



Co-funded by
the European Union



Conference materials
of the V All-Ukrainian scientific and practical conference
of young scholars and higher education applicants

MODERN SCIENTIFIC AND TECHNICAL RESEARCH IN THE CONTEXT OF LINGUISTIC SPACE (IN ENGLISH)

Dnipro
May 14, 2026





Co-funded by
the European Union



Project No. 10101974 - DigitalFL - ERASMUS+ CAAC 2021-2024
Funded by the European Union. Views and opinions expressed herein do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.



Oles Honchar Dnipro National University
Faculty of Ukrainian and Foreign Philology and Study of Arts
Department of English Language for Non-Philological Specialities

**MODERN SCIENTIFIC AND TECHNICAL RESEARCH IN THE CONTEXT
OF LINGUISTIC SPACE (IN ENGLISH)**

*Conference materials
of the V All-Ukrainian scientific and practical conference
of young scholars and higher education applicants*

Dnipro, May 14, 2026

Dnipro
Publisher Bila K. O.
2026

UDC 81'243'276.6(043.2)

M78

Recommended for publication by the Academic Council of the Faculty of Ukrainian and Foreign Philology and Study of Arts, Oles Honchar Dnipro National University (protocol № 7 of 24.03.2026).

Reviewers:

Bobukh N. M., Doctor of Philological Sciences, Professor, Head of the Department of the Ukrainian, Foreign Languages and Translation, Poltava University of Economics and Trade;

Biriukova D. V., Candidate of Philological Sciences, Associate Professor of the Department of Foreign Philology, Translation and Professional Language Training, University of Customs and Finance;

Kyrpyta T. V., Candidate of Philological Sciences, Associate Professor of the Department of Translation and Foreign Languages, Ukrainian State University of Science and Technologies.

The materials are published in the author's edition.

The authors are responsible for the content of the materials.

EDITORIAL BOARD

Members of editorial board:

Iryna Popova, Doctor of Philological Sciences, Professor, Dean of the Faculty of Ukrainian and Foreign Philology and Study of Arts; **Olena Hurko**, Doctor of Philological Sciences, Professor, Head of the Department of English Language for Non-Philological Specialities; **Olha Aliseienko**, Candidate of Philological Sciences, Associate Professor of the Department of English Language for Non-Philological Specialities; **Olena Kondratieva**, Candidate of Pedagogical Sciences, Associate Professor of the Department of English Language for Non-Philological Specialities; **Vira Osypenko**, Doctor of Philosophy in Philology, Associate Professor of the Department of English Language for Non-Philological Specialities; **Olha Posudiiivska**, Candidate of Philological Sciences, Associate Professor of the Department of English Language for Non-Philological Specialities (executive secretary); **Tetyana Pryshchepa**, Candidate of Philological Sciences, Associate Professor of the Department of English Language for Non-Philological Specialities; **Iryna Suima**, Candidate of Philological Sciences, Associate Professor of the Department of English Language for Non-Philological Specialities; **Tetiana Vorova**, Candidate of Philological Sciences, Associate Professor of the Department of English Language for Non-Philological Specialities; **Olena Osadcha**, Senior Lecturer of the Department of English Language for Non-Philological Specialities; **Oksana Bovkunova**, Lecturer of the Department of English Language for Non-Philological Specialities; **Natalia Kaliberda**, Lecturer of the Department of English Language for Non-Philological Specialities; **Hanna Mudrenko**, Lecturer of the Department of English Language for Non-Philological Specialities.

M78 **Modern Scientific and Technical Research in the Context of Linguistic Space (in English)** : Conference materials of the V All-Ukrainian scientific and practical conference of young scholars and higher education applicants. Dnipro. May 14, 2026. Dnipro: Publisher Bila K. O., 2026. 282 p.

ISBN 978-617-645-542-4

The collection of conference materials includes academic works of the V All-Ukrainian scientific and practical conference of young scholars and higher education applicants "Modern Scientific and Technical Research in the Context of Linguistic Space (in English)" on natural, humanitarian, socio-economic, engineering and technical studies and the latest information technologies.

For students, post-graduates, teachers of higher educational establishments and scholars.

UDC 81'243'276.6(043.2)

ISBN 978-617-645-542-4

© Authors, 2026

Sergiy Okovytyy,
Doctor of Chemical Sciences, Professor,
Honoured Worker of Science and Technology of Ukraine,
Distinguished Educator of Ukraine,
Corresponding Member of the National Academy of Sciences of Ukraine,
Rector of Oles Honchar Dnipro National University

**WELCOMING SPEECH TO PARTICIPANTS
OF THE V ALL-UKRAINIAN SCIENTIFIC AND PRACTICAL
CONFERENCE OF YOUNG SCHOLARS AND HIGHER EDUCATION
APPLICANTS “MODERN SCIENTIFIC AND TECHNICAL RESEARCH
IN THE CONTEXT OF LINGUISTIC SPACE (IN ENGLISH)”**



Dear colleagues, researchers, and young scholars!

It is both a privilege and pleasure to warmly welcome you to the V All-Ukrainian Scientific and Practical Conference of Young Scholars and Higher Education Applicants “Modern Scientific and Technical Research in the Context of Linguistic Space (in English)”. Bringing together a wide range of perspectives and disciplines, this conference reflects the depth, diversity, and evolving character of contemporary research.

Marking its fifth year, the conference has established itself as a significant platform for the integration of scientific advancements and linguistic expertise. In the modern

world, a scholar's success is determined not only by the depth of research, but also by the ability to communicate it within the global academic community.

In the times that test endurance and prompt rethinking of priorities, the continuity of intellectual work takes on particular significance. Maintaining focus, sustaining dialogue, and pursuing research even under challenging circumstances reflect a deeper commitment to knowledge as an enduring value. In this light, the conference becomes not only an academic event, but also a space where thoughtful inquiry and a shared sense of purpose quietly affirm the resilience of the scholarly community.

What brings together the diverse fields represented at this conference is their subject matter, as well as a shared orientation towards understanding, interpretation, and discovery. Whether the focus is on natural sciences, technology, the humanities, or socio-economic studies, each contribution reflects an effort to engage with the complexity of the contemporary world and to give it a coherent form through research. The choice of English as the language of the conference further highlights its international orientation and integration into the global exchange of ideas and collaboration.

We would like to extend a warm and sincere welcome to students and young researchers joining us from overseas universities. Your presence enriches this conference with diverse perspectives, cultural experiences, and new academic approaches. International cooperation is essential in the modern scientific world, and we truly value the opportunity to cooperate with you. Particular importance should also be given to the involvement of first-year students, making initial steps in their research area, for whom academic engagement serves both as a stage of vocational development and a formative experience shaping their ways of thinking and communicating. Their openness to new ideas and willingness to engage in dialogue ensure the perpetuation and renewal of scholarly traditions.

I would like to express my sincere appreciation to the organizing committee and the Department of English Language for Non-Philological Specialities for their

continued support of this inspiring initiative. Their work helps to create an environment in which young scholars are encouraged to think critically, exchange ideas effectively, and develop both intellectually and professionally.

I wish all the participants a productive conference and engaging discussions. May the ideas presented here continue to evolve, shaping future research and contributing to the advancement of contemporary science!

Iryna Popova,
Doctor of Philological Sciences, Professor,
Dean of the Faculty of Ukrainian
and Foreign Philology and Study of Arts,
Oles Honchar Dnipro National University

**WELCOMING SPEECH TO PARTICIPANTS
OF THE V ALL-UKRAINIAN SCIENTIFIC AND PRACTICAL
CONFERENCE OF YOUNG SCHOLARS AND HIGHER EDUCATION
APPLICANTS “MODERN SCIENTIFIC AND TECHNICAL RESEARCH
IN THE CONTEXT OF LINGUISTIC SPACE (IN ENGLISH)”**



Dear conference participants!

I sincerely welcome you to the opening of the V All-Ukrainian Scientific and Practical Conference of Young Scholars and Higher Education Applicants “Modern Scientific and Technical Research in the Context of Linguistic Space (in English)”!

We are living in an age when philology extends beyond the fields of literary studies and linguistics. Nowadays, language is not just an object of study, but a key professional competency and the Department of

English-Language for Non-Philological Specialities applies a comprehensive approach that combines in-depth academic research with the practical acquisition of English language skills as a part of the higher education process.

Today the academic community has come together, with research covering an extremely wide variety of topics – from fundamental humanistic values to advanced technical developments. It is particularly encouraging to note the presence of young researchers – undergraduates and postgraduates – among the participants. Your involvement in the events of this kind is a significant first step towards building your professional portfolio. Your enthusiasm for carrying out complex research problems is a guarantee that Ukrainian science has a prosperous future! The contemporary world presents us with challenges that cannot be overcome within the confines of a single field of knowledge, for we live in an era of interdisciplinarity, where technological progress requires ethical reflection, and the development of society is impossible without digital transformation. That is precisely why our conference aims to create a platform for the dialogue between technical rationalism and humanistic wisdom.

The priority of our university is not only to engage in high-quality research, but also to present it on the global stage. Today, the English language is not just a means of communication; it is a means of validating scientific knowledge. Proficiency in academic English enables scientific research to go beyond the limits of local laboratories and to be presented at the global level, including publications in the international journals, indexed by Scopus and Web of Science.

Dear researchers, your academic inquiry provides the foundation that the modern society is based on. It plays an important role in the process of adaptation of global experience to the Ukrainian context whilst preserving our national identity. We have an ambitious goal: to establish Ukrainian science as an authoritative field within the international community, as its role in present-day reality is to contribute to the global integration, along with cherishing cultural heritage and advancing human resources. Today, we are participating in a conference that brings together technical insights and humanitarian analysis, becoming the perfect platform for new achievements!

The sessions of the conference will be conducted within the framework of the following topics: 1) modern studies in the sphere of natural sciences; 2) topical issues

of social sciences and humanities; 3) modern research in the sphere of socio-economic sciences and information technologies; 4) actual problems of engineering and technical sciences and modern information technologies.

I wish all participants constructive dialogue, inspiration and the successful implementation of your academic achievements. May the atmosphere of scientific investigation that prevails in our faculty encourage the emergence of new intellectual breakthroughs!

Thank you for your attention! Let's have productive conference sessions!

*Olena Hurko,
Doctor of Philological Sciences, Professor,
Head of the Department of English Language
for Non-Philological Specialities,
Oles Honchar Dnipro National University*

**WELCOMING SPEECH TO PARTICIPANTS
OF THE V ALL-UKRAINIAN SCIENTIFIC AND PRACTICAL
CONFERENCE OF YOUNG SCHOLARS AND HIGHER EDUCATION
APPLICANTS “MODERN SCIENTIFIC AND TECHNICAL RESEARCH
IN THE CONTEXT OF LINGUISTIC SPACE (IN ENGLISH)”**



Dear conference participants,
young scholars and higher education
applicants!

It is a great pleasure for me to
welcome you to the V All-Ukrainian
Scientific and Practical Conference of
Young Scholars and Higher Education
Applicants “Modern Scientific and
Technical Research in the Context of
Linguistic Space (in English)”!

Our conference is a unique event
which helps young academicians to
integrate their studies into the international
academic discourse, from formulating
the research results on paper to presenting
them in English-speaking environment.

It is an important step for overcoming the language barrier, coping with psychological stress and anxiety resulting from the necessity to speak and answer questions in

English. The conference contributes to the development of English presentation skills, which boosts the young scholars' confidence during further participation in foreign scientific projects and reporting at academic events, organized by the institutions abroad.

The conference space covers the achievements from different academic areas, ranging from social, humanitarian and economic studies to natural and technical sciences, engineering and modern information technologies, thus forming a large academic team of novice researchers and creating a vast platform for sharing scientific findings. It becomes a powerful instrument for the young scholars' professional and personal growth and a starting point for the majority of the participants striving to join the network of international academic collaboration.

I wish all the young scholars and higher education applicants to feel free to express their innovative ideas, to be engaged in stimulating discussions and ask thought-provoking questions. May this conference become an important step for your future academic career! May this event help to establish professional networks with your research peers and contribute to your experience in academic collaboration!

PANEL 1

Modern Studies in the Sphere of Natural Sciences

(DNU, Zoom)

D. Anutdinova, T. Ostanina, O. Aliseienko

LABORATORY ASSESSMENT OF KIDNEY FUNCTIONAL STATUS: TRADITIONAL AND MODERN METHODS

Kidney pathology ranks among the leading causes of chronic non-communicable diseases, highlighting its significance in modern clinical medicine. Impairment of kidney function accompanies the course of many somatic disorders, including arterial hypertension, diabetes mellitus, heart failure, and systemic connective tissue diseases. Therefore, timely and accurate assessment of kidney function is a necessary condition for early diagnosis, proper treatment strategy selection, and prevention of progression to renal insufficiency.

A distinctive feature of kidney pathology is its prolonged asymptomatic or mildly symptomatic course in the early stages. Clinical manifestations typically appear only after a significant reduction in the kidney's functional reserve, at which point therapeutic interventions are considerably limited. For this reason, laboratory methods play a key role in detecting initial functional impairments before the development of pronounced morphological changes.

Traditional laboratory indicators, which have been used in clinical practice for decades, remain the foundation of kidney disease diagnosis. However, they have certain limitations, including insufficient sensitivity at the early stages of damage. The development of modern laboratory technologies, the emergence of new biomarkers, and the implementation of calculation-based methods for assessing glomerular filtration rate have significantly expanded diagnostic capabilities. In this context, a systematic analysis of both traditional and modern laboratory methods for assessing kidney functional status is particularly relevant.

The use of modern methods, including the assessment of tubular injury markers, urine proteomics, bioimpedance evaluation of kidney function, and advanced molecular tests, enables earlier and more accurate detection of impairments, allows for the prediction of chronic kidney disease progression, and facilitates monitoring of treatment effectiveness. Comparative analysis of methods indicates that optimal assessment of kidney functional status is achieved through a combined approach, integrating classical laboratory indicators with modern biomarkers, thereby increasing diagnostic accuracy and enhancing the clinical value of the results.

Traditional laboratory methods for assessing kidney functional status remain fundamental in clinical practice and are widely used both during initial patient examination and in dynamic monitoring. They are valued for their accessibility, simplicity, and ability to provide information about the primary functions of the kidneys. Despite the emergence of modern high-sensitivity techniques, classical indicators continue to form the foundation of nephrological diagnostics.

One of the key areas is the assessment of nitrogen excretion function, particularly the level of serum creatinine, which serves as an indicator of glomerular filtration rate. Elevated creatinine indicates reduced kidney function; however, this parameter is influenced by age, sex, body weight, and muscle mass, requiring a comprehensive approach to interpretation. Another important indicator is urea, formed during protein metabolism. Its level also reflects renal functional capacity, but it is less specific due to influences from diet, hydration, and liver function, so its diagnostic value increases when combined with other data.

Urinalysis provides information on the physical, chemical, and microscopic characteristics of urine. The detection of proteinuria, hematuria, leukocyturia, or casts allows for the identification of early or specific kidney function impairments. Microalbuminuria is particularly important for the early diagnosis of renal damage in diabetes mellitus and hypertension.

Traditional methods also include functional tests to assess the kidney's concentrating and filtration ability. The Zimnitsky test evaluates daily variations in urine specific gravity, while the Rehberg test, which measures creatinine clearance,

long served as the “gold standard” for glomerular filtration rate, though it is now gradually being replaced by calculation-based formulas.

Contemporary nephrology focuses on the early diagnosis of kidney function impairments, as traditional indicators such as creatinine and urea often lag behind the actual nephron damage. Advances in biochemistry, molecular diagnostics, and calculation-based formulas have enabled the development of a comprehensive system for evaluating kidney function, providing high sensitivity and specificity even at early stages of pathology.

Calculation-based methods for determining GFR

Glomerular filtration rate (GFR) is a key integrative indicator of kidney functional status. It reflects the volume of plasma filtered through the glomeruli per unit of time and allows assessment of the functionally active nephron mass. In clinical practice, the following approaches are commonly used:

- MDRD Formula (Modification of diet in renal disease): Takes into account serum creatinine level, age, sex, and ethnicity. It is most commonly used in adults with reduced kidney function.
- CKD-EPI Formula (chronic kidney disease epidemiology collaboration): Provides a more accurate estimation of GFR in patients with normal or mildly reduced kidney function, reducing the error of the MDRD formula at higher creatinine values.
- Combined Formulas (creatinine + cystatin C): Offer more reliable results in patients with low muscle mass, the elderly, and children.

Calculation-based GFR methods are considerably more convenient than classical clearance tests, as they do not require 24-hour urine collection and allow rapid assessment of kidney function at any time. They are also widely used for chronic kidney disease risk stratification, dosing of nephrotoxic drugs, and planning of renal replacement therapy.

Cystatin C as a high-sensitivity marker

Cystatin C is a low-molecular-weight protein produced by all nucleated cells and is almost completely filtered by the glomeruli without reabsorption. Unlike

creatinine, its level is not influenced by muscle mass, diet, or sex, making it particularly valuable in the elderly, children, and patients with wasting conditions.

Studies show that Cystatin C rises significantly earlier than creatinine, allowing the detection of initial glomerular filtration impairment before the onset of clinical symptoms. Cystatin C is also incorporated into modern combined GFR formulas, enhancing the accuracy of predicting the development of renal insufficiency.

Biomarkers of glomerular and tubular injury

Modern laboratory practice includes the use of early nephron injury markers, enabling the detection of pathology at a subclinical level:

- NGAL (neutrophil gelatinase-associated lipocalin): Increases within 2–4 hours after proximal tubular injury, especially during acute ischemia or toxic damage.
- KIM-1 (kidney injury molecule-1): Expressed in proximal tubules following ischemic or toxic injury; levels correlate with the severity of damage.
- IL-18 (interleukin-18): A pro-inflammatory cytokine that helps differentiate inflammatory from nephrotoxic injury.
- β 2-microglobulin: A marker of tubular reabsorption; elevated urinary levels indicate tubular damage.

The combined use of these markers with traditional indicators and calculation-based formulas allows for early diagnosis, prognosis, and monitoring of therapy effectiveness, particularly in patients at high risk of developing chronic kidney disease.

Modern approaches to assessing nitrogen excretion function.

In addition to biomarkers, modern laboratory diagnostics evaluate 24-hour creatinine clearance and the ratio of urine to plasma concentrations of various metabolites (sodium, potassium, urea). The use of high-sensitivity methods for measuring these parameters allows the assessment of glomerular filtration efficiency and tubular function even when creatinine levels are within the normal range.

Integration of data into clinical practice

Contemporary assessment of kidney function involves a comprehensive approach:

- Calculation of GFR using CKD-EPI or MDRD formulas;
- Measurement of Cystatin C and NGAL for early detection of injury;

- Evaluation of tubular injury biomarkers (KIM-1, IL-18, β 2-microglobulin);
- Analysis of electrolyte and acid-base balance;
- Dynamic monitoring and prediction of the risk of progression to renal insufficiency.

This integrated approach significantly improves diagnostic accuracy, enables the detection of subclinical forms of kidney disease, and allows timely treatment adjustments, reducing the risk of progression to chronic kidney disease.

Acute kidney injury (AKI) is a clinical syndrome characterized by a sudden decrease in glomerular filtration and disruption of the body's water-electrolyte and acid-base balance. According to current KDIGO guidelines, AKI is diagnosed when creatinine increases by ≥ 0.3 mg/dL within 48 hours or urine output decreases to < 0.5 mL/kg/h for 6–12 hours. Early detection of acute kidney injury is critically important, as timely diagnosis reduces the risk of developing chronic kidney disease and improves patient prognosis.

Classical methods for assessing kidney function include measuring serum creatinine and urea levels. Increases in these indicators signal reduced glomerular filtration; however, they have limited sensitivity, especially in the early stages of injury. Creatinine begins to rise only after the loss of approximately 50% of nephron mass, so delayed elevation can complicate early diagnosis. Urea is less specific because its concentration depends on diet, dehydration, bleeding, and catabolic processes.

Urinalysis and urine sediment examination allow detection of hematuria, proteinuria, leukocyturia, and cylindruria, indicating renal-origin injury. Proteinuria, especially in the form of tubular casts, indicates tubular damage. Changes in urine color and clarity, increased specific gravity, or unstable concentrating ability are also used to assess the severity of acute injury.

Traditional indicators often lag behind actual nephron damage, so in modern practice early kidney injury biomarkers are used, which allows detection of pathology before clinical symptoms appear. The most important markers include:

- NGAL (neutrophil gelatinase-associated lipocalin): rapidly increases in serum and urine within 2–4 hours after tubular injury, making it valuable for early

diagnosis of acute tubular damage, for example after cardiovascular surgery or administration of contrast agents.

- KIM-1 (kidney injury molecule-1): a protein expressed in proximal tubules during ischemic or toxic injury. Its level in urine reflects the severity of damage and correlates with the prognosis of kidney function recovery.
- IL-18 (interleukin-18): a pro-inflammatory cytokine that rises in ischemic and inflammatory kidney processes. Its measurement allows differentiation between inflammatory injury and nephrotoxic changes.
- Cystatin C: a marker of glomerular filtration that rises significantly earlier than creatinine and is not affected by the patient's muscle mass, which is especially important in elderly and debilitated patients.

Chronic kidney disease (CKD) is a progressive disorder of kidney structure and function lasting more than three months, accompanied by reduced glomerular filtration or the presence of markers of kidney damage. In the early stages, CKD often remains asymptomatic, so timely diagnosis allows slowing disease progression and preventing end-stage renal failure.

A key indicator of kidney function is the glomerular filtration rate (GFR), which is estimated using modern formulas such as CKD-EPI and MDRD, taking into account creatinine level, age, sex, and ethnicity. GFR allows classification of CKD stages and guides therapy decisions and planning for renal replacement therapy.

An early marker of glomerular injury is microalbuminuria, which precedes overt proteinuria. Proteinuria reflects prolonged glomerular damage and predicts the rate of CKD progression.

Modern diagnostics also include assessment of tubular injury biomarkers such as NGAL, KIM-1, β 2-microglobulin, and IL-18, which enable detection of pathology at early stages and prediction of further loss of kidney function.

For CKD monitoring, it is important to evaluate the dynamics of GFR, creatinine levels, proteinuria, and biomarkers, as well as electrolyte and acid-base balance. Integration of traditional and modern methods allows early diagnosis, progression

prediction, therapy personalization, and timely initiation of renal replacement therapy, reducing the risk of complications.

Laboratory diagnostics of the kidneys continues to develop rapidly, adapting to the needs of modern medicine for early detection and accurate assessment of kidney status in patients with acute and chronic diseases. Traditional indicators, such as creatinine and urea, although remaining foundational, are insufficiently sensitive for diagnosing pathology at early stages. Modern approaches focus on the use of high-sensitivity biomarkers, calculation-based glomerular filtration rate (GFR) formulas, and digital technologies for integrated kidney function assessment, allowing detection of injury before clinical symptoms appear. Biomarkers such as NGAL, KIM-1, IL-18, β 2-microglobulin, and cystatin C can reflect early glomerular and tubular damage and enable prompt diagnosis. For example, an increase in NGAL in urine or serum a few hours after toxic exposure or ischemia allows timely adjustment of therapy and prevention of progression to renal failure, while traditional indicators may remain within normal limits for several days. KIM-1 and IL-18 provide additional information on the severity of injury and the presence of an inflammatory component, which is important for assessing the risk of organ function recovery. The use of cystatin C allows more accurate GFR estimation regardless of the patient's muscle mass, which is particularly important in the elderly, children, and debilitated patients.

The development of genomic and proteomic technologies opens new opportunities for personalized nephrology. Genetic studies allow identification of patients at increased risk of nephrotoxicity, rapid progression of chronic kidney disease, or susceptibility to acute injury. Proteomic and metabolomic studies provide information about specific proteins, peptides, and metabolites characteristic of different types of kidney damage, enabling differential diagnosis and disease course prediction. This is particularly valuable in complex pathologies such as diabetes, hypertension, and cardiovascular diseases, where kidney injury may develop unnoticed by standard laboratory tests.

Integration of digital technologies and artificial intelligence into laboratory diagnostics allows simultaneous processing of large volumes of clinical and laboratory

data. Machine learning algorithms can predict the risk of developing acute or chronic kidney failure, taking into account hundreds of parameters: creatinine level, cystatin C, NGAL, proteinuria, electrolyte balance, age, comorbidities, and history of previous interventions. Such algorithms are already used in large clinics for early patient assessment in intensive care units, post-cardiac surgery, and when prescribing nephrotoxic drugs, enabling timely prevention of severe complications.

The development of portable (point-of-care) and mobile laboratory tests allows rapid determination of NGAL, KIM-1, cystatin C, and other markers directly in clinical settings, including outpatient clinics and intensive care units. This ensures quick decision-making, reduces the time between diagnosis and therapy initiation, and enables real-time monitoring of kidney status. Combining these technologies with classical methods, such as GFR estimation and proteinuria measurement, creates a comprehensive system for assessing kidney function, covering all aspects of organ performance—glomeruli, tubules, electrolyte balance, and functional reserve.

The future of laboratory kidney diagnostics lies in full personalization, integration, and high sensitivity. Combining data from traditional indicators, modern biomarkers, genetic tests, proteomics, and artificial intelligence algorithms enables the creation of individualized patient profiles, prediction of acute and chronic kidney injuries, determination of optimal treatment strategies, and planning of renal replacement therapy. This opens new prospects for early diagnosis of subclinical kidney pathology, prevention of severe complications, and improvement of patient quality of life. Through the implementation of integrated and personalized approaches, laboratory diagnostics becomes not merely a tool for assessing kidney function but a key element of modern nephrology, capable of predicting, preventing, and optimizing patient treatment in various clinical situations.

Conclusions. 1. Laboratory assessment of kidney functional status is a key element of modern nephrology and clinical medicine. Traditional indicators, such as creatinine, urea, and glomerular filtration rate, remain foundational but have limited sensitivity in the early stages of pathology.

2. The use of biomarkers of glomerular and tubular injury (NGAL, KIM-1, IL-18, cystatin C) enables early detection of kidney damage, prediction of disease severity, and assessment of the potential for organ function recovery, which is important for selecting patient management strategies.

3. A comprehensive approach combining traditional indicators, modern biomarkers, GFR calculation formulas, and digital technologies increases diagnostic accuracy, allows assessment of kidney functional reserve, and detects hidden electrolyte imbalances.

4. Genomic and proteomic methods, artificial intelligence, portable laboratory systems, and mobile tests provide personalized diagnostics, risk prediction for kidney injury, estimation of disease progression speed, and optimization of treatment.

5. Combining traditional and innovative methods ensures early, accurate, and personalized diagnosis, allows monitoring of acute and chronic kidney disease progression, prevents complications, and improves patient quality of life.

REFERENCES

1. Болігнано Д. та ін. Біомаркери ушкодження нирок. Київ: Медицина, 2020.
2. Клименко С. М., Романенко М. П. Нефропротекція та рання діагностика ушкодження нирок. Київ: Медицина, 2020.
3. Колесник М. О., Дудар І. О., Гончар Ю. І. та ін. Лікування анемії у хворих з хронічною нирковою недостатністю: метод. рек. Київ, 2003.
4. Пиріг Л. А., Дудар І. О. Механізми прогресування захворювань нирок // Медичний реферативний журнал. 1998. № 3–4. Розд. I.
5. Endre Z. H. et al. Early detection of acute kidney injury: the role of functional and damage biomarkers // *Nephron Clinical Practice*. 2011. Vol. 119. P. c105–c111.
6. Kati Kaartinen. Настанова 00226. Лікування хронічної хвороби нирок. 2020.
7. KDIGO 2021 Clinical Practice Guideline for the Management of Chronic Kidney Disease // *Kidney International Supplements*. 2021. Vol. 11, No. 1. P. 1–150.
8. Koyner J. L. et al. Biomarkers predict AKI progression and mortality // *Journal of the American Society of Nephrology*. 2010. Vol. 21. P. 1748–1756.
9. Levey A. S., Stevens L. A. Estimating GFR using the CKD-EPI equation // *Annals of Internal Medicine*. 2009. Vol. 150. P. 604–612.
10. McCullough P. A. et al. Role of biomarkers in acute kidney injury // *Journal of the American College of Cardiology*. 2011. Vol. 57. P. 2401–2412.
11. Peres L. A. B. et al. Current trends in renal biomarker research // *Clinica Chimica Acta*. 2020. Vol. 501. P. 49–61.
12. Stevens L. A. et al. Evaluating GFR equations in diverse populations // *Clinical Journal of the American Society of Nephrology*. 2010. Vol. 5. P. 1402–1412.
13. Vaidya V. S., Ferguson M. A., Bonventre J. V. Biomarkers of acute kidney injury // *Annual Review of Pharmacology and Toxicology*. 2008. Vol. 48. P. 463–495.
14. Vaidya V. S. et al. Emerging biomarkers for renal injury: clinical applications // *Nature Reviews Nephrology*. 2008. Vol. 4. P. 404–416.
15. Zappitelli M. et al. Pediatric AKI biomarkers: NGAL, KIM-1, and IL-18 // *Pediatric Nephrology*. 2007. Vol. 22.

INFLAMMATION BIOMARKERS IN CHRONIC DISEASES

Chronic inflammation is a key link in the pathogenesis of many common non-infectious diseases, such as atherosclerosis, rheumatoid arthritis, chronic obstructive pulmonary disease (COPD), metabolic syndrome, type 2 diabetes mellitus, obesity, chronic renal failure, and neurodegenerative processes [1]. It is characterized by persistent activation of the immune system, cytokine dysregulation, tissue infiltration by immunocompetent cells, and an imbalance between pro- and anti-inflammatory factors. The determination of inflammation biomarkers is of great importance for early diagnosis, monitoring of disease activity, assessment of treatment efficacy, and prognosis of disease progression [2].

Among the classic laboratory indicators of systemic inflammation are C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), fibrinogen, seromucoids, as well as acute phase cytokines – interleukins (IL-1 β , IL-6, IL-8), tumor necrosis factor alpha (TNF- α). CRP is an acute phase protein synthesized by hepatocytes under the action of IL-6 and IL-1 β [3]. Elevated plasma CRP levels indicate an active systemic inflammatory response and correlate with the severity of the inflammatory process, including in cardiovascular pathologies, autoimmune and infectious diseases [4]. IL-6 is a central mediator between the immune system and the liver, stimulates the synthesis of acute phase proteins, and participates in glucose metabolism and the formation of insulin resistance [5]. TNF- α is a potent pro-inflammatory cytokine that activates endothelial cells, leukocytes, and macrophages, enhancing the cascade reaction of inflammation and apoptosis [6].

Chronic inflammation differs from acute inflammation in its constant, low-level production of cytokines and slow but progressive tissue damage. In atherosclerosis, TNF- α , IL-1 β , and CRP contribute to endothelial activation, atheromatous plaque formation, and thrombogenesis. In rheumatoid arthritis, increased expression of IL-1 β , IL-6, and TNF- α stimulates cartilage degradation through the activation of osteoclasts

and metalloproteinases [7]. In patients with type 2 diabetes mellitus, elevated levels of CRP, IL-6, and TNF- α are markers of metabolic inflammation, which disrupts insulin signaling pathways and contributes to the development of vascular complications [3, 5].

Recent years have been marked by active research into new molecular biomarkers that reflect deeper pathogenetic mechanisms. These include microRNAs (miR-21, miR-155, miR-146a), which regulate the expression of cytokine genes and Toll-like receptors [6]; adipokines (leptin, adiponectin, visfatin), which form the link between adipose tissue, metabolism, and inflammation; oxidative markers – malondialdehyde (MDA), superoxide dismutase (SOD), catalase – reflect the level of free radical damage [4]. Cell markers of macrophage activation (CD68, CD163), which determine the M1/M2 phenotype of the immune response, are also promising.

The integration of classical and new biomarkers into clinical practice allows the creation of multicomponent diagnostic panels for stratifying patients according to the risk of complications and selecting personalized therapy [7]. The combination of serological, cytokine, and molecular markers increases the accuracy of diagnosis and promotes the transition to preventive and personalized medicine.

Thus, inflammatory biomarkers play a key role in understanding the pathogenesis of chronic diseases. Their comprehensive determination has significant potential for early diagnosis, prognosis, and therapy monitoring, as well as for assessing the risk of systemic complications. Further research in this area will contribute to the development of new therapeutic strategies aimed at controlling chronic inflammation and reducing mortality from non-communicable diseases.

REFERENCES

1. Calder P., Bosco N., Bourdet-Sicard R. Inflammatory disease processes and interactions with nutrition. *British Journal of Nutrition*. 2022, 128 (5). P. 892–905.
2. Gabay C., Kushner I. Acute-phase proteins and other systemic responses to inflammation. *New England Journal of Medicine*. 2020, 382 (8). P. 738–749.
3. Ridker P. A test in context: high-sensitivity C-reactive protein. *Journal of the American College of Cardiology*. 2021, 78 (1). P 96–108.
4. Reuter S., Gupta S. C., Chaturvedi M. M., Aggarwal B. B. Oxidative stress, inflammation, and cancer. *Free Radical Biology and Medicine*. 2021, 160. P. 108–122.
5. Hotamisligil G. S. Inflammation, metaflammation and immunometabolic disorders. *Nature Reviews Immunology*. 2023, 23 (4). P 251–267.

6. O'Connell R. M., Rao D. S., Baltimore D. microRNA regulation of inflammatory responses. *Annual Review of Immunology*. 2021, 39. P. 295–323.
7. Chen L., Deng H., Cui H. Inflammatory responses and inflammation-associated diseases in organs. *Oncotarget*. 2021, 12(4). P. 376–393.

I. Baranenko, K. Holoborodko, O. Hurko

THE IMPACT OF ROBINIA PSEUDOACACIA ON CHERNOZEM TRANSFORMATION IN ANTI-EROSION PLANTATIONS OF THE STEPPE ZONE

In the steppe zone of Ukraine, the black locust (*Robinia pseudoacacia* L.) is one of the most widespread tree species used for creating protective shelterbelts and anti-erosion plantations. Despite its high adaptability and rapid growth, this species exerts a specific, and in some cases destructive, influence on reference fertile soils – Chernozems. Research indicates that the replacement of natural steppe vegetation with acacia monocultures triggers a series of morphological, physicochemical, and biological transformations of the soil cover.

The influence of *R. pseudoacacia* on the physical state of Chernozem is differentiated. On one hand, forest plantations intensify soil aggregation processes, manifested by an increase in the proportion of agronomically valuable fractions (1-2 mm). Conversely, studies by Gorban et al. (2020) recorded the emergence of large structural elements (>10 mm), which are not inherent to calcium-rich Chernozems under typical steppe vegetation [1]. Along with this, an increase in bulk density and particle density is observed, which leads to a reduction in total porosity.

The root system of *R. pseudoacacia* significantly impacts hydrodynamic processes in the soil profile through the production of root exudates. The secretion of these compounds leads to a decrease in saturated hydraulic conductivity. According to research by Xiao et al., the mechanism of this phenomenon lies in the increase of the bound water fraction, which results in the narrowing of the effective radius of

filtration channels [3]. An important functional feature of such plantations is their moisture accumulation capacity: an increase in plant-available water content has been recorded in the upper soil layer (0-20 cm) compared to treeless control plots [2].

The most significant destructive consequence of cultivating *R. pseudoacacia* on Chernozems is the progressive depletion of their chemical potential. Growing acacia leads to a decline in soil organic matter. Specifically, a decrease in carbon content by an average of 0.4% has been recorded in the one-meter soil layer [1, p. 2]. The functioning of acacia ecosystems is accompanied by gradual acidification of the soil profile (a pH decrease of 0.2 units in the 1-m layer) and an increase in hydrolytic acidity. A key indicator of the deterioration of soil adsorption capacity is a substantial reduction in cation exchange capacity – by an average of 11 cmol/100 g [1].

Paradoxically, alongside these degradational chemical changes in soil chemical parameters, *R. pseudoacacia* biogeocenoses are characterized by a high level of microbiological activity. Results of metagenomic analysis conducted by K. Bereczki et al. demonstrate that the soil microbiome under acacia plantations features higher bacterial diversity indices compared to oak phytocenoses [5]. The dominant taxa in the microbial community structure are the phyla Acidobacteriota, Actinobacteriota, and Proteobacteria. Under conditions of progressive phosphorus deficiency, microorganisms carrying the functional *phoD* gene play a crucial ecological role. This specific group of prokaryotes produces the enzyme alkaline phosphatase, the activity of which correlates positively with the age of the plantation. Enhanced synthesis of this enzyme acts as a compensatory and adaptive mechanism of the soil microbiome, aimed at mobilizing recalcitrant compounds and replenishing the pool of mobile phosphorus forms [4].

In conclusion, despite high anti-erosion efficiency and the ability to accumulate moisture in the upper genetic horizons, the long-term exploitation of *Robinia pseudoacacia* monocultures on Chernozems in the Steppe zone initiates degradational transformations of the soil cover. These negative changes manifest as progressive acidification, intensified dehumification, and a significant depletion of the mineral phosphorus pool. Therefore, when designing forest reclamation measures, it is essential

to consider these ecological risks; priority should be given to creating mixed plantations as a tool to stabilize the organic matter balance and preserve the reproductive capacity of Chernozems.

REFERENCES

1. Changes in Physical and Chemical Properties of Calcic Chernozem Affected by Robinia pseudoacacia and Quercus robur Plantings / V. Gorban [et al.]. *Ekológia (Bratislava)*. 2020. Vol. 39, no. 1. P. 27 – 44. DOI: <https://doi.org/10.2478/eko-2020-0003>.
2. Gorban V., Huslysty A. Changes in selected properties of Calcic Chernozem due to cultivation of Robinia pseudoacacia and Quercus robur. *Folia Oecologica*. 2023. Vol. 50, no. 2. P. 196–203. DOI: <https://doi.org/10.2478/foecol-2023-0018>.
3. Investigating saturated hydraulic conductivity and its variation in a fine-grained soil with root exudates of Robinia pseudoacacia L. / T. Xiao [et al.]. *Journal of Rock Mechanics and Geotechnical Engineering*. 2025. Vol. 17. DOI: <https://doi.org/10.1016/j.jrmge.2025.03.056>.
4. *Phod*-harboring bacterial communities mediated slow and fast phosphorus transformation in alkaline soil of a Robinia pseudoacacia afforestation chronosequence / Y. Wang [et al.]. *Plant and Soil*. 2023. Vol. 488. P. 1–16. DOI: <https://doi.org/10.1007/s11104-023-05990-z>.
5. Soil Parameters and Forest Structure Commonly Form the Microbiome Composition and Activity of Topsoil Layers in Planted Forests / K. Berezki [et al.]. *Microorganisms*. 2024. Vol. 12, no. 6. Art. 1162. DOI: <https://doi.org/10.3390/microorganisms12061162>.

