nickolaevich,</b> PhD of Technical Sciences, Associate Professor, Head of the Department of Industrial Thermal Power Engineering, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy</p>	<p><b>Сморodin Сергей Николаевич,</b> кандидат технических наук, доцент, заведующий кафедрой промышленной теплоэнергетики, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики</p>
<p><b>Litvinova Alexandra Vladimirovna,</b> Senior lecturer, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy</p>	<p><b>Литвинова Александра Владимировна,</b> старший преподаватель, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики</p>
<p><b>Marushchak Yulia Igorevna,</b> Postgraduate student, Vitebsk State Technological University</p>	<p><b>Марущак Юлия Игоревна,</b> аспирант, Витебский государственный технологический университет</p>
<p><b>Yasinskaya Natalya Nikolaïevna,</b> Docteur en Sciences Techniques, Chef de Département, Université technologique d'État de Vitebsk</p>	<p><b>Ясинская Наталья Николаевна,</b> доктор технических наук, заведующий кафедрой, Витебский государственный технологический университет</p>

<b>Lapaev Filipp Valer'evich,</b> Postgraduate student, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy	<b>Лапаев Филипп Валерьевич,</b> аспирант, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики
<b>Makhotina Lyudmila Gertsevna,</b> Doctor of Technical Sciences, professor, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy	<b>Махотина Людмила Герцевна,</b> доктор технических наук, профессор, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологий и энергетики
<b>Ruzanova Ekaterina Alexandrovna,</b> Deputy Head of the Department for Organization of Admission of Applicants, Assistant of the Department of Fundamentals of Machine Design, Saint Petersburg State University of Industrial Technologies and Design, the Higher School of Technology and Energy	<b>Рузанова Екатерина Александровна,</b> заместитель начальника Отдела по организации приема абитуриентов, ассистент кафедры основ конструирования машин, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики
<b>Mel'nichuk Mariya Sergeevna,</b> Postgraduate student, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy	<b>Мельничук Мария Сергеевна,</b> аспирант, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики
<b>Dubovyi Vladimir Klimentevich,</b> Doctor of Technical Sciences, professor, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy	<b>Дубовый Владимир Климентьевич,</b> доктор технических наук, профессор, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики
<b>Rakipov Antoniy Sergeevich,</b> Postgraduate student, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy	<b>Ракипов Антоний Сергеевич,</b> аспирант, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики
<b>Nazarova Anna Nikolaevna,</b> PhD in Economics, Head of the Department of Marketing and Logistics, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy	<b>Назарова Анна Николаевна,</b> кандидат экономических наук, заведующий кафедрой маркетинга и логистики, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики
<b>Viryacheva Evgenia Valeryevna,</b> Associate Professor of Marketing and Logistics Department, Deputy Director of the Institute of Management and Economics, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy	<b>Вирячева Евгения Валерьевна,</b> доцент кафедры маркетинга и логистики, заместитель директора Института менеджмента и экономики, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики
<b>Vasiliev Mikhail Vladimirovich,</b> Postgraduate student, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy	<b>Васильев Михаил Владимирович,</b> аспирант, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики

<b>Nikiforova Vera Dmitrievna,</b> Doctor of Economic Sciences, professor, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy	<b>Никифорова Вера Дмитриевна,</b> доктор экономических наук, профессор, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики
<b>Kovalenko Anna Vladimirovna,</b> PhD in Economic Sciences, Associate Professor, Saint Petersburg State University of Chemistry and Pharmacy	<b>Коваленко Анна Владимировна,</b> кандидат экономических наук, доцент, Санкт-Петербургский государственный химико-фармацевтический университет
<b>Nikiforov Alexander Alexandrovich,</b> PhD in economic sciences, Assistant Professor, Saint Petersburg Mining University	<b>Никифоров Александр Александрович,</b> кандидат экономических наук, доцент, Санкт-Петербургский горный университет
<b>Zlotnitskaya Tatiana Sergeevna,</b> PhD in Economics, Associate Professor, Department of History, Philosophy and Culture Studies, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy	<b>Злотницкая Татьяна Сергеевна,</b> кандидат экономических наук, доцент, кафедра истории, философии и культурологии, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики
<b>Kotova Anastasia Yurievna,</b> Senior Lecturer, Department of Management and Law, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy	<b>Котова Анастасия Юрьевна,</b> старший преподаватель, кафедра менеджмента и права, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики
<b>Mushenko Roman Dmitrievich,</b> Postgraduate student, Saint Petersburg State Institute of Technology (Technical University)	<b>Мушенко Роман Дмитриевич,</b> аспирант, ФГБОУ ВО «Санкт-Петербургский государственный технологический институт (технический университет)»
<b>Malikhina Olesya Vladimirovna,</b> PhD in Economics, Associate Professor of the Department of Business Informatics, Saint Petersburg State Institute of Technology (Technical University)	<b>Малихина Олеся Владимировна,</b> кандидат экономических наук, доцент кафедры бизнес-информатики, ФГБОУ ВО «Санкт-Петербургский государственный технологический институт (технический университет)»
<b>Nuzhnaya Ksenia Gennadievna,</b> Senior Lecturer at the Department of Economics and Industrial organization, Saint Petersburg State Institute of Technology (Technical University)	<b>Нужная Ксения Геннадьевна,</b> старший преподаватель кафедры экономики и организации производства, Санкт-Петербургский государственный технологический институт (технический университет)
<b>Freidkina Elena Mikhailovna,</b> PhD in Economics, Associate Professor, Director of the Institute of Management and Economics, Head of the Department of Economics and Industrial Management, Saint Petersburg State University of Industrial Technologies and Design, Higher School of Technology and Energy	<b>Фрейдкина Елена Михайловна,</b> кандидат экономических наук, доцент, директор Института управления и экономики, зав. кафедрой экономики и организации производства, Санкт-Петербургский государственный университет промышленных технологий и дизайна, Высшая школа технологии и энергетики



**МАТЕРИАЛЫ**  
**V Всероссийской научно-практической конференции**  
**с международным участием**  
**«ДИАЛОГ ПОКОЛЕНИЙ: ИЗУЧАЕМ. ОБУЧАЕМ. УЧИМСЯ»**

2024 • Часть I

**PROCEEDINGS**  
**of the V All-Russian Research and Practice Conference**  
**with International Participation**  
**«DIALOGUE OF GENERATIONS: LEARN. TEACH. STUDY»**

2024 • Part I

Редактор и корректор А. А. Чернышева  
Технический редактор А. А. Чернышева

Научное электронное издание сетевого распространения

Системные требования:  
электронное устройство с программным обеспечением  
для воспроизведения файлов формата PDF

Режим доступа: [http://publish.sutd.ru/tp\\_get\\_file.php?id=202016](http://publish.sutd.ru/tp_get_file.php?id=202016), по паролю.  
- Загл. с экрана.

Дата подписания к использованию 19.09.2024. Изд. № 5323/24

Высшая школа технологии и энергетики СПбГУПТД  
198095, СПб., ул. Ивана Черных, 4.