I. Chumakov, N. Yesipova, O. Osadcha

EXPOSURE OF COPPER ON REPRODUCTIVE SYSTEMS OF FISH

Since February 24, 2022, Ukraine has been experiencing large-scale military operations that have led to the destruction of infrastructure and significant environmental pollution, including water bodies, with toxic compounds. Heavy metals, including copper, are among the most common toxicants in such water bodies [1]. Not only heavy metals are capable of bioaccumulation but are ubiquitous and pervasive too. They do not dissolve or decompose in water. Particularly, copper affects the physiological and morphological parameters of fish, which worsens their quality as a food product and poses a threat to public health [2]. Studies show that the copper content in water bodies in the Dnieper region has increased several times over the two years of war [3].

The mechanism of chronic effects of elevated copper concentrations on biochemical processes in fish remains poorly understood. Majority of studies are focused on acute exposure to copper during short periods of time. However, such approach does not provide explicit picture of its real effect on fish.

Work in this area was initiated by us last year. In a chronic experiment on guppy fish (*Poecilia wingei*), it was found that copper at a concentration of 0.02 mg/L causes fatty liver disease along with serious disturbances in the structure of the gills [4]. However, the effect of chronic copper concentrations on the reproductive system of fish remains unclear, which is important for the control of natural fish populations.

Therefore, the aim of present study was to study the effect of chronic exposure to copper at a concentration of 0.02 mg/L on the histological structure of fish gonads under long-term experimental conditions.

We found that there were no morphological or visible signs of intoxication. Though there was 21% difference in dry weight in experimental fish compared to control ones. Importantly, copper has drastically changed oogenesis processes preventing formation of matured eggs in females. Additionally, the toxicant had hazardous impact on spermatogenesis processes by decreasing amount of germ cells, spermatogenic cells and lobule's areas. Finally, we observed intersexuality in experimental fish. It is of a crucial concern since it can potentially alter gender ratio in wild populations. Altogether, it resulted in suppressed larval birth indicating disturbances in embryonic development.

REFERENCES

1. Repez, F., and Mirela A. "The Environment – a 'Silent Victim' of Armed Conflicts." *Annals of the University of Oradea: International Relations and European Studies* 12, no. 2 (2019): 123–133.
2. Malhotra, N., Ger, T.-R., Uapipatanakul, B., Huang, J.-C., Chen, K. H.- C. , & Hsiao, C.-D. (2020). Review of Copper and Copper Nanoparticle Toxicity in Fish. *Nanomaterials*, 10(6), 1126. <https://doi.org/10.3390/nano10061126>
3. Yesipova, N., Sharamok, T., Sklyar, T., Marenkov, O., Gudym, N., & Foroshchuk, V. (2023). The hydroecological characteristics of current state of the Zaporizhzhia (Dnipro) reservoir and its tributaries. *Ribogospodars'ka Nauka Ukraini.*, 4(66), 35–48. <https://doi.org/10.61976/fsu2023.04.035>
4. Yesipova, N. B., Khromykh, N. O., Sharamok, T. S., Marenkov, O. M., Zhuravlov, D. V., & Chumakov, I. O. (n.d.). Structural and Functional State of Liver, Gills, and Muscle Tissue of Fishes under Chronic Copper Intoxication. *Hydrobiological Journal*, 62(2), 43–53. <https://doi.org/10.1615/HydrobJ.v62.i2.30>

ENGLISH IN BUSINESS COMMUNICATION AND INTERNATIONAL ECONOMIC RELATIONS

English has become the dominant language of global business, international trade and economic diplomacy. In the context of growing globalization, the ability to communicate effectively in English is a key factor determining the success of companies and specialists operating in international markets. Business English functions as a universal linguistic tool that enables partners from different cultural and economic backgrounds to reach mutual understanding, negotiate agreements and build long-term professional cooperation [2]. Moreover, it serves as a medium for expressing complex technical, financial and managerial concepts in a clear and standardized way [4].

One of the central aspects of English-language business communication is the use of standardized terminology and unified formats of documentation. Contracts, financial reports, presentations, and correspondence are predominantly conducted in English, which reduces the risk of misinterpretation and improves the transparency of economic transactions [5]. Additionally, English facilitates the creation of professional documents that comply with international standards, such as IFRS reports or corporate governance guidelines. The rapid development of digital technologies and global information platforms has intensified the use of English as a medium for virtual meetings, webinars, cross-border project management [4].

In international economic relations, English plays a strategic role in facilitating collaboration between governments, corporations, and global institutions. Organizations such as the World Trade Organization, the International Monetary Fund, and the World Bank conduct the majority of their communication in English [4]. Similarly, multinational corporations rely on English for internal communication, client relations, and negotiation of contracts across different regions. Consequently, specialists in economics, finance, and management increasingly require advanced proficiency in

professional English to participate fully in international dialogues, policy development, and economic forecasting [1]. Business communication training also enhances cross-cultural awareness, which is critical for managing global teams and avoiding misunderstandings.

Furthermore, English serves as a bridge for knowledge transfer and innovation. International conferences, research publications and professional forums predominantly use English, enabling professionals to share insights, adopt best practices, and integrate technological and financial innovations across borders. In this way, English not only facilitates operational communication but also contributes to strategic decision-making and global competitiveness.

Thus, English is not only a means of communication but also a crucial component of economic integration. It enhances the effectiveness of business interaction, supports international partnerships, and contributes to the formation of a unified global economic space. Consequently, the development of English-language competence becomes an essential element of professional training for future economists, managers and business leaders [2].

REFERENCES

1. Bargiela-Chiappini F., Nickerson C., Planken B. *Business Discourse*. London: Palgrave Macmillan, 2014.
2. Crystal D. *English as a Global Language*. Cambridge: Cambridge University Press, 2012.
3. Jenkins J. *Global Englishes*. 3rd ed. London: Routledge, 2015.
4. Kankaanranta A. Business English Lingua Franca in intercultural (business) communication. *Language at Work-Bridging Theory and Practice*, 2008, 3 (4).
5. Nickerson C. The death of the non-native speaker? English as a lingua franca in business communication: A research agenda. *Language Teaching*, 2015, 48 (3), P. 390-404.

MODERN PARADIGMS OF THE IMPACT OF VITAMIN D ON HUMAN HEALTH

Vitamin D plays an essential role in maintaining human health. In modern medicine, it is considered not only a nutrient but also a steroid prohormone that regulates many physiological processes. Vitamin D receptors (VDR) are present in most cells of the human body, which explains its wide biological activity. According to recent global studies, vitamin D deficiency is a major health problem associated with an increased risk of many chronic diseases [3, p. 4].

Recent clinical guidelines emphasize the importance of maintaining adequate vitamin D levels in different population groups. For children and adolescents, sufficient vitamin D is essential for bone mineralization and the proper development of the immune system [2, p. 11]. In older adults, particularly those over 75, adequate levels significantly reduce the risk of falls and hip fractures, which are common causes of disability in this age group [1, p. 18]. Furthermore, research indicates that sufficient vitamin D levels during pregnancy are associated with a lower risk of preeclampsia, preterm birth, and gestational diabetes [1, p. 22].

Another critical aspect is the immunomodulatory function of vitamin D. Unlike traditional antibiotics, vitamin D enhances the natural defense mechanisms of the body by modulating both innate and adaptive immunity. It stimulates the synthesis of antimicrobial peptides, such as cathelicidins and defensins, which help destroy viruses and bacteria. Studies published in the Cochrane Database show that regular supplementation may reduce the incidence of acute respiratory infections by 20-25%, especially in individuals with severe deficiency [4, p. 52].

Vitamin D also plays an important role in metabolic and cardiovascular health. Vitamin D receptors are present in pancreatic beta cells, which are responsible for insulin production. Studies indicate that adequate vitamin D levels may support insulin

sensitivity and help manage the risk of developing type 2 diabetes [2, p. 24]. In addition, vitamin D influences the cardiovascular system by regulating the renin–angiotensin system and helping to maintain normal blood pressure levels [2, p. 28].

Recent scientific research highlights the relationship between vitamin D and brain function. Vitamin D participates in neuroprotective processes and may help reduce the risk of neurodegenerative diseases by assisting with the regulation of amyloid plaques in the brain [3, p. 12]. It is also involved in the synthesis of neurotransmitters, such as serotonin and dopamine, which influence mood and emotional stability [4, p. 58].

However, excessive intake of vitamin D may lead to hypervitaminosis and pathological calcification of tissues, particularly the kidneys. Therefore, supplementation should be balanced and carried out under medical supervision [3, p. 8].

In conclusion, modern scientific research demonstrates that vitamin D plays a significant role in maintaining bone health, immune protection, metabolic balance, and neurological function. Maintaining an optimal level of vitamin D through adequate sunlight exposure, a balanced diet, and appropriate supplementation is an important strategy for improving overall human health and longevity.

REFERENCES

1. Holick M. Vitamin D for the Prevention of Disease: An Endocrine Society Clinical Practice Guideline. *Journal of Clinical Endocrinology & Metabolism*. 2024. Vol. 109. P. 11–35.
2. The Lancet Diabetes & Endocrinology. Vitamin D and extra-skeletal health: new insights. *The Lancet*. 2024. Vol. 12. P. 158–172.
3. National Institutes of Health (NIH). Vitamin D: Fact Sheet for Health Professionals. *Office of Dietary Supplements*. 2024. 24 p.
4. Cochrane Database of Systematic Reviews. Vitamin D supplementation for prevention of acute respiratory tract infections: A systematic review. *Cochrane Library*. 2024. №1. P. 45–62.

INNOVATIVE APPROACHES TO FOOD PROCESSING TECHNOLOGIES: ENHANCING QUALITY, SAFETY AND SUSTAINABILITY

The food processing industry stands at a critical crossroad, driven by the dual imperatives of meeting global nutritional demands and addressing arising environmental challenges. Modern food technologies increasingly rely on interdisciplinary engineering solutions that integrate principles of biochemistry, material science, thermodynamics, and automation to optimize production efficiency while preserving nutritional value and ensuring product safety [1, p. 34].

Among the most significant recent developments is an application of non-thermal processing methods including high-pressure processing (HPP), pulsed electric field (PEF) technology, and ultraviolet irradiation. These techniques allow manufacturers to eliminate pathogenic microorganisms and extend shelf life without subjecting products to elevated temperatures, in this way preserving heat-sensitive vitamins, enzymes, and bioactive compounds that are destroyed during conventional pasteurization [2, p. 87].

Nanotechnology represents another frontier in food engineering. The application of nanoemulsions, nanoencapsulation, and nano-based packaging materials has demonstrated considerable potential for improving bioavailability of functional ingredients, controlling flavour release, and creating active antimicrobial barriers in food packaging. Studies have confirmed that nanoencapsulation of omega-3 fatty acids, for instance, significantly reduces oxidative degradation during storage and processing [3, p. 156].

The integration of artificial intelligence and machine learning into food production lines constitutes a transformative engineering advancement. Computer vision systems now enable real-time quality grading of raw materials on conveyor belts, detecting surface defects, colour deviations, and foreign objects with accuracy surpassing human inspection [1, p. 41]. Predictive algorithms further allow manufacturers to anticipate

equipment failures, reduce downtime, and optimize energy consumption across the entire production cycle.

Sustainability considerations are reshaping engineering priorities across the food technology sector. The adoption of circular economy principles has spurred innovation in by-product valorisation – transforming processing waste, such as fruit pomace, dairy whey, and grain bran into value-added ingredients rich in dietary fiber, protein, and polyphenolic antioxidants [4, p. 212]. These approaches simultaneously reduce environmental impact and diversify income flows for food manufacturers.

In Ukraine, food technology research occupies a strategically important position given the country's role as a major agricultural producer. Domestic research institutions are actively investigating post-harvest preservation technologies, novel fermentation processes for functional food development, and the engineering of gluten-free and allergen-reduced product formulations suited to both domestic consumption and export markets [2, p. 94].

In conclusion, the trajectory of modern food processing technologies reflects a broader shift toward precision, sustainability, and consumer-centered design. Continued investment in engineering research within this field is essential for ensuring food security, advancing public health outcomes, and strengthening the competitive position of Ukrainian food industry in global markets.

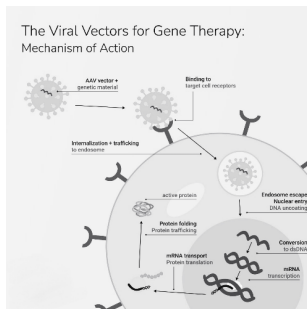
REFERENCES

1. Fellows P. J. Food Processing Technology: Principles and Practice. 4th ed. Cambridge : Woodhead Publishing, 2017. 1040 p.
2. Knorr D., Augustin M. A. Food Engineering Innovations Across the Food Supply Chain. London : Academic Press, 2021. 388 p.
3. McClements D. J. Nanoparticle- and Microparticle-Based Delivery Systems. Boca Raton : CRC Press, 2015. 572 p.
4. Ruiz Morales J. M. Sustainable Food Processing and Engineering Challenges. Amsterdam : Elsevier, 2021. 446 p.

VIRUSES IN THE SERVICE OF HUMANITY: FROM PATHOGENS TO BIOTECHNOLOGY TOOLS

Most people perceive viruses only as pathogens, but modern science also considers them useful tools. They are capable of penetrating cells and transferring genetic material, which makes them valuable for research in molecular biology, medicine, and genetic engineering [1].

The first studies of viruses began in the late 19th century. At that time, the tobacco mosaic virus was discovered and it was proven that there are infectious agents smaller than bacteria [3]. Since then, viruses have become not only the subject of scientific research, but also a practical tool in biotechnology.



The most important use of viruses is as vectors for gene transfer. They are modified so that they do not cause disease but can transfer the necessary genes into cells. This is used in gene therapy, where viruses deliver normal copies of genes to human cells to treat hereditary diseases such as cystic fibrosis, hemophilia, or muscular dystrophy [1, p. 2]. Adenoviruses, adeno-associated viruses, and lentiviruses are most commonly used.

Viruses are widely used in the creation of vaccines. Weakened or inactivated viruses stimulate the immune system without causing disease. Viral vectors also allow the creation of modern recombinant vaccines that are safer and more effective [3].

Another promising area is oncolytic viruses, which infect and destroy cancer cells. They are modified so that they only affect tumor cells and cause almost no harm to healthy cells [1].

In the food industry, bacteriophages are used to combat harmful bacteria (Salmonella, Listeria, E. coli). They help to improve food safety and reduce the use of chemical preservatives.

Viruses are also used in agriculture. For example, baculoviruses are used as environmentally friendly insecticides against pests, which reduces the use of chemicals [4].

In addition, in ecology and biotechnology, viruses help purify water and wastewater from bacteria and toxins. They are also used to create biosensors and nanostructures that detect pollution or promote the decomposition of harmful substances.

REFERENCES

1. Flint S., Enquist L., Racaniello V., Skalka A. Principles of Virology (4th ed.). – Washington: ASM Press, 2015.
2. Lodish H., Berk A., Kaiser C. A. Molecular Cell Biology (8th ed.). – New York: W. H. Freeman and Company, 2016.
3. Будзанівська І., Шевченко Т., Коротеєва Г. та ін. – Вірусологія: підручник Київський національний університет імені Тараса Шевченка, 2019.
4. Скроцька О.І., Пирог Т.П. Загальна вірусологія: Конспект лекцій для студ. напрямку 6.051401 «Біотехнологія» – К.: НУХТ, 2011/ – 137 с.

T. Huliaieva, T. Denysenko, O. Posudiiievskia

CHOLESTEROL: METABOLISM, FUNCTIONS AND RISKS

Cholesterol is a fat-like organic compound that is important for the normal functioning of the body. It is an essential component of cell membranes. It participates in the synthesis of vitamin D and hormones that regulate various important processes in the body, including sex hormones (testosterone, estrogen, progesterone); and it contributes to the production of bile acids. About 80% of cholesterol is produced in the body, mainly by the liver, while the remaining 20% comes from animal-based products. Despite its important functions, excessive consumption of fatty products increases the risk of cardiovascular diseases, which are associated with cholesterol. In 1968, the American Heart Association recommended limiting egg consumption due to their high cholesterol content, which contributed to its negative reputation. Since then,

cholesterol has remained a controversial substance regarding its impact on human health.

Once inside the body, cholesterol breaks down into proteins and, together with other lipids, is transported in the blood as part of lipoproteins – complexes of lipids and proteins. Lipids determine the size and density of these particles: the more lipids they contain, the larger the complex and the lower its density is. Proteins on the surface of lipoproteins act as «address labels» that determine their function (Fig. 1). Based on lipid content, lipoproteins are classified into high-density (HDL), low-density (LDL), and very low-density (VLDL) lipoproteins.

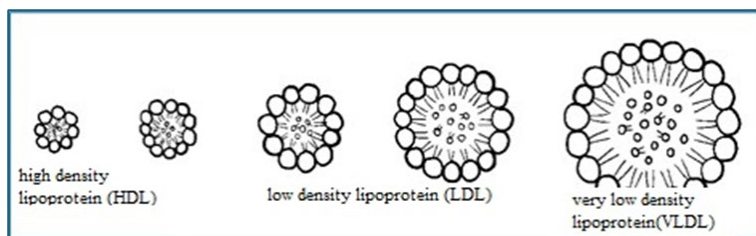


Fig. 1. Lipoproteins of different densities

HDL lipoproteins contain little fat and a high amount of protein, due to which they are called “good cholesterol”. They remove excess cholesterol by transporting it back to the liver for bile synthesis. Bile is secreted into the intestine, where it helps digest fats. Part of the bile is excreted from the body, while another portion is reabsorbed and returned to the liver. LDL and VLDL contain a large amount of fat and little protein, and they transport cholesterol from the liver to other tissues. As they move through the blood vessels, they can be deposited on the vessel walls, forming plaques. An excess of these lipoproteins leads to narrowing and blockage of the vessels, increasing the risk of heart attack and stroke. That is why they are called “bad cholesterol”.

The body needs a balance between “good” and “bad” cholesterol, and nutrition plays a key role in this. Fatty meat, fast food, fried dishes, trans fats, sugar, pastries, and fatty sauces promote the formation of LDL and VLDL. In contrast, fish, seafood,

egg yolks, caviar, liver, hard cheese, seeds, and carrots, as well as cranberry juice, support the synthesis of HDL. The total content of HDL, LDL, and 1/5 of the triglyceride level determines the total cholesterol level in the blood. It should not exceed 5 mmol/L. At the same time, the “bad cholesterol” level should be no more than 1.8 mmol/L, and the “good cholesterol” one should be at least 1 mmol/L [3].

The increased total cholesterol level may be manifested by headaches, dizziness, impaired memory and attention, yellowish formations on the skin and at the corners of the eyes, pain around the navel after eating, appetite and digestive disorders, heart problems, angina attacks, and weight loss. In order to lower cholesterol levels, it is recommended to quit smoking and excessive alcohol consumption, maintain physical activity, healthy body weight, and avoid stress. Foods that help reduce blood cholesterol include nuts, greens, vegetable oils, lean fish, berries, seeds, garlic, and whole grains. However, if less than 20% of fat fractions are obtained from food, the body will begin to produce cholesterol above normal levels.

Low cholesterol levels also have negative effects on health. They may occur as a result of infectious diseases, extreme dieting, starvation, liver disorders, thyroid and adrenal gland pathologies, as well as stress. The main symptoms include decreased appetite, pain in muscles, digestive problems, poor sleep, and reduced libido. Cholesterol deficiency increases the risk of developing osteoporosis, diabetes, lung diseases, mental disorders, and can lead to hormonal imbalances.

Cholesterol is essential for the body to function properly, particularly for hormone synthesis and bile production. However, its excess increases the risk of heart attack and stroke. The increased cholesterol levels are often caused by stress, unhealthy habits, and excessive consumption of fatty foods. To reduce the risk of cardiovascular diseases, it is important to maintain a healthy lifestyle and a balanced diet.

REFERENCES

1. Біологічна і біоорганічна хімія: у 2 кн.: підручник. Кн. 1 Біоорганічна хімія / [Зіменковський Б.С., Музиченко В.А., Ніженковська І.В. та ін.]; за ред. Б.С. Зіменковського – К.: ВСВ «Медицина», 2014. – 272 с.
2. Непорада К.С. Метаболізм ліпідів – 2. Обмін холестеролу. Патохімія ліпідного обміну. Полтава: Українська медична стоматологічна академія, кафедра біохімії.

3. Центр громадського здоров'я МОЗ України. Як контролювати свій холестерин. 2021. URL: <https://phc.org.ua/news/yak-kontrolyuvati-sviy-kholesterin>
4. Koropetska N.Yu., Ostapyuk Yu.I. Cholesterol: for and against // Scientific Messenger of Lviv National University of Veterinary Medicine and Biotechnologies. Series: Economical Sciences. 2019. Vol. 21, № 92. P. 169–171.

A. Kaliberda, R. Dolinski, N. Kaliberda

EPIDEMIOLOGY AND ECONOMIC BURDEN OF MENTAL DISORDERS IN THE STRUCTURE OF PUBLIC HEALTH

Modern epidemiology of mental disorders – that is, the science that studies their prevalence, causes, and consequences at the population level – indicates that humanity is effectively facing a «silent pandemic». It remains largely unnoticed not because it is rare, but because of stigma (prejudiced attitudes toward mental illness) and the complexity of diagnosis. According to data from the World Health Organization and the Global Burden of Disease (GBD) studies, about 1 billion people worldwide – roughly one in eight – live with a diagnosed mental disorder.

Although relative prevalence rates have somewhat stabilized since 2005, the total number of people affected continues to grow. This is driven by population growth, rapid urbanization, and socio-economic instability. Particularly concerning is a recent trend: a 25–30% increase in depression and anxiety among young people (ages 10–24). This means that mental health problems are increasingly beginning at a stage of life when individuals are just entering education and the workforce, creating long-term risks for both economic productivity and the intellectual potential of societies.

It is important to understand that mental health is closely linked to physical (somatic) health. People with severe mental disorders, such as schizophrenia or bipolar affective disorder (BAD), have a 1.5–3 times higher risk of cardiovascular diseases and are 2–3 times more likely to develop diabetes and metabolic syndrome (a cluster of metabolic disturbances that includes, among other things, obesity). This co-occurrence

of multiple conditions is called comorbidity (the presence of two or more disorders at the same time), and it significantly worsens outcomes. As a result, life expectancy in these patients is reduced by 10–20 years – primarily due to underdiagnosed or undertreated physical illnesses rather than the mental disorders themselves.

When these clinical facts are translated into economic terms, the scale of the problem becomes even clearer. According to estimates by the World Economic Forum, by 2030 the global economic burden of mental disorders will reach approximately \$6 trillion per year. For comparison, projected annual losses from cancer are about \$0.8–1.1 trillion, and from cardiovascular diseases about \$1 trillion. In other words, mental disorders impose a greater economic burden than these major disease groups combined. This is largely because mental disorders often begin early in life and can affect a person’s ability to work for decades.

Disease Category	Share of Global YLD* (%)	Projected Annual Losses (by 2030)	Primary Cause of Losses
Mental Disorders	≈ 15% – 18%	\$6.0 trillion	Productivity loss among young adults
Cardiovascular Diseases	≈ 10% – 12%	\$1.04 trillion	Direct medical costs and premature death
Oncology (Cancers)	≈ 3% – 5%	\$0.9 trillion	Expensive treatment and high early mortality
Diabetes Mellitus	≈ 6% – 8%	\$0.8 trillion	Complications and prolonged hospitalization

*YLD – Years Lived with Disability;

Parameter	Depressive Disorders	Diabetes Mellitus (Type 2)
Global Prevalence	Over 300 million people (≈3.8% of the population)	About 537 million people (≈10.5% of adults)

Parameter	Depressive Disorders	Diabetes Mellitus (Type 2)
Age of Onset	Most often 15–30 years (peak productivity)	Most often after 45 years (shifting towards 30+)
Impact on Disability	One of the leading causes of YLD (Years Lived with Disability)	High, but often due to late complications
Structure of Economic Losses	Primarily indirect (productivity loss – 70%)	Primarily direct (medications, insulin, hospitalizations)
Mortality Risk	High risk of suicide and somatic catastrophes	High risk due to CVD* and renal failure

*CVD – Cardiovascular Disease;

Importantly, most of these economic losses are not due to direct healthcare costs. Only about one-third is spent on treatment. The remaining two-thirds are indirect losses: presenteeism (reduced productivity while at work), absenteeism (missing work due to illness), and premature disability. In high-income countries, the overall costs associated with mental health already account for about 3–4% of GDP, with up to 70% of that driven by lost productivity.

The situation is further exacerbated during global crises. The COVID-19 pandemic led to a 25–27% increase in depression and anxiety within just the first year. In Ukraine, the ongoing war adds another layer of complexity, reshaping the structure of mental disorders: post-traumatic stress disorder (PTSD), stress-related (reactive) conditions, and increased use of psychoactive substances as a coping mechanism are becoming more prevalent.

Despite this, funding for mental health remains critically low—on average, less than 2% of national healthcare budgets worldwide. This creates what is known as a «treatment gap», meaning that the majority of people do not receive the care they need. In low- and middle-income countries, 75–85% of individuals receive no treatment at all, allowing the problem to accumulate into an even greater social and economic burden over time.

At the same time, investment in mental health is among the most cost-effective interventions. Research shows that every \$1 invested in the treatment of depression and anxiety yields about \$4 in economic return, primarily through restored productivity and improved overall health.

In conclusion, mental health is not a narrow medical issue but a foundation of physical well-being, social stability, and economic development. Recognizing this connection is key to addressing the «silent pandemic» the world is facing today.

REFERENCES

1. Freeman Melvyn. World mental health report: Transforming mental health for all. *World psychiatry*. 21:3 – October 2022. P. 391-392.
2. Bloom D. E., and others. The Global Economic Burden of Noncommunicable Diseases. Geneva: World Economic Forum. 2011. http://www3.weforum.org/docs/WEF_Harvard_HE_GlobalEconomicBurdenNonCommunicableDiseases_2011.pdf
3. Global Burden of Disease Studies (GBD). *The Lancet Psychiatry*. October, 2025. Volume 406, Number 10513. P. 1701-1922.

I. Karamushka, A. Alekseeva, O. Osadcha

ECOLOGICAL-AESTHETIC POTENTIAL OF STRUCTURAL GRASSES IN WINTER LANDSCAPES OF URBANIZED TERRITORIES

Contemporary urbanization processes are accompanied by profound transformation of natural landscapes, resulting in the deterioration of the ecological condition of the urban environment and a decline in biodiversity levels. Under these conditions, green construction and the reconstruction of urban plantings require the introduction of resilient plant components capable of ensuring ecological efficiency and spatial-visual expressiveness of landscapes throughout the year. Traditional approaches to landscaping, oriented primarily toward annual or a limited range of woody species, frequently prove insufficiently resilient to climate changes and high anthropogenic pressure.

In temperate climate zones, where the period of physiological dormancy of plants lasts 4–5 months, urban landscapes in winter are typically characterized by monochromatism and visual depression. This necessitates the search for plant-based solutions capable of forming structural and aesthetic integrity in urban spaces during the non-vegetative period without a significant increase in maintenance costs. One response to these challenges is the implementation of the “New Perennial Movement” concept, which envisages the active use of ornamental grasses (family *Poaceae*) as key structural elements of the landscape, capable of providing year-round decorativeness and high ecological functionality [4].

The present study analyzes the ecological-biological characteristics and aesthetic potential of structural grasses based on a synthesis of data from contemporary scientific research and leading global landscape practices. The morphological-anatomical adaptations of grasses to winter conditions, their role in supporting urban biodiversity, the principles of forming the winter image of the urban landscape are examined.

Ornamental grasses are distinguished by high adaptability to the stressful conditions of the urbanized environment. The majority of species employed in landscaping (in particular *Panicum virgatum* and *Schizachyrium scoparium*) evolved under conditions of extreme temperatures and moisture deficit, which substantially reduces requirements for maintenance and irrigation [5]. An important factor in winter hardiness is the anatomical structure of the shoots. Representatives of the genera *Miscanthus* and *Calamagrostis* are characterized by elevated lignin and silicon content in sclerenchyma tissues, which ensures mechanical strength of the stems and their ability to retain vertical form under snow and wind loads [1]. Dense-turf grass form a compact base within which the dead leaf mass creates a natural thermal-insulation layer, protecting renewal buds from frost damage.

During the winter period, ornamental grasses continue to perform a number of important ecological functions. Uncut clumps serve as habitats for the overwintering of beneficial entomofauna, while the seeds of certain species, particularly of the genus *Panicum*, constitute a significant food base for granivorous birds, thereby contributing

to the preservation of urban fauna [2]. The powerful fibrous root system of grasses (for example, in *Panicum virgatum* – reaching 2–3 m) effectively stabilizes the soil, preventing erosion processes on slopes and technogenic sites. The vertical structure of the aboveground biomass promotes snow retention, which exerts a positive influence on spring soil moisture.

An important advantage of ornamental grasses in contemporary landscape architecture is their capacity for aesthetic senescence (beauty of decay). The winter expressiveness of compositions is formed through the combination of clear form, diverse texture, and interaction with light [3]. Species with sturdy vertical stems, in particular feather reed grass (*Calamagrostis* × *acutiflora* ‘Karl Foerster’), create distinct graphic accents, contrasting with the horizontal plane of snow cover and the masses of urban development. Inflorescences (for instance, in *Miscanthus* and *Molinia*) acquire silvery, bronze, or golden hues in winter, effectively capture hoarfrost and rime, and reflect low winter sunlight, producing an effect of internal luminescence. The elastic stems of grasses impart dynamism to the winter landscape, responding to air movement and generating a characteristic visual-auditory effect.

Based on the analysis of ecological resilience and decorative properties, the following species and cultivars are recommended for conditions in Ukraine:

- *Calamagrostis* × *acutiflora* (‘Karl Foerster’, ‘Overdam’) – cold-hardy, sterile, highly tolerant of urban conditions, with clearly retained vertical form in winter;
- *Panicum virgatum* (‘Northwind’, ‘Shenandoah’) – warm-season, drought-tolerant species that provides structural expressiveness and coloristic accents;
- *Miscanthus sinensis* (‘Gracillimus’, ‘Morning Light’) and sterile hybrids (*M.* × *giganteus*) – for the formation of volumetric compositions subject to control of invasiveness.
- *Molinia caerulea* – for creating an effect of transparency and a light architectural “veil”.

Thus, the use of structural grasses constitutes an effective tool for the formation of resilient and aesthetically expressive winter landscapes in urbanized territories. Their introduction enables the resolution of the problem of seasonal decorativeness,

a reduction in operational costs, and an improvement in the ecological indicators of the urban environment, through the support of biodiversity and soil protection. A promising direction for further research is the selection of sterile cultivars with the aim of preventing biological pollution.

REFERENCES

1. Darke R. (2007). The Encyclopedia of Grasses for Livable Landscapes. Timber Press.
2. Hitchmough J. Exotic plants and plantings in sustainable urban landscapes. Landscape and Urban Planning. 2011, 100 (4), P. 380–382.
3. Kingsbury N (2016). Planting: A New Perspective. Timber Press, 2016
4. Oudolf P., Kingsbury N. (2013). Landscapes in Landscapes. Thames & Hudson.
5. Thetford M., Miller D. Ballard S. (2009). Evaluation of Ornamental Grasses for the Northern Gulf Coast. University of Florida IFAS Extension.
6. Yuan X., Liu J. (2024). Research on the Application of Ornamental Grasses in Urban Landscape Design. Journal of Landscape Research, 16 (2), 45–49.

O. Kobets, I. Kofan, O. Hurko

ROLE OF THE ANTIOXIDANT SYSTEM IN *PRUNUS* PLANT ADAPTATION TO ABIOTIC STRESS

Current climate change is accompanied by increasing average temperatures, prolonged drought periods, and the growing intensity of various abiotic stress factors that negatively affect the productivity of fruit crops. Plants cultivated in steppe regions are particularly vulnerable because such environments are characterized by high temperatures, water deficiency, and significant fluctuations in environmental conditions. Therefore, studying the mechanisms of plant adaptation to adverse environmental factors is an important scientific task. A key component underlying plant resistance to stress conditions is the antioxidant system, which protects cells from damage caused by reactive oxygen species (ROS) [4].

Abiotic stress factors such as drought, high temperatures, soil salinity, and excessive solar radiation disrupt the balance between reactive oxygen species formation

and detoxification in plants. These species include superoxide anion (O_2^-), hydrogen peroxide (H_2O_2), and hydroxyl radicals ($\bullet OH$). Under normal physiological conditions, ROS are produced in small amounts during metabolic processes and participate in cellular signaling and regulation. However, under stress conditions, their accumulation significantly increases, leading to oxidative stress and damage to cellular components [1; 2].

Excessive accumulation of ROS can cause lipid peroxidation of cell membranes, protein degradation, and nucleic acid damage, which ultimately disrupts normal cellular metabolism. To prevent oxidative damage, plants have developed a complex antioxidant defense system that includes enzymatic and non-enzymatic components. The enzymatic antioxidants include superoxide dismutase (SOD), catalase (CAT), various peroxidases (POD), and ascorbate peroxidase (APX). Superoxide dismutase catalyzes the conversion of superoxide radicals into hydrogen peroxide, which is subsequently decomposed into water and molecular oxygen by catalase and peroxidases. The coordinated action of these enzymes enables plants to efficiently detoxify reactive oxygen species and maintain cellular stability under stress conditions [2].

The non-enzymatic antioxidant system includes compounds such as ascorbic acid, glutathione, carotenoids, phenolic compounds, and flavonoids. These substances are capable of scavenging reactive oxygen species and participate in maintaining the redox balance within plant cells. Phenolic compounds and flavonoids also play an important role in protecting plant tissues from oxidative damage and environmental stress [3].

In representatives of the genus *Prunus*, encompassing economically important fruit crops such as peach (*Prunus persica*) and almond (*Prunus dulcis*), the antioxidant system plays a crucial role in developing of tolerance to unfavorable environmental conditions. Numerous studies have demonstrated that drought and high-temperature stress lead to increased activity of antioxidant enzymes, particularly SOD, CAT, and peroxidases, as well as to the accumulation of antioxidant metabolites that help reduce oxidative damage in plant tissues [5].

Particular attention is paid to the antioxidant defense mechanisms in interspecific hybrids of the genus *Prunus*. Interspecific hybridization is widely used in breeding programs to combine economically valuable traits and improve plant adaptability. For example, hybrids between peach (*Prunus persica*) and almond (*Prunus dulcis*) can combine high fruit quality with increased tolerance to drought and other environmental stresses. Such hybrids often exhibit enhanced antioxidant enzyme activity and more efficient detoxification of reactive oxygen species, which contributes to maintaining cellular integrity under stress conditions [6].

Thus, the antioxidant system represents an important component of the adaptive mechanisms of *Prunus* species under abiotic stress conditions. Efficient antioxidant defense supports cellular homeostasis and protects against oxidative damage, which is particularly critical in arid and semi-arid environments. Further research on antioxidant responses in interspecific *Prunus* hybrids may contribute to a better understanding of plant adaptation mechanisms and facilitate the development of new cultivars with enhanced tolerance to environmental stress.

REFERENCES

1. Apel K., Hirt H. Reactive oxygen species: metabolism, oxidative stress, and signal transduction. *Annual Review of Plant Biology*. 2004. 55. P. 373–399.
2. Foyer C. H., Noctor G. Oxidant and antioxidant signalling in plants: a re-evaluation of the concept of oxidative stress in a physiological context. *Plant, Cell & Environment*. 2005. 28(8). P. 1056–1071.
3. Gill S. S., Tuteja N. Reactive oxygen species and antioxidant machinery in abiotic stress tolerance in crop plants. *Plant Physiology and Biochemistry*. 2010. 48(12). 909–930.
4. Gradziel T. M., Martínez-Gómez P. Almond breeding. In: *Plant Breeding Reviews*. 2013. 37. P. 207–258.
5. Mittler R. Oxidative stress, antioxidants and stress tolerance. *Trends in Plant Science*. 2002. 7(9). P. 405–410.
6. Sofo A., Dichio B., Xiloyannis C., Masia A. Antioxidant defenses in olive trees during drought stress: changes in activity of some antioxidant enzymes. *Functional Plant Biology*. 2005. 32(1). P. 45–53.

ROLE OF LABORATORY TESTS IN MONITORING CHRONIC DISEASES (DIABETES, CARDIOVASCULAR DISORDERS)

This paper examines the crucial role of laboratory tests in monitoring chronic diseases, particularly diabetes mellitus and cardiovascular disorders. Chronic diseases are among the leading causes of morbidity and mortality worldwide, accounting for significant healthcare burdens. Early diagnosis, continuous monitoring, and effective management are essential to prevent complications and improve patients' quality of life. Laboratory tests provide objective data that guide clinical decision-making, track disease progression, and evaluate treatment effectiveness.

Introduction. Chronic diseases such as diabetes mellitus (DM) and cardiovascular diseases (CVD) have seen a dramatic rise in prevalence over recent decades. According to the World Health Organization (WHO), over 422 million people globally suffer from diabetes, while CVD remains the leading cause of death worldwide [1; 2]. Effective management of these conditions requires regular monitoring to prevent long-term complications such as nephropathy, retinopathy, myocardial infarction, and stroke. Laboratory tests serve as a cornerstone in this process, offering precise and reliable indicators of disease status.

Laboratory Monitoring in Diabetes Mellitus. Diabetes mellitus is characterized by chronic hyperglycemia due to impaired insulin secretion, insulin resistance, or both. Monitoring glycemic control is essential to reduce the risk of microvascular and macrovascular complications. The most widely used laboratory tests include:

1. **Fasting Plasma Glucose (FPG)** – Provides a snapshot of blood glucose levels after an overnight fast and is used for both diagnosis and monitoring of diabetes.

2. **Glycated Hemoglobin (HbA1c)** – Reflects average blood glucose over the previous 2–3 months, serving as a reliable marker of long-term glycemic control [3].

3. **Lipid Profile** – Diabetic patients often exhibit dyslipidemia, which increases cardiovascular risk. Regular monitoring of total cholesterol, LDL-C, HDL-C, and triglycerides is recommended.

4. **Renal Function Tests** – Creatinine, estimated glomerular filtration rate (eGFR), and urine albumin-to-creatinine ratio help detect early diabetic nephropathy.

Studies have shown that patients with regular HbA1c and lipid profile monitoring experience fewer complications and better overall metabolic control. Moreover, combining laboratory data with clinical assessment enables personalized treatment adjustments, including medication titration and lifestyle interventions [4].

Laboratory Monitoring in Cardiovascular Disorders. Cardiovascular diseases, including coronary artery disease, heart failure, and hypertension, represent a major global health challenge. Laboratory tests play a pivotal role in diagnosis, risk stratification, and monitoring therapeutic response. Key tests include:

1. **Lipid Profile** – Monitoring LDL-C, HDL-C, triglycerides, and total cholesterol is essential for managing atherosclerotic risk and guiding statin therapy.

2. **High-sensitivity C-reactive Protein (hs-CRP)** – Serves as a biomarker of systemic inflammation and is associated with increased cardiovascular risk.

3. **Cardiac Biomarkers (Troponins, BNP/NT-proBNP)** – Detect myocardial injury and heart failure progression, enabling timely intervention [5].

4. **Glucose and HbA1c** – Many CVD patients have coexisting diabetes; monitoring glycemic control is crucial in these cases.

Recent research emphasizes that a combination of traditional and novel laboratory markers allows clinicians to better predict adverse cardiovascular events and adjust therapy proactively. For instance, monitoring troponin levels in chronic heart failure patients has been linked with early detection of myocardial stress, reducing hospitalizations and improving outcomes [6].

Integration of Laboratory Data in Chronic Disease Management. The integration of laboratory testing into patient care involves a multidisciplinary

approach, where physicians, nurses, and laboratory specialists collaborate to interpret results and optimize therapy. Modern digital health platforms and electronic medical records enable tracking trends over time, facilitating early detection of deterioration and timely intervention. For chronic diseases, proactive laboratory monitoring reduces hospitalization rates, lowers healthcare costs, and enhances patient quality of life.

Conclusion. Laboratory tests are indispensable tools in the management of chronic diseases, particularly diabetes and cardiovascular disorders. Regular monitoring of glycemic indices, lipid profiles, renal function, and cardiac biomarkers allows clinicians to detect early complications, evaluate treatment efficacy, and implement personalized interventions. Continued advancements in laboratory diagnostics and integration with digital health systems promise to further improve outcomes for patients with chronic conditions.

REFERENCES

1. World Health Organization. Global Report on Diabetes. WHO, 2021.
2. Roth G. A., Mensah G. A., Johnson C. O. *et al.* Global burden of cardiovascular diseases and risk factors, 1990–2019. *J. Am. Coll. Cardiol.* 2020. Vol. 76. P. 2982–3021. URL: <https://doi.org/10.1016/j.jacc.2020.11.010>.
3. American Diabetes Association. Standards of Medical Care in Diabetes. *Diabetes Care.* 2025. Vol. 48, Suppl. 1. P. S1–S210.
4. Stratton I. M, Adler A. I, Neil H. A, *et al.* Association of Glycaemia with Macrovascular and Microvascular Complications of Type 2 Diabetes (UKPDS 35). *BMJ.* 2000. Vol. 321. P. 405–412.
5. Thygesen K, Alpert J. S, Jaffe A. S, *et al.* Fourth Universal Definition of Myocardial Infarction (2018). *Circulation.* 2018. Vol. 138. P. e618–e651.
6. Januzzi J. L., Chen-Tournoux A. A, Moe G. W. High-Sensitivity Troponin in Chronic Heart Failure: Implications for Risk Stratification. *Eur Heart J.* 2019. Vol. 40. P. 2219–2227.

PSYCHOLOGICAL FACTORS OF CONSUMER CHOICE IN THE FUNCTIONAL FOOD MARKET

The global food industry is currently shifting from basic nutrition to functional health benefits. Functional foods, which are designed to provide physiological benefits beyond standard nutritional value, are becoming a central element of the modern diet. It is crucial to recognize that the success of such products depends not only on their chemical composition and processing methods, but also on deep-seated psychological triggers. This study explores how mental perceptions and consumer behavior dictate the market dynamics of healthy eating.

Psychological Determinants

Consumer choice in the functional food sector is rarely a purely rational process. It is heavily influenced by the "health halo" effect, where consumers perceive a product as overall healthier based on a single functional attribute (e.g., "high protein" or "probiotic-rich") [1, p. 445]. Psychological comfort plays a vital role; many consumers use functional foods as a tool for emotional regulation and a sense of control over their long-term well-being [3, p. 118]. Furthermore, cognitive biases regarding "naturalness" often lead buyers to prefer minimally processed functional ingredients, even when technological fortification provides superior nutritional outcomes [2, p. 605].

Methodology

The research methodology involves a comprehensive analysis of current trends in the functional food market and the psychological triggers of consumers. The study employs a qualitative approach, examining the relationship between food technology innovations and consumer perception. Particular attention is paid to the "clean label" trend and how it correlates with the psychological need for transparency and safety [2, p. 606]. The integration of sensory analysis and behavioral psychology allows for a deeper understanding of why certain functional ingredients, such as probiotics or adaptogens, gain more trust than others, despite similar technological benefits [1, p. 448].

The findings indicate that the “conscious eating” movement is a primary driver for functional food consumption. Consumers are no longer just looking for calories; they are seeking “emotional value” and “preventive health” solutions [1, p. 450]. A significant result of the study is the identification of the “sustainability-health” link: products that are perceived as environmentally friendly are automatically psychologically rated as “healthier” for the individual. This suggests that for a food technologist, the challenge is not only to create a stable functional formula, but also to ensure that the product narrative aligns with the user’s mental model of a “pure” and “functional” lifestyle.

Conclusion

The materials demonstrate that psychological factors, such as the “health halo” effect and the desire for conscious consumption, are as important as technological innovation in the functional food market. For a food technologist, success lies in the synergy between a scientifically grounded formula and a clear, psychologically appealing communication of health benefits. Future developments in this field should focus on personalizing functional nutrition to meet both the physiological and emotional needs of the consumer, ensuring a holistic approach to healthy eating.

REFERENCES

1. Arvola, A., Vassallo, M., Dean, M., Lampila, P., Lestani, A., Lahteenmaki, L., & Shepherd, R. (2008). Predicting intentions to purchase organic food: The role of affective and moral attitudes. *Appetite*, 50(2-3), 443–454. URL: <https://doi.org/10.1016/j.appet.2007.09.010>
2. Siegrist, M. (2008). Factors influencing public acceptance of innovative food technologies and products. *Trends in Food Science & Technology*, 19(11), 603–608. URL: <https://doi.org/10.1016/j.tifs.2008.01.017>
3. Hori H (2021). The Psychology of Food Choice and Eating Behavior. *Journal of Nutritional Psychology*, 12(4), 115–129. URL: <https://pubmed.ncbi.nlm.nih.gov/34204567/>

METHODS OF ASSESSING MUSCLE STRENGTH IN PHYSICAL THERAPY

Assessment of muscle strength is an essential part of a patient's physical examination. It helps identify possible neurological deficits and evaluate the presence and severity of muscle weakness. Muscle strength testing also allows physicians to distinguish true weakness from problems such as muscle imbalance or reduced endurance. In clinical practice, this procedure may also be called motor testing, muscle strength grading or manual muscle testing.

Muscle strength can be evaluated using several approaches, including manual, functional, and mechanical methods. The level of strength depends on a combination of morphological and neural factors. These include the cross-sectional area and structure of the muscle, musculotendinous stiffness, motor unit recruitment, rate coding, motor unit synchronization, and neuromuscular inhibition [2].

Muscle strength testing is used to detect weakness and assess neuromuscular, musculoskeletal, and neurological conditions. It helps diagnose diseases, monitor their progression, guide rehabilitation programs and analyze treatment effectiveness. This assessment is especially important in neurological examinations for patients with conditions such as stroke, brain or spinal cord injury, neuropathy and amyotrophic lateral sclerosis [1].

The gold standard for screening assessment is Manual Muscle Testing (MMT). This is a method where the therapist evaluates the patient's effort visually and through their own resistance, without using complex devices. The Medical Research Council (MRC) Scale for Muscle Strength is the most widely accepted clinical method for grading muscle strength. In this approach, key muscles are tested against the examiner's resistance, and the patient's strength is graded on a scale from 0 to 5. A score of 0 indicates no visible muscle contraction, while 1 represents only a slight contraction without movement. A grade of 2 means the patient can move the limb through the full range

when gravity is eliminated. Grade 3 indicates movement against gravity, grade 4 represents movement against gravity with some resistance, and grade 5 equal to normal muscle strength against full resistance [2].

If an objective number is needed rather than a score, instrumental methods are used. One of the most common is dynamometry. A handgrip dynamometer measures hand grip strength, which is a marker of the patient's overall strength status. A back or leg dynamometer assesses the strength of back extensors and leg muscles. Another instrumental method is isokinetic testing, performed on computerized dynamometers. It measures strength during movement at a constant speed, providing detailed data on torque at different angles, making it the gold standard for sports medicine and research [1].

Strength can also be assessed indirectly through functional tests. Gait analysis can reveal weakness in the gluteal muscles, known as the Trendelenburg sign, or weakness in the calf muscles, indicated by a weak push-off. Timed tests are also used, such as the 5x sit-to-stand test which assesses leg muscle strength, and the One-Repetition Maximum test which determines the maximum weight a patient can lift once [3].

In conclusion, muscle strength assessment is an essential part of physical therapy and clinical examination. Various methods, including manual muscle testing, instrumental measurements, and functional tests, allow therapists to evaluate muscle strength accurately. Using these assessment techniques helps develop effective rehabilitation programs and ultimately improves patient results.

REFERENCES

1. P. Jacobs, K. Jackson, L. Hampton. Muscle Strength Testing. 2025. URL: https://www.physio-pedia.com/Muscle_Strength_Testing
2. U. Naqvi, K. Margetis, A. L. Sherman. Muscle Strength Grading. 2025. URL: <https://www.ncbi.nlm.nih.gov/books/NBK436008/>
3. B. Sears. Purpose and Methods of Muscle Strength Grading. 2025. URL: <https://www.verywellhealth.com/muscle-strength-measurement-2696427>

POST-TRAUMATIC STRESS DISORDER

Post-Traumatic Stress Disorder is a psychiatric disorder that can occur in people who have experienced or witnessed a traumatic event. Such events may include war, combat, terrorist attacks, serious accidents, natural disasters, sexual or physical assault, or the sudden death of a loved one [1, p. 3]. PTSD is now understood as the outcome of a wide variety of traumatic experiences, not just those of veterans, and it encompasses behavioral, emotional, and spiritual aspects of functioning.

However, not everyone who experiences trauma develops PTSD. The disorder arises from a complex interaction of factors. As researchers explain, understanding the origins of PTSD involves examining the human stress response and how the brain processes overwhelming experiences [3, p. 45]. Risk factors include the severity and duration of the trauma, previous traumatic experiences, lack of social support, and pre-existing mental health conditions [2, p. 28].

The experience of PTSD is highly individual, but the symptoms generally cluster into four main categories, as outlined in contemporary research [2, p. 52].

Firstly, intrusive memories. A person may repeatedly relive the traumatic event through unwanted memories, flashbacks – where it feels as if the trauma is happening again – or nightmares. These intrusions can be triggered by everyday things, like a loud noise or a specific smell. Secondly, avoidance. The individual actively tries to avoid thoughts, feelings, or conversations related to the trauma. They may also avoid people, places, or activities that remind them of the event. For example, someone who survived a car accident may refuse to drive or even be a passenger in a vehicle. Thirdly, negative changes in thinking and mood. This includes persistent negative beliefs about oneself or the world (e.g., “I am bad, no one can be trusted”), feelings of detachment from others, inability to experience positive emotions, and memory problems related to aspects of the traumatic event [2, p. 67]. Fourthly, changes in physical and emotional reactions, also known as hyperarousal. This manifests as being easily startled, feeling

constantly “on edge” or tense, having angry outbursts, difficulty sleeping, and engaging in reckless or self-destructive behavior.

In addition to psychotherapy, medication can be helpful. However, medications are rarely indicated as primary therapy but can be used to treat symptoms and address comorbid PTSD diagnoses [3, p. 134].

In conclusion, Post-Traumatic Stress Disorder is a complex condition rooted in the brain's natural response to overwhelming threat. It manifests through intrusive memories, avoidance, negative mood changes, and hyperarousal. However, it is essential to remember that PTSD is not a sign of weakness – it is a treatable medical condition [2, p. 112]. With appropriate professional help, including evidence-based psychotherapy and medication, along with strong social support, individuals can process their trauma, manage their symptoms, and regain control over their lives. The path to recovery is challenging, but it is absolutely possible.

REFERENCES

1. Motta R. W. *Post-Traumatic Stress Disorder: Latest Developments in Diagnosis, Causes, and Treatments*. IntechOpen. 2024.
2. Resick P. A., LoSavio S. T. *Traumatic stress*. 2nd ed. Taylor and Francis. 2024.
3. *Post-Traumatic Stress Disorder*. Springer, Berlin. 2021.

K. Nevolova, T. Sharamok, O. Osadcha

BIOASSAY AS A METHOD FOR ASSESSING THE TOXICITY OF FRESHWATER BODIES IN KYIV REGION

The deterioration of surface water quality under intensifying anthropogenic pressure remains one of the central environmental challenges of the present day. Within Kyiv Region, freshwater bodies are exposed to the combined effects of urbanisation, municipal and industrial effluents, surface runoff from transport infrastructure, and diffuse agricultural inputs. Under such conditions, hydrochemical analysis alone does not always provide an adequate account of the ecological condition of the aquatic

environment, as it cannot fully capture the integrated biological impact of multiple contaminants acting simultaneously [1–4]. For this reason, bioassay has become an important tool for the integral assessment of water toxicity and ecological risk [1–4].

The aim of the study was to assess the toxicity of freshwater bodies in Kyiv Region by means of bioassay using *Daphnia magna* in an extended 96-hour exposure test. The relevance of this approach lies in the fact that short-term assays are primarily suited to detecting acute toxicity, whereas delayed and sublethal responses often remain insufficiently represented. Extending the exposure period to 96 hours allows for a more precise evaluation of chronic toxic effects, particularly in water bodies affected by multicomponent anthropogenic pollution [1–4]. The thesis specifically defines the object of research as freshwater bodies of Kyiv Region and the subject of research as water quality assessed by means of a 96-hour bioassay with *Daphnia magna* as the test organism [4].

The study focused on three water bodies characterised by different types and intensities of anthropogenic influence: Pond No. 15 in the Sviatoshyn district of Kyiv, Lake Luhove (Opechen-5), and the Stuhna River. These sites were selected because they differ in the degree of urbanisation of adjacent areas, the dominant sources of contamination, and their hydrological features. Lake Luhove is subject to considerable technogenic pressure associated with dense urban development, limited water exchange, the accumulation of pollutants in bottom sediments, and stormwater runoff from built-up areas. The Stuhna River is influenced by a combination of industrial, agricultural, and domestic sources. Pond No. 15 is likewise affected by the urban environment, although the overall pressure appears less pronounced than in the other two studied sites [5; 9; 10].

Daphnia magna was used as the test organism because of its high sensitivity to a wide range of pollutants, short life cycle, and suitability for laboratory cultivation, which explains its extensive use in aquatic toxicology and standardised ecotoxicological testing [1–4; 8]. Experimental conditions were aligned, as closely as possible, with the requirements of DSTU 4241:2003 and DSTU ISO 6341:2005 [1; 2]. Active individuals aged 6–24 hours were selected for the assay. Water intended for cultivation

was pre-settled and aerated; temperature was maintained at 20 ± 2 °C, and the photoperiod was 16:8 [1–4].

Each water sample was tested in three parallel replicates. Every replicate contained 10 individuals of *Daphnia magna* placed in 500 ml test vessels. A control group was maintained in prepared laboratory water. The total exposure period was 96 hours. Throughout the experiment, both mortality and behavioural changes were recorded, including reduced locomotor activity, impaired coordination, loss of balance, prolonged retention in the upper water layer, and impulsive chaotic movements. This design made it possible to assess not only acute toxicity but also chronic sublethal effects in the tested samples [1–4; 6; 7].

No mortality was recorded in the control group, which confirms the adequacy of the experimental conditions. In the test samples, by contrast, toxic effects developed progressively over time. The highest level of toxicity was observed in water from Lake Luhove, where *Daphnia magna* mortality reached 33.3% by the end of the 96-hour exposure. In the Stuhna River sample, mortality amounted to 23.3%, whereas in Pond No. 15 it reached 13.3% [5; 9; 10]. According to the thesis abstract, the first lethal effects appeared after 24 hours in Lake Luhove, after 48 hours in the Stuhna River, and after 64 hours in Pond No. 15, which indicates differences not only in toxic load but also in the temporal profile of toxic action.

In addition to lethality, all experimental groups displayed behavioural responses indicative of latent toxic impact even where mortality remained relatively low. The observed manifestations included decreased activity, slower swimming, disorientation, disturbed equilibrium, and erratic impulsive movements. Such alterations are ecotoxicologically significant because, under natural conditions, they may reduce population fitness, disrupt trophic interactions, and reflect the onset of chronic stress in aquatic ecosystems [5–8]. The extended exposure protocol therefore proved useful for identifying delayed toxic responses that would be less evident in shorter assays [3; 4; 6].

According to Bondar's scale, water from Pond No. 15 and the Stuhna River may be classified as slightly toxic, whereas water from Lake Luhove falls into the moderately

toxic category. At the same time, according to Kovalenko's scale, all tested samples belong to toxicity class IV. The thesis abstract likewise states that, under Bondar's scale, Kovalenko's scale, DSTU 4241:2003, and OECD-based interpretation, the studied samples were classified as slightly toxic, class IV [2; 5]. Even so, the presence of pronounced sublethal effects indicates the need for systematic ecological monitoring of these water bodies and shows the limitations of relying exclusively on short-term assays or physicochemical analysis [5–7; 9].

The results confirm the high informative value of bioassay as a method of integral water quality assessment. Unlike traditional hydrochemical approaches, bioassay makes it possible to reveal the cumulative biological action of a complex mixture of contaminants, including situations in which the concentrations of individual substances do not appear critical [5; 6; 9]. The thesis explicitly notes that standard chemical analysis showed that most pollutant concentrations did not exceed sanitary and hygienic limits, whereas bioassay with *Daphnia magna* still revealed latent toxicity that would have remained undetected by routine analytical control alone.

The practical value of the study lies in the possibility of applying this approach in local environmental monitoring systems, in the assessment of recreational water bodies, and in the planning of environmental protection measures for freshwater ecosystems in Kyiv Region [5; 9; 10]. The scientific novelty of the work, as formulated in the thesis, resides in the application of an extended 96-hour bioassay capable of identifying not only acute but also delayed toxicity under conditions of multicomponent pollution [2].

Thus, the study demonstrated that all three analysed water bodies are subject to toxic loading of differing intensity. The most unfavourable condition was found in Lake Luhove, where the highest mortality and the most pronounced behavioural disturbances in *Daphnia magna* were recorded. The Stuhna River also showed a substantial toxic effect, consistent with available evidence of its anthropogenic contamination. Pond No. 15 proved to be the least toxic among the investigated sites; nevertheless, adverse biological effects were identified there as well. These findings support the use of

bioassay as an effective means of detecting latent ecotoxicity in aquatic ecosystems and as an essential component of a comprehensive water quality assessment framework [1–10].

REFERENCES

1. DSTU 4241:2003. Natural Water Quality. Bioassay Using *Daphnia magna* Straus (Cladocera, Crustacea).
2. DSTU ISO 6341:2005. Water Quality. Determination of the Inhibition of the Mobility of *Daphnia magna* Straus (Cladocera, Crustacea). Acute Toxicity Test.
3. ISO 6341:2012. Water Quality – Determination of the Inhibition of the Mobility of *Daphnia magna* Straus (Cladocera, Crustacea) – Acute Toxicity Test.
4. OECD Guideline for the Testing of Chemicals No. 211. *Daphnia magna* Reproduction Test.
5. Karpenko, O. V. Monitoring of surface-water ecotoxicity by means of bioassay. *Ecological Safety and Nature Management*.2021. No. 32. Pp. 63–68.
6. Knysh, I. V. Bioassay in aquatic environments: current trends and practice. *Environmental Protection and Nature Management*.2022. No. 1. Pp. 112–117.
7. Kozyrieva, M. V. Standardisation of test organisms in water bioassay methods. *Scientific Papers of Yuriy Fedkovych Chernivtsi National University. Biology*.2020. No. 3. Pp. 76–82.
8. Kulyk, O. A. *Daphnia* as a bioindicator of water toxicity: methodological guidelines. *Ecological Research*.2019. Vol. 11, No. 2. Pp. 50–56.
9. Lytvynenko, L. M. The practice of applying bioassay in monitoring water bodies of Kyiv Region. *Ecology and Nature Management*.2016. No. 5. Pp. 88–94.
10. Melnychuk, S. D. Methods of bioassay for the toxicity of surface waters. *Scientific Papers of NULES of Ukraine. Series: Ecology and Biotechnology*.2017. No. 230. Pp. 115–119.

A. Oskalenko, H. Novik, O. Posudiiievaska

IMPROVEMENT OF CHOCOLATE-GLAZED FONDANT-FILLED CANDIES FOR PEOPLE WITH DIABETES

It is well known that confectionery products are primarily represented by candies, in particular, by chocolate-glazed ones. The filling base of candies is highly diverse, ranging from fondant to chocolate fillings, and they are united by their delicate texture and rich chocolate flavor [4, p. 180].

Despite their significant taste advantages, according to the data of the World Health Organization, the number of people suffering from diabetes is increasing every year [1, p. 95]. This creates a demand for alternative confectionery products with

reduced sugar content or for replacing sugar with sweeteners. The manufacturing of such products is not only a response to social challenges, but also a promising direction for innovation in the confectionery industry.

The relevance of this problem stems from the fact that most candies contain a large amount of sucrose, and the modern confectionery industry is faced with the necessity of developing special-purpose candies, namely for consumers with diabetes who enjoy sweets.

In the improved recipe formula, erythritol performs the function of a volumizing sweetener, forms the structure of the fondant filling, ensures a fine-crystalline consistency, and does not affect blood glucose levels. Stevia is used to enhance sweetness due to its high sweetening capacity and is added in small quantities to avoid bitterness. The combination of these sweeteners provides a pleasant, balanced taste and preserves the characteristic organoleptic properties of the candies [3, p. 75].

Physicochemical analysis showed that the improved formulation has a reduced caloric value, lower moisture content, and a higher mass fraction of dry substances compared to traditional candies. The glycemic index of the product is significantly reduced, making it safe for people with impaired carbohydrate metabolism (Table 1).

Table 1

Physicochemical Composition of Chocolate Candies with Sugar and Sugar Substitutes

Indicators	Sugar	Stevia	Erythritol
Moisture content, %	7	5	7
Fat content, % per 100 g .	12	5	12
Protein content, % per 100 g.	5	4	4
Carbohydrate content, % per 100 g	70	15	15
Titrateable acidity, %	0,1	0,2	0,1
Caloric value, kcal	430	250	250

The organoleptic evaluation confirmed that candies with sweeteners retain a pleasant taste, an intense chocolate aroma, a delicate consistency of the fondant filling, uniform

color, and a glossy glaze surface. Thus, the consumer properties of the improved candies are not inferior to those of traditional products (Fig. 1).

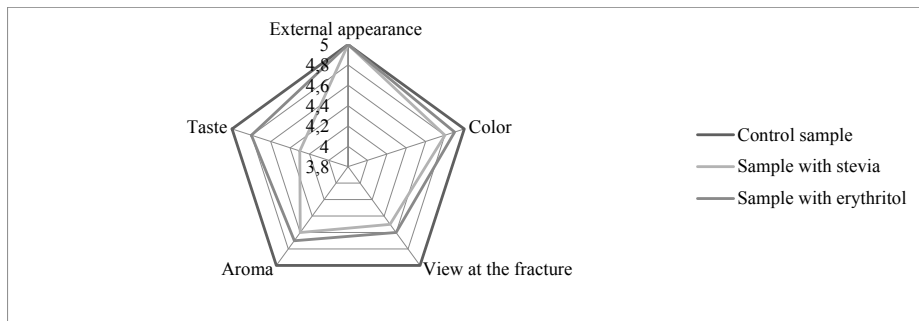


Fig. 1. Profile of organoleptic evaluation of samples

Therefore, the proposed natural sugar substitutes can be recommended for the usage in candy manufacturing technology for the industrial production of functional confectionery products intended for the category of population suffering from diabetes.

REFERENCES

1. Паньків В.І. Цукровий діабет: визначення, класифікація, епідеміологія, фактори ризику. *International Endocrinology Journal*. 2013; 7 (55): 95-104. DOI: 10.22141/2224-0721.7.55.2013.84685
2. Самохвалова О. В., Кучерук З. І., Олійник С. Г. та ін. Технологія борошnianих кондитерських виробів: навч. посібник. Харків, 2017. 572 с.
3. Сирохман І.В. Завгородня М.В. Товарознавство харчових продуктів функціонального призначення: навч. посібник. Київ: Центр учбової літератури, 2009. 544с.
4. Шідакова-Каменюка О., Шкляєв О. Комплексна кваліметрична оцінка якості кремозивних цукерок збагачених насінням чіа. *Biota. Human. Technology*. 2025. №3. С. 180–192. DOI: [https:// doi.org/10.58407/bht.3.25.1](https://doi.org/10.58407/bht.3.25.1)

RECENT ADVANCES IN PROTEIN ENGINEERING: MODIFICATION OF ENZYME PROPERTIES

Protein engineering is a branch of molecular biology that investigates ways of producing proteins with new properties.

Enzymes – biological catalysts of a protein nature – are used in many industrial processes. It is known that enzymes accelerate chemical reactions by up to 10^{17} times. Enzymes are used in chemical synthesis processes, as biosensors, in medicines and for the production of foodstuffs, detergents and synthetic cleaning agents. The industrial application of enzymes is limited by their low activity and thermal stability under *in vitro* conditions. This necessitates the search for more effective biocatalysts, including the creation of artificially modified enzymes using protein engineering methods.

To improve the stability of enzyme molecules, certain amino acids are replaced with others. For example, the thermal stability of triose phosphate isomerase was successfully increased by replacing amino acids at two positions. Asparagine and glutamine are frequently replaced with other amino acids. This is because, at high temperatures, asparagine and glutamine residues undergo deamination to form ammonia, aspartic acid and glutamic acid, leading to a loss of the polypeptide chain's conformation and enzyme activity.

As is well known, the half-life of enzyme proteins ranges from a few minutes to several hours. This variability is linked to differences in the number of disulfide bonds within the protein molecule and the presence or absence of certain amino acids at the N-terminus of the molecule. For example, if different amino acids are attached to the N-terminus of the β -galactosidase enzyme molecule, the lifespan of the modified protein *in vitro* can vary from 2 minutes to 20 hours.

Amino acids that prolong the lifespan of proteins can be incorporated into proteins using genetic engineering methods. The introduction of additional amino acid residues into proteins leads to their stabilization.

Table 1. The half-life of β -galactosidases containing different amino acids at the N-terminus

Attached amino acids	Half-life
Methionine, serine, alanine	> 20 hours
Threonine, valine, glycine	> 0 hours
Isoleucine, glutamic acid	> 30 minutes
Tyrosine, glutamine	\approx 10 minutes
Proline	\approx 7 minutes
Phenylalanine, leucine, aspartic acid, lysine	\approx 3 minutes
Arginine	\approx 2 minutes

For example, the introduction of several amino acid residues into the polypeptide chain of *Bacillus stearothermophilus* protease results in a 340-fold increase in enzyme activity at a temperature of 100°C [1].

REFERENCES

1. Іншина Н. М. Біотехнологія : навч. посіб. Вид-во СумДПУ ім. А.С. Макаренка, Суми, 2009. 172 с.

P. Tishchenko, O. Osadcha

THE IMPACT OF PHYSICAL ACTIVITY ON THE BODY OF A YOUNG PERSON DURING STRESS

The functional state of students' bodies is largely determined by their lifestyle, which combines high nervous-emotional load, low physical activity, and individual characteristics of development. At the age of 17–22, biological maturation of the organism and social development of the personality continue. Therefore, this period requires purposeful measures to ensure harmonious physical, mental, and social development.

The educational process is accompanied by numerous stress factors, including significant intellectual workload, lack of time for rest and sleep, the need to adapt to new organizational conditions of study, information overload, and constant psycho-emotional tension. Prolonged overload of the nervous system leads to fatigue, which

manifests as a feeling of tiredness even before work begins, loss of interest, apathy, irritability, headaches, and dizziness [2; 3].

The reserve of functional capabilities of the body, which ensures the maintenance of balance between the internal state and the external environment, determines its adaptive potential. These reserves include informational, energetic, and metabolic resources that are spent to maintain the necessary level of functioning of body systems and can be restored after exertion. An important role in these reactions is played by the cardiovascular system, which quickly responds to external stimulation and serves as an indicator of the overall adaptive potential of the organism [1].

One of the most effective means of reducing nervous-emotional tension and increasing adaptive capacity is optimal physical activity. Physical exercises contribute to the development and strengthening of functional systems of the body, particularly the nervous, cardiovascular, and musculoskeletal systems, ensure harmonious functioning of internal organs, and increase vitality and working capacity.

The stimulating effect of physical exercises is associated with the activation of metabolic processes, improvement of systemic blood circulation, increased oxygenation of the brain, and intensification of nervous activity. This contributes to the optimization of cognitive functions, particularly attention, memory, and speed of thinking. The protective function manifests in strengthening the immune system and increasing resistance to infectious agents and adverse environmental factors. The corrective effect ensures coordination and balance in the functioning of internal organs and systems. The stabilizing effect of physical activity lies in balancing excitation and inhibition processes in the central nervous system, which contributes to the normalization of the psycho-emotional state, increased stress resistance and improvement of overall well-being [5].

Systematic physical education determines not only the physical but also the moral, intellectual, and aesthetic development of an individual. Students who regularly engage in physical exercises demonstrate higher levels of self-organization, communicative competence, responsibility and self-control. They adapt more easily to the requirements of the educational process and show increased efficiency in mental activity. The adaptive

reserves of students' bodies are directly dependent on the regularity and intensity of physical activity. Rationally dosed exercises contribute to strengthening functional systems, increasing tolerance to psycho-emotional overload, and optimizing the regulation of nervous processes. Physical exercises performed in an aquatic environment are characterized by a pronounced relaxing effect due to the combination of hydrostatic pressure, temperature factors, and uniform load on the main muscle groups [3; 4].

A decrease in anxiety levels is observed after performing aerobic exercises such as jogging, swimming, cycling, breathing exercises, and rhythmic gymnastics. Aerobic loads activate metabolic processes, improve brain oxygenation, and stimulate the secretion of serotonin and norepinephrine, which ensures stabilization of the emotional state, reduction of fatigue, and improvement of mood [4].

The calming effect of physical exercises is explained by their rhythmic nature, repetition of motor actions, optimal interaction between excitation and inhibition processes in the central nervous system, and regulation of neurohumoral balance. Regular physical activity contributes to the normalization of stress hormone levels (cortisol and adrenaline) and stimulates the synthesis of neurotransmitters associated with positive emotional states – serotonin, endorphins, and dopamine – which creates a state of emotional balance and psychological comfort [5].

The analysis of scientific sources shows that physical activity is a key factor in enhancing the adaptive capacity of young people under stress, as regular exercise strengthens functional systems, stabilizes the psycho-emotional state, increases stress resilience, and improves overall performance; moreover, considering students' individual characteristics in physical education ensures effective prevention of chronic stress consequences and provides a foundation for maintaining and strengthening health during intensive academic activity.

REFERENCES

1. Hnatenko O. P. Impact of physical activity on students' mental health: An empirical study. *Current Issues of Physical Education and Sports: Proceedings of the International Scientific and Practical Conference*, Kyiv, May 10–11, 2024. P. 56–59.
2. Levchuk S. M. Social support as a factor of mental well-being of youth: Analysis of modern approaches. *Bulletin of Zaporizhzhia National University: Social Sciences*, 2023. №. 1. P. 22–29.

3. Tilikina N. V. Physical activity as a factor in supporting the physical and mental health of youth in wartime conditions: Monograph, TsUL, Kyiv, 2023. 180 p.
4. Yatsenko T. S., Hrynyk V. M. Psychological resilience of youth in crisis conditions: Theoretical and methodological aspects, *Psychology and Society*, № 4, 2022. P. 33–41.
5. Zaika O. O., Vyshar V. M., Heta O. M. Impact of physical exercise on psychological well-being: An empirical study. *Bulletin of Zaporizhzhia National University: Pedagogical Sciences*, № 2, 2021. P. 45–52.

O. Trukhym, O. Vinnyk, O. Osadcha

MODERN REHABILITATION APPROACHES IN THE MANAGEMENT OF PHANTOM LIMB PAIN

Phantom limb pain (PLP) is pain perceived in an amputated body part. It is typically described as burning, stabbing, shooting or pulsating and may resemble electric shocks or cramps. It should be distinguished from phantom sensations, such as tingling or itching, which are non-painful and create the illusion that the limb is still present. PLP also differs from residual limb pain [1, p. 660].

According to an analysis of data from 16 countries, approximately 64% of patients report PLP [9, p. 6-8]. This condition can significantly impede rehabilitation. Severe or persistent pain increases emotional strain and limits prosthesis use, thereby reducing quality of life.

Pharmacological treatment remains first-line therapy, but it is often ineffective and has numerous side effects. The etiology of PLP is not fully understood, leading to inconsistent treatment outcomes. Therefore, alternative approaches targeting different pathophysiological mechanisms should be considered [1, p. 660-661].

Mirror therapy (MT) is one of the most studied methods for managing PLP. This simple and accessible technique helps alleviate the sensorimotor mismatch. Patients move their intact limb in front of a mirror placed vertically in the sagittal plane, which provides the illusion of movement in the missing limb [1, p. 662]. Research indicates that MT is effective, particularly when performed at least three times per week for

an extended period. However, some patients may experience a temporary exacerbation of pain after the session due to a protective response [5, p. 1221, 8, c. 8].

The main limitation of MT is low realism and level of immersion, as the visual illusion is often unconvincing. This can be partly addressed by virtual or augmented reality (VR/AR). By providing richer somatosensory feedback and enabling asynchronous movements with game elements, these technologies can increase patient motivation and engagement. Unlike MT, which is mainly suitable for unilateral amputations, VR/AR can be applied to bilateral cases [1, p. 662]. Although evidence for effectiveness of VR in PLP is still insufficient, such systems show high potential for the rehabilitation process [5, p. 1221].

Another treatment option for PLP is motor imagery (MI). The literature describes two strategies, namely visual and kinesthetic imagery. Visual imagery involves mentally performing movements without physical activity, whereas kinesthetic imagery is based on the sensation of muscle and joint activation and appears to be more effective. The more vivid the imagined movement, the lower the intensity of pain [2, p. 321].

Graded Motor Imagery (GMI) is a comprehensive approach that combines several sensorimotor interventions [8, p. 2]. It has demonstrated meaningful therapeutic and long-lasting effects [8, p. 8]. The traditional GMI protocol includes three consecutive phases: limb laterality, visual motor imagery and mirror therapy. In the laterality phase, patients view images of limbs in different positions and identify whether each represents a left or right limb. GMI is designed to progress gradually through all stages. As noted above, MI and MT can be applied independently. In clinical practice, GMI may be implemented partially, using only selected components [4, p. 294-297].

Sensory discrimination training (SDT) is a method aimed at restoring cortical organization through neuroplasticity. It entails stimulating closely spaced but distinct areas of the residual limb. Patients assess the nature of each stimulus and receive feedback on the accuracy of their responses. Stimulation can be manual, vibrotactile or electrical, but none is clearly superior. It is thought that focusing on sensory input improves alignment between the physical and neural representations of the limb [3, p. 2].

Functional prostheses demonstrate superior PLP reduction compared to cosmetic ones, owing to enhanced sensory input, muscle activation and visual feedback. This strategy is acknowledged by experts as an integral component of multimodal rehabilitation [5, p. 1222].

It should be emphasized that PLP is influenced not only by central and peripheral nervous system mechanisms but also by psychosocial, cognitive and emotional factors [6, p. 2-6]. Cognitive-behavioral therapy has proven effective for other chronic pain conditions and may reduce PLP intensity by targeting these factors, although its exact mechanisms require further investigation [5, p. 1222].

In conclusion, phantom limb pain is a complex and often debilitating condition that can profoundly affect patients' daily lives, well-being and rehabilitation. Effective management requires a comprehensive, multimodal approach, combining pharmacological and non-pharmacological methods tailored to the individual. Given the wide variability in the underlying mechanisms of PLP, personalized strategies are essential for optimal pain relief and meaningful recovery [7, p. 1-2].

REFERENCES

1. Alfaifi N. Y., Winokur E. J. Integrating Complementary Therapies in Managing Phantom Limb Pain: A Case Review. *Pain Management Nursing*. 2024. Vol. 25, No. 6. P. 660-665.
2. Correlation between kinesthetic motor imagery of an amputated limb and phantom limb pain / M. Yoshimura et al. *Prosthetics & Orthotics International*. 2022. Vol. 46, No. 6. P. 321-325.
3. Efficacy of a novel sensory discrimination training device for the management of phantom limb pain: protocol for a randomised placebo-controlled trial / S. Oatway et al. *BMJ Open*. 2025. Vol. 15, No. 11. P. 1-8.
4. Graded motor imagery and its phases for individuals with phantom limb pain following amputation: A scoping review / K. J. Falbo et al. *Clinical Rehabilitation*. 2023. Vol. 38, No. 3. P. 287-304.
5. Limakatso K., Parker R. Treatment Recommendations for Phantom Limb Pain in People with Amputations: An Expert Consensus Delphi Study. *PM&R*. 2021. Vol. 13, No. 11. P. 1216-1226.
6. Pain without presence: a narrative review of the pathophysiological landscape of phantom limb pain / H. Wu et al. *Frontiers in Pain Research*. 2025. Vol. 6. P. 1-10.
7. Shi W., Prabhakaran B., Annaswamy T. Editorial: Phantom pain: mechanisms and updates in management. *Frontiers in Pain Research*. 2025. Vol. 6. P. 1-2.
8. The Efficacy of Graded Motor Imagery and Its Components on Phantom Limb Pain and Disability: A Systematic Review and Meta-Analysis / K. Limakatso et al. *Canadian Journal of Pain*. 2023. Vol. 10, No. 1. P. 1-11.
9. The prevalence and risk factors for phantom limb pain in people with amputations: A systematic review and meta-analysis / Limakatso K., Bedwell J. G., Madden. J. V., Parker R. *PLOS ONE*. 2020. Vol. 15, No. 10. P. 1-21.

NATURAL SALAD DRESSING AS A WAY TO UTILIZE SECONDARY PLANT RAW MATERIALS AND SUPPORT HEALTH

Secondary plant raw materials are generated during the processing of agricultural crops and include husks, stems, meal, pomace, and oil cake. They contain proteins, amino acids, polyphenols, pectins, vitamins, minerals, and essential oils, becoming a valuable resource for the food industry and pharmacology. The use of secondary plant raw materials helps reduce food waste, conserve resources, and create functional foods and dietary supplements [1].

Tomato seeds account for about seventy percent of waste and are rich in proteins and lipids, while the skin and pomace contain fiber, polyphenols, vitamins, and lycopene [2]. Products derived from secondary tomato raw materials have antioxidant, anti-inflammatory, cardio- and hepatoprotective properties. They help improve the lipid profile of blood, support the nervous system, normalize gastrointestinal function, and slow down skin aging [3–5].

A salad dressing with antioxidant properties based on tomato oil was developed. It is suitable for salads and rich in natural antioxidants. Tomato oil is a promising ingredient in functional nutrition due to its high content of linoleic acid, lycopene, tocopherols, and vitamins A and E. It gives products a bright red color, a light tomato aroma, and enhances their functionality and attractiveness.

The antioxidant content per 1 kg of dressing includes 278–528 mg of tocopherols, 30–60 mg of lycopene, 6–7 mg of quercetin, less than 2 mg of rutin, and a total flavonoid content of 110 mg. The product is rich in vitamins and micronutrients: vitamin E – 396 mg, C – 70.4 mg, K – 87.8 µg (microgram), B₁ – 0.06 mg, B₂ – 0.003 mg, B₃ – 0.45 mg, B₆ – 1.27 mg; potassium – 619.9 mg, magnesium – 119.1 mg, sodium – 387.3 mg, iron – 6.7 mg. The dressing is characterized by a high content of unsaturated fats (>80%), including linoleic acid (omega-6) – 42.3%, oleic acid (omega-9) – 36.5%,

and linolenic acid (omega-3) – 1.7%. The omega-6/omega-3 ratio is 24:1, which requires balancing with other sources of omega-3.

The dressing is a complete source of antioxidants due to the presence of lycopene, tocopherols, and vitamin C, which help neutralize free radicals, slow aging, reduce inflammatory processes, and support cellular health.

Conclusion. The obtained dressing based on tomato and olive oils is characterized by a high content of natural antioxidants, unsaturated fatty acids, a vitamin-mineral complex, and balanced organoleptic properties. It contributes to cardiovascular health, regulation of metabolic processes, immune function, and antioxidant protection of the body, and is recommended as an element of functional nutrition, especially for individuals seeking to avoid artificial additives and maintain a healthy lifestyle.

REFERENCES

1. Benderska O., Bessarab A., Iegorov B., Kashkano M., Shutyuk V. Біологічна цінність побічних продуктів переробки томатів. *Food Science and Technology*, 2021, 15(1). 28-36 DOI: <https://doi.org/10.15673/fst.v15i1.1972>
2. Frusciante L., Carli P., Ercolano M.R., Pernice R., Di Matteo A., Fogliano V., Pellegrini P. Antioxidant nutritional quality of tomato. *Molecular Nutrition and Food Research*, 2007, 51(5), P. 609–617.
3. Kumar M. Valorization potential of tomato (*Solanum lycopersicum* L.) seed: nutraceutical quality, food properties, safety aspects, and application as a health-promoting ingredient in foods. *Horticulturae*, 2022, 8(3), 265.
4. Maldonado-Torres R., Morales-Camacho J.I., López-Valdez F., Huerta-González L., Luna-Suárez S. Assessment of techno-functional and nutraceutical potential of tomato (*Solanum lycopersicum*) seed meal. *Molecules*, 2020, 25(18), 4235.
5. Nakov G., Brandolini A., Estivi L., Effect of tomato pomace addition on chemical, technological, nutritional, and sensorial properties of cream crackers. *Antioxidants*, 2022, 11(11), 2087.

PROSPECTS FOR THE DEVELOPMENT OF LACTOSE-FREE YOGURTS USING INULIN AND STEVIA EXTRACT

At the current stage of the food industry development, the creation of functional products that combine high nutritional value and health-promoting properties is of particular relevance. The increase in the number of people with lactase deficiency and carbohydrate metabolism disorders justifies the necessity of the development of lactose-free dairy products, including yogurts [2, p. 140].

Yogurt is one of the most widespread fermented dairy products, characterized by a high content of proteins, vitamins, and minerals, as well as the presence of probiotic microorganisms that positively affect the intestinal microflora [4]. Modern studies indicate the feasibility of improving yogurt production technologies through the use of functional ingredients [5, p. 55].

The aim of this work is to substantiate the development of a lactose-free yogurt of functional purpose using inulin and stevia extract.

In the course of the study, it has been established that the use of the enzyme lactase (β -galactosidase) allows the hydrolysis of lactose into glucose and galactose, enabling the consumption of the product by people with lactase deficiency [6, p. 382].

One of the promising functional ingredients is inulin – a natural prebiotic that stimulates the growth of beneficial intestinal microflora, improves the product consistency, and reduces its caloric value [3]. Studies show that the addition of inulin contributes to the improvement of structural and mechanical properties of yogurt and reduces syneresis [5, p. 55].

To reduce sugar content, the use of natural sweeteners is advisable. One of the most promising ones is stevia extract, which is characterized by high sweetness, low caloric value, and does not affect blood glucose levels [1].

Lactose-free dairy products are gaining attention due to health concerns and

consumer demand. They improve digestibility while maintaining nutritional value and overall product quality.

It is important to note that the development of lactose-free yogurts using functional ingredients opens new opportunities for creating products with predetermined properties.

Thus, the combination of probiotic cultures with the prebiotic inulin and stevia extract makes it possible to create a synbiotic product of functional purpose with reduced caloric content, which meets modern requirements of healthy nutrition and represents a promising direction in the development of food technologies.

The development of innovative dairy products plays an important role in modern food technology. The introduction of functional ingredients allows not only the enhancement of nutritional properties, but also the improvement of product competitiveness in the market. Such approaches contribute to the formation of a balanced diet and support overall well-being. Further studies in this field will focus on optimizing formulations and expanding the range of lactose-free products.

REFERENCES

1. Види цукрозаміників. URL: <https://fitforma.ua/vydy-cukrozaminykiv/>
2. Вітряк О., Замай Ж., Фабріченко К. Безлактозні йогурти з додаванням рослинної сировини // Технічні науки та технології. – 2023.
3. Інулін – натуральна клітковина та пребіотик у здоровому раціоні. URL: <https://allnutrition.ua>
4. Йогурт // Вікіпедія: вільна енциклопедія. URL: <https://uk.wikipedia.org/wiki/Йогурт>
5. Сичова О.О., Завгородній М.М., Поліщук Г.С. Розроблення нового виду йогурту з інуліном // Матеріали конференції. – Тернопіль, 2025.
6. Stanhrit A.A., Buchkevych I.R., Kurka M.S. Fundamentals of Lactose-Free Dairy Product Production. Available at: <https://doi.org/10.30525/978-9934-26-511-2-14>

ECOPHYSIOLOGICAL MECHANISMS OF ADAPTATION AND DISPERSAL OF ARALIACEAE (JUSS.) SPECIES IN THE STEPPE DNIPRO REGION

Introduction. Plant introduction is one of the key processes shaping modern flora and influencing ecosystem dynamics. Members of the Araliaceae family, including *Hedera helix*, *Aralia elata*, and *Schefflera actinophylla*, exhibit a wide range of ecological strategies that allow them to successfully colonize new habitats. Analyzing the ecophysiological adaptation mechanisms of these species is particularly important for predicting their performance under the steppe climate of the Dnipro Steppe region, where extreme temperature fluctuations, limited water availability, and high solar radiation create significant abiotic stress for non-native species.

Materials and Methods. For this study, current literature on growth physiology, water relations, photosynthetic activity, and dispersal mechanisms of Araliaceae species in various climatic conditions was analyzed. Special attention was given to comparing species' responses to drought, temperature fluctuations, and different light regimes. English-language scientific sources documenting the success of introduced species and the mechanisms of their biological resilience were used as primary references.

Results and Discussion.

1. Photosynthetic Plasticity and Water Relations

Photosynthetic plasticity is a key adaptive mechanism in Araliaceae species. Studies show that *Hedera helix* can maintain a high level of photosynthetic activity even under low light conditions due to efficient light utilization and regulation of the stomatal apparatus [5, p. 240]. This allows the plant to adapt to various light environments, including open steppe areas with intense solar radiation.

Water stress in steppe conditions is a critical limiting factor. Some species demonstrate the ability to maintain turgor during prolonged drought periods by reducing transpiration and efficiently using available water resources [2, p. 1054], which enhances their survival under harsh environmental conditions.

2. Reproduction and Dispersal Strategies

Vegetative reproduction, typical of *Hedera*, *Aralia*, and *Schefflera*, ensures stable population expansion at the local level. Seedlings, root suckers, and rapid regeneration after mechanical damage provide these species with competitive advantages over native flora [3, p. 1726].

Seed dispersal by birds and small mammals (epizoochory and ornithochory) promotes long-term expansion of Araliaceae beyond primary cultivation sites [4, p. 98], increasing their invasive potential.

3. Phenological Changes under Climatic Conditions

Climatic factors of the Steppe Dnipro region, particularly large temperature amplitudes, affect plant phenological cycles. In Araliaceae species with a short growing season, flowering and fruiting phases may shift, ensuring timely seed reproduction before peak drought periods [1, p.1477]. This phenological flexibility increases the chances of survival and adaptation for non-native species under stressful environmental conditions.

Conclusions

Adaptive mechanisms of Araliaceae species include:

- high photosynthetic plasticity and efficient water management, promoting survival under drought;
- the ability for vegetative reproduction and regeneration, enhancing invasive potential;
- phenological flexibility, allowing avoidance of abiotic stress.

These traits make Araliaceae species potentially successful introductions in steppe ecosystems, particularly in the Dnipro region. Further field studies on these mechanisms will help refine predictive models of their dispersal and impact on local biocenoses.

REFERENCES

1. Bradshaw W. E., Holzapfel C. M. Evolutionary response to rapid climate change. *Science*. 2006. 312(5779). 1477–1478.
2. Niinemets Ü. Photosynthesis and resource distribution through plant canopies. *Plant, Cell & Environment*. 2007. 30(9). 1052–1071.

3. Pyšek P. et al. A global assessment of invasive plant impacts on resident species, communities and ecosystems: the interaction of impact measures, invading species' traits and environment. *Global Change Biology*. 2012. 18(5). 1725–1737.
4. Richardson, D. M. et al. Naturalization and invasion of alien plants: concepts and definitions. *Diversity and Distributions*. 2000. 6(2). 93–107.
5. Valladares, F. & Niinemets, Ü. Shade tolerance, a key plant feature of complex nature and consequences. *Annual Review of Ecology, Evolution, and Systematics*. 2008. 39. 237–257.

D. Zheleznov, N. Kondratiuk, O. Posudiiievskia

MODIFICATION OF GELLAN GUM AS AN APPROACH TO REGULATING ITS RHEOLOGICAL, MECHANICAL AND THERMAL PROPERTIES

Gellan gum is an anionic microbial polysaccharide that is widely used in the food, pharmaceutical, and biomedical fields due to its biocompatibility, biodegradability, gel-forming ability, and low toxicity. Its structural organization, represented by a linear tetrasaccharide repeating unit, determines the presence of reactive centers – namely, primary hydroxyl and carboxyl groups – which provide broad opportunities for selective chemical functionalization. At the same time, native gellan exhibits several technological limitations, including sensitivity to the nature and concentration of cations, the need for relatively high dissolution temperatures, and insufficient stability of some ionically crosslinked gels under physiological conditions. Therefore, the modification of gellan gum is currently considered one of the most promising approaches for the development of materials with tailored properties [1-3].

In the study [1] new derivatives of gellan gum were synthesized by covalent attachment of octadecylamine to the polysaccharide backbone. The incorporation of long hydrophobic alkyl chains into the hydrophilic polymer framework enabled the modification of dissolution temperature conditions and significantly affected the gelation process, as well as the mechanical strength and stability of the resulting hydrogels. Importantly, some derivatives demonstrated the ability to form hydrogels under conditions close to physiological ones, which substantially expands the potential

applications of gellan in cell encapsulation, delivery of bioactive compounds, and the development of soft biomaterials.

The review [2] systematizes synthetic strategies for gellan modification along two main pathways: via primary hydroxyl groups and via carboxyl groups. The authors demonstrate that these reactive centers enable reactions, such as etherification, esterification, amidation, sulfation, as well as other types of functionalization, which allow the regulation of solubility, polydispersity, mucoadhesion, mechanical stability, responsiveness to external stimuli, and transport properties of the material. A particularly important conclusion is that gellan modification is not merely a means of altering individual properties, but rather a platform for designing materials with predictable structure and function – from wound dressings and tissue engineering scaffolds to controlled drug delivery systems and active packaging materials.

Another important direction is presented in the study [3], where a chassis platform was developed for the biosynthesis of a new variant of acetylated gellan gum with ultrahigh molecular weight. The authors demonstrated that rational control of biosynthetic processes enables the production of a polysaccharide with improved textural and rheological properties without the use of conventional harsh physicochemical modification methods.

Thus, modified gellan should be considered to be a next-generation biopolymer, suitable for design of the materials with predetermined properties for biomedical, pharmaceutical, food, and packaging applications.

REFERENCES

1. Agnello, S., Gasperini, L., Mano, J. F., Pitarresi, G., Palumbo, F. S., Reis, R. L., & Giammona, G. (2017). Synthesis, mechanical and thermal rheological properties of new gellan gum derivatives. *International Journal of Biological Macromolecules*, *98*, 646–653. <https://doi.org/10.1016/j.ijbiomac.2017.02.029>
2. Majumdar, A., Ghorai, P., & Ganguly, J. (2026). Synthetic strategies for the modification of primary hydroxyl and carboxyl groups of gellan towards the development of advanced biomaterials. *Carbohydrate Research*, *563*, 109870. <https://doi.org/10.1016/j.carres.2026.109870>
3. Ming, Y., Shi, Z., Wang, W., Li, J., Lin, Y., Sha, W., Li, G., Wu, M., & Ma, T. (2026). Directed synthesis, characterization and rheological properties of an ultrahigh molecular weight acetylated-gellan gum. *Carbohydrate Polymers*, *381*, 125201. <https://doi.org/10.1016/j.carbpol.2026.125201>

PANEL 2

Topical Issues of Social Sciences and Humanities

(DNU, Zoom)

A. Bonhar, R. Velychko, O. Osadcha

FEATURES OF THE FORMATION OF COPING STRATEGIES IN ADOLESCENTS DURING MARTIAL LAW

Martial law in Ukraine creates difficult psychological conditions for adolescents, accompanied by a constant sense of danger, uncertainty, and loss of stability. As a result, this can lead to increased levels of stress, anxiety, and emotional tension. In such conditions, coping strategies play an important role, that is, the ways in which adolescents try to adapt to difficult circumstances, overcome challenges, or reduce the negative impact of stressful situations. The concept of coping (from the English word “cope” – “to overcome,” “to manage,” “to deal with”) is understood as cognitive, emotional, and behavioral efforts aimed at overcoming difficulties in the process of human interaction with the environment [1, p. 16].

The war context significantly complicates adolescents’ stress experiences due to the overlap of specific socio-psychological factors. The process of self-regulation formation in adolescents is closely related to the social context and the development of reflection. Despite the natural tendency of adolescents toward impulsivity, the conditions of martial law accelerate the formation of coping strategies due to the need for constant adaptation to crisis conditions.

Considering that coping strategies manifest in three domains – emotional, behavioral, and cognitive – cognition is viewed as an important internal resource of coping strategies. The cognitive domain of coping is reflected in the ability to comprehend a stressful situation and one’s actions within it. Accordingly, the formation of coping

strategies involves cognitive appraisal, which “implies certain intellectual means, namely reasoning about the problem, analyzing the situation, and considering ways to solve it” [2, p. 41]. R. Lazarus distinguishes three main processes of human interaction with stressors: primary cognitive appraisal, secondary cognitive appraisal, and coping [3, p. 85]. Thus, primary cognitive appraisal allows a person to quickly determine the significance of a stressful situation and its possible consequences. This is followed by the next stage of understanding the situation associated with secondary cognitive appraisal. Secondary cognitive appraisals are reflective thoughts about a negative event that arise after the primary intuitive evaluative reaction: “Is it possible to do something in this situation?” Secondary cognitive appraisal influences the choice of strategy and the outcome of the coping process. It acts as an intermediate stage between the stress response and coping. Its specificity determines the type of emotional reaction in a stressful situation. If a stressor is perceived as a challenge, it contributes to maintaining control over the development of the situation and the outcome of coping [3, p. 85]. Research on coping behavior has been further developed by scholars such as C. Carver, who analyzed the stress and coping theories of R. Lazarus and S. Folkman. In adolescence, reflective thinking—the ability to analyze one’s thoughts, behavior, and experiences—helps individuals understand their strengths and weaknesses, evaluate actions, and choose effective coping strategies. During this stage, adolescents experiment with ways of responding to difficult circumstances, including wartime stress. The formation of these strategies depends on personal traits, such as the level of reflection and locus of control. During martial law, adolescents can manage stress by regulating emotions, analyzing their actions, planning behavior in dangerous situations, discussing experiences with parents or peers, and using self-soothing techniques to reduce anxiety and restore a sense of control.

REFERENCES

1. Karamushka, L. M., Snihur, Yu. S. Psychology of Choosing Coping Strategies by Managers of Educational Organizations: Monograph. Kyiv: H. S. Kostyuk Institute of Psychology of the National Academy of Educational Sciences of Ukraine, 2024. 188 p. ISBN 978-617-7745-46-3.

2. Dubinina, M. I. Cognitive characteristics of personality as a coping resource for women's professional self-realization. Scientific Bulletin of Kherson State University. Series: Psychological Sciences, 2018. Issue 2, Vol. 1, pp. 40–44.
3. Prokofieva, O., Smirnov, B., Prokofieva, O. Features of coping strategies in adolescence [Electronic resource]. Melitopol: Bohdan Khmelnytsky Melitopol State Pedagogical University, 2021. URL: <https://apsijournal.com/index.php/psyjournal/article/view/1156>

M. Demchenko, V. Yashkina

CHANGES IN LEXICAL DIVERSITY IN THE WORKS OF TERRY PRATCHETT

Changes in lexical diversity in works of an author can be a source of a lot of valuable information for a research of a writer's linguistic style. Decrease or increase in lexical variation can be a sign of a change in style, in target demographic of a text, specific features of lexis of characters etc. Furthermore, this criterion may also be indicative of changes in cognitive abilities of an author. For example, Alzheimer disease (AD) in its mild phase can lead to a language deficit [5]. This early symptom may appear even before any clinically significant ones. Therefore, study of lexical variation may help researchers in the medical field to understand early markers of the incurable disease. This may lead to a treatment that can significantly postpone later development of AD [4].

Terry Pratchett's body of work and specifically his fantasy cycle Discworld was chosen as a subject for this research due to several factors. The first one being the author's usage of a wide range of various lexis in his works. There can be found a lot of examples of slang, dialect words, author's neologisms and other unconventional lexis in the novels of T. Pratchett. The other reason for this choice is the fact that the writer was officially diagnosed with AD in 2007 [7]. This makes it possible to observe changes in lexical variation before and after the moment the subject was informed about their disease which is one of the main criteria for this type of research proposed by Garrard during the analysis of the works of Iris Murdoch [1].

The main methods used during the research were type-token ratio (TTR) and count of percentage of indefinite pronouns. These methods were used in research of lexical diversity in other studies that were focused on the body of work of Agatha Kristy, Iris Murdoch and Terry Pratchett [1–3, 6]. Also, analytical and descriptive methods were used to validate the conclusions made based on the previous two methods.

During the the research it was found that there are both a pattern of decrease in lexical variation and of increase in percentage of indefinite pronouns in the texts of T. Pratchett’s novels. These trends can be seen on fig. 1 and fig. 2. It can be assumed that this change may be indicative not only of the author’s conscious stylistic choices but also of alterations of his cognitive abilities during the course of his career.

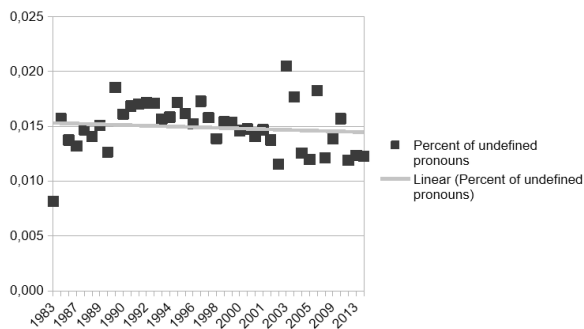


Fig. 1. Percentage of indefinite pronouns in the works of T. Pratchett

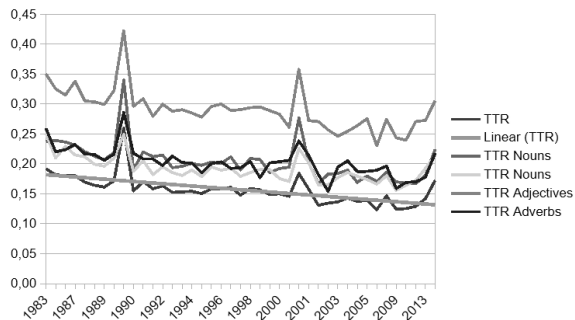


Fig. 2. Lexical diversity in the works of T. Pratchett

However, changes in percentage of indefinite pronouns may be explained by other factors. It was chosen to check examples of such usage in the novel *Unseen Academicals* (2009). This book was chosen because it was written after the diagnosis of AD and due to its high percentage of indefinite pronouns and low lexical diversity based on the data obtained.

It was found that in a lot of examples indefinite pronouns were used as a part of regular expressions as seen below:

- ‘Is there **something wrong**?’
- ...that someone singing a song about how patriotic they were was either **up to something** or a Head of State.
- ...can’t you stick your fingers down his throat **or something**?
- And you don’t want **anything to do with** him.
- Did **anything go wrong**? [8]

In other cases indefinite pronouns were used to create suspense or mystery or to make or amplify a comic effect which can be seen on the tab. 1.

Table 1

Usage of indefinite pronouns with a comic purpose

Fragment from <i>Unseen Academicals</i>	Comment
...a dwarf, selling beauty products to Miss and Mrs Troll, via ladies like Glenda, a human, because although dwarfs and trolls were officially great chums these days, because of something called the Koom Valley Accord, that sort of thing only meant much to the sort of people who signed treaties	The word «something» is used to convey the fact that the character is not familiar with the accord that is brought up in the text. The author is using this pronoun to satirize the situation when a certain document which is forgotten by all can dictate important aspects of our lives
‘Here we are, Mister Nutt, still warm,’ said Glang, arriving from the back of the shop holding something that looked like something taken from an animal that was now, you hoped for its own sake, dead	The pronoun is used twice in one sentence which creates a tautology. Usage of this technique may be explained by the author’s aim to create and amplify comic effect of the expression
‘Tell her–’ Vetinari hesitated, and then smiled. ‘Ah, yes, Sugarbean. Did she bribe the guards with food? Something baked, perhaps?’	The pronoun is used to create a comic effect. The character ironically asks if there was a bribe offered with something baked, instead of saying directly, with pastries

Conclusion. Based on the data obtained it can be concluded that there is an increase in usage of indefinite pronouns in the works of T. Pratchett. However, it should be noticed that a lot of examples of such usage are motivated by the author. Furthermore, the data obtained indicates a trend of decrease in lexical diversity in the works of Pratchett. This may be a result not only of the author's stylistic choices but also of changes that occurred as a result of his condition.

To further research this subject other works of T. Pratchett may be added to the studied sample, in particular the early novels of the author, *The Dark Side of the Sun* (1976) and *Strata* (1981). Additionally, the short fiction of the writer should be analyzed, specifically *A Stroke of the Pen: The Lost Stories* (2023) which was released posthumously. Moving average type-token ratio (MATTR) method would be appropriate for the research of the later because it can effectively process texts of varying sizes.

REFERENCES

1. Garrard P. [та ін.]. The effects of very early Alzheimer's disease on the characteristics of writing by a renowned author // *Brain: A Journal of Neurology*. 2005. № Pt 2 (128). P. 250–260.
2. Lancashire I., Hirst G. Vocabulary Changes in Agatha Christie's *Mysteries* as an Indication of Dementia: A Case Study // 19th Annual Rotman Research Institute Conference, Cognitive Aging: Research and Practice. 2009. № 10 (8). P. 5.
3. Le X. [та ін.]. Longitudinal detection of dementia through lexical and syntactic changes in writing: a case study of three British novelists // *Literary and Linguistic Computing*. 2011. № 4 (26). P. 435–461.
4. Leifer B. P. Early Diagnosis of Alzheimer's Disease: Clinical and Economic Benefits // *Journal of the American Geriatrics Society*. 2003. № 5s2 (51).
5. Liu Z. [та ін.]. Automatic Diagnosis and Prediction of Cognitive Decline Associated with Alzheimer's Dementia through Spontaneous Speech Kuala Terengganu, Malaysia: IEEE, 2021. P. 39–43.
6. Pattison M., Begde A., Wilcockson T. D. W. Detecting Dementia Using Lexical Analysis: Terry Pratchett's *Discworld* Tells a More Personal Story // *Brain Sciences*. 2026. № 1 (16). P. 94.
7. Pauli M. Pratchett announces he has Alzheimer's // *The Guardian*. 2007.
8. Pratchett T. *Unseen academicals: a Discworld novel* / T. Pratchett, London: Doubleday, 2009. 400 p.

THE TRANSFORMATION OF CINEMATIC AESTHETICS AND STYLE IN THE DIGITAL ERA

The media specificity of cinema has always been quite difficult to define. What is called the “classical period of film aesthetics” consisted of a series of debates about the identity of film, based on arguments specific to the medium. Walter Benjamin, Siegfried Kracauer, and André Bazin all participated in similar debates about the nature of cinema, attempting to define how it differed from other arts. According to Rodowick, the difficulty lay in the hybrid nature of cinema: a combination of moving photographic images, sounds and music, as well as speech and writing. A similar theoretical tactic was employed in the early days of video. Theorist and critic Amy Taubin has described how early video artists, led by Nam June Paik, sought to emphasize the specificities of the video medium, such as electronic distortions, low-definition images, and the flow of video images as opposed to the frame transitions of film. Taubin calls this a “false distinction” emphasized by video artists, since at the time video could not compete with avant-garde cinema on technical and artistic grounds [2].

To obtain funding and a place in the museum, video artists had to fetishize difference. This deliberate distinction exaggerated differences at a time when creating video art was still difficult and confusing, and focused the argument on the ontology of the medium. Video artists emphasized this because, at that time, video could not compete with avant-garde cinema on technical and artistic grounds.

As video approached film in quality, this distinction began to lose significance in popular discourse. Film critic Manohla Dargis, writing in 2005, notes how the New York Video Festival renamed itself “Scanners” and how film critics now rarely mention whether a film was shot on film or video [2]. As film theorist John Belton points out, unlike the advent of sound, color, and widescreen imaging, the adoption of digital technologies at the level of visual representation was practically unnoticeable. Without external or technical knowledge, audiences can’t always tell whether what

they're watching was shot, processed, edited, or distributed digitally. For this reason, and perhaps in response to some revolutionary claims about the impact of digital technologies on cinema, Belton has called it a false revolution. He cautions that we shouldn't be blinded by economic factors, but rather take a closer look at what's truly different about filmmaking with digital technologies. He argues that digital technologies simply provide a better tool for certain functions, but cautions against assuming that this represents a new aesthetic.

Video differs from film not only in its specific characteristics, such as light information, detail clarity, and depth of field, as mentioned above, but also the processes of digital filmmaking encourage different aesthetic paths. In 1948, Alexandre Astruc coined the term "caméra-stylo" or "pen camera" in France to describe a more intimate and personal style of photography, which he foresaw would be made possible by the technology of compact and mobile 16 mm film cameras [3]. He concluded his manifesto, "The Camera Stylo," with this quote: "...for although we know what we want, we do not know if, when, or how we can do it..." [3, p. 135]. Cameras are lightweight and relatively inexpensive, and ambient light is often sufficient for digital capture. The camera can increasingly function like a pen, spontaneously writing in the moment without the industrial process of film production. Progressive directors and cinematographers are taking advantage of the camera's new flexibility to capture images and situations that were previously either impossible or prohibitively expensive.

REFERENCES

1. Auslander P. *Liveness: Performance in a Mediatized Culture*. London: Routledge Publ., 2008. P. 29–45.
2. Bay-Cheng S. *Theatre Squared: Theatre History in the Age of Media*. Theatre Topics, 2007. № 1 (17).
3. Jensen A. *Theatre in a Media Culture: Production, Performance and Perception since 1970*. Jefferson: North Carolina, McFarland Publ., 2014. P. 127–136.

SPEECH DEVELOPMENT SUPPORT FOR UKRAINIAN CHILDREN IN IRELAND

In recent years, the issue of supporting the speech and language development of Ukrainian children living in Ireland has become increasingly relevant. Due to the ongoing war in Ukraine, many families have moved to European countries, including Ireland. As a result, Ukrainian children have entered Irish educational institutions and must adapt to a new linguistic and social environment. This situation creates specific challenges for speech and language development, especially for children who already have speech disorders or communication difficulties [1; 2].

Speech development plays an essential role in a child's cognitive, social, and emotional development. Early identification and intervention in speech disorders significantly improve children's communication skills and learning outcomes. For Ukrainian children in Ireland, speech development often occurs in a bilingual context, where the child uses Ukrainian as a native language and English as the language of education and communication in society. Bilingualism can enrich a child's linguistic abilities, but it may also complicate the process of diagnosing speech disorders, as specialists must distinguish between language differences and actual speech difficulties [2; 3].

Speech and language therapists in Ireland play an important role in supporting children with communication disorders. Their work includes assessing speech and language abilities, developing individualized therapy programs, and cooperating with teachers and parents. Effective speech therapy often involves play-based activities, language games, and interactive exercises that help children develop vocabulary, pronunciation, and communication skills [4].

An important aspect of supporting Ukrainian children is maintaining their native language while learning English. Supporting a child's first language contributes to better cognitive development and facilitates learning a second language. Therefore,

cooperation between speech therapists, educators, and families is essential for creating a supportive bilingual environment that promotes the successful speech development and social integration of Ukrainian children in Ireland [3; 4].

In conclusion, speech development support for Ukrainian children in Ireland is a significant factor in their educational and social adaptation. Speech and language therapists, teachers, and parents must work together to ensure effective communication development while respecting the child's linguistic and cultural background.

REFERENCES

1. Current problems in communicative development of children with special educational needs: Ukrainian and European scientific context / H. V. Bilavych et al. *Wiadomości Lekarskie*. 2023. Vol. 76, no. 8. P. 1838–1845. URL: <https://doi.org/10.36740/wlek202308124>
2. Kay-Raining Bird E., Genesee F., Verhoeven L. Bilingualism in children with developmental language disorder: A narrative review // *Journal of Communication Disorders*. 2016. Vol. 63. P. 1–14.
3. Paradis J. The development of English as a second language with and without specific language impairment // *Journal of Speech, Language, and Hearing Research*. 2016. Vol. 59. P. 171–187.
4. Shevchuk-Kliuzheva O. V. Speech development challenges for Ukrainian children in forced migration: the role of primary and secondary social contexts // *Opera in Linguistica Ukrainiana*. 2024. No. 31. P. 435–445. URL: <https://doi.org/10.18524/2414-0627.2024.31.309464>

K. Kocherzhyna, S. Riabovol

SMALL TALK PHRASES AS A PART OF EFFECTIVE COMMUNICATION

Small talk is an important part of our daily communication with people. It is essential to create good long-lasting impression and make new acquaintances. Nowadays, small talk is a target topic for research in many humanitarian fields, especially psychology and sociology. Simple chatting at the beginning of the working day has the huge potential to deal with different social issues like ageism or hazing.

Small talk has been evolving throughout the history, along with the concept of networking. Under the Renaissance, it started getting shape thanks to the economic

progress. The trade was developing, people constantly met partners from other countries and negotiated business deals. At first, small talk was typical of nobility and merchants. But now it is a basic part of effective communication in different areas of human life, and an unofficial requirement when meeting new people. It keeps evolving, as it is getting new forms and peculiarities in the digital age.

The relevance of the study is based on the current growth of online communication. Remote work has had a huge toll on human socializing skill over the past decade. Rapid development of social media and networks, COVID-19 pandemic with its quarantines and ongoing war have been forcing Ukrainians to move to the online space. Over time, people become more and more hesitant to speak and interact with each other. “While individuals are increasingly reporting burnout from videoconferencing interactions, the results reported here suggest that a way to potentially combat this burnout is through engaging in small talk”, A. Guydish and J. E. Fox Tree state [1].

From a linguistic point of view, small talk can be called “a metacommunicative (accompanying informative communication) type of communicative behavior that satisfies human needs for social cohesiveness” [3, p. 95]. To put it in a simpler way, small talk is a communication strategy that has a set of clear functions in a world of human interaction. First of all, it should be polite and entertaining, and pleasing for the interlocutors, which helps create new bounds and establish an individual in a highly competitive environment.

The specific choice of small talk phrases often depends on the setting, the situation where the conversation takes place. There is a set of phrases which can serve as the “soft openers” [4] for the conversation. It is an appropriate start of the dialog, as it helps break the ice and create warm positive atmosphere between the speakers. Moreover, such phrases can reduce tension if the speakers do not know each other well enough.

There are some examples of the small talk phrases used in a casual interaction:

- *How're things with you?*
- *How was your weekend?*
- *Have you had a busy day / morning so far?*
- *Lovely weather today, isn't it?*

If it is a public event, small talk can be a great way to meet new people and build up closer relationships.

- *Have you been here / to one of these events before?*
- *What brings you here today?*
- *How do you know ... (some people)?*

Small talk is quite often linguistically playful; thus, you can use slang and a lot of phrasal verbs in it.

- *I should let you get back to it / work.*
- *Let's catch up again soon.*

Effective communication is not only about speaking, but also about listening. That is why small talk consists of the follow-up questions. They help ensure that the conversation keeps going and show your engagement. Such expressions can be a real proof of attentive listening and sincere interest:

- *I can imagine that it was great / challenging / interesting.*
- *Really? How did that go?*
- *That sounds interesting / fun.*
- *Tell me more about that.*

Part of the importance of mastering small talk is knowing how to finish the conversation. D. Fine emphasizes that being a good conversationalist includes the ability to end an interaction gracefully, leaving the other person feeling positive about the encounter [2, p. 113].

Small talk is an exciting part of English to study from the different points of view. It remains relevant as an essential part of the modern speaking culture and a strategic life skill. So, there is enormous potential for further research about its cognitive and pragmatic functions and the role in shaping human speech.

REFERENCES

1. Guydish A. J., Fox Tree J. E. Small talk in videoconferencing improves conversational experience and fosters relationships. *Cognition and Emotion*, 39(4), 2025. P. 757–769. URL: <https://doi.org/10.1080/02699931.2024.2392178>
2. Fine D. *The Fine Art of Small Talk*. New York, 2023. 272 p.

3. Shevchenko I., Matyukhina Y., Drazdauskienė M. L. The evolution of the English small talk: a cognitive-pragmatic analysis. *Cognition, communication, discourse*, 23, 2021. P. 87–98. URL: <http://doi.org/10.26565/2218-2926-2021-23-06>
4. Your guide to small talk topics, phrases and openers in English. British Council. URL: <https://englishonline.britishcouncil.org/blog/articles/your-guide-to-small-talk-topics-phrases-and-openers-in-english/>

D. Kolisnyk, M. Tkachenko, N. Kaliberda

APPLIED ORIENTATION OF MATHEMATICS EDUCATION AS A MEANS OF FORMING STUDENTS' LIFE COMPETENCIES

Modern mathematics education faces the challenge of bridging the gap between abstract theoretical knowledge and its practical application in everyday life. Students often perceive mathematics as a set of formulas and rules detached from real needs, which reduces motivation and complicates the development of key competencies.

The practical orientation of mathematics learning helps to overcome this problem by introducing life-related tasks into the educational process. This approach fosters the development of skills in information analysis, financial literacy, time management, communication, and decision-making in various life situations.

The importance of this study lies in the need to form students' ability to apply mathematical knowledge to solving practical tasks, ensuring their readiness for future professional and social challenges.

The aim of the work is to substantiate the pedagogical significance of the applied orientation of mathematics education and to outline ways of its implementation in the school mathematics curriculum.

From a pedagogical perspective, the practical orientation of learning plays a crucial role in shaping students' motivation. When learners see that mathematical laws explain phenomena of the surrounding world – from engineering structures to economic calculations – they begin to perceive mathematics as a useful and engaging tool rather than merely an abstract science. This approach stimulates cognitive interest, promotes

a positive attitude toward the subject, and opens opportunities for the development of each student's creative potential [3, p. 7].

One of the main objectives of mathematics education is to develop students' ability to acquire knowledge independently and apply it not only in mastering other disciplines but also in everyday life. For these skills to truly evolve, the content of learning must include the acquisition of general methods of thinking – such as analysis and synthesis, proof by contradiction, the use of counterexamples, generalization, and deduction. These techniques help students to master the material more deeply while simultaneously strengthening its practical orientation.

Solving applied problems enables students to better understand the principles of enterprise operations and economic sectors, while also fostering interest in specific professions. The use of such tasks creates problem situations in lessons that encourage students to seek new knowledge and deepen their theoretical understanding of technical and other disciplines [1, p. 109].

Already at the middle stage of education, the practical orientation of mathematics becomes particularly evident. For instance, in Grade 6 students begin to learn the concept of percentages, which allows them to analyze store discounts and recognize the usefulness of fractions in everyday life. In Grade 7 they are able to solve problems reducible to equations and identify geometric forms in the surrounding world – for example, recognizing right triangles and distinguishing between right and obtuse angles. In Grade 8 students move on to more complex and life-relevant topics: they study the basics of financial literacy, plan their weekly budgets, conduct their first mini-research projects, and gradually learn to manage their own finances. This gradual development of applied skills demonstrates that mathematics is not only an academic subject but also a tool for building life competencies.

It has been established that successful problem-solving in mathematics and applied contexts, as well as the investigation of problem situations using mathematical methods and techniques, requires students to master certain activity foundations or guiding rules. These may take the form of advice, instructions, algorithmic prescriptions,

heuristic schemes, or plans. They apply both to solving individual problems or problems of certain types and to studying concepts, properties, phenomena, and laws, conducting observations, performing experiments, and implementing projects [2, p. 34].

It is important to emphasize that the practical orientation of mathematics has a significant impact on student motivation. When learners see how mathematical patterns explain real-world phenomena – from constructing architectural structures to planning a family budget – they begin to perceive mathematics as a useful and interesting tool. This stimulates cognitive activity, fosters a positive attitude toward the subject, and helps to unlock each student’s creative potential.

Equally important is the role of the teacher, who must sustain interest in learning, propose applied tasks, create problem situations, and encourage students to conduct their own experiments. Pedagogical mastery ensures the transition from abstract knowledge to its practical application, enabling students to perceive interdisciplinary connections and understand the complexity of modern knowledge.

Thus, the practical orientation of mathematics education is not only a didactic technique but also a strategic direction for the development of modern schooling. It contributes to the formation of competent, independent, and socially active individuals capable of using mathematics as a universal tool for solving life and professional tasks. Therefore, the implementation of applied approaches in the educational process should be considered a necessary condition for the modernization of education and the preparation of students for successful integration into the knowledge society.

REFERENCES

1. Безручко О. В. Створення музики до фільму з використанням віртуальних електронних інструментів: теоретичні та практичні аспекти // Соціально-гуманітарний вісник: зб. наук. пр. Харків: СГ НТМ «Новий курс», 2023. Вип. 45. С. 107–112. [Електронний ресурс]. Режим доступу: <https://www.researchgate.net/publication/380365165>
2. Бурда М. І., Васильєва Д. В., Волошена В. В., Вашуленко О. П., Тарасенкова Н. А. Прикладна спрямованість навчання математики в гімназії: методичний посібник [Електронне видання]. Київ: Видавничий дім «Освіта», 2024. 161 с. ISBN 978-966-983-496-6.
3. Новікова О. Л. Реалізація прикладної спрямованості курсу математики в ліцеях: кваліфікаційна робота на здобуття ступеня магістра / наук. керівник Т. С. Армаш. Кривий Ріг: КДПУ, 2025. 58 с.

PSYCHOLOGICAL FACTORS OF STRESS RESILIENCE IN YOUNG PEOPLE UNDER CONDITIONS OF SOCIAL INSTABILITY

Today, stress resilience is essential for modern individuals. It is based on the ability to respond adequately and mobilize oneself in difficult situations, maintain self-efficacy, tolerance, and tact, and the capacity to distance oneself from unnecessary information or situations. Stress resilience is defined as a complex, integral personality trait interconnected with a set of intellectual, cognitive, emotional, and personal qualities that enable individuals to withstand significant mental, physical, volitional, and emotional loads while maintaining functional effectiveness in stressful situations [2, p. 60].

Within the structure of personality, psychologists distinguish emotional, volitional, intellectual, motivational, communicative, operational, and other components of stress resilience. Moreover, all components of stress resilience as a psychological construct are interrelated, with less developed components potentially being compensated by the stronger development of others [3, p. 49].

Research on the formation and development of stress resilience in contemporary science focuses on two main groups of factors: external factors, which include characteristics of environmental influences, and internal factors, which comprise a complex of psychophysiological, personal, and socio-psychological characteristics of the individual.

However, within the psychological community, there is no consensus regarding the definition and justification of internal factors of stress resilience. Scholars lack a unified understanding of their essence, components, and role in shaping an individual's ability to resist the negative effects of stressful situations and respond to them appropriately.

At the same time, specialists typically attribute the following to external factors:

- appraisal of stressful situations;
- coping behavior;

- the impact of traumatic events on personality and the level of their processing;
- social support;
- availability of professional and personal experience;
- psychological readiness to act in extreme situations.

Internal factors of stress resilience are generally considered to be personality resources, including self-concept, locus of control, level of cognitive development, communicative competence (sense of belonging), empathy, emotional stability, endurance, knowledge, skills, abilities to cope with stressful situations, anxiety level, self-esteem, and specific features of reality perception [1, p. 20].

Thus, stress resilience is viewed as an integral personality trait that ensures the maintenance of effectiveness under conditions of mental and emotional strain. Its formation is determined by the interaction of external and internal factors. Although scholars have not reached a definitive consensus regarding internal factors, it is precisely their interaction with external influences that determines an individual's ability to adapt to stressful conditions and respond to them constructively.

REFERENCES

1. Бардин Н. Стресостійкість: навч. посіб. Львів : Львів. держ. ун-т внутр. справ, 2021. 204 с.
2. Єрмакова Н., Сауленко О. Психологічні особливості проявів стресостійкості у сучасній молоді. Молодий вчений. 2020. Т. 11, № 87. С. 59–62.
3. Кацавець Р. Психологія особистості : навч. посіб. 2-ге вид. Київ : Алерта, 2025. 150 с.

V. Korniienko, O. Osetrova, O. Aliseienko

PSYCHOSOCIAL ADAPTATION OF UKRAINIANS AFTER RETURNING FROM ABROAD

After the start of the full-scale war, many Ukrainians left the country in search of refuge abroad and encountered significant challenges, including language barriers, lack of knowledge of local legislation, and social isolation. This further intensified the need to establish specialized facilities for temporary accommodation and highlighted

the issue of social adaptation. The development of such institutions began shortly thereafter, and today we can observe that many Ukrainians feel protected abroad and have access to housing, language learning, healthcare, education, and other essential services.

It should be noted that Ukrainians who left at the beginning of the war have largely integrated into the societies of their host countries. Many of them travel freely across Europe, work, make plans for the future, and have adapted to their new lives. In this regard, it has become increasingly relevant in the field of social work to identify effective approaches to minimizing and overcoming the challenges associated with the return of Ukrainians to their home country. There is a growing need to develop adaptive strategies and provide comprehensive support, including psychological rehabilitation, social reintegration, and a personalized approach to each individual. Ukrainians returning after the war will require assistance in addressing urgent issues such as employment, financial support, and housing in cases of loss due to hostilities. In other words, the diversity of challenges necessitates a wide range of social services.

Special attention should be paid to specific age groups, particularly young people and the elderly. Elderly individuals were often taken abroad by their families or forced to leave due to a lack of alternatives. Having adapted to life in their host countries, they may face significant difficulties with reintegration upon returning to Ukraine.

With regard to young people, a different set of challenges may arise. Living abroad, acquiring a new language, and adapting to different social environments may create barriers upon their return. Children and adolescents may face difficulties such as insufficient proficiency in Ukrainian, gaps in education, and social isolation due to challenges in finding peer groups, which may lead to bullying. Therefore, the development of a specialized area within social work to address these issues is not only appropriate but necessary to improve the social adaptation of Ukrainians [1].

Particular attention should also be paid to the issue of language barriers, which may become even more pronounced. On the one hand, insufficient proficiency in the

native language among Ukrainians who have lived abroad may hinder their reintegration into society. On the other hand, there is a positive aspect: returning individuals may bring valuable international experience that can contribute to the development of humanitarian fields.

It should also be noted that the shortage of foreign language specialists remains a pressing issue. Unfortunately, interest in language learning is not widespread among Ukrainians, and the increasing reliance on artificial intelligence has led to a decline in attention to translation quality among younger generations. This may negatively affect the development of future specialists due to insufficient language proficiency. Therefore, increasing young people's interest in learning foreign languages particularly with an emphasis on quality should become a priority. Ukrainians who are proficient in their native language, have international experience, and possess multilingual communication skills will be highly competitive in the modern labor market. Conversely, those lacking such competencies may face reduced employment opportunities.

REFERENCES

1. Воробйов Н. О. Україна в світових міграційних процесах: проблема повернення біженців та шляхи їх вирішення : кваліфікаційна робота / Н. О. Воробйов ; наук. кер. О. В. Коляда ; Міністерство фінансів України, Державний податковий університет, факультет податкової справи, обліку та аудиту, кафедра економічної політики, маркетингу та бізнес-аналітики. Ірпінь, 2025. 51 с.
2. Президент України. Питання Національної ради з відновлення України від наслідків війни : Указ України від 21 квітня 2022 р. № 266/2022. URL: <https://zakon.rada.gov.ua/laws/show/266/2022#Text> (дата звернення: 15.12.2025).

**SOCIAL WELFARE OF MILITARY PERSONNEL,
INTERNALLY DISPLACED PERSONS, AND UKRAINIANS ABROAD
IN THE CONTEXT OF CURRENT WAR CHALLENGES**

Social welfare is a crucial component of the national social protection system. russia's full-scale invasion has significantly increased the burden on this system, as the state must now ensure the rights and needs not only of military personnel, veterans, and their families, but also of millions of Ukrainians who have been forced to leave their homes.

Before the full-scale invasion of the russian federation in 2022, Ukraine already had a developed legal framework for supporting military personnel, ATO/JFO veterans, and the families of fallen soldiers.

Social protection for military personnel was regulated by the Law of Ukraine "On Social and Legal Protection of Military Servicemen and Their Family Members", which guaranteed financial support, housing, rehabilitation, and medical care. However, the system required modernization, particularly in terms of psychological adaptation after service.

Support for internally displaced persons (IDPs) was regulated by the Law "On Ensuring the Rights and Freedoms of Internally Displaced Persons". This legislation provided assistance with accommodation, registration, and employment, although these mechanisms were limited in scope and funding.

Following the outbreak of the full-scale war, the social welfare system had to expand rapidly to respond to unprecedented challenges affecting military personnel, veterans, their families, IDPs, persons with disabilities, and others affected by hostilities.

The state significantly strengthened guarantees for military personnel. Service members and their families received increased financial support, insurance coverage, rehabilitation programs, opportunities for professional retraining, and assistance with social adaptation to civilian life.

In 2023-2024, the activities of veteran support centers intensified. These centers provide legal, psychological, employment, and educational assistance. The development of the Unified Register of Veterans represents an important step toward a more systematic support system integrating economic, medical, educational, and psychological services.

The number of IDPs in Ukraine has exceeded five million. The state has expanded housing programs, financial assistance, and support for employment and education. IDPs receive aid through the social protection system, local authorities, and international organizations.

A positive example is the partnership between the state and international organizations, which provide housing, humanitarian assistance, business development grants, and temporary protection abroad. However, significant challenges remain, including the uneven distribution of aid, lengthy integration processes, and a shortage of housing in host communities.

The war has forced millions of Ukrainians to leave the country temporarily. According to UN data, approximately eight million Ukrainians have become refugees. Their support is ensured through international agreements between Ukraine and host countries.

European countries have granted Ukrainians temporary protection, access to housing, healthcare, education, and the labor market. Many countries also provide financial assistance, child benefits, and free social services. A key challenge is that the level of support varies significantly between countries, and some programs remain available only if refugees stay abroad and maintain their official status.

Despite the support provided, many Ukrainians abroad face difficulties, including language barriers, unemployment, unstable income, housing issues, and emotional stress. Improving their situation requires strengthening cooperation between Ukraine and host countries, simplifying access to consular services, and developing reintegration programs for returnees.

A comparison of the social protection system before 2022 and during wartime demonstrates its adaptability and resilience. Despite unprecedented challenges, Ukraine has

managed to expand support mechanisms through reforms, decentralization, and international partnerships.

At the same time, the war has exposed several systemic problems, including insufficient funding, administrative burdens, unequal access to services, and outdated mechanisms for supporting Ukrainians abroad.

Thus, social welfare in modern Ukraine is not only a component of the human rights system but also a key instrument for strengthening stability, social cohesion, and public confidence in the future.

REFERENCES

1. Закон України «Про забезпечення прав і свобод внутрішньо переміщених осіб» від 20 жовтня 2014 р. № 1706-VII. URL: <https://zakon.rada.gov.ua/laws/show/1706-18#Text> (дата звернення: 15.12.2025).
2. Закон України «Про загальнообов'язкове державне соціальне страхування» від 23 вересня 1999 р. № 1105-XIV. URL: <https://zakon.rada.gov.ua/laws/show/1105-14#Text> (дата звернення: 15.12.2025).
3. Закон України «Про соціальний і правовий захист військовослужбовців та членів їх сімей» від 20 грудня 1991 р. № 2011-XII. URL: <https://zakon.rada.gov.ua/laws/show/2011-12#Text> (дата звернення: 15.12.2025).
4. Конституція України: Закон України від 28 червня 1996 р. № 254к/96-ВР. URL: <https://zakon.rada.gov.ua/laws/show/254%D0%BA/96-%D0%B2%D1%80#Text> (дата звернення: 15.12.2025).

K. Krupiy, H. Mudrenko

BARRIERS TO SOCIAL INCLUSION OF PEOPLE WITH DISABILITIES AND WAYS TO OVERCOME THEM

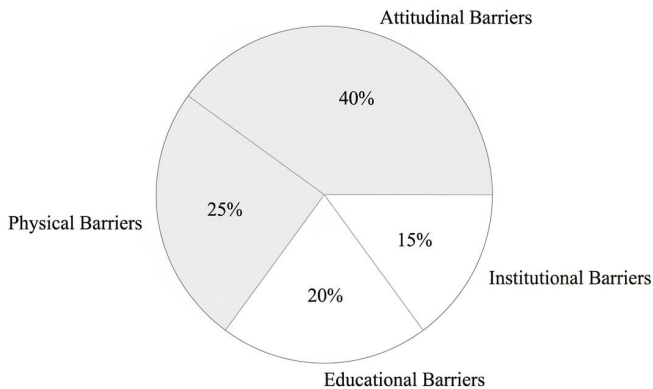
Throughout history, people with disabilities have often been perceived as a disadvantaged and marginalized group. Until the 18th century, disability was frequently interpreted as a manifestation of sin, demonic possession, or supernatural forces, which led to stigma and social exclusion. As such, the disabled person was often ostracized by his/her community [5].

The 21st century has seen a significant change in how people view disability, and people with disabilities have gained greater prominence in societal affairs. These

positive changes have been accompanied by efforts toward full social inclusion for people living with disabilities. Even so, significant barriers to social inclusion still remain. Social inclusion refers to the effective participation of an individual in all aspects of society, both socially and economically. Conversely, social exclusion is the process of being excluded from participation in societal life. It can lead to disengagement from education and employment, thereby further alienating individuals with disabilities from the community and resulting in negative outcomes.

It is therefore imperative that barriers leading to social exclusion be addressed in order to create a harmonious society in which people with and without disabilities can contribute equally. This paper discusses the barriers that prevent social inclusion for people with disabilities, particularly those with physical and intellectual impairments. It also highlights strategies that can be used to overcome these barriers and promote inclusion.

Retish and Reiter define an attitude as “a learned predisposition to respond in a consistently favorable or unfavorable manner toward a given object.” Attitudes influence the way individuals react to situations and behave. Therefore, our behavior toward others is shaped by our attitudes. Negative perceptions of disability often result in attitudinal barriers.



Attitudinal barriers are considered the greatest obstacle to social inclusion for people with disabilities. Research by Heyne, Schleien, and McAvoy (1993) found that

fear-based negative attitudes toward people with disabilities were the main obstacle to developing friendships between people with and without disabilities. These findings are supported by reports from individuals with disabilities, who identify negative attitudes as the most difficult barrier they face. Glowacki suggests that such attitudes arise from the tendency to blame individuals for the physical, psychological, and social consequences of their impairments [6]. This perspective places undue focus on the disability itself, causing individuals to define themselves in terms of their limitations.

Pity is another attitudinal barrier that is prevalent in society. This attitude is reinforced by the charity-based approach, which often portrays people with disabilities as the most needy and pitiful, emphasizing the tragic aspects of disability [2]. Although this approach can be effective in raising funds, it has negative consequences for social inclusion. The pity-based mindset portrays people with disabilities as dependent on others, thereby reinforcing their perceived inferiority.

Inclusion values individual differences and recognizes the valuable contributions that each person can make to society. Although governments have promoted equal treatment for all citizens regardless of age, gender, or disability, this has not been sufficient to ensure social inclusion. As Smith states, “equal treatment does not always result in equal opportunity” [4]. Equal treatment alone does not guarantee that the rights of people with disabilities are fully respected. Many government efforts have focused primarily on welfare policies rather than on creating inclusive educational environments. Participation in the labor market is important not only for financial independence but also for fostering a sense of belonging within the community.

The provision of inclusive leisure services that meet the needs of people with disabilities is one strategy that can increase social inclusion [3]. Education also plays a central role in promoting inclusion, as it is the first step in socialization outside the family environment. Government policies have significantly contributed to progress in this area.

Many countries have recognized that people with disabilities can be productive members of society and live successfully in community-based settings. As a result,

policies that once promoted segregation and isolation have been replaced by those emphasizing inclusion and integration. Despite this progress, the National People with Disabilities and Carer Council (2009) notes that many individuals with disabilities still experience exclusion and isolation due to persistent social barriers [1]. Thus, these issues are interconnected, and achieving full inclusion requires addressing all barriers equally.

In conclusion, social inclusion of people with disabilities is a complex and ongoing process that requires a comprehensive and systematic approach. Only by addressing all existing barriers can society become more open, equitable, and inclusive, ensuring equal opportunities for all individuals regardless of their abilities.

REFERENCES

1. Australian Human Rights Commission 2011, About Disability Rights. Web.
2. Coppola, J.J. 2007. Accessibility study of businesses with Main Street addresses, The Andover Commission on Disability, New York.
3. Glowacki, R. 2007, Literature review for captivate: local participation for all, Disability Services Commission Department of Sport and Recreation, Perth.
4. Heyne, L. Schleien, S. & McAvoy, L. 1993, Making Friends: Using recreating activities to promote friendship between children with and without disabilities, Minneapolis: Institute on Community Integration.
5. Jenkins, J. & Pigram, J.J. 2003, Encyclopedia of Leisure and Outdoor Recreation, Routledge.
6. Smith, F. 2008, 2011 Australians with disabilities and social inclusion: Getting on the agenda, The Brotherhood of St Laurence's Social Inclusion Down Under Symposium.

K. Krut, N. Stymik

THE IMPACT OF SOCIAL MEDIA AND “BRAIN ROT” PHENOMENA ON STUDENTS’ MOTIVATION: SPOTIFY EDITS AND PLAYLISTS AS LEARNING STIMULUS

In recent years, social media has had a significant impact on our lives. Platforms like TikTok, Instagram and YouTube influence not only how we communicate but also how we think and study. One modern phenomenon connected to heavy social media use is called “brain rot”. Many students use this term to describe moments when they

feel overwhelmed, distracted, or unable to focus because of constant online stimulation. However, the very same digital world that gives us brain rot also offers surprisingly effective tools for motivation, including aesthetic Spotify playlists and motivational edits based on book characters or the famous “*dark academia*” aesthetic. This article explores how brain rot appears, how it affects motivation, and how music can actually help students concentrate.

What Is Brain Rot and How Does Social Media Create It?

The word was even voted Oxford’s Word of the Year in 2024 [1]. Brain Rot is an informal way to describe a state of mental overload caused by fast, repetitive online content. It happens when a person spends a long time scrolling through short videos, memes and other effortless, rapid content. Social media apps are designed to capture attention with bright visuals, quick sounds, and endless unexpected shifts. Over time, this trains the mind to expect instant stimulation, making slower activities such as reading, writing or studying, feel unusually boring. It is as if the brain whispers: “Why is this paragraph taking longer than 3 seconds? Where is the jump cut?” [2].

The first recorded use of brain rot was found in 1854 in Henry David Thoreau’s book *Walden*, which reports his experiences of living a simple lifestyle in the natural world. As part of his conclusions, Thoreau criticises society’s tendency to devalue complex ideas, or those that can be interpreted in multiple ways, in favour of simple ones. He sees this as indicative of a general decline in mental and intellectual effort: “While England endeavours to cure the potato rot, will not any endeavour to cure the brain-rot – which prevails so much more widely and fatally”.

Examples of Brain Rot

Brain rot can appear in many everyday situations. A common example is when a student opens their phone for just a few minutes and ends up scrolling for an hour without noticing the time. Another example is when people constantly quote TikTok sounds in real life or find it hard to watch a full movie without checking their phone. Many students also report that they cannot focus on homework unless there is loud music or at least some background noise that resembles the digital chaos they are used to. All these examples show how digital habits influence attention, memory, and behaviour.

Effects of Brain Rot

Brain rot mostly affects attention and productivity. Students may feel more distracted, impatient, or unmotivated. Tasks that require long concentration, such as studying for exams, suddenly feel heavy and complicated. Brain rot can also disturb sleep because bright screens and endless scrolling overstimulate the brain before bedtime. Emotionally, it can create restlessness or anxiety when a person is away from their phone. As a result, students often struggle to start or finish school tasks: not because they lack ability, but because their attention has been trained to expect faster rewards.

How Motivation Works

Motivation is an inner force that pushes a person to start or complete a task. Psychologists often divide it into intrinsic motivation (doing something because you enjoy it) and extrinsic motivation (doing something for a reward or to avoid consequences). Motivation grows when tasks feel meaningful or enjoyable. It decreases when tasks feel boring, difficult or disconnected from personal goals. Because brain rot makes slow tasks feel harder, it lowers both intrinsic and extrinsic motivation. Suddenly even opening a textbook feels exhausting.

The Impact of Social Media and Brain Rot on Students' Motivation

Social media influences motivation in two key ways. First, it reduces the ability to stay focused on long-term tasks because the brain becomes used to fast, short content. After watching hundreds of short videos, the process of writing a long essay seems too slow to be interesting. Second, it changes reward expectations: online content gives instant pleasure, while studying requires effort before reward. Consequently, many students procrastinate or feel unmotivated.

However, social media also has a surprisingly positive side. Aesthetic study videos, motivational edits and virtual 'study-with-me' creators can inspire students. Digital spaces become sources of emotional support, aesthetic atmosphere, and even academic enthusiasm, something older generations never saw coming.

Spotify Playlists and Edits as Learning Stimuli: How Music Helps the Brain

One of the most surprising benefits of digital culture is the popularity of aesthetic Spotify playlists and motivational edits. Many students create playlists that reflect

certain moods or “vibes” such as “*main character energy*”, “*dark academia*”, or “*toxic study motivation*”. These playlists help create an emotional environment that makes studying feel more dramatic, meaningful, or simply less boring.

Music influences the brain in powerful ways. It can reduce stress, improve concentration with steady rhythms, and support memory by connecting information to emotions. Background music can also make difficult tasks feel more pleasant, thus increasing motivation. Energetic beats, such as “phonk” (slang for “funk”), may boost productivity for short tasks, while calm instrumental tracks help with reading, writing or deep thinking.

Conclusion

The brain rot phenomenon shows how modern social media very strongly shapes attention, thinking and motivation. Constant exposure to fast digital content can make studying more difficult, but it also inspires new creative methods for improving focus; examples are personalised Spotify playlists and motivational edits. Students today need to find a balance between online entertainment and healthy study habits. When used wisely, digital tools can support learning rather than harm it. In a world that changes quickly and constantly demands attention, understanding how technology affects our minds allows us to stay motivated, productive, and more aware of our own cognitive processes, even if our playlists contain dramatic violins one minute and chaotic “phonk” the next.

REFERENCES

1. Oxford Word of The Year. OUP. 2024. URL: <https://corp.oup.com/news/brain-rot-named-oxford-word-of-the-year-2024/>
2. Yuhan Chen et al. The Effect of Short-form Video Addiction on Users' Attention, 2022. URL: https://www.researchgate.net/publication/366031047_The_effect_of_short-form_video_addiction_on_users'_attention

HUMAN-AI COLLABORATION IN TRANSLATION: FROM POST-EDITING TO CO-CREATION

Today, in 2026, as large language models (LLMs) such as GPT-series, Claude, Gemini, and specialized translation models like Lara V2 radically reshape the translation landscape, we stand at the threshold of a new paradigm. Traditional machine translation followed by post-editing (Machine Translation Post-Editing, MTPE) is no longer the dominant approach. We are moving toward genuine co-creation, where humans and AI work as equal partners: not merely “correcting mistakes,” but jointly creating text in real time. This evolution not only boosts efficiency but also unlocks new possibilities for creativity, cultural adaptation, and strategic quality management.

Evolution from traditional neural machine translation to modern generative models has transformed the translator's role from a mere corrector of drafts into a collaborative creator. While early systems offered speed and cost reductions, they often struggled with cultural nuances and caused editor fatigue. Today's human-AI symbiosis leverages real-time feedback and prompt engineering, allowing professionals to guide the technology iteratively and achieve a deeper level of creative partnership.

Key examples include:

- Lara (from Translated.com) – a specialized translation LLM that generates context-aware drafts, taking into account the entire document, glossaries, and company style.
- HumanAI from EasyTranslate – humans select only the critical segments (tone, brand voice, subtle nuances), while AI handles the bulk.
- In literary and creative translation, LLMs suggest variants, stylistic options, while humans choose and polish – true joint creative work.

Co-creation offers significant efficiency and scale, enabling the processing of vast text volumes while reducing editing time by up to 60%. By combining AI's speed and consistency with human emotional depth and cultural nuance, the resulting quality

often surpasses what either could achieve alone. This shift liberates translators from routine tasks, allowing them to focus on strategic roles like brand localization and creative copywriting.

However, challenges remain regarding authorship, ethical transparency, and potential cultural biases in AI models. While these advancements require new competencies like prompt engineering, high-level specialists remain essential for oversight, ensuring that human creativity and accountability stay at the heart of the process.

Over the next few years, the industry will shift toward fully interactive platforms where humans and AI collaborate in real-time, integrating multimodal capabilities across text, image, and voice. This evolution will establish new quality standards and reshape academic programs to focus on collaborative translation models. To stay competitive, companies and freelancers should adopt continuous feedback loops and master prompt engineering while ensuring human oversight for critical content. Success will depend on balancing efficiency with metrics that prioritize creativity and human agency.

Thus, the transition from post-editing to co-creation is not merely a technological shift – it is a paradigm change. AI ceases to be just a “tool” and becomes a co-creator. The human remains at the center: as strategist, creator, and guarantor of quality. Such collaboration enables what neither side can achieve alone – fast, accurate, culturally sensitive, and genuinely creative translation.

REFERENCES

1. Stahlberg F. Neural machine translation: A review. *Journal of Artificial Intelligence Research*, 2020, № 69. P. 343–418.

MODERN AESTHETICS AND THE PROBLEM OF ANTHROPOCENTRIC DOMINANCE OVER NATURE

In modern society, there is a deep-seated belief that humans are the masters of the Earth. We reshape the landscape to fit our personal standards of beauty and comfort, often without considering the ethical cost. This paper argues that modern aesthetics often serve as a tool for domination, transforming nature from a powerful, independent force into a “meek decoration”.

The crisis in our relationship with nature is not just technical, but deeply cultural and ethical. The relationship between humans and nature is a major focus of ecological ethics. Lynn White suggests that our ecological problems come from cultural beliefs that treat nature as a “slave” or a resource. Aldo Leopold proposed a different view: humans should be “members” of the natural community rather than “conquerors”. Modern scholars also discuss how consumer culture creates “artificial copies” of nature. These copies give us an illusion of harmony while allowing us to keep total control over the environment.

Lynn White (1) identifies the “roots of our ecological crisis” in the traditional belief that nature is merely a resource meant to serve human needs. Other researcher Tetiana Gardashuk (2) explores ecosophy, suggesting that we need new “conceptual parameters” to understand our place in the world. This means moving away from seeing nature as an object and seeing it as a system we belong to. Anatoliy Yermolenko (3) emphasizes the “ethics of responsibility”. He suggests that our social existence is tied to how we answer for our impact on the environment. If we act only for pleasure, we fail our ethical responsibility. In her work on Aesthetics, O.V. Stoliarenko (5) discusses how modern culture often replaces reality with “artificial copies”. This is clearly seen in how we “design” nature:

The Fountain as a Symbol of Subjugation: While ancient canals were built for irrigation and survival, the modern fountain is a “cage” for water. We force a wild

element into a graphic schedule for our entertainment. It becomes a trophy of the human ego rather than a part of the natural cycle.

The Paradox of the Cut Flower: Using Aldo Leopold's (4) "Land Ethic", we can see that a flower should be respected as a member of the biotic community. However, consumer culture treats it as a "dull thing for décor". We kill the symbol of life to "celebrate" life, proving that our aesthetic wishes are placed higher than the life of the creature itself.

In the conclusion, as Aldo Leopold famously wrote, we must stop seeing the land as a property and start seeing it as a community to which we belong. Human dominance is a learned behavior of modern culture, found in everything from our clothes to our home decor. To resolve this "beauty-pain" standard, we must adopt an ethics of responsibility. True beauty should be found in the independence and health of nature, not in our ability to conquer it. Human beings are not born with a desire to destroy. Instead, modern culture teaches us to be conquerors through the things we buy and the way we decorate our lives. Moving forward, we should strive for a "true harmony" that respects the environment as it is, rather than trying to control and own it.

REFERENCES

1. Вайт Л. Коріння нашої екологічної кризи / Л. Вайт // Глобальні проблеми людства. К. : Либідь, 1992. С. 142–156.
2. Гардашук Т. В. Концептуальні параметри екософії / Т. В. Гардашук. К. : Парапан, 2005. 132 с.
3. Ермоленко А. М. Етика відповідальності та соціальне буття людини / А. М. Ермоленко. К. : Наукова думка, 1994. 200 с.
4. Леопольд А. Календар піщаного графства / А. Леопольд ; [пер. з англ.]. К. : Еко-право, 2004. 272 с.
5. Столяренко О. В. Естетика : навч. посіб. / О. В. Столяренко. К. : Центр учбової літератури, 2007. 256 с.

COGNITIVE AND PRAGMATIC ASPECTS OF PERSUASION IN ADVERTISING DISCOURSE

Persuasion as a concept has been studied and discussed by scholars across various disciplines, including linguistics, semiotics and pragmatics. It can be defined as the impact on the consciousness of an individual through appealing to their critical judgment, selecting and logically ordering facts and conclusions according to a unified functional goal of the statement, as well as through logical proof, sometimes combined with emotional influence [3, p. 184].

According to numerous studies, the following persuasive techniques prevail in advertising discourse:

1. **Demonstrating distinction.** The advertiser presents a product or service as unique, emphasizing that no other provider can offer the same quality.

2. **Honoring commitment.** The advertiser pledges to continue offering the product or service in accordance with the highest standards.

3. **Expressing authority.** The advertiser emphasizes long-term experience and expertise as guarantees of quality.

4. **Hyperbolizing.** The advertiser exaggerates the excellence of the product or service.

5. **Glorification.** The advertiser highlights customer care as a top priority.

6. **Providing proof.** The advertiser offers social or scientific evidence supporting the value of the product or service and its worthiness of purchase.

7. **Expressing solidarity.** The advertiser seeks to establish emotional and social bonds between the customer and the company in order to encourage loyalty.

8. **Proving success.** The advertiser demonstrates success in delivering products or services and maintaining market credibility [2, p. 85].

Selecting appropriate advertising channels is essential in today's fragmented media environment. To determine where the target audience is most likely to interact

with content, pragmatists evaluate the advantages and disadvantages of various platforms, including email marketing, social media, search engines, and television. Context plays a crucial role in pragmatic advertising, as campaigns are designed to fit the economic, social, and cultural environments in which they are launched. For instance, advertisements created for one country often require substantial adaptation to function effectively in a different cultural context.

Another important aspect of pragmatic advertising is the ability to respond rapidly to market changes. Real-time ad placement combined with dynamic pricing strategies enables advertisers to remain competitive while optimizing revenue. A persistent challenge in pragmatic advertising is maintaining creativity while ensuring practical effectiveness. Marketers must develop innovative strategies that capture audience attention without causing saturation or fatigue. A representative example is Apple's "**Shot on iPhone**" campaign, which leveraged user-generated content to demonstrate camera quality, combining authenticity with a clear and persuasive practical message [4, pp. 304–305].

From a cognitive perspective, advertising can produce several types of effects:

- a) **cognitive**, related to understanding and memory of the advertisement;
- b) **attitudinal**, involving the emotions elicited by the advertisement;
- c) **behavioral**, referring to the degree to which an individual is persuaded to act.

Some researchers argue that advertising operates through a hierarchical effect, where cognition leads to attitude formation, and attitude subsequently leads to behavior. This model is particularly valid when the consumer has already been persuaded at the cognitive level [1, p. 281].

REFERENCES

1. Al-Bahrani R. H., Ali S. K. A cognitive linguistic study of the persuasive/attention strategies used in selected American English e-advertisements. *Arab World English Journal (AWEJ). Special Issue on CALL*. 2021. №7. P. 279–298. URL: <https://dx.doi.org/10.24093/awej/call7.20>
2. Al-Shboul O. K., Al-Khawaldeh N. N., Alkhawaldeh A. A., Hamdan H. J., Al-Oliemat A. S. Cognitive aspects of persuasion in marketing discourse: a cognitive linguistic study. *Eurasian Journal of Applied Linguistics*. 2024. Vol. 10, №1. P. 81–91. URL: <http://dx.doi.org/10.32601/ejal.10108>

3. Motreniuc D. Communicative strategies and techniques of persuasion in advertising ecological discourse. *Probleme de lingvistică romano-germanică și comunicare interculturală* (Conferința științifică cu participare internațională), Universitatea de Stat din Moldova. 2024. P.184-189 URL: <https://doi.org/10.5281/zenodo.10650074>
4. Muxamedova M. Q. Pragmatic aspect of advertisement. *Research and Implementation Scientific-Methodical Journal*. 2024. Vol. 02, Iss. 12. P. 302-306.

V. Petkov, O. Dyomshyna

BIOCHEMICAL MECHANISMS OF ACTION OF NATURAL XENOBIOTICS AND ADAPTOGENS IN THE CONTEXT OF ENHANCING STRESS RESISTANCE: ETHICAL AND EVIDENCE-BASED DIMENSIONS OF CONTEMPORARY RESEARCH

In the context of the growing impact of chronic stress factors associated with socio-economic instability, military conflicts, and global public health challenges, the issue of maintaining the adaptive capacity of the human organism is gaining particular relevance. Biomedical research is increasingly focusing on natural xenobiotics and adaptogens as potential means of enhancing stress resistance and optimizing recovery processes [1]. Interest in these compounds is driven by their ability to influence key regulatory systems of the body, including antioxidant defense, neurotransmitter activity, and the functioning of the hypothalamic–pituitary–adrenal axis. At the same time, the scientific discourse in this field remains ambiguous due to the limited evidence base, the fragmentary nature of experimental data, and the complexity of their interpretation in a clinical context.

An analysis of contemporary publications indicates that a significant portion of claims regarding the efficacy of adaptogens is based on in vitro studies or animal models, raising concerns about the validity of their direct extrapolation to humans. In this regard, it is appropriate to refer to the methodological approaches articulated by Karl Popper, who emphasized the fundamental impossibility of the final verification of scientific theories, as well as to Thomas Kuhn's concept of scientific paradigms,

which allows the current state of adaptogen research to be interpreted as partially operating within established but insufficiently critically reassessed frameworks. In particular, the widespread assumption of the inherent “safety of the natural” often lacks rigorous empirical validation, while contradictory findings tend to be overlooked within the research community

The biochemical mechanisms of adaptogen action – such as their influence on NF- κ B and Nrf2 signaling pathways, regulation of cortisol levels, and modulation of oxidative stress – undoubtedly represent an area of substantial scientific interest and suggest the potential of these compounds as regulators of cellular processes. However, as emphasized by contemporary scholars, including proponents of evidence-based medicine, the identification of a molecular mechanism is not sufficient to substantiate clinical efficacy. This gives rise to the so-called translational gap between laboratory findings and actual therapeutic outcomes, necessitating further systematic investigation.

Particular attention within the current scientific discourse is given to the interpretation of “naturalness” as a criterion of safety. Biochemical and toxicological studies demonstrate that natural xenobiotics, including alkaloids, flavonoids, and other plant secondary metabolites, may exert both beneficial and potentially harmful effects on the organism. In this context, it is essential to distinguish between the origin of a substance and its biological activity, as it is the latter that determines its safety and effectiveness. Such an approach helps to avoid oversimplified interpretations and provides a more robust basis for the evaluation of adaptogens in medical practice.

An important dimension of the issue is the ethical aspect of both research and application of natural protective agents. The principles of bioethics formulated by Tom Beauchamp and James Childress – namely autonomy, beneficence, non-maleficence, and justice – acquire particular significance in situations where the level of scientific evidence remains limited. Insufficient transparency regarding the efficacy and safety of adaptogens may lead to the formation of distorted expectations among consumers, thereby undermining the principle of informed consent. At the same time, the commercialization of the dietary supplement market, as highlighted in health economics

research, introduces additional risks associated with the dominance of marketing strategies over scientific evidence.

The socio-economic dimension of the problem is reflected in unequal access to such products as well as in the insufficient level of their regulation. In many countries, adaptogens are marketed as over-the-counter products, which limits control over their quality and safety. Simultaneously, the increasing demand for plant resources, such as ginseng and Rhodiola, raises concerns regarding the sustainable use of natural ecosystems, as discussed in contemporary environmental research and in the concept of responsibility articulated by Hans Jonas.

The question of the boundary between therapeutic use and the enhancement of human functional capacities beyond physiological norms remains controversial. In this regard, current bioethical debates demonstrate a lack of consensus on the permissibility of so-called “biomedical enhancement.”

Thus, the analysis of contemporary research indicates the need for a cautious and scientifically grounded approach to the evaluation of natural xenobiotics and adaptogens as means of enhancing stress resistance. Their potential as regulators of biochemical processes is evident; however, the current level of evidence is insufficient to draw definitive conclusions regarding their clinical effectiveness. Under these conditions, the integration of biomedical research with ethical and methodological analysis becomes particularly important, enabling the development of a more balanced approach to their use. Future research prospects are associated with the implementation of randomized clinical trials, increased transparency of scientific data, and the improvement of regulatory mechanisms, which will ensure both the efficacy and safety of these compounds in the context of human health support.

REFERENCES

1. Dyomshyna O., Ushakova G., Stepchenko L. Protective properties of humic substances under combined stress. *Functional Foods and Bioactive Compounds: Modern and Medieval Approaches*. 2023. Vol. 31. P. 67-69.

GREEN THEORY IN INTERNATIONAL RELATIONS: EXPANDING AND CHALLENGING TRADITIONAL PERSPECTIVES

Global political, economic, and environmental processes have become increasingly interconnected over the past centuries. Although these connections are not always immediately visible, their impact is undeniable. In this context, environmental issues have moved beyond the domestic sphere of individual states and have acquired a distinctly global dimension, as ecological challenges such as climate change and natural disasters transcend national borders.

Environmental problems are relatively new to international relations (IR) theory. While they are now firmly embedded within the field, they cannot be effectively addressed through traditional mechanisms such as military defence or deterrence. This reveals the limitations of classical paradigms and highlights the need for alternative frameworks.

At the same time, human responsibility toward the environment has gained importance. Humans are both the main contributors to environmental degradation and the key actors capable of addressing it. This creates an ethical obligation to protect ecosystems and reconsider IR beyond narrow state interests, incorporating long-term planetary sustainability.

Environmental Challenges and the Rise of Green Theory

Environmental issues such as climate change, rising global temperatures, biodiversity loss, and freshwater scarcity are no longer abstract concerns but pressing global realities. For instance, prolonged droughts in sub-Saharan Africa have intensified competition for resources, while rising sea levels threaten the existence of low-lying island states such as the Maldives. Similarly, large-scale wildfires in Australia and North America illustrate how environmental crises can undermine economic stability and exceed the capacities of individual states.

These examples demonstrate that environmental problems are closely linked to security, development, and international cooperation. As such challenges increasingly

transcend national borders, they expose the limitations of state-centred approaches in international relations.

Although green theory emerged in the late twentieth century, its roots can be traced back to the nineteenth century, particularly as a response to industrialisation. While industrial progress brought economic growth, it also generated environmental harm, prompting the rise of ecological awareness.

Green international relations theory is closely connected to international political economy. Since the 1970s, it has become clear that environmental problems – whether local or global – affect all states. However, economic interests often hinder collective action, particularly regarding the distribution of financial responsibilities between developed and developing countries. Green theory emphasises the need for both global awareness and local action, encapsulated in the principle “think globally, act locally.”

Following the 1992 Earth Summit in Rio de Janeiro, sustainable development became a central concept. Although widely adopted, this approach has been criticised. However, it remains contested. “Shallow” ecologists support it as a practical solution, while “deep” ecologists argue that it reinforces global inequalities and human dominance over nature.

Green Theory and Classical Approaches

Traditional theories of international relations – such as realism, neoliberalism, constructivism, and critical theory – have historically paid limited attention to environmental issues, often demonstrating what has been termed “ecological blindness”. In contrast, green theory places environmental concerns at the centre of global politics.

Rather than rejecting classical approaches, green theory builds upon and extends them. It recognises environmental problems as unintended consequences of modern economic and social practices. As Ulrich Beck suggests, they are “the stowaways of normal consumption”.

From a realist perspective, international relations are driven by power and survival. However, green theory highlights those environmental challenges – such as resource scarcity – can also become sources of conflict, thereby expanding the concept of security. Realism’s focus on military power often overlooks these non-traditional threats.

Neoliberalism emphasises international cooperation through institutions and agreements. While green theory acknowledges the importance of such mechanisms, it argues that existing frameworks, including the United Nations and the Paris Agreement, remain insufficient without a deeper consideration of ecological limits and long-term sustainability. Furthermore, green theorists criticise global capitalism for exacerbating environmental degradation and inequality.

Constructivism and critical theory focus on norms, values, and social structures, yet they often underestimate the role of the physical environment. Green theory introduces a crucial distinction between anthropocentrism (human-centred thinking) and ecocentrism, which recognises the intrinsic value of nature. Scholars such as Andrew Hurrell and Robyn Eckersley argue that ignoring environmental factors results in an incomplete understanding of global politics.

The Potential and Limitations of Green Theory

Green theory offers an interdisciplinary framework that integrates political science, ecology, philosophy, and sociology. This approach enables a more comprehensive understanding of global processes by emphasising the interdependence between human societies and the natural environment.

However, it also faces criticism. Some scholars argue that its ecocentric approach is too radical. Hayward, for example, questions the feasibility of fully abandoning anthropocentrism in IR [3]. Others suggest that concepts such as “limits to growth” rely on outdated assumptions and require revision.

Critics also highlight the perceived idealism of green theory, arguing that its proposals may be difficult to implement within the current global system. Nevertheless, these critiques help refine and strengthen the theoretical framework.

Its application varies across contexts. Developed countries, such as Germany and Sweden, are better positioned to integrate green principles into innovation and policy. For developing countries, green theory offers a framework for advocating fairer distribution of environmental responsibilities, taking historical inequalities into account.

Conclusion

Green international relations theory offers a valuable perspective by integrating environmental concerns into the analysis of global politics, economics, and security. It expands traditional approaches by emphasising the interconnectedness of human and natural systems and the importance of long-term sustainability.

While it does not provide all the answers, green theory encourages a rethinking of international relations, shifting environmental sustainability from a peripheral concern to a central priority. Its future relevance will depend on how effectively its principles can be adapted to real-world political and economic conditions. Ultimately, achieving a balance between environmental protection and economic development remains one of the key challenges for both developed and developing nations.

REFERENCES

1. Dobson A. & Eckersley R. (eds.) *Political Theory and the Ecological Challenge*. Cambridge University Press. 2010.
2. Beck U. *Risk Society: Towards a New Modernity*. Sage: London. 1992. p. 40.
3. Hayward T. *Ecological Thought: An Introduction*. Cambridge: Polity Press. 1995.
4. Paterson M., Burchill S., Linklater A., Devetak R., & Donnelly J. (eds). *Green Politics in Theories of International Relations*. New York: Palgrave MacMillan. 2005. P. 235–258.
5. Steans J., Pettiford L., Diez T., & El-Anis I. (eds). *Green Perspectives in An Introduction to International Relations Theory*. Edinburgh: Pearson Education Limited. 2010. P. 205–230.

M. Prysiazniuk, N. Parfinovych, N. Kaliberda

PEDAGOGY IS A SCIENCE NOT OF TEACHING, BUT OF UNDERSTANDING

Thousands of years ago, humanity began to take shape as civilizations emerged along fertile river valleys, such as in Mesopotamia and Egypt. Writing was developed around 3200 BCE in Mesopotamia, marking a monumental step in recording human knowledge and communication.

By 2500 BCE, the earliest schools appeared, mainly dedicated to training scribes in the art of writing and arithmetic, essential for managing temples, trade, and

government records. Education at this stage was reserved for a select group, primarily priests and scribes, who held the power of knowledge.

In ancient Greece, around the 5th century BCE, education began focusing on the individual, aiming to cultivate well-rounded citizens. Philosophers like Socrates, Plato, and Aristotle advocated for an education that developed critical thinking, moral virtues, and a love of wisdom, establishing a foundation that would shape Western thought.

During the Roman Empire, education became more structured and accessible to young male citizens, focusing on rhetoric, law, and literature to prepare future leaders. Christianity later shifted education's emphasis toward religious teachings, as monastic schools aimed to instill piety and preserve sacred knowledge.

The Renaissance in Europe revived classical ideals, promoting a humanistic approach that valued the study of literature, science, and the arts. This era paved the way for the modern concept of schooling, emphasizing the development of each individual's potential and preparing society for an age of enlightenment and progress.

Teaching other people – especially teaching the generation that will follow you into the adult world – can be one of the most rewarding professions on the planet. It can also be a very challenging profession. Certainly, effective teaching involves presenting a topic or skill in such a way that students can understand and eventually master it. Yet it involves many other things as well. For instance, teachers must motivate students to want to learn the subject matter, must help students recognize what genuine learning actually involves, and – in order to appropriately individualize instruction – must assess each student's progress in learning and development. And, in general, good teachers create an environment in which students believe that if they work hard and have reasonable support, they can achieve at high levels.

For teachers, mastering the multifaceted nature of teaching takes time and practice, of course. But it also takes considerable knowledge about human learning and motivation, developmental trends, individual and group differences, and effective classroom practices. Such topics are the domain of educational psychology [1, p. 25].

As professionals, teachers are decision makers who must choose among many, many possible strategies for helping students learn and develop. Certainly, teaching is an art to some degree: Good teachers are creative and innovative, and they add many imaginative touches to enhance classroom lessons and activities. But that art must be based on a firm foundation of research findings both about how human beings learn and about how teachers can help them learn effectively; in other words, it must be based on the science of learning and the science of instruction. Good teaching involves evidence-based practices – the use of instructional methods and other classroom strategies that research has consistently shown to bring about significant gains in students’ development and academic achievement.

Many research studies involve quantitative research: They yield numbers that reflect percentages, frequencies, or averages related to certain characteristics or phenomena. For example, a quantitative study might provide information about students’ scores on achievement tests, students’ responses to rating-scale questionnaires, or school district records of students’ attendance and dropout rates.

Not all research on learning and instruction is good research, of course. Furthermore, people sometimes draw inappropriate conclusions from even the best of research studies. It’s important, therefore, that teachers understand what various kinds of research studies can and cannot tell us about learning and instruction [1, p. 32].

A correlational study examines the possible relationships between two or more variables. It helps understand how certain human traits might be related or how certain behaviors might consistently appear with specific environmental factors. Correlation measures the degree to which two characteristics appear or change together. For example, one variable may increase as the other increases (positive correlation) or decrease as the other increases (negative correlation).

These studies sometimes involve comparing groups with different characteristics, like age or gender. For instance, a study might compare reading achievement scores between boys and girls or investigate whether children with more home reading experience learn to read faster at school.

Correlations allow making predictions about one variable based on the other. For example, if older children generally show greater abstract thinking skills than younger children, we might expect high school students to engage better in abstract discussions than fourth graders. However, such predictions are general and may not hold true for every individual.

A key limitation of correlational studies is that while they show relationships, they don't explain why these relationships exist.

In many cases, a teacher must step into a role that resembles that of a parent, offering guidance, stability, and encouragement that some children may not receive at home. A true educator does more than simply impart knowledge; they strive to deeply understand each student, seeing beyond the surface into the unique challenges and inner worlds of the young minds they guide. Many children today carry invisible burdens – emotional scars from difficult childhood experiences, often stemming from neglect, trauma, or unkind treatment by those meant to protect them. These early adversities can hinder a child's ability to learn, diminishing their confidence and sometimes stifling their intellectual curiosity. For a teacher, understanding and addressing these underlying struggles becomes a fundamental part of supporting a child's educational journey.

In the modern classroom, empathy is not just a virtue but a necessity. When a teacher recognizes that a child's struggle with academic material may stem from something deeper, they can offer support that goes beyond academics – through patience, reassurance, and small gestures that make a student feel seen and valued. The sensitive teacher understands that, for some students, school is not only a place to learn but also a refuge, a place where they can feel safe and respected, perhaps for the first time. By offering stability and kindness, teachers provide a foundation on which these students can begin to heal and, in turn, become more receptive to learning.

Equally essential is the teacher's awareness that no two students are alike in their capacity to process and retain information. Some children naturally grasp concepts with ease, while others may need additional time or alternative methods to fully understand. An effective educator recognizes these differences and adapts their approach, striving

to present material in varied, accessible ways that speak to diverse learning styles. Flexibility in teaching is key – not all students will excel through traditional methods; some may benefit from visual aids, hands-on activities, or opportunities for peer collaboration.

The task of reaching each student requires teachers to continuously adjust, reflect, and innovate in their instructional methods. A classroom that accommodates individual differences does not lower its standards but rather elevates the potential of all its students by ensuring that each one feels capable of success. Through this adaptive and inclusive approach, teachers cultivate an environment where every child, regardless of background or learning style, can experience the satisfaction of understanding and the empowerment that comes from mastering new skills.

Ultimately, the role of a teacher is not just to teach facts and figures but to nurture, inspire, and guide each student toward becoming a confident learner. It is a role that demands not only expertise in a subject but also an unyielding commitment to empathy, patience, and a genuine desire to see each child thrive. In a world where many children carry unseen burdens, the compassionate and insightful teacher becomes a beacon of hope, fostering resilience, curiosity, and the joy of learning in all their students.

Equally important is inclusive education, which is based on the idea that every child deserves not only a place in the classroom, but also a meaningful role in it. Teachers who are truly committed to inclusivity recognize that their task is not merely to accommodate differences but to actively embrace them. Real inclusion requires not just structural adjustments but also a mindset shift – one where diversity is seen as a strength, and every student feels valued and supported.

To achieve this, teachers must adopt flexible teaching methods that can be adapted to meet varied learning needs. Rather than relying on traditional, one-size-fits-all approaches, inclusive education challenges educators to explore differentiated instruction, ensuring that each child can access the curriculum at their own pace and in ways that make sense to them.

Moreover, inclusive education calls on teachers to foster a classroom environment that goes beyond academics, cultivating students' social and emotional well-being.

Recognizing that many children come from challenging backgrounds, educators are urged to create safe, nurturing spaces where students can express themselves without fear of judgment. When teachers prioritize these aspects, they enable students to overcome barriers, build resilience, and find joy in learning.

The United Nations Educational, Scientific and Cultural Organisation (UNESCO) first stated in 1994 that inclusive schools were the most effective way to counter discriminatory approaches and attitudes towards students with a disability. International legislation and policy subsequently evolved to challenge exclusionary practices and focus attention on equity and access to high quality education for all, while respecting diversity (UNESCO, 2008). According to UNESCO (2009) ‘... an “inclusive” education system can only be created if ordinary schools become more inclusive in other words, if they become better at educating all children in their communities’. Article 24 of the United Nations Convention of the Rights of Persons with Disabilities recognizes that education should be accessible ‘... without discrimination and on the basis of equal opportunity ... within an inclusive education system at all levels ...’. It is widely acknowledged, nonetheless, that children with disabilities continue to experience different forms of exclusion which vary depending upon their type of disability, domicile and the culture or class to which they belong (UNICEF, 2013) [2, p. 21].

In a constantly changing world, pedagogy itself must evolve to address the diverse challenges facing modern education. As societies grow increasingly complex, educators are not only called to transmit knowledge but to foster deep understanding and empathy, creating inclusive and supportive learning environments that recognize each student's unique needs. This shift in focus demands that pedagogy be as dynamic as it is thoughtful, integrating new methodologies, practices, and technologies that can enhance engagement and adaptability.

In response to these demands, modern pedagogical practices are evolving in ways that leverage both scientific research and technological advancements. Innovative approaches, like personalized learning and adaptive teaching strategies, empower educators to meet each student where they are, helping them to grow beyond mere academic achievement and towards a holistic understanding of the world. Technologies

such as digital learning tools, virtual classrooms, and interactive platforms enable teachers to offer a range of experiences tailored to varied learning styles, fostering an environment where every student can thrive.

In striving to adapt to the complex needs of our societies, pedagogy remains a science and art that champions growth, understanding, and the potential of each learner.

REFERENCES

1. Ormrod, J. E. (2020). *Educational Psychology: Developing Learners* (10th ed.). Boston, MA: Pearson Education.
2. Forlin, C., & Loreman, T. (Eds.). (2014). *Measuring Inclusive Education*. Bingley, UK: Emerald Group Publishing.

N. Reyes, O. Bovkunova

THEATRICAL SPACE ON THE SCREEN

One of the first tasks facing the broadcast team is to create the impression of the stage space from a distance. To this end, broadcasts often include additional material before the performance begins to help contextualize the theatre space and create an immersive experience. The broadcast directors always show the theater's exterior and interior, as well as footage of the theater's internal audience interacting with each other and taking their seats. Thus, for approximately 15 minutes before the start of the performance, the remote audience is encouraged to visually and acoustically blend the theater and cinema spaces in which they are located, and, ideally, to merge them. The stage itself, however, is rarely shown in these pre-performance shots, despite the fact that it is where the internal audience most often directs their gaze.

The camera placement for broadcasts is unique to each production. Generally, the tendency is to stay on the actor as he delivers his lines. Voiceovers and silent reactions are used when the listener's reaction is crucial to the context of the scene. For example, in the broadcast of the Comédie-Française production of *Electra / Oreste* by Corentin Leconte (director of the stage version by Ivo van Hove), the audience in the theater

observes a long, expressive shot of Orestes, who stands in amazement at the arrival of Menelaus [2]. Menelaus's speech plays in the background, while Orestes's face expresses fear at the inevitable retribution for his murder. In this case, a reverse-angle shot is used, which draws attention to a moment imbued with psychological content. Tim van Someren, director of the National Theatre's screening of Josie Rourke's production of "Coriolanus," begins preparations for the screening of the play with a static wide shot, known as a "scratch" [2].

Based on this recording, a script for the future broadcast is prepared, including dialogue and important stage directions. Camera angles and movements are detailed for the first time. This script is then tested during a full-dress rehearsal, filmed without an audience, which is later viewed by the technical and creative team on a large screen. At this stage, the script undergoes further refinement, not only in terms of camerawork and editing techniques, but also in terms of makeup, costume details, lighting, and sound. The team strives to avoid any interpretative discrepancies between the on-screen and stage versions of the performance that could be caused by recording errors.

A second full-scale rehearsal with cameras is held the day before the live broadcast. This allows for all adjustments made during the previous stage to be verified [18, p. 466]. The visual presentation of the performance has many options, especially if it is possible to create detailed storyboards and conduct rehearsals for filming, as is the case with most National Theatre broadcasts. Thus, in the RSC broadcast of Richard II, the director of the screen version, Robin Lau, conveys the stage space of Gregory Doran's production using a dramatic opening sequence: beginning with an overhead shot of the Duchess of Gloucester slumped on her husband's covered coffin, the camera slowly pans back toward the proscenium, until finally it reaches the edge of the stage and the front rows of the audience. Stopping at this point, the image presented cinemagoers with a complete view of the entire scene, including an image of the church nave projected onto the stage backdrop, as well as a group of characters gathered for the funeral, who do not actually appear in Shakespeare's text. Throughout the episode that leads into the first scene of Shakespeare's play, the debate between Bolingbroke

and Norfolk, tightly framed individual shots or shots of two characters alternate with shots of the overall stage space, taken from several different angles. Editing using the zoom-in/zoom-out method allows the characters to be presented within the overall stage setting, including, at moments of the most intense tension, close-ups and medium shots. This also becomes a successful way to construct a continuous narrative and lead from one point of interest – the Duchess of Gloucester at the funeral – to another – the dialogue between the two dukes.

Mixed perspective isn't always used in Lau's work. His 2013 broadcast of *Othello*, directed by Iqbal Khan for the RSC, begins with a shimmering guitar sound in the darkness. This is followed by a downward shot of the stage, followed by a view of the actors from the left. From this point, a smooth zoom-in reveals the central characters, Iago and Roderigo, as they discuss Cassio's recent promotion to lieutenant [1]. The three-minute sequence features footage from several of the seven cameras, often presenting a slow-motion version of the shot-counter-shot sequence. This is the speaker's perspective, looking at the other person, followed by the listener's perspective. The two people are shown in a first medium shot and are always the center of attention. The sequence is shot to show the dominance of one character, Iago. The positioning of the characters, with Iago towering over the seated Roderigo, involves the use of varying camera heights. To express the inner essence of the episode – the beginning of Iago's intrigues, an external confrontation of cameras is used, while the failed lieutenant stands out in the plan due to filming from a higher level.

A closer and tightly framed broadcast style "*Othello*" corresponds to the grammar of the on-screen image, familiar from cinema and, especially, from television, in which closeness to the faces and bodies of the actors is the norm. Thanks to this approach, the viewer becomes a silent participant in the conversation, since visually the authors deliberately bring the picture closer to natural vision. This intimate, inclusive and engagement-oriented perspective provides access to the nuances of facial expressions and other expressive features of a person's psychological life. It is precisely this emotional immediacy that defines a certain advantage of on-screen broadcasts over in-person theatrical experience.

REFERENCES

1. Lukowski A. King Lear. Time Out. Available from: <http://timeout.com/london/theatre/kinglear-17> [Accessed 28th March 2026].
2. Latour B. Reassembling the Social: An Introduction to Actor-Network Theory. Oxford, Oxford University Press Publ., 2005. 301 p.

V. Riazanov, O. Shatalovych

DAVID BENTLEY HART'S THEODICY IN THE CONTEXT OF FORMATION OF THE SPIRITUAL AND VALUE SPHERE OF CONTEMPORARY SOCIETY

The problem of evil is one of the fundamental problems of philosophy, accompanying human society from the earliest stages of its historical development. It has no simple solutions and will likely remain relevant until the end of humanity's existence. At the same time, in today's context, this problem requires a qualitatively new rethinking, as well as the development of appropriate approaches to its resolution.

David Bentley Hart is one of the most original and profound Orthodox thinkers of our time, who explores the problem of evil from a theological and religious-philosophical perspective. In his work "The Doors of the Sea: Where Was God in the Tsunami?", he proposed a new approach to this problem, highlighting a series of weak arguments put forward by proponents of its traditional and popular theological solution. First and foremost, D. B. Hart critiques the articles published in The Guardian on December 28, 2004 – "How Can Religious People Explain Something Like This?" by Martin Kettle [3] and "Disaster Ignites Debate: Was God in the Tsunami?" by Ron Rosenbaum [4]. He also analyzes the widespread thesis that "if God is truly omnipotent, then He is not good, and if He is good, then He is not omnipotent", as well as materialistic interpretations of the nature of evil. According to David Bentley Hart, the weaknesses in the arguments of M. Kettle, R. Rosenbaum, and proponents of the materialistic approach are as follows: 1. They engage in debate regarding a conception of God that corresponds to their own ideas; 2. God is reduced to an ethical agent and a limited

psychological person; 3. Their argumentation is based on a complex of anthropomorphic notions [1, p. 13-14]. At the same time, Hart notes that it is impossible to dismiss such arguments, however controversial they may be, since they are rooted in “a peculiar rage against injustice, a rejection of easy consolation, and an unwillingness to come to terms with evil” [1, p. 15]. He also points to a certain internal irony that permeates the arguments of skeptics who use the problem of evil as a basis for denying the existence of God. In his view, such arguments could hardly have arisen in a mind not shaped by the moral universe of Christian culture [1, p. 15]. Hart’s conclusion seems well-founded, since both the problem of God’s existence and the problem of evil, as well as the very concept of theodicy, arise within the framework of the European Christian cultural tradition. In this sense, the problem of unbelief, which the thinker discusses, also has a deeply Christian foundation.

In general, it is worth noting that Hart, when discussing the issue of theodicy, proceeds from apologetic considerations. He writes: “If we honestly ask ourselves what kind of God it is that all our skeptics so despise, we must ultimately conclude that although he is not the God proclaimed by the Christian Gospel, he is nonetheless a certain weak and distorted echo of that proclamation” [1, p. 24-25]. In fact, Hart points to the cognitive fallacy of the “Straw Man”, which, in his view, is committed by representatives of the atheist camp, since their arguments often demonstrate an insufficient understanding of the Christian tradition and prove vulnerable in light of their own logic. At the same time, he assesses both fundamentalist (interpreting the tragedy as God’s wrath) and conservative (understanding it as a “divine lesson”) reactions as pathological. D. Hart identifies another group of reactions from the Christian community as “rationalization” [1, p. 26]. In his view, all these primitive reactions are united by the conviction that “in all the apparent randomness of nature’s violence there is a divine plan that explains every instance of suffering, poverty, and loss in a certain overall sum” [1, p. 29]. Hart also takes a critical view of the tradition of *theologia naturalis*, believing that it ultimately gives rise to a rationalistic theodicy [1, p. 53].

The question arises: what, exactly, is theodicy for David Bentley Hart, given his critical stance toward its common Christian variants? The thinker’s answer is as follows:

“The primary task of theodicy is to explain why paradise is not a logical possibility”. According to Hart, the Christian worldview is not a rational conclusion drawn from empirical experience, but rather emerges as a moral and spiritual capacity [1, p. 57-58]. At the same time, the theologian emphasizes, the biblical understanding of evil has always been more radical and “fantastic” and has differed significantly from the deistic version of theodicy or any of its philosophical interpretations. It should also be emphasized that, in general, David Bentley Hart adheres to the Augustinian line of theodicy. On this point, he notes: “Christian thought from the very beginning denies that (in and of themselves) suffering, death, and evil have any ultimate value or spiritual significance. It asserts that they are cosmic accidents, ontological shadows, inherently devoid of substance or purpose” [1, p. 61]. From this and other passages, it follows that the theologian shares the traditional Christian position, according to which evil has no positive ontological status and is regarded as the absence of good.

As already noted, D. Hart rejects any version of theodicy that asserts that evil is part of God’s design and is included in His historical plan. He considers such a justification of God to be blasphemous and frivolous [1, p. 100]. In his view, the quintessence of the Gospel is the message about the evil of death, its paradoxical nature and unjust dominion over the world, as well as the fact that God is not pleased with and does not “thrive on” human death. He is not the mysterious architect of evil, but conquers hell through the power of the Cross. God is life, light, and infinite love, and the path to His Kingdom does not follow the contours of nature, history, or logic; it is revealed through the historical “absurdity” and scandal of Christ’s empty tomb [1, p. 101].

In summary, the main features of D. Hart’s theodicy can be outlined as follows: 1. The thinker’s overall strategy is dialectical in nature: he criticizes both atheistic and materialistic understandings of God and their fundamentalist-conservative religious counterparts; 2. Rationalist theodicy, in his view, oversimplifies the profound problem of God’s existence and the presence of evil in the world by granting evil a positive historical and cosmological status; 3. Hart’s theodicy is grounded in the traditional Augustinian thesis that evil lacks a positive ontological status; 4. It has a distinctly New Testament and Christological character. In fact, in D. Hart’s religious-philosophical

teaching, theodicy appears not as an intellectual practice of justifying God for the evil in the world, but as a recognition of the limitations of any “God-talk”, which cannot be fully exhausted by philosophical, religious, or ethical vocabularies.

REFERENCES

1. Hart D. The doors of the sea: where was God in the tsunami? Grand Rapids: William B. Eerdmans Publishing Company, 2005. 109 p.
2. Kettle M. How can religious people explain something like this? // The Guardian. 28 Dec. 2004. URL: <https://www.theguardian.com/environment/2004/dec/28/religion.comment> (дата звернення: 06.02.2026).
3. Rosenbaum R. Disaster ignites debate: Was God in the tsunami? // Observer. 6 Jan. 2005. URL: <https://observer.com/2005/01/disaster-ignites-debate-was-god-in-the-tsunami/> (дата звернення: 06.02.2026).

M. Serezhchenko, N. Diachok

CONTEMPORARY TRANSLATION STANDARD IN THE AI ERA

The rapid development of information and artificial intelligence technologies has led to the growing relevance of their integration into translation practices, thereby transforming the perception of translation standards [3]. Traditionally, translation standards have been associated with linguistic correctness and adherence to lexical, grammatical, and stylistic norms. Currently, these standards are significantly influenced by technological developments and therefore require reinterpretation. The question of why translation standards are necessary becomes particularly relevant in the contemporary context. In its modern understanding, a translation standard serves not merely as a set of prescriptive rules but as a regulatory and operational framework that ensures the consistency, reliability, and functional adequacy of translated texts.

Drawing on the principles of ISO 17100 [2], translation standards can be conceptualized through three interrelated dimensions:

Technological, which includes the use of translation tools, machine translation systems, and digital resources;

Professional, which reflects competencies, responsibilities, and ethical considerations of translators;

Linguistic, which concerns accuracy, adequacy, and compliance with target language norms.

These dimensions interact dynamically and evolve under the influence of both external and internal factors.

The emergence of neural machine translation has marked a turning point in translation practice [4], shifting from an optional tool to, in some cases, a central component of the translation process. As a result, contemporary standards include the following requirements within the technological dimension: acceptable levels of automation, mandatory human post-editing, quality control procedures, and data security considerations.

Technological changes have a direct impact on the professional dimension. The role of the translator now includes functions such as post-editing, quality assurance [1], and risk assessment. Translators are expected to be proficient in using AI tools and capable of critically evaluating machine-generated output.

At the same time, the linguistic dimension is also affected. While AI systems allow greater variability in phrasing, specialized domains—for example, military translation—maintain strict requirements for clarity, consistency, and terminological precision. In this context, the linguistic dimension becomes more regulated, as errors may have serious practical consequences.

In conclusion, translation standards can be perceived as a dynamic, multi-dimensional system in which technological, professional, and linguistic dimensions interact and evolve. The integration of modern technologies not only changes the technical aspects of translation but also redefines professional roles and shifts normative priorities. While AI enhances efficiency, it does not replace human translators but rather transforms their role into that of experts responsible for ensuring the reliability and safety of the final text. Therefore, contemporary translation standards should be understood as a practical necessity that enables effective, consistent, and safe translation in complex communicative environments

REFERENCES

1. Freitag, M., Foster, G., Grangier, D., Ratnakar, V., Tan, Q., & Macherey, W. (2021). *Experts, errors, and context: A large-scale study of human evaluation for machine translation*. Transactions of the Association for Computational Linguistics. https://doi.org/10.1162/tacl_a_00437
2. International Organization for Standardization. (n.d.). *ISO – International Organization for Standardization*. <https://www.iso.org/home.html>
3. Krasulia, A. (2021). *Zastosuvannia shtuchnoho intelektu v perekladatskii diialnosti: vid mynuloho do maibutnoho* [The usage of artificial intelligence in translation: from the past to the future]. In *Modusy suchasnoho perekladoznavstva* [Modalities of contemporary translation studies]. Sumy: Sumy State University. <https://www.researchgate.net/publication/349947187>
4. Google Cloud. (n.d.). *Neural machine translation (NMT) model*. <https://docs.cloud.google.com/translate/docs/advanced/nmt-model>
5. Romaniukha, M. V. (2020). *Normuvannia perekladatskoi diialnosti: mizhnarodnyi aspekt* [Norms in translation: international aspect]. *Naukovyi visnyk Mizhnarodnoho humanitarnoho universytetu* [International Humanitarian University Herald]. Odesa: Helvetica Publishing Group. http://www.vestnik-philology.mgu.od.ua/archive/v46/part_3/40.pdf

O. Shvydkyi, N. Styrnik

NEUTRALITY AS A COUNTRY'S FOREIGN POLICY: ADVANTAGE OR DRAWBACK?

There are many strategies for countries to use in building their foreign policy. While some of them choose to look for allies and join international organisations and military alliances, others prefer to remain neutral. It seems like such countries are invincible because none of their neighbours need to fight with them since they adhere to neutrality and non-interference. There are advantages and drawbacks of such models in today's world. Some countries for some period during their history chose neutrality in foreign relations, others gave up their non-interference and non-alignment. There are big challenges for neutral countries in modern international relationships?

Advantages and Drawbacks

Neutrality offers several important advantages. First, it reduces the risk of becoming a battlefield. By avoiding military alliances, neutral states are less likely to be drawn into wars. Switzerland's survival through two World Wars is often cited as proof of this logic. Second, neutrality enhances diplomatic credibility. Neutral states

are often trusted as mediators and hosts for peace negotiations. Vienna, Geneva and Helsinki became key hubs of international diplomacy precisely because they were not aligned with military blocs.

There is also an economic advantage. Neutral states can trade with various parties in a conflict, increasing economic resilience. However, neutrality also has significant drawbacks. The most obvious is vulnerability. A neutral state must be able to defend itself alone; otherwise neutrality becomes meaningless. Moreover, neutrality can limit political influence. By refusing alliances, a state may lose access to collective decision-making and security guarantees.

Another major drawback is moral ambiguity. When large-scale aggression or violations of international law occur, neutrality may appear as indifference. In the words of a contemporary security scholar, Marko Begovic: *“Neutrality can shift from principled restraint to strategic silence in the face of injustice”* [1].

Reasons to Remain Neutral

States choose neutrality for different but interconnected reasons. For many small and medium-sized countries, neutrality is a strategy of survival. Located between stronger powers, neutrality helps them avoid becoming a proxy or battleground. Finland during the Cold War and Switzerland in both World Wars are classic examples.

Another reason is national identity. In some countries, neutrality becomes part of political culture. Austria and Switzerland present themselves as ‘Peace States’, whose mission is to facilitate dialogue rather than confrontation. There is also a legal motivation. Neutrality is supported by international law, particularly by the Hague Conventions. As noted in the Ukrainian legal review: *“The institution of neutrality evolved as a legal mechanism aimed at limiting the spread of war and protecting non-belligerent states”* [2]. Finally, neutrality allows strategic flexibility. Neutral states can cooperate with different partners without being locked into rigid alliance structures.

Reasons to Abandon Neutrality

Despite its benefits, many countries have abandoned neutrality when it no longer guaranteed security. The most powerful reason is external threat. When aggressive

neighbours or regional instability make self-defence impossible, joining an alliance becomes more rational.

This is why Sweden and Finland moved toward NATO after Russia's invasion of Ukraine. Neutrality, or multi-vector foreign policy, did not protect Ukraine in 2014 or 2022 and this had a profound impact on European security thinking.

Economic and political integration also plays a role. Membership of the EU, for example, requires solidarity and common foreign policy positions which may conflict with strict neutrality. According to a recent geopolitical analysis: *“In an era of systemic rivalry, neutrality is increasingly difficult to reconcile with the demands of collective security and shared responsibility”* [1].

Modern Challenges for Neutral Countries

Globalisation, hybrid warfare and economic sanctions have dramatically changed the meaning of neutrality. Today wars are not only fought with soldiers, guns and tanks, but with cyberattacks, energy pressure, disinformation and financial weapons. Remaining neutral in such conditions is extremely difficult. For example, when international sanctions are imposed, neutral countries must decide whether to comply. Refusing sanctions may appear as supporting aggression, while enforcing them may violate strict neutrality.

Another challenge is value-based politics. Modern international relations are increasingly framed in terms of democracy, human rights, and international law. Neutrality can clash with the expectation that states should defend these values.

Conclusion

Neutrality remains one of the most fascinating and paradoxical strategies in foreign policy. It can provide security, economic stability, and diplomatic influence, especially for small and medium-sized states. However, in a world marked by aggressive revisionism, hybrid warfare and value-based alliances, neutrality is becoming harder to maintain. While neutrality once offered a shield against war, today it often offers only partial protection. As global conflicts increasingly demand moral and political positioning, neutrality risks being perceived not as wisdom, but as avoidance. Neutrality

is thus neither purely an advantage nor simply a drawback: it is a strategy whose effectiveness depends on geopolitical context, military capability, and the evolving norms of the international system.

REFERENCES

1. Begović M. The Concept of Political Neutrality Where We Are At? 2025. Taylor & Francis. <https://www.tandfonline.com/doi/full/10.1080/17430437.2025.2560193#d1e102>
2. Romchuk M. Neutrality in International Law: Formation and Development of The Concept. 2024. Philosophy, Economics and Law Review. <https://phelr.com.ua/en/journals/tom-4-2-2024/neytralitet-v-mizhnarodnomu-pravi-stanovlennya-ta-rozvitok-kontseptsiyi>

O. Shyrochkin, O. Osadcha

THE EFFECTIVENESS OF MODERN APPROACHES IN NEUROLOGICAL REHABILITATION OF POST-STROKE PATIENTS

Stroke remains one of the leading causes of long-term disability, which makes the implementation of modern rehabilitation methods in neurological practice extremely important. Current post-stroke rehabilitation is based on the principles of neuroplasticity, individualized treatment, and the use of modern technologies that facilitate the recovery of impaired functions [1, p. 1; 2, p. 1].

Neuroplasticity the brain's ability to reorganize neural connections after injury is the fundamental basis of most recovery strategies. Intensive, repetitive, and task-specific exercises stimulate the formation of new neural pathways, supporting the restoration of impaired motor, sensory, and cognitive functions [3, p. 2]. Early rehabilitation, initiated immediately after the patient's condition stabilizes, demonstrates significantly better functional outcomes and reduces the risk of long-term loss of independence [1, p. 3].

Robotic rehabilitation provides high-intensity motor training, precision, and repeatability of exercises, helping to optimize the recovery process. The use of robotic exoskeletons and interactive mechanotherapy systems has demonstrated effectiveness in improving coordination, muscle strength, and gait parameters [3, p. 4].

Virtual reality (VR) technologies increase patient motivation by immersing individuals in simulations of real-life situations, thereby facilitating the development of skills required for daily activities. VR-based rehabilitation has advantages over traditional therapy, as it provides enriched feedback, task variability, and higher patient engagement all of which are essential for effective motor learning [2, p. 5].

Functional electrical stimulation (FES) activates weakened muscles through electrical impulses, helping to restore voluntary movement control, reduce spasticity, and improve motor performance. This method is particularly effective for gait impairments and upper limb dysfunction [3, p. 6].

Brain-computer interfaces (BCIs) are emerging as a promising direction in rehabilitation, as they enable patients with severe motor deficits to train by converting brain activity into device commands. This process activates the motor cortex even in the absence of actual movement [2, p. 6].

Non-invasive brain stimulation (NIBS) aims to modulate cortical excitability, thereby enhancing motor and cognitive recovery when combined with standard rehabilitation interventions [3, p. 7]. The integration of these techniques with conventional physical therapy helps optimize interhemispheric balance, which is a critical mechanism in post-stroke recovery [2, p. 7].

The best rehabilitation outcomes are achieved when modern technologies are integrated into multidisciplinary programs that include physical, cognitive, speech, and psychological therapy. A systematic approach and the timely application of evidence-based rehabilitation methods improve patients' chances of returning to an active and independent life [4, p. 2].

Telerehabilitation also plays an important role in expanding access to professional care. It enables remote monitoring and individualized support, which is especially valuable for patients with limited mobility, those living in remote areas, or those requiring long-term follow-up rehabilitation [3, p. 8].

REFERENCES

1. Li X., He Y., Wang D., Rezaei M. Stroke Rehabilitation: From Diagnosis to Therapy. *Frontiers in Neurology*, 2024.

2. Marín-Medina D. S., Arenas-Vargas P. A., Arias-Botero J. C., Gómez-Vásquez M., Jaramillo-López M. F., Gaspar-Toro J. M. New Approaches to Recovery After Stroke. *Neurological Sciences*, 2024.
3. Moskiewicz D., Sarzyńska-Długosz I. Modern Technologies Supporting Motor Rehabilitation After Stroke: A Narrative Review. *Journal of Clinical Medicine*, 2025.
4. Evidence-Based Review of Stroke Rehabilitation (EBRSR). *Evidence Reviews*. 2026.

D. Smytska, S. Riabovol

COLOUR AS METAPHOR: A VISUAL ANALYSIS OF ENGLISH IDIOMS

Colour is one of the most powerful tools of human cognition. It shapes emotions, associations, social symbols, and cultural codes that we unconsciously use in communication. The English language, like many others, actively employs colour in metaphors and figurative expressions. Colour-based idioms make it possible to convey complex emotional states, social judgments, intensity of events, or moral characteristics.

In design, colour plays a similar role – it sets the mood, creates emphasis, and communicates meaning without words. That is why analysing English idioms through the lens of visual culture is important for understanding how language and design interact with one another.

The meanings attached to colours in idiomatic expressions are far from random; they reflect deeply rooted principles of perceptual and emotional psychology. The same associations that guide colour use in visual design also shape how colours function metaphorically in language [3].

Red, commonly employed in design to convey energy, intensity, and danger, appears in idioms associated with strong emotions or critical states, such as anger (*see red*) and financial loss (*in the red*).

Blue, valued in design for its calming, cool, and stabilizing effect, similarly denotes sadness (*feel blue*) or abstract, idealistic thinking (*blue-sky thinking*) in language.

Green, strongly linked to nature, freshness, and growth, gives rise to idioms expressing envy (*green with envy*) and lack of experience (*a green recruit*).

Black, associated in design with elegance but also with mourning and tragedy, frequently conveys negativity or moral judgment in idiomatic usage (*blacklist*, *black mood*).

White, symbolizing purity, simplicity, and lightness in design, is reflected in idioms that emphasize innocence or moral softening (*white lie*, *white knight*). Collectively, these parallels demonstrate that both language and design draw upon a shared emotional colour code rooted in human perception and cultural experience [3].

Each idiomatic expression can be effectively “translated” into the visual language of design. By aligning verbal metaphors with colour, emotion, and compositional choices, idioms become not only easier to interpret but also highly compatible with visual and multimodal learning [1].

For example, the idiom *to feel blue* draws on the colour blue to convey sadness or melancholy; in design, this meaning can be represented through cool hues, minimalist compositions, and soft, flowing lines.

The phrase *to see red*, associated with anger or an emotional outburst, naturally lends itself to visualizations built on intense contrasts, sharp angles, and forceful, dynamic compositions.

Similarly, *green with envy* translates into designs that emphasize vivid green accents, strong contrasts, and expressive visual focus—often centered on the eyes or facial tension.

The idiom *a white lie*, which implies moral mitigation or gentle justification, can be rendered through pastel palettes, diffused lighting, and smooth, unobtrusive forms.

Finally, *black sheep*, signifying deviation from the norm or social isolation, is visually articulated through stark contrast, such as a single dark element set against a lighter background [1].

These examples illustrate that idioms function as visual codes, capable of being transformed into posters, illustrations, or symbolic logos that communicate meaning instantly and intuitively. This confirms that idioms function not only as linguistic

metaphors but also as visual codes that can be effectively rendered through colour, composition, and form [2].

We conclude that in English idioms, colour is not merely a decorative element but a key metaphorical code. It reflects cultural patterns of thought, emotional states, social judgments, and behaviour. Analysing such idioms from a design perspective makes it possible to better understand colour psychology and its influence on communication.

Thus, language and design are two systems that use colour according to similar principles: to evoke emotion, convey meaning, and create imagery. English idioms serve as a bridge between word and image, making the abstract visible.

REFERENCES

1. Jalilzada A. Color-indicating idioms in English: semantics, history, and syntactic patterns. *Global Spectrum of Research and Humanities*, 2(5). 2025. P. 82-92. URL: <https://doi.org/10.69760/gsrh.0250205010>
2. Nassau K. The psychology of colour. *Encyclopaedia Britannica*. 2026. URL: <https://www.britannica.com/science/color/The-psychology-of-colour>
3. Sviličić N., Radek I., Grabar I. Color semiotics: color as a medium of communicating culture and emotions. *Collegium Antropologicum*, Vol. 48. No 1. P. 1-7. 2024. URL: <https://doi.org/10.5671/ca.48.1.1>

V. Striukova, O. Panchenko

EQUIVALENCE AND ADEQUACY IN TRANSLATING R. KIPLING'S POETRY

The translation of poetry presents a complex challenge due to the necessity of preserving not only semantic content but also stylistic, rhythmic, and cultural features of the original text. «A successful translation is one that looks or sounds like the original, but with one clarification – the translated text must be communicatively equivalent to the original» [2, p. 33, quoted by 1, p. 54]. In contemporary translation studies the notions of equivalence and adequacy occupy a central position, particularly

in the field of literary translation. Equivalence in translation can be understood as a multidimensional concept encompassing semantic, stylistic, formal, and functional aspects. Semantic equivalence ensures the preservation of meaning, while stylistic equivalence aims to reproduce the expressive and emotional tone of the original text. Formal equivalence focuses on structural features such as rhyme and meter, whereas functional equivalence is concerned with achieving a similar impact on the reader. Adequacy, in contrast, prioritizes the communicative function of the translated text. An adequate translation does not necessarily replicate all formal features of the original but seeks to convey its artistic value and stylistic identity in a way that is accessible and meaningful to the target audience. In poetic translation, full equivalence is rarely attainable due to linguistic and cultural differences. Therefore, adequacy becomes the dominant criterion guiding the translator's decisions. In the process of translating Kipling's poetry, translators frequently face the dilemma of choosing between formal equivalence and functional adequacy. Attempts to preserve rhyme and meter may lead to distortions in meaning, while a focus on semantic accuracy may result in the loss of stylistic expressiveness. To resolve this conflict, translators employ various translation strategies and transformations, including lexical substitution, grammatical restructuring, and stylistic adaptation. Compensation is often used to offset losses in one area by enhancing another, for example, by introducing expressive devices elsewhere in the text. Adequacy thus manifests as a dynamic balance between different levels of equivalence. It allows the translator to prioritize the preservation of the overall artistic effect and the author's idiosyncrasy rather than adhering strictly to formal correspondence.

Ukrainian translations of Kipling's poetry illustrate the complexity of achieving both equivalence and adequacy. The differences between English and Ukrainian prosodic systems make it difficult to maintain the original rhythm and rhyme scheme. Additionally, cultural references may require adaptation or explanation to ensure comprehension. Another challenge lies in reproducing the emotional and stylistic nuances of the original text. Kipling's use of irony, for example, may be subtle and context-dependent, making it difficult to convey without altering the tone. Despite these difficulties, successful

translations demonstrate that it is possible to achieve a high degree of adequacy through careful linguostylistic analysis and creative interpretation.

To conclude, an effective translation must balance semantic accuracy, stylistic expressiveness, and cultural relevance. Linguostylistic analysis plays a crucial role in identifying the key features of the original text and determining the most appropriate strategies for their reproduction.

REFERENCES

1. Альошина М. Д. Критерії та принципи визначення адекватності відтворення ідіостилю автора в перекладі. Науковий вісник Міжнародного гуманітарного університету. 2018 № 37. Т.3. С 54–57.
2. Демецька В.В. Теорія адаптації в перекладі: дис. д.ф.н.: спец. 10.02.16 – Перекладознавство. К, 2008. 580 с.

D. Svystun, O. Osadcha

THE USE OF INTERACTIVE EDUCATIONAL MATERIALS IN SPEECH THERAPY WITH PRESCHOOL-AGED CHILDREN

Speech development in preschool-aged children is one of the key areas of focus for specialists in special education. During this period, speech skills are actively forming, phonemic awareness is developing, vocabulary is expanding, and connected speech is improving. If speech disorders arise at this stage, they can affect not only communication but also the child's overall mental development, academic performance, and social adaptation. That is why speech therapy assistance in preschool age must be systematic, methodologically sound, and understandable to the child. One effective way to organize such work is through the use of interactive educational materials. The distinctive feature of an educational game lies in the purposeful combination of learning and play tasks. Organizing learning in the form of a game is based on a child's natural desire to immerse themselves in an imaginary situation and act according to its rules, which fully corresponds to the age-specific characteristics of preschool-aged children [2].

Interactive educational materials are specially designed learning tools that involve the child's active participation in completing tasks and interacting with the educational content. These include interactive presentations, multimedia exercises, electronic games, educational apps, digital flashcards, and tasks used via a computer, tablet, or interactive whiteboard. Children perceive the rules of an educational game as conditions that support the game's concept. Failure to follow them disrupts the flow of the game and reduces interest in it. If the rules are not defined in advance, gameplay can become chaotic, resulting in educational tasks remaining unfulfilled [1].

In speech therapy, interactive materials are used to develop various components of speech. They help form correct pronunciation, develop phonemic awareness, enrich vocabulary, and improve grammatical structure. For example, a child can identify the position of a sound within a word, select words related to a specific topic, form word combinations, or construct simple sentences. Such tasks are easily adapted to the child's individual abilities, gradually increasing in complexity according to their level of speech development.

Interactive exercises are also effective for developing coherent speech. Children can compose stories based on a series of story pictures, establish the sequence of events, or describe objects and situations. Educational games help expand vocabulary, foster grammatically correct and coherent speech, and develop phonemic awareness and imagination. Among effective methods for stimulating speech, word games, quests, and quizzes deserve special mention, as they contribute not only to the development of speech skills but also to social interaction, intellectual activity, and the child's emotional well-being [3].

Thus, interactive teaching materials are an effective tool for organizing speech therapy work with preschool-aged children. Their use increases children's interest in learning, stimulates cognitive activity, and creates favorable conditions for the development of speech skills and the overcoming of speech disorders.

REFERENCES

1. Bibik, N. M. (2023). Hra v navchanni molodshykh shkolyariv: variatyvnist' pidkhodiv do zastosuvannya [Game in the education of younger schoolchildren: variability of approaches to application]. *Ukrayins'kyi pedahohichnyy zhurnal –Ukrainian Pedagogical Journal* [in Ukrainian].

2. Ribtsun Yu. V. Preschooler: Correctional-Developmental and Educational Work with Children with Phonetic-Phonemic Speech Underdevelopment: Educational and Methodological Manual. Kyiv (2014).
3. Tarasenko, H. S., et al. (2010). Orhanizatsiya dytyachoyi ihrovoyi diyal'nosti v konteksti nastupnosti doshkil'noyi ta pochatkovoyi osvity: navch.-metod. posib. Organization of children's play activity in the context of continuity between preschool and primary education: teaching-methodical manual. Kyiv: Vydavnychyy Dim «Slovo» [in Ukrainian].

K. Syrko, N. Styrnik

SOFT POWER AS A TOOL OF MODERN DIPLOMACY: A COMPARATIVE STUDY OF THE EU, THE USA AND CHINA

Joseph Nye offered a clear definition of soft power in his book *Soft Power*. He describes it as follows: *“A country may obtain the outcomes it wants in world politics because other countries – admiring its values, emulating its example, aspiring to its level of prosperity and openness – want to follow it. In this sense, it is also important to set the agenda and attract others in world politics, and not only to force them to change by threatening military force or economic sanctions”* [1].

The key difference between hard and soft power lies in the mechanism of influence: soft power works through attraction, while hard power works through coercion – sanctions, threats or incentives. Hard power is based on pressure, while soft power is based on attraction.

The European Union, the United States of America and the People's Republic of China were selected for comparative analysis, as each represents a unique model of soft power in the modern world. The US exerts influence primarily through the global dissemination of its culture, media and educational institutions. The EU relies on persuasive appeal, the promotion of democratic values and regional integration mechanisms. China promotes its international image through economic initiatives, cultural programmes and active diplomacy. Analysis of these different approaches provides insight into how global actors attempt to shape international perceptions and behaviour through non-coercive means.

The Concept of Soft Power

In modern international relations, soft power is an instrument of influence based not on coercion or economic pressure, but on attractiveness and persuasiveness. Its sources are the values that a state embodies in its culture, consistency in domestic policy, and the ability to build trusting international relations. Soft power rests on three pillars:

1. The Culture of the Country – when it resonates with other nations and arouses genuine interest. A striking example is the ‘Korean Wave’ (Hallyu), thanks to which K-pop music, TV series and cinema have turned South Korea into a cultural centre of global significance. Young people learn Korean not because of political pressure, but because of their fascination with the culture.

2. Political Values – which the state consistently embodies both within and outside the country. Values only gain strength when the state truly lives by them. When a country preaches democracy but suppresses opposition at home, it undermines any efforts in the sphere of soft power. On the contrary, consistent adherence to principles, even when it is inconvenient, gradually wins trust.

3. Foreign Policy – which is perceived by the international community as legitimate and morally justified. Joseph Nye, in his book ‘Soft Power’, cites the example of Jimmy Carter's human rights policy. In Argentina, where in the 1970s the military junta rejected American criticism, this same position of the United States became a source of respect two decades later when former political prisoners came to power [1].

Soft power works over time, creating effects over years or generations. One-off gestures are quickly forgotten, but systematic policies that are consistent with declared values build reputational capital. It requires authenticity, patience and faith in one's own principles. Countries that successfully cultivate soft power find that the most influential weapon may not be threat, but inspiration; not dictatorship, but example. It is in this ability to ignite people's imaginations and hearts that the secret of long-lasting international influence lies.

Soft Power of the European Union, the United States and China

The soft power strategies of the European Union, the United States and China reflect distinct political models and approaches to international influence. While all

three actors seek to shape global perceptions through non-coercive means, they rely on different sources and instruments of attraction.

The European Union's soft power is primarily based on its normative appeal and institutional model. By promoting values such as democracy, human rights and the rule of law, the EU exercises influence through standards, regulations and conditionality rather than military or cultural dominance [1]. The attractiveness of EU membership and governance has encouraged political and economic reforms in neighbouring regions, particularly through enlargement and neighbourhood policies [1]. In addition, development aid and educational programs such as Erasmus+ strengthen the EU's image as a cooperative and value-orientated actor [2]. However, internal divisions and slow decision-making processes limit the coherence of EU soft power.

The soft power of the United States has historically derived from the global reach of its culture, values and institutions. American popular culture, higher education and digital platforms have played a central role in shaping global perceptions and promoting liberal democratic ideals [1]. US universities and non-governmental organizations further reinforce long-term influence by creating transnational networks and supporting civil society abroad. At the same time, controversial foreign policy actions and domestic political polarisation have periodically undermined the credibility and moral authority of the United States, weakening its soft power appeal [3].

China's soft power strategy combines cultural diplomacy with economic statecraft and strong state control. Initiatives such as Confucius Institutes and international media expansion aim to promote Chinese culture and narratives, while the Belt and Road Initiative uses infrastructure investment and development financing to enhance China's global image [4]. Nevertheless, concerns over human rights, censorship and transparency limit the effectiveness of these efforts. As Nye and Wang argue, sustainable soft power depends on trust and legitimacy, which cannot be fully generated through economic influence alone [1; 4].

Comparative Analysis

A comparative analysis of the European Union, the United States and China reveals three distinct models of soft power, each shaped by different political

structures, historical experiences, and strategic priorities. Although all three actors seek to influence international outcomes through attraction rather than coercion, the sources and mechanisms of their soft power differ significantly.

The European Union relies primarily on normative and institutional influence. Its soft power is rooted in the promotion of democratic values, legal standards and models of governance, which are disseminated through enlargement policies, neighbourhood initiatives and regulatory frameworks. This approach enables the EU to shape preferences through legitimacy and long-term incentives rather than cultural dominance or military power [1]. However, the effectiveness of EU soft power is often constrained by internal fragmentation and slow decision-making, which can weaken its external coherence [3].

The United States represents a culturally driven and market-orientated model of soft power. Its global influence stems from the worldwide reach of popular culture, higher education, technological innovation and non-state actors. These decentralised mechanisms allow US soft power to penetrate societies more deeply and informally than institutional approaches [1]. At the same time, American soft power is highly sensitive to the perceived legitimacy of US foreign policy. Military interventions and domestic political polarisation have, at times, reduced international trust and undermined the attractiveness of the American model [3].

China's soft power strategy is characterised by a state-centred and economically orientated approach. Through cultural diplomacy, global media expansion, and large-scale economic initiatives such as the Belt and Road Initiative, China seeks to enhance its international image and influence [4]. While economic engagement has increased China's visibility and presence, concerns regarding human rights, political control, and transparency limit the conversion of material resources into genuine attraction. As Nye and Wang emphasise, soft power cannot be effectively generated through state control alone and depends on credibility and trust [1; 4].

Overall, the comparison highlights that no single model of soft power is universally dominant. The EU excels in normative influence, the United States in cultural and societal appeal, and China in economically supported outreach. The effectiveness of each model ultimately depends on global perceptions of legitimacy,

consistency between values and policies, and the ability to adapt to a rapidly changing international environment.

Conclusion

Research into the soft power of the European Union, the United States and China demonstrates three different models of international influence. The EU relies on normative appeal, promoting democratic values through its enlargement policy. The US represents a culturally-orientated model, with its influence stemming from popular culture, higher education and technological innovation. China demonstrates an economically-orientated state approach through cultural diplomacy and large-scale economic initiatives.

A comparative analysis shows that none of the models is universally dominant. The EU is limited by internal fragmentation, the US by perceptions of the legitimacy of its foreign policy, and China faces concerns about human rights and transparency.

Therefore, the effectiveness of each model depends on the global perception of legitimacy, consistency of values and policies. Soft power cannot be created solely through state control or economic influence: it depends on authenticity and trust. Countries that successfully cultivate soft power understand that the most powerful weapon may not be threat but inspiration. It is in this ability to ignite the imagination and hearts of people that the secret of long-lasting international influence lies.

REFERENCES

1. Nye J. S. Jr. *Soft Power: The Means to Success in World Politics*. PublicAffairs, 2009. <https://www.almendron.com/tribuna/wp-content/uploads/2020/02/joseph-s-nye-jr-soft-power.pdf>
2. British Council. *Soft power today: Measuring the effects*. https://www.britishcouncil.org/sites/default/files/3418_bc_edinburgh_university_soft_power_report_03b.pdf
3. Nye J. S. Jr. *The Paradox of American Power: Why the Worlds Only Superpower Cant Go It Alone*. 2002. https://api.pageplace.de/preview/DT0400.9780198034360_A23605597/preview-9780198034360_A23605597.pdf
4. Nye J. S. Jr., Wang J. *Hard Decisions on Soft Power: Opportunities and Difficulties for Chinese Soft Power*. 2023. https://www.researchgate.net/publication/370312273_Hard_Decisions_on_Soft_Power_Opportunities_and_Difficulties_for_Chinese_Soft_Power

MANAGING UNESCO WORLD HERITAGE SITES UNDER CLIMATE CHANGE AND ENVIRONMENTAL RISK

The management of UNESCO World Heritage Sites has become increasingly complex in the context of climate change and environmental risk. Traditionally, heritage conservation focused on preserving the physical integrity of sites and restoring damage after it occurred. However, accelerating environmental changes have challenged this approach, requiring a shift toward more dynamic and forward-looking strategies. This paper explores how climate change reshapes heritage management by introducing new risks, redefining vulnerability, and promoting adaptation, risk management, and inclusive governance as central components of conservation practice.

UNESCO World Heritage Sites are designated due to their “Outstanding Universal Value,” meaning they hold cultural, natural, or mixed significance that is important to all humanity [10]. It should be highlighted their protection is not solely the responsibility of individual states but a shared international duty. This global dimension makes their preservation particularly important, but also more complicated when facing global challenges such as climate change.

Climate change introduces a new category of risks that differ from traditional threats to heritage. These risks are long-term, cumulative, and often irreversible, which makes them fundamentally different from sudden or localized damage [8]. Existing conservation frameworks were largely developed under assumptions of environmental stability, meaning they are not fully equipped to handle gradual but transformative changes. As a result, heritage management must now account for uncertainty and long-term environmental processes rather than focusing only on immediate threats.

The types of climate-related risks affecting heritage sites are diverse and interconnected. These include sea-level rise, coastal erosion, increasing temperatures, storms, droughts, wildfires, flooding, and melting ice or permafrost [5]. These processes can damage both cultural and natural heritage. Cultural sites may experience structural

instability, material degradation, or loss of authenticity, while natural sites face ecosystem disruption, species loss, and shifts in ecological balance. What makes these risks particularly challenging is that they often interact, amplifying their overall impact.

To better understand how heritage sites are affected, the concept of vulnerability is essential. Vulnerability is shaped by three key factors: exposure, sensitivity, and adaptive capacity. Exposure refers to the degree to which a site is in contact with climate hazards, sensitivity describes how fragile or susceptible the site is to damage, and adaptive capacity reflects the ability to respond and cope with these challenges [7]. Together, these elements determine how severely a site will be impacted by environmental change. This framework represents a more analytical and systematic approach compared to traditional conservation methods.

As a response to these challenges, heritage management has undergone a significant shift from conservation to risk management [2]. Instead of reacting to damage after it occurs, modern approaches emphasize anticipation, prevention, and resilience. This transformation reflects a broader change in thinking: heritage is no longer seen as something static to be preserved unchanged, but as something that must be actively managed in a changing environment [6].

Modern risk identification tools play a crucial role in this new approach. These include climate projections, scenario planning, environmental impact assessments, hazard mapping, and continuous monitoring systems. Their main purpose is early detection of threats, allowing managers to prepare for potential future scenarios rather than simply responding to damage after it has already occurred. This proactive approach increases the chances of protecting heritage sites in the long term [9].

At the core of contemporary heritage management lies adaptation. Adaptation involves adjusting conservation techniques, modifying infrastructure when necessary, and integrating climate considerations into planning processes [1]. As emphasized above, adaptation aims to reduce vulnerability and strengthen long-term resilience. It recognizes that some level of change is inevitable and seeks to manage that change in a way that preserves the essential values of heritage sites.

However, adaptation also has clear limitations. Some climate impacts may be too severe to manage effectively, and legal frameworks protecting heritage sites often restrict how much they can be altered. Additionally, many drivers of climate change operate on a global scale, meaning they cannot be addressed solely through local management efforts [3]. This highlights the need for broader international cooperation and climate policy alongside local conservation strategies.

Another crucial element in managing heritage under climate change is the role of local communities. Local populations possess valuable knowledge and maintain daily interactions with heritage sites, which can significantly contribute to resilience. Their involvement enhances management effectiveness, strengthens legitimacy, and improves long-term compliance with conservation measures [4]. Moreover, social sustainability – ensuring that communities benefit from and support conservation efforts – is increasingly recognized as an integral part of risk management.

The development of research in this field reflects these changes in practice. Initially, studies focused mainly on site-level conservation. Over time, research evolved through transitional and climate-focused phases, eventually leading to the current interdisciplinary approach. Today, heritage management integrates climate science, policy analysis, ethics, and global governance. This shift demonstrates a growing recognition that heritage conservation cannot be separated from broader environmental and societal processes.

In conclusion, climate change has fundamentally transformed the way UNESCO World Heritage Sites are managed. Traditional conservation methods are no longer sufficient in the face of long-term and complex environmental risks. Instead, risk-based approaches, adaptation strategies, and inclusive governance have become essential. Protecting world heritage is no longer just about preserving physical sites, but about safeguarding shared human history in a rapidly changing world. This requires not only local action but also global cooperation, interdisciplinary knowledge, and a willingness to rethink how heritage is understood and protected for future generations.

REFERENCES

1. Brimblecombe P., Grossi C. M., Harris, I. (2017). Are cultural heritage and resources threatened by climate change? A systematic literature review. *Climatic Change*, 142 (1), 227–254.
2. Fatorić S., Seekamp E. (2017). Climate change adaptation in heritage management: A review of the literature. *Climatic Change*, 142 (1–2), 9–23.
3. ICOMOS. (2013). *Guidance on Climate Change and Cultural Heritage*. International Council on Monuments and Sites.
4. Mason R., Avrami E. (2002). Heritage values and challenges for conservation in a changing climate. *Conservation and Management of Archaeological Sites*, 5 (4), 203–217.
5. Nguyen K. N., Baker S. (2023). Climate Change Impacts on UNESCO World Heritage-Listed Cultural Properties in the Asia-Pacific Region: A Systematic Review of State of Conservation Reports, 1979–2021. *Sustainability*, 15 (19), 14141
6. Pendlebury J. (2015). Conservation in the age of climate change: Heritage values and risk management. *International Journal of Heritage Studies*, 21 (6), 559–575.
7. Phillips H., Marzano M. (2019). Heritage at risk: Conceptual frameworks for climate change adaptation. *International Journal of Heritage Studies*, 25(6), 567–582.
8. Samuels K. L. (2022). Global Climate Change and UNESCO World Heritage. *International Journal of Cultural Property*, 29 (4), 409–432.
9. Smith C. M., Waterton E. (2025). Integrating climate risk in cultural heritage: A critical review of assessment frameworks. *Heritage*, 8(8)
10. UNESCO World Heritage Centre. (2016). *Managing natural World Heritage sites: Guidelines for climate change adaptation*. UNESCO Publishing.

A. Okata, I. Kofan, O. Osadcha

INTERACTIVE LEARNING TECHNOLOGIES AS A TOOL FOR OVERCOMING COGNITIVE PASSIVITY OF LEARNERS IN THE CONTEXT OF DIGITAL TRANSFORMATION OF THE EDUCATIONAL PROCESS

Interactive learning technologies in contemporary education are regarded as one of the key tools for overcoming learners' cognitive passivity, which is intensified in the context of digital transformation, information overload, and changes in knowledge perception [4]. Despite unprecedented access to educational resources, there is a decline in the depth of material comprehension, fragmented thinking, difficulties with sustained attention, and a tendency to seek quick answers without critical analysis. This situation necessitates the development of pedagogical approaches that ensure active student engagement, foster learner agency, cultivate independent thinking, and support intrinsic

motivation. In this context, interactive technologies are not merely a set of digital tools but a comprehensive pedagogical strategy based on dialogue, collaboration, problem-based inquiry, and reflection [9; 10].

Cognitive passivity in the digital age is multifaceted and linked to several interrelated factors. First, the information environment promotes rapid scanning rather than deep comprehension, fostering superficial cognitive strategies [8]. Second, the spread of “clip thinking” alters attention structure and complicates the understanding of logically organized texts and long-term intellectual effort [11]. Third, persistent reliance on reproductive learning models oriented mainly toward information recall does not meet the cognitive needs of modern learners and does not provide conditions for active knowledge construction. As a result, a gap emerges between the potential of digital tools and actual educational outcomes, manifested in reduced motivation, underdeveloped critical thinking, and limited ability to apply knowledge in new situations [5; 7].

Interactive learning technologies can address these challenges by shifting from passive reception of information to active engagement. Their pedagogical value lies in organizing the learning process as a space for co-creation, where learners act as active participants rather than passive consumers of knowledge. Methods such as discussions, simulations, role-playing, project-based activities, research tasks, and digital collaborative environments contribute to deeper understanding, development of communication skills, and responsibility for learning outcomes. Gamification is particularly effective, integrating achievement mechanics, levels, instant feedback, and emotional engagement. Unlike external motivation based on grades, a gamified environment supports the sense of progress, autonomy, and meaningful activity, positively influencing sustained learning motivation [8; 10].

A key feature of interactive technologies is their potential to foster critical thinking, which is crucial in the digital information space. Working with alternative sources, analyzing multiple perspectives, articulating personal positions, evaluating information credibility, and reflecting on outcomes develop information literacy and responsible decision-making skills. Collaborative learning using digital tools enhances interaction, making it continuous and flexible, and supports social competencies and teamwork

skills. This aligns with modern educational requirements for forming not only knowledge but also comprehensive life competencies [2; 3].

Effective integration of interactive technologies requires a systemic approach combining methodological, digital, and psycho-pedagogical components. Methodologically, it involves blending interactive and traditional forms of work, using problem-oriented tasks, organizing research activity, and applying an activity-based approach. The digital component includes online platforms, multimedia resources, formative assessment tools, and instant feedback mechanisms that enable personalized learning. The psycho-pedagogical aspect focuses on creating a safe educational environment, supporting intrinsic motivation, fostering reflection, and accommodating individual learner differences. The interaction of these components creates conditions for overcoming cognitive passivity and improving educational quality [1; 6].

Practical implementation of interactive technologies demonstrates positive effects on learning outcomes, engagement, and key competencies development. The combination of blended learning, project-based work, and gamification creates a holistic environment of active interaction, enabling learners to act, explore, collaborate, and reflect. At the same time, the effectiveness of these approaches depends on teachers' readiness, digital competence, methodological culture, and capacity for pedagogical innovation. This underscores the need for updated teacher education and professional development that integrates pedagogy, psychology, and digital technology [9; 11].

Future research should focus on personalized learning through adaptive digital systems, the use of artificial intelligence in interactive engagement, methods for assessing cognitive activity, and optimal models for combining online and offline learning. Investigating the impact of interactive technologies on learners' emotional well-being, autonomy, and lifelong self-development is also promising [8; 10].

In conclusion, interactive technologies are a critical factor in modernizing education and effectively addressing cognitive passivity in the context of digital transformation. They support the shift toward activity-based, learner-centered, and technologically flexible learning models, meeting the demands of the information

society and fostering active, critically thinking individuals capable of meaningful social and professional engagement [5; 7].

REFERENCES

1. Бровко К. Цифрові технології як чинник активізації пізнавальної спрямованості студентів університету в процесі вивчення іноземної мови. Вища освіта України. 2025. № 2(97). С. 64-69.
2. Захарова Г. Б., Старікова Л. П., Силенко Ю. В. Формування цифрової компетентності майбутнього вчителя початкових класів засобами SMART технологій. Інноваційна педагогіка. 2025. № 80 (2). С. 127-130.
3. Лисевич О., Павлик О., Бондар К. Інтеграція цифрових технологій у освітній процес для формування критичного мислення учнів початкової школи. Acta paedagogica volyniensis. 2025. Вип. 1. С. 101–115.
4. Сахарова А. С., Кофан І. М. Інтерактивні технології як чинник модернізації сучасного освітнього процесу. The XIII International scientific and practical conference «Modern digital technologies and problems of their use», November 24-26. 2025. Prague, Czech Republic. P. 142-144.
5. Тардаскіна Т. М. Інноваційні підходи до цифрової трансформації вищої освіти. Економіка. Менеджмент. Бізнес. 2024. № 2(45). С. 91-98.
6. Ткаченко В., Усатов Б., Шмиголь Р. Інтерактивні технології у контексті міждисциплінарного підходу до навчання як передумова успішності майбутньої професійної діяльності фахівців. Вісник Черкаського національного університету імені Богдана Хмельницького. Серія Педагогічні науки. 2023. № 4. С. 16-21.
7. Bobro N. The Impact of Artificial Intelligence Technologies on Educational Strategies. Педагогічні інновації: ідеї, реалії, перспективи. 2024. № 33(2). P. 92-99.
8. Fung K. Y., Lui T. L. R., Tao Y., Sin K. F. MotiBo: The Impact of Interactive Digital Storytelling Robots on Student Motivation. Human-Computer Interaction. 2026. P. 1-3.
9. Lee J., Hung J.-T., Soylyu M. Y., Popescu D., Zhang Cui C., Grigoryan G., et al. Socratic Mind: Impact of a Novel GenAI-Powered Assessment Tool on Student Learning and Higher-Order Thinking. Computers and Society. 2025. P. 1-25.
10. Sampanis N. Innovative Tangible Interactive Games for Enhancing AI Knowledge and Literacy in Elementary Education: A Pedagogical Framework. Computers and Society. 2025. P. 1-8.
11. Vehrer A., Palfalusi Z. The Application of Virtual Environments and AI in Higher Education: Experimental Findings in Philosophy Teaching. Computers and Society. 2025. С. 1-12.

PANEL 3

Modern Research in the Sphere of Socio-Economic Sciences and Information Technologies

(DNU, Zoom)

I. Anikin, T. Vorova

MODERN RESEARCH IN SOCIO-ECONOMIC SCIENCES AND INFORMATION TECHNOLOGIES

Modern research in socio-economic sciences and information technologies highlights the profound transformation of global society under the influence of digitalization, automation, and data-driven innovation. Scholars emphasize that technological progress reshapes economic structures, social behavior, and public governance, creating both new opportunities and new challenges.

Digital Transformation of the Economy

Contemporary studies show that big data analytics, cloud computing, and Industry 4.0 technologies significantly increase productivity, optimize supply chains, and stimulate the creation of new business models. Digitalization is becoming a key driver of competitiveness in both developed and developing countries [1].

Artificial Intelligence in Economic Decision-Making

AI-based systems are increasingly used for forecasting economic trends, tax optimization, and risk management. These technologies improve the accuracy of decisions but raise questions regarding transparency, ethical use, and algorithmic bias [2].

E-Governance and Data-Driven Public Policy

Governments around the world adopt digital platforms to improve administrative efficiency, enhance public participation, and strengthen transparency. Research shows that smart governance contributes to more sustainable and inclusive development [3].

Digital Inequality and Social Stratification

Rapid technological advancement widens the gap between social groups with differing levels of access to information technologies. This contributes to disparities in income, education, and labor market participation [4].

Cybersecurity as a Socio-Economic Imperative

The expansion of digital infrastructure increases the risk of cyberattacks, which threatens financial stability, political processes, and the operation of critical national services. Cybersecurity is therefore becoming a central element of socio-economic research [5].

Transformation of Labor Markets

Automation and remote work platforms are reshaping employment structures. Demand for digital competencies grows rapidly, while traditional professions undergo significant changes or disappear entirely [6].

FinTech Innovations and Digital Finance

Blockchain, digital currencies, and mobile banking systems diversify financial services and improve access to them. However, they also require new regulatory frameworks and raise concerns regarding fraud prevention.

Integration of IT in Education and Research

E-learning tools, virtual simulations, and AI-powered educational platforms improve the accessibility and quality of education. Research demonstrates that digital tools enhance learning outcomes and support lifelong learning.

REFERENCES

1. Luo, C., Li, X., & Zhang, Y. (2025). Reshaping the Digital Economy with Big Data: A Meta-Analysis of Trends and Technological Evolution. *Electronics*, 14(13).
2. Zheng, S., Chen, L., Wang, H. (2025). Inequality in the Digital Economy: The Impact of Artificial Intelligence on Income Gap. *Computers, Environment and Urban Systems*.
3. Salesforce Research. (2020). The AI Economist: Improving Equality and Productivity with AI-Driven Tax Policies. arXiv:2004.13332.
4. Ivanov, A., & Kovalenko, T. (2024). Digital Transformation of Social Governance. *Economic and Finance Review*.
5. Petrova, M. (2024). Systematic Analysis of the Smart Economy Concept: Industry 4.0 Challenges. *Futurity Economics & Law*.
6. Koval, O. (2023). Digitalization of the Financial Sector: Theoretical Principles and Main Trends. *Dnipro State University Journal*.

EMERGING TRENDS IN DIGITAL MARKETING: AI, PERSONALIZATION AND OMNICHANNEL INTEGRATION

Digital marketing has become the cornerstone of modern business strategy, driven by rapid technological innovation and changing consumer expectations [2]. Today's marketers must leverage digital tools and analytics to personalize campaigns, engage customers in real time, and create seamless experiences across platforms [2]. Modern strategies emphasize data-driven insights, automated customer interactions, and integrated multichannel engagement. Key drivers of this transformation include:

- **Big Data & Analytics:** Collecting and processing vast customer data for deeper insights and refined market segmentation.
- **AI & Machine Learning:** Automating personalized promotions and content generation at scale.
- **Marketing Automation & CRM:** Using systems, chatbots, and triggered messaging to streamline campaigns and customer service [2].
- **Social Media & Content:** Leveraging platforms like TikTok and Instagram to create engaging content and support two-way interactions.
- **Omnichannel Integration:** Unifying online, mobile, and in-store channels to deliver a cohesive brand experience [3].

Big data analytics and AI are central to targeted marketing. By analyzing customer data from websites, apps, and CRM systems, marketers can identify patterns and predict preferences. McKinsey reports that 71% of consumers now expect personalized interactions, while 76% become frustrated when personalization is lacking. AI-powered tools automate this process: generative AI crafts relevant content at scale, and predictive models tailor promotions to individual behavior. Companies using advanced analytics and AI can tailor offers to highly specific customer segments, significantly boosting marketing efficiency. Yet many still face data issues: a 2024 survey shows that 33% of

organizations lack sufficient data for analysis, and 24% cite poor data quality as a major challenge [1]. Strengthening data governance and integration is essential to unlock the full potential of data-driven marketing.

Social media remains essential for engaging today's audiences, with over 4.7 billion active users worldwide. These platforms support interactive, two-way communication – unlike traditional one-way marketing [4]. Personalized content is especially effective: studies show that tailored posts on Facebook and Instagram significantly increase engagement and brand favorability [4]. High-quality content, responsive community management, influencer collaborations, and targeted ads build trust, expand reach, and create emotional connections that drive repeat business.

Adopting an omnichannel strategy – coordinating multiple sales and communication touchpoints – is vital for customer retention. Studies show that roughly 73% of shoppers now use multiple channels (online, mobile app, in-store) during their purchase journey [3]. Companies with strong omnichannel engagement retain about 89% of their customers, compared to only ~33% for businesses with weaker strategies [3]. A seamless experience across online, social, and in-store channels boosts loyalty and lifetime value. Features like “buy online, pick up in-store” and unified loyalty programs add convenience and trust.

Retailers with strong omnichannel strategies achieve about 9.5% annual revenue growth, compared to only ~3.4% for less integrated peers [3]. This advantage results from higher conversion rates and lower customer acquisition costs. By aligning digital and in-store touchpoints, companies eliminate redundancies and meet customers wherever they are. Since consumers now expect a consistent brand experience across all devices and channels, delivering this cohesion provides a significant competitive edge.

In summary, digital marketing is evolving into a highly personalized, data-driven discipline. The integration of big data analytics, AI, and omnichannel engagement enables companies to tailor offers and messages in real time, strengthening customer satisfaction and loyalty [1]. Targeted personalization and a unified omnichannel presence stand out as especially effective strategies. Recent data highlight this trend: 83% of

consumers report increased loyalty to brands that offer personalized experiences [3]. By aligning marketing automation, content creation, and channel integration, businesses gain agility and deeper customer insights. Those that effectively leverage these digital tools will set new benchmarks for customer engagement and sustainable growth.

REFERENCES

1. Data-Driven Marketing Study 2024: AI application exposes fundamental problem, data quality remains a major challenge – DDMA. *DDMA*. URL: <https://ddma.nl/kennisbank/data-driven-marketing-study-2024-ai-application-exposes-fundamental-problem-data-quality-remains-a-major-challenge/#:~:text=The%20DDMO%202024%20shows%20that,visible%20in%20this%20regard%20either> (date of access: 20.11.2025).
2. Nanda S. The Transformation of Marketing in the Digital Age | AACSB. *Global Business Education Network* | AACSB. URL: <https://www.aacsb.edu/insights/articles/2025/02/the-transformation-of-marketing-in-the-digital-age#:~:text=Rapid%20technological%20progress%20and%20altering,technical%20innovation,%20and%20ethical%20considerations> (date of access: 20.11.2025).
3. Omnichannel Statistics For Retailers And Marketers (2025) | UniformMarket. *UniformMarket*. URL: <https://www.uniformmarket.com/statistics/omnichannel-shopping-statistics#:~:text=73,omnichannel%20shoppers> (date of access: 20.11.2025).
4. The Influence of Social Media Marketing on Brand Loyalty. *Access Denied*. URL: <https://www.preprints.org/manuscript/202408.0332> (date of access: 20.11.2025).

V. Bovkunov, O. Bovkunova

INTERNATIONALIZATION OF GLOBAL ECONOMIC AND POLITICAL SPACE

Transnational corporations (TNCs) are currently the driving force of the internationalization of the global economy. In 1939, there were approximately 300 TNCs worldwide, and by the end of the 20th century, the number of TNCs had increased almost 200-fold. Parent companies are primarily located in developed countries (approximately 72%), while subsidiaries are located in developing countries (approximately 65.2%). One of the concepts behind the emergence and development of TNCs is the small size of the domestic market with increasing production volumes. Under antitrust regulation, there is an objective need to enter the markets of other

countries while simultaneously enjoying the competitive advantages of large corporations.

In the international arena, alongside the state, tens of thousands of various non-state entities make significant contributions to the economy and politics, weakening the role of the state, which bears increasing burdens in both domestic and international environments. Since the beginning of the 21st century, TNCs have assumed a new role. Developed TNCs are active players on the global political stage, often rivaling states. The relationship between the state and the corporation is based on the fact that economic growth is determined by the efficiency of the corporations operating within it, and corporate structures operate within the territory of the state within the framework of its legislation.

Globalization brings to the forefront the issue of state responsibility both to the international community and to its own population. It was intended that the activities of transnational corporations in developed countries should be regulated by the Charter of Economic Rights and Duties of States (1972). [2] Article 2 of this charter indicated the right of each state:

- regulate and control foreign investment within the limits of their national jurisdiction in accordance with their laws and regulations; in accordance with their national objectives and priorities, no State shall be compelled to grant preferential treatment to foreign investment;

- regulate and supervise the activities of transnational corporations within their national jurisdiction and take measures to ensure that such activities do not conflict with their laws, regulations, and orders and are consistent with their economic and social policies. Transnational corporations should not interfere in the internal affairs of the host state;

- nationalize, expropriate, or transfer foreign property.

However, the role of this charter was steadily diminished at the initiative of the United States. In 1987, the UN General Assembly discussed the "Concept of International Economic Security." It was close to the "Charter of Economic Rights and Duties of States," but did not contain the system of economic rights and duties of states

necessary for its implementation and proved unfeasible. After the Charter was revised by the UN (1992), it ceased to be one of the defining international documents, and TNCs were given unlimited freedom in their economic activities. [3] As a compromise, the concept of “social responsibility” was proposed, which was considered an integral part of the corporate risk management strategy [4].

Currently, the primary role in governing the activities of TNCs is played by national legislation, which regulates the admission of foreign direct investment (FDI) and the conditions of operation in their economies. FDI accounts for more than 50% of all financial flows into host countries and, for many countries, represents a source of funds that does not require repayment, unlike loans. Countries continue to facilitate access for FDI into their economies, with favorable changes reflected in lower tax rates and an increase in the number of bilateral treaties at the international level. TNCs internationalize their businesses in stages – having established themselves in national markets, they begin foreign trade activities using FDI, gradually expanding their geographic reach. However, recently, more and more companies are becoming transnational from the moment they are founded, since in the context of globalization, new companies are often founded by specialists with experience working for other TNCs. There are four main motives for TNCs to undertake FDI, which can be combined:

- 1) expansion (capture) of foreign markets;
- 2) increasing the efficiency of production of goods and services;
- 3) ensuring access to the host country's resources;
- 4) adding fundamentally new assets to the firm.

There are two forms of investment expansion: acquisitions and mergers with existing firms and greenfield investments. The volume of FDI by all transnational corporations today plays a more significant role than traditional trade. TNCs control more than 30% of global private sector production, and 90% of the total market volume. FDI is accumulated in the head offices of developed countries (in the US, France, the UK, Germany, and Japan, it accounts for more than two-thirds). There is a clear increase in investment in the service and IT sectors, while at the same time the

share of TNC participation in the extractive industry, agricultural sector, etc. is decreasing [5].

REFERENCES

1. Gilsing, R., Türetken, O., Grefen, P., Ozkan, B., Adali, O. E. Business Model Evaluation: A Systematic Review of Methods. *Pacific Asia Journal of the Association of Information Systems*. 2022. V. 14, № 4. Pp. 26-61. DOI: 10.17705/1pais.14402.
2. Polido A., Pires S.M., Rodrigues C., Teles F. (2019) Sustainable development discourse in Smart Specialization Strategies. *Journal of Cleaner Production*, Vol. 240, 118224. DOI: <https://doi.org/10.1016/j.jclepro.2019.118224>
3. Pop D., Stamos I. (2024) Regional Disparities and the Localisation of the Sustainable Development Goals in the EU. *Journal of Common Market Studies*. DOI: <https://doi.org/10.1111/jcms.13679>
4. Van de Ven M., Lara Machado P., Athanasopoulou A., Aysolmaz B., Turetken O. Key performance indicators for business models: a systematic review and catalog. *Information Systems and E-Business Management*. 2023. № 21. P. 753–794. DOI: 10.1007/s10257-023-00650-2.
5. Zu L., Carlyle T. Purpose-driven leadership for sustainable business: From the Perspective of Taoism. *International Journal of Corporate Social Responsibility*, 2019. Vol. 4 (3). P. 4–31. DOI: <https://doi.org/10.118640991-019-0041-z> (date of access: 23.03.2026).

K. Chelovan, O. Aliseienko

INTERNATIONAL MARKETING TOOLS IN THE XXIst CENTURY

The XXIst century has completely transformed the way companies approach marketing. Rapid advances in digital technology, global communication, and data analysis have made marketing faster, more interconnected, and truly international. Nowadays businesses face the challenge of reaching audiences across the globe while maintaining a consistent brand image and staying profitable. To succeed in this environment, companies need tools and strategies that consider both global trends and local cultural differences [1].

Marketing is no longer just about selling a product; it is about connecting with people, building relationships, and creating experiences that resonate across cultures [2]. Consumers now expect brands to be responsive, culturally aware, and genuinely engaging, which makes the marketing landscape more dynamic than ever. Companies that fail to adapt to these changes risk losing relevance quickly, while those that innovate

can reach new markets and audiences faster than ever before. Understanding how to balance global consistency with local flexibility has become a key skill for marketers today. A clear marketing strategy is the foundation for any successful effort. It helps companies identify who their audience is, what message they want to communicate, which channels to use, and how to measure success. Without this, even the most advanced tools can fall flat [3].

Taking into consideration the example of Apple, simplicity, innovation, and emotional connection are the key features the company focuses its global marketing on. This approach has helped Apple become one of the most recognized and loved brands in the world. A strong strategy does not just drive immediate engagement; it builds long-term loyalty and brand value. Companies that lack a clear vision often struggle to maintain coherence across markets, which can dilute their brand identity. Strategic planning also allows businesses to anticipate market changes and adapt proactively, rather than reactively, which is crucial in a fast-moving digital world. By defining clear goals, companies can allocate resources efficiently and measure progress effectively, ensuring that every marketing dollar counts.

Digital technology has changed everything. Traditional advertising through print or television is still around, but it is now complemented or even replaced by digital channels that allow for precise targeting and instant feedback [4]. Social media platforms like Instagram, TikTok, Facebook, and LinkedIn, along with websites, blogs, email campaigns, and video content on platforms like YouTube or Reels, give companies the ability to reach audiences anywhere in the world. Social media allows brands to create communities, interact directly with consumers, and build loyalty. Netflix, for example, engages audiences worldwide with humor and local-language posts, while IKEA adapts Instagram campaigns to reflect regional home styles and preferences.

These platforms make marketing more personal and interactive, rather than one-way communication. Companies that embrace these tools can quickly respond to trends and build lasting relationships with global audiences. Social media also allows brands

to monitor consumer sentiment in real time, helping them adjust strategies before small issues become larger problems. Moreover, interactive content and campaigns can encourage user participation, making audiences feel more involved with the brand. At the same time, data analytics and artificial intelligence have become central to modern marketing. Companies can collect massive amounts of information from websites, apps, and social media and turn it into actionable insights [5]. AI helps predict customer behavior, personalize offers, adjust pricing, and measure outcomes in real time. Amazon illustrates this perfectly. Its algorithms track browsing and purchasing behavior to suggest products, offer complementary items, and adjust prices dynamically. This makes shopping easier for customers, increases sales, and strengthens loyalty across many markets.

The use of AI also allows businesses to experiment with new strategies efficiently, reducing the risk of costly mistakes. As more companies adopt these technologies, data-driven marketing becomes a critical competitive advantage. With AI, brands can segment audiences more precisely and deliver messages tailored to individual preferences, increasing engagement and conversion rates.

Additionally, predictive analytics helps companies forecast trends, anticipate demand, and make strategic decisions that keep them ahead of competitors. Influencer marketing has also become a key tool. Working with trusted online personalities allows brands to communicate authentically and reach audiences in a more relatable way. Unlike traditional adverts, influencer content feels personal, which makes people more likely to engage with it or make a purchase. Many global brands collaborate with multiple influencers across different regions to maximize the cultural relevance. This approach also allows companies to tap into niche communities that are highly engaged and loyal [6]. When executed thoughtfully, influencer campaigns can strengthen brand credibility and create meaningful connections that last beyond a single promotion. Influencer partnerships also provide insights into consumer preferences and behavior, as audiences often interact directly with sponsored content. This direct feedback loop helps brands adjust campaigns quickly, making influencer marketing both flexible and powerful.

E-commerce has removed many barriers, allowing companies to sell directly to consumers around the clock, anywhere in the world. Beyond just being a sales channel, e-commerce is a powerful marketing tool. Platforms like Amazon and Alibaba enable companies to reach customers instantly while gathering data to refine marketing strategies and improve the customer experience. Online stores also allow brands to showcase a wider range of products, test new offerings, and respond to consumer demand faster than traditional retail. The flexibility of e-commerce makes it an essential part of any global marketing strategy. Companies that integrate e-commerce with social media and digital advertising gain an even stronger competitive edge [7]. E-commerce also facilitates personalized recommendations, dynamic pricing, and targeted promotions, which increase customer satisfaction and repeat purchases. Moreover, the global reach of online platforms allows small and medium businesses to compete internationally without the need for physical stores in every country.

However, international marketing is not just about technology – it is also about understanding culture. Localization goes far beyond translating content; it requires adapting products, campaigns, and communication to align with local tastes, expectations, and cultural values. McDonald’s provides a clear example. While keeping its global brand image, it adapts menus and marketing campaigns for each country. In India, it offers vegetarian and chicken options instead of beef; in Japan, it promotes seasonal items like the Teriyaki Burger; and in Poland, it collaborates with local celebrities and ingredients. This approach shows that understanding and respecting local culture is essential for connecting with audiences and achieving success globally.

Cultural sensitivity also helps prevent misunderstandings and builds trust with local consumers, which is vital for long-term success. Companies that prioritize cultural adaptation often find that their brand is perceived as more reliable and trustworthy [9]. This strategy also allows businesses to experiment creatively with local trends while maintaining a cohesive global identity. In practice, companies use a mix of tools to achieve their goals. Social media drives engagement and brand awareness, while SEO and search engines improve visibility. AI and data analytics help personalize experiences, influencer marketing builds trust, e-commerce enables direct access to

markets, and localization ensures cultural relevance. While digital tools provide wide global reach, strategies like influencer collaborations and local adaptation make marketing truly meaningful to consumers.

The most successful companies are those that combine global strategy with local sensitivity. By blending technology with a human approach, they can stay agile and relevant in diverse markets. Adapting to both global trends and local needs ensures that brands remain competitive and appreciated by their audiences. Marketers also need to be flexible and innovative, constantly testing new channels and approaches to stay ahead of competitors. Building strong relationships with consumers through authentic engagement remains a key differentiator in global marketing today.

Therefore, international marketing in the XXIst century is all about balance. Companies must embrace digital tools, AI, e-commerce, social media, and influencer partnerships while paying attention to cultural differences. Brands like Coca-Cola, Apple, Amazon, and McDonald's show that blending technology, strategy, and cultural understanding drives not only profit but also loyalty and global recognition [8]. Businesses that can innovate while keeping a human touch will thrive in a world that is more connected than ever before. Those that ignore cultural nuances or rely solely on technology risk losing relevance, while those who combine innovation with empathy will create lasting connections and long-term success. By constantly evolving and integrating new trends, companies can maintain a competitive edge and build meaningful relationships with audiences across the globe.

REFERENCES

1. Le Meunier-FitzHugh, K. (2021). *Marketing: A very short introduction*. Oxford University Press. <https://academic.oup.com/book/42090>
2. Maloney Adam Czym jest marketing? Wyjasnienie definicji, celu i rodzajow. Oppizi, 2024. <https://oppizi.com/pl/pl/blog/marketing-fundamentals/what-is-marketing>
3. Marketing Theory. (n.d.). *SAGE Publications*. Retrieved April 21, 2026, from <https://journals.sagepub.com/home/mtq>
4. Mürütsöy, M., & Toksarı, M. (2017). A theoretical study on discussions about marketing theory. *Turkish Journal of Marketing*, 2(1), 1–8. <https://www.tujom.org/index.php/1/article/view/>
5. OpenStax. *Principles of marketing*. Rice University. 2022. <https://openstax.org/details/books/principles-marketing>
6. Rust R.T. Marketing's theoretical and conceptual value proposition. *AMS Review*, 9 (1–2), 1–4. 2019. <https://pmc.ncbi.nlm.nih.gov/articles/PMC7384275/>

7. ScienceDirect. (n.d.). *Marketing theory*. Retrieved April 21, 2026, from <https://www.sciencedirect.com/topics/social-sciences/marketing-theory>
8. Twin Alexandra Understanding Marketing in Business: Key Strategies and Types. Investopedia, 2026. <https://www.investopedia.com/terms/m/marketing.asp>
9. What is social media marketing? <https://www.salesforce.com/in/blog/social-media-marketing>

Y. Deineka, O. Aliseienko

CRYPTOCURRENCY ADOPTION IN UK COMMERCIAL BANKING: OPPORTUNITIES, CHALLENGES AND REGULATORY PERSPECTIVES

The financial industry has experienced a significant transformation over the past decade driven by the emergence of blockchain technology and cryptocurrencies. Digital currencies such as Bitcoin, Ethereum and Ripple operate via decentralised networks using cryptographic security mechanisms that differ fundamentally from traditional banking infrastructure [1]. As commercial banks in the United Kingdom face growing pressure from digitally native consumers and fintech competitors, the question of whether and how to integrate cryptocurrency-related services into their operations has become increasingly urgent. This study examines the role of cryptocurrencies in transforming the UK banking sector, focusing on the opportunities and challenges faced by commercial banks.

The research employs a mixed-methods approach combining qualitative analysis of publicly available documents, including Financial Conduct Authority (FCA) consultation papers, Bank of England bulletins and executive earnings-call transcripts, with quantitative secondary data from Chainalysis, Statista and the Office for National Statistics. A descriptive multiple-case research design enables comparison across global systemically important institutions, mid-tier incumbents and digital-first challengers [2]. Qualitative data was analysed through a five-stage coding cycle generating eight primary themes: regulatory clarity, compliance cost, capital treatment, cybersecurity hazard, customer demand, competitive positioning, technical preparedness and reputational vulnerability.

The findings reveal a clear spectrum of adoption. Digital-first challengers allow customers to buy, store and transfer over thirty different tokens through their mobile applications. Revolut’s “Crypto Pockets” feature, launched in April 2023, generated over £100 million in net fee income during its first year, demonstrating the revenue potential of retail cryptocurrency services [3]. In contrast, incumbent banks including Barclays, HSBC, Lloyds and NatWest have largely refrained from direct retail cryptocurrency offerings, citing fraud risks, unclear capital treatment and anti-money laundering obligations. Nevertheless, these institutions are increasingly active at the wholesale and infrastructure levels: Barclays invested in Copper, an institutional-grade custody firm; Standard Chartered co-founded Zodia Custody; HSBC joined the Contour consortium to digitise letters of credit; and Lloyds participated in the Marco Polo network to test tokenised receivables [4].

The UK cryptocurrency customer base has expanded substantially. As illustrated in Figure 1, the number of users grew from 0.34 million in 2017 to 23.95 million by 2025, with particularly rapid growth between 2020 and 2023. This trajectory reflects both increased mainstream awareness and growing institutional acceptance of digital assets.

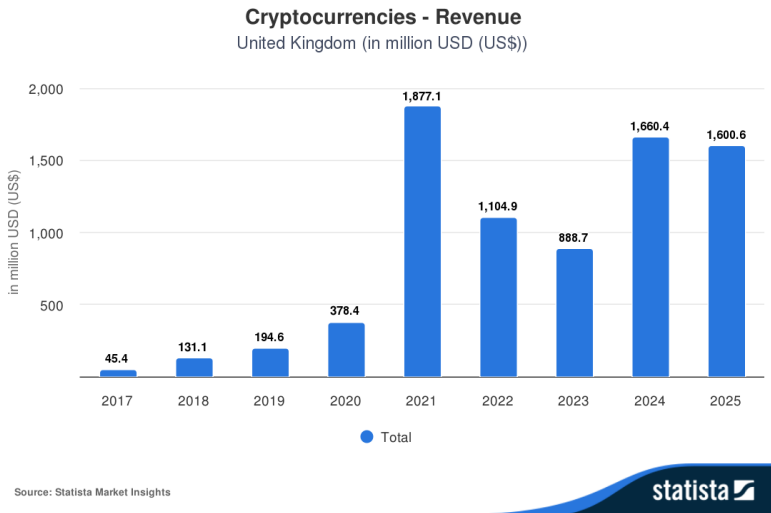


Fig. 1. Cryptocurrency users in the United Kingdom, 2017–2025 (Statista, n.d.)

The generational dimension of this growth is equally significant. Figure 2 demonstrates that millennials (18.4%) and Generation Z (16.8%) represent the highest ownership rates, while older demographics show considerably lower engagement. This pattern creates a strategic imperative for banks: 38% of UK cryptocurrency investors report having changed their primary bank due to transfer restrictions to exchanges [3]. Customers holding both fiat and cryptocurrency accounts transact 17% more frequently and exhibit 23% lower churn rates than fiat-only clients, indicating substantial lifetime value for institutions that accommodate this segment [5].

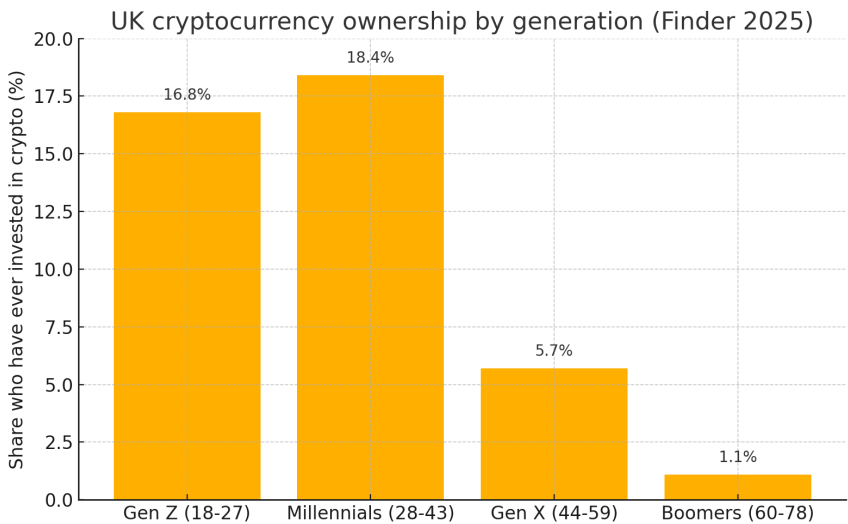


Fig. 2. UK cryptocurrency ownership by generation (Finder, 2025)

Beyond market demand, distributed ledger technology offers operational efficiencies. HSBC’s Contour platform reduced letter-of-credit processing from five days to twenty-four hours [4]. Competitive pressure from global exchanges offering sub-0.1% trading costs and twenty-four-hour settlement further compels traditional banks to reassess their digital asset strategies.

However, significant barriers impede adoption. Regulatory uncertainty is the most prominent obstacle: as of March 2025, only 41 out of 455 FCA anti-money laundering

applications had been approved, yielding a 9% acceptance rate [6]. The Basel Committee assigns a 1,250% risk weight to unbacked crypto-assets, meaning a £1 million Bitcoin holding consumes the same capital as a £12.5 million corporate loan [7]. Cybersecurity risks are substantial, with UK losses reaching £750 million in 2024 [6]. Operational complexity arising from legacy COBOL-based systems and the need for specialised middleware further slows integration.

International comparison highlights the role of regulatory clarity. The EU's Markets in Crypto-Assets (MiCA) regulation provides a unified licensing passport across 27 member states, while Switzerland's FINMA framework permits fully licensed crypto-banking. The United States presents a fragmented landscape where overlapping SEC, CFTC and state-level oversight dampens enthusiasm. The UK, still awaiting a Digital Assets Bill, occupies a middle position where ambiguity generates "analysis paralysis" [8].

In conclusion, this study identifies a widening gap between consumer demand for cryptocurrency services and the capacity of traditional UK banks to deliver them. The research recommends that the FCA develop a progressive regulatory roadmap with explicit AML/KYC requirements and streamlined licensing; that banks pursue partnerships with approved crypto-platforms and invest in blockchain infrastructure for asset tokenisation and cross-border payments; and that preparations for a UK central bank digital currency advance concurrently with private sector innovation. Balancing regulatory compliance with technological adaptation will determine which institutions succeed as the digital banking landscape evolves.

REFERENCES

1. Aiazbekov, A. (2023) 'Cryptocurrency as a method of payment in the tourism sector', *Financial Internet Quarterly*, 19(1), pp. 57–65. doi:10.2478/fiqf-2023-0006.
2. Amabile, T.M. (1996) *Creativity in Context*. London: Routledge. doi:10.4324/9780429501234.
3. Auer, R., Farag, M., Lewrick, U., Orazem, L. and Zoss, M. (2023) 'Banking in the shadow of Bitcoin? The institutional adoption of cryptocurrencies', *SSRN Electronic Journal*. doi:10.2139/ssrn.4416784.
4. Bank for International Settlements (2022) *Prudential treatment of cryptoasset exposures – second consultation*. Available at: <https://www.bis.org/bcbs/publ/d533.htm> (Accessed: 29 April 2025).
5. Böhme, R., Christin, N., Edelman, B. and Moore, T. (2015) 'Bitcoin: economics, technology, and governance', *Journal of Economic Perspectives*, 29(2), pp. 213–238. doi:10.1257/jep.29.2.213.

6. Cesilia Mambile and Ishengoma, F. (2024) 'Exploring the non-linear trajectories of technology adoption in the digital age', *Technological Sustainability*. doi:10.1108/techs-11-2023-0050.
7. Cumming, D., Johan, S. and Pant, A. (2019) 'Regulation of the crypto-economy: managing risks, challenges, and regulatory uncertainty', *Journal of Risk and Financial Management*, 12(3), p. 126. doi:10.3390/jrfm12030126.
8. Dacre, N., AlJaloudi, O., Thiam, M., Qader, M., Al-Mhdawi, M. and Qazi, A. (2024) 'Capturing fintech's role in optimising financial risk management'. doi:10.36227/techrxiv.173195460.03889403/v1.

E. Deineka, O. Aliseienko

SUSTAINABLE COMPETITIVE ADVANTAGE IN PREMIUM ATHLEISURE RETAIL: A CASE STUDY OF LULULEMON CAMBRIDGE

The global athleisure market has experienced exponential growth over the past decade, with premium brands seeking to differentiate themselves through product innovation, community engagement and experiential retail strategies. Lululemon Athletica, founded in Canada in 1998, has emerged as a global leader in this segment, pioneering the fusion of high-performance fabrics with lifestyle aesthetics [1]. With a market capitalisation exceeding £28 billion and over 711 stores worldwide, the company has established a distinctive position through its vertically integrated business model and community-centric approach [2]. This study examines the retail marketing strategies employed by Lululemon's Cambridge branch and evaluates how these strategies contribute to sustainable competitive advantage (SCA) in the premium athleisure sector.

The research adopts a qualitative case study methodology, applying the retail marketing mix framework proposed by McGoldrick [3] and the retail value equation model [4]. Primary data was collected through direct store observation, mystery shopper visits to both Lululemon Cambridge and its nearest competitor Sweaty Betty, and analysis of the in-store environment, customer service interactions and visual merchandising. Secondary data was drawn from corporate annual reports, consumer

review platforms including Trustpilot, and academic literature on retail strategy and brand management.

The findings reveal that Lululemon Cambridge achieves SCA through several interconnected mechanisms. First, the merchandise strategy combines vertical integration with localised product exclusivity. Unlike multi-brand retailers, Lululemon designs and sells 100% of its own products, granting complete control over inventory and brand image. The Cambridge branch further differentiates itself through an exclusive co-branded collection with the University of Cambridge, featuring university-embroidered versions of bestselling items such as the Scuba Hoodie and Define Jacket [5]. This geographically protected collaboration creates a unique selling proposition unavailable at any other location globally, anchoring the global brand within the local community.

Second, the store's communication strategy relies on a decentralised, grassroots model rather than traditional mass advertising. Local fitness ambassadors, community boards featuring Cambridge yoga teachers and run leaders, and free in-store events such as "Running Starts Here Cambridge" foster authentic relationships with consumers [6]. The brand's iconic Manifesto, integrated into store visuals and reusable shopping bags, functions as a semiotic tool aligning the brand with self-improvement and wellness values rather than purely commercial objectives [7]. This approach significantly reduces customer acquisition costs while creating an emotional connection that competitors find difficult to replicate authentically.

Third, the physical retail environment is engineered as an extension of the brand's wellness philosophy. The Cambridge store employs a free-flow layout that encourages leisurely browsing and reduces psychological pressure [3]. The proprietary "Pant Wall" system organises leggings by sensation rather than size or colour, simplifying complex decision-making for technical apparel while functioning as a destination magnet drawing customers deeper into the store [8]. Non-transactional decompression zones near fitting rooms reinforce the store's function as a community hub rather than a conventional retail outlet.

Fourth, the customer service model represents a fundamental departure from traditional retail practice. Store employees are designated "Educators" and trained as

technical consultants rather than sales assistants, with their role centred on communicating the “Science of Feel” behind proprietary fabrics such as Nulu and Everlux [2]. A mystery shopper comparison conducted at both Lululemon and Sweaty Betty Cambridge revealed significant differences: at Lululemon, the educator demonstrated superior technical knowledge, asked detailed follow-up questions and provided targeted product recommendations during a 43-minute consultation, whereas Sweaty Betty’s assistant, while warm and approachable, was unable to satisfy the researcher’s technical requirements within 24 minutes [9].

Fifth, the pricing strategy reinforces brand equity through deliberate avoidance of frequent discounting. Core products such as leggings (£88–£118) and jackets (£118) maintain consistent pricing, with seasonal surplus redirected to a discrete “We Made Too Much” section rather than traditional sale events. This discipline conditions customers to purchase at full price and preserves the perception of investment value [2]. By contrast, Sweaty Betty’s reliance on 20% student discounts and frequent site-wide promotions, while effective for volume acquisition, risks long-term erosion of brand equity.

In conclusion, Lululemon Cambridge demonstrates that sustainable competitive advantage in premium athleisure retail derives from the integrated deployment of proprietary technology, localised exclusivity, community-led communication, experiential store design and pricing discipline. However, the study identifies a critical vulnerability: the disconnect between the brand’s premium positioning and its post-purchase service experience, particularly regarding inconsistent application of the Quality Promise for fabric defects. The research recommends granting store-level management greater autonomy in return decisions, expanding student-focused ambassador programmes to increase penetration of the university demographic, and developing location-specific membership benefits such as priority access to local events to strengthen switching costs and reinforce long-term customer loyalty.

REFERENCES

1. AILogoMaker (2025) ‘Logo analysis of Lululemon and Alo: a comparison of two iconic athleisure brands’. Available at: <https://ailogomakerr.com/blog/logo-analysis-of-lululemon-and-alo-a-comparison-of-two-iconic-athleisure-brands> (Accessed: 8 December 2025).

2. Barney, J. (1991) 'Firm resources and sustained competitive advantage', *Journal of Management*, 17(1), pp. 99–120.
3. Brands Untapped (2024) 'Curating Cambridge and lululemon launch University of Cambridge co-branded activewear'. Available at: <https://www.brandsuntapped.com/curating-cambridge-and-lululemon-launch-university-of-cambridge-co-branded-activewear/> (Accessed: 3 December 2025).
4. Design4Retail (2024) 'Unseen: the power of scent at retail'. Available at: <https://www.design4retail.co.uk/news-blog/unseen-the-power-of-scent-at-retail/> (Accessed: 3 December 2025).
5. Emerald Publishing (2025) 'From global to local: a semiotic analysis of lululemon's sport marketing symbol system'. Available at: <https://www.emerald.com/insight/content/doi/10.1108/IJMSM-04-2025-0167> (Accessed: 1 December 2025).
6. Eventbrite (2024) 'Lululemon Cambridge Events'. Available at: <https://www.eventbrite.co.uk/o/lululemon-cambridge-60116982623> (Accessed: 1 December 2025).
7. GemPages (2025) 'Everything you need to know about retail store layouts in 2025'. Available at: <https://gempages.net/blogs/shopify/retail-store-layouts> (Accessed: 4 December 2025).
8. Goworek, H. and McGoldrick, P. (2015) *Retail Marketing Management: Principles and Practice*. London: Pearson Education Limited.
9. Jones, C. (2021) 'Retail marketing: introduction and overview' [PowerPoint presentation]. MOD007235: Retail and Experiential Marketing. Available at: <https://canvas.anglia.ac.uk/courses/21527/files/1976272> (Accessed: 6 December 2025).

M. Drozdov, N. Matveeva, O. Novikova

USAGE OF A SYSTEM BASED ON ARTIFICIAL INTELLIGENCE IN EDUCATIONAL SYSTEMS OF UKRAINE AND EUROPE

Nowadays an Artificial Intelligence is one of the widest recognized technologies in all our life. It simplifies routine work and gives more time for creative part. Unfortunately, usage of AI in education process is quite limited. This text is written to analyse usage of AI in educational systems of Europe and Ukraine.

The European Commission's White Paper on Artificial Intelligence, titled "A European approach to excellence and trust", lays out a comprehensive vision for how the EU intends to harness the potential of AI while safeguarding fundamental rights and values.

The White Paper recognizes that artificial intelligence plays a dual role in the educational landscape. First, AI technologies themselves offer powerful tools for

improving education and training systems. Second, education systems must evolve to equip citizens with the skills and awareness necessary to navigate a world increasingly shaped by AI.

The Commission's approach is built on the understanding that "people should be able to trust" digital technology, and that "trustworthiness is also a prerequisite for its uptake" [1, p. 2]. This principle applies equally to the integration of AI in educational settings, where concerns about data privacy, algorithmic bias, and the appropriate role of automated decision-making must be carefully addressed.

Central to the European strategy is the Digital Education Action Plan, which the described as a mechanism to "help make better use of data and AI-based technologies such as learning and predictive analytics with the aim to improve education and training systems" [1, p.7].

Ukraine is developing a deliberate approach to artificial intelligence regulation, with education serving as both a key application area and a foundation for building AI skills. The Ministry of Digital Transformation's "White Paper on Artificial Intelligence Regulation in Ukraine" outlines a two-stage framework.

"The essence of the approach is to divide the path to mandatory regulation into two stages: the preparatory stage and the stage of implementation of the law analogous to the EU Artificial Intelligence Regulation" [2, p. 13].

Methodology for Assessing AI Impact on Human Rights: This tool, described as "a set of questions and derived refinements that allow assessing the impact of a particular AI product on human rights (low, medium, high)" [2, p. 19], provides a framework for educational institutions to evaluate AI tools they adopt.

Regulatory Sandbox: Defined as "a controlled environment within which AI products will be able to be developed or tested under the supervision and with the involvement of expert support of the state" [2, p. 20], the sandbox offers edtech developers a space to test products with state oversight. Selection privileges exist for "small and medium-sized businesses and startups" [2, p. 20].

Voluntary Labeling of AI Systems: This mechanism provides "clear and structured information about the design, functions, algorithms, and other aspects of

artificial intelligence systems” [2, p. 20]. The White Paper notes that labeling helps users “make informed decisions” [2, p. 21]. For educational AI tools, labeling could inform teachers, students, and parents about how systems work and what safeguards exist.

The second stage involves implementing mandatory regulation analogous to the EU AI Act. The White Paper states that this is “a logical, consistent, and objectively determined step” [2, p. 26], driven by both EU integration goals and the need for adequate human rights protection.

This approaches can be summarized in Table 1.

Table 1

Comparison between Ukraine and EU approaches

Dimension	Ukraine	European Union
Stage of Development	Preparatory stage with voluntary tools; mandatory regulation planned	Advanced regulatory framework with proposed mandatory requirements for high-risk AI
Driving Factors	EU integration, wartime context, domestic market characteristics	Single market integrity, global competitiveness, fundamental rights protection
Education-Specific Tools	Integrated into broader digital transformation; regulatory sandbox for edtech	Digital Education Action Plan; AI curriculum for developers; master’s programs networks
Regulatory Philosophy	Gradual implementation with capacity building; learning from EU experience	Risk-based approach with prior conformity assessment for high-risk applications
Implementation Timeline	Two-stage: voluntary tools now; mandatory regulation aligned with EU AI Act after EU adoption	Phased implementation proposed; ongoing legislative process

The comparison highlights a clear gap in the maturity of AI regulation between Ukraine and the European Union. While the EU has already developed a comprehensive, risk-based regulatory framework with concrete requirements for high-risk AI systems, Ukraine remains in a preparatory phase, relying on voluntary tools and gradual capacity building.

REFERENCES

1. European Commission. (2020). White Paper on Artificial Intelligence: A European approach to excellence and trust [Electronic source] Link: https://commission.europa.eu/publications/white-paper-artificial-intelligence-european-approach-excellence-and-trust_en

2. Ministry of Digital Transformation of Ukraine. (2024.). White Paper on Artificial Intelligence Regulation in Ukraine: Vision of the Ministry of Digital Transformation of Ukraine Version for Consultation.

A. Hrynenko, O. Kondratieva

THE IMPACT OF MESSAGING APPS ON YOUTH COMMUNICATION SKILLS

The instant ability of information through apps, web browsers and social media platforms is fostering a new culture of communication, offering diverse ways to stay connected. Among younger generations, texting has emerged as primary form of interaction surpassing both phone calls and in-person conversations.

Social media plays a significant role in helping adolescents sustain existing relationships and form new connections with their peers. Many teens view social media as a vital tool for staying connected, often highlighting the importance of group chats in creating a strong sense of community and belonging [3, p. 25].

Today's youth naturally gravitate toward online communication, as their social dynamics differ significantly from those of face-to-face interactions. People have changed their ways of communicating in favor of digital environment. They have access to more productive forms of social interaction and to more varied communities [1]. Social network expansion is a key benefit of Social Media Use (SMU). Younger people consider social media to be an integral component of their daily lives. Developing technologies make it possible to find and create new spaces for and forms of communication [2, p. 33]. Modern communication among youth is increasingly based on abbreviations, visual elements, GIFs, emojis and stickers, which may be considered as a return to the use of elements of ancient pictographic writing.

Social media serves as a platform not only for forming new connections but also for sustaining relationships with long-standing friends and family members. Many individuals have highlighted the advantages of utilizing social media to maintain

communication with relatives who reside at a distance, thereby fostering a sense of connection despite geographical barriers [7, p. 11].

The most common messaging apps today are YouTube, TikTok, Instagram, Snapchat and Facebook [6, p. 68]. They emphasize visual content and instant sharing, reflecting modern communication preferences. Video calls and group messaging break geographical barriers [4, p. 81].

According to a Pew Research Center survey, YouTube is the most popular social media platform among youth, with 95% of teens using it. TikTok comes next with 67%. At the same time, Facebook has become much less popular among teens, as its usage dropped from 71% in 2014–2015 to only 32%. Snapchat and Instagram still remain highly popular, although preferences for these platforms differ depending on demographic factors [6, p. 15].

In conclusion, social media apps have significantly shaped how young people communicate, redefining both the quality and the manner of their interactions. Although these platforms provide numerous advantages, they also spark ongoing concerns within society that are likely to persist.

REFERENCES

1. Aglamaz F., Rodriguez-Menes J. Offline and online communities: Differences and consequences for social inequalities. *ScienceDirect*, 2021.
2. Mude G., Undale S. Social Media Usage: A Comparison between Generation Y and Generation Z in India. *IGI Global*, 2023.
3. Nagata J. Health Benefits of Social Media Use in Adolescents and Young Adults. *Springer Nature*, 2025.
4. O'Brien J. How Technology is Redefining Communication Patterns among Today's Youth. *Techbuzzireland.com*, 2024.
5. Rainie L., Fox S. Just-in-time Information through Mobile Connections. *Pew Research Center*, 2012.
6. Vogels E., Gelles-Watnick R. Teens, Social Media and Technology. *Pew Research Center*, 2022.
7. Winstone L. Social media use and social connectedness among adolescents in the United Kingdom: a qualitative exploration of displacement and stimulation. *BMC Public Health*, 2021.

THE ROLE OF DIGITAL LITERACY OF THE POPULATION IN REDUCING CYBER RISKS

Today, we are constantly online: studying, working, scrolling through feeds, or chatting. But the more time we spend on the web, the easier it is to run into trouble-ranging. Most often, people put themselves at risk due to carelessness or because they don't know basic security rules. That is why digital literacy is so important right now. For Ukraine today, this is a top priority, as in a time of war, information security becomes a vital part of national defense. Cyber risks can lead to a breach of the confidentiality, integrity, and availability of information, system failures, and damage to individuals and legal entities, their property, and critical infrastructure [9]. Cyber risks lead to the spread of panic. This negatively affects the stability of public administration and the overall psychological well-being of citizens. The use of cyberattacks and disinformation tools creates "information noise," making it difficult for citizens to distinguish truth from fiction. This lowers the level of trust in official information sources and government. Information manipulation and attacks on digital communications are part of an information war. This complicates informed decision. The impact of cyber risks forces society to transform: there is a growing need for a high level of digital literacy and information culture. Citizens are compelled to master fact-checking skills and personal data protection to minimize the negative consequences of their online presence [8].

In Ukraine, CERT-UA is responsible for responding to cyberattacks, monitoring cyberspace, detecting threats, and analyzing incidents. If a threat is detected, then you should: stay calm and record the details – note the time of detection, any suspicious actions, and possible changes in system operation, isolate the problem, disconnect the affected device from the network to prevent the attack from spreading, inform the specialists [1]. Ukraine is the second most attacked country in the world in cyberspace, following the United States. These statistics are a direct consequence of the ongoing

war with Russia [5]. Mistakes we use are using weak or identical passwords, ignoring software updates, falling for phishing links, unsafe use of public Wi-Fi networks, excessive information sharing and poor privacy settings. Typical Scheme: the user receives an email like from a bank, follows a link, and downloads a malicious file. Consequences of such attacks: the loss of personal data leads to financial theft, fraud, or blackmail. Common Signs of Phishing: requests for personal data, suspicious sender address, grammar or spelling mistakes, suspicious attachments (.zip, .exe, .html), urgency or threats, links hidden in images [4].

Article 32 of the Constitution of Ukraine – no one will be subject to interference in their personal and family life. The following actions are prohibited without the person`s consent: collection, storage, use, dissemination of confidential information about an individual [7, Article 32, Section 2]. Article 55 of the Constitution of Ukraine – everyone has the right to protect their rights in court [7, Article 55, Section 2]. Article 64 of the Constitution of Ukraine – under conditions of martial law or a state of emergency, certain rights and freedoms may be temporarily restricted. However: such restrictions must be based solely on legal grounds [7, Article 64, Section 2].

Use complex passwords, do not click on suspicious links, never share sensitive data over the phone, avoid posting personal information online, be cautious when filling out forms and surveys, protect your physical documents [2]. Signs of fakes: lack of sources or dates, one-sided reporting, emotional manipulation. Countering Fake News: verify info via trusted sources, avoid emotional posts without reliable links, report and block disinformation [3]. Law of Ukraine “On the Basic Principles of Ensuring Cybersecurity of Ukraine” defines: how the state protects information, who is responsible for cybersecurity, procedures for responding to cyberattacks [6].

Nowadays, being tech-savvy is not just a skill but a necessity. We use smartphones for almost everything, so it`s important to protect passwords and recognize fake information. This is especially crucial during the war, when cyberspace is used for spreading panic and stealing data. Therefore, digital literacy is as important as basic education and helps keep both people and the state safer etc.

REFERENCES

1. CERT-UA. URL: <https://cert.gov.ua/> (date of access: 30.03.2026)
2. MS Detector Media. URL: <https://ms.detector.media/mediadoslidzhennya/post/37877/2025-05-06-indeks-mediagramotnosti-ukraintsiv-zalyshajetsya-vvsokym-ale-za-rik-znvzvsva-riven-tsyfrovoi-kompetentnosti-doslidzhennya-detektora-media/> (date of access: 30.03.2026)
3. MS Detector Media. URL: <https://ms.detector.media/trendi/post/35685/2024-07-30-personalna-infogigiena-pid-chas-vivay-vak-zakhyshchatvsya-vid-toksvchnogo-kontentu/> (date of access: 30.03.2026)
4. Pischivska hromada. URL: <https://pischivska-gromada.gov.ua/> (date of access: 30.03.2026)
5. ProIT. URL: <https://proit.ua/> (date of access: 30.03.2026)
6. Закон України «Про основні засади забезпечення кібербезпеки України» № 2163-VIII від 05.10.2017 (Відомості Верховної Ради (ВВР), 2017, № 45, ст. 403). URL: <https://zakon.rada.gov.ua/> (date of access: 08.04.2026)
7. Конституція України. Розділ II. Права, свободи та обов'язки людини і громадянина. URL: <https://constitution.in.ua/chapters/2/> (date of access: 30.03.2026)
8. Кожина А. В. Особливості впливу соціальних мереж на прозорість і підзвітність органів публічної влади в умовах дії воєнного стану в Україні. *ІНВЕСТИЦІЇ: ПРАКТИКА ТА ДОСВІД*. № 6 (2025). Р. 168-177. URL: <https://www.nayka.com.ua/index.php/investplan/article/download/5948/6011/13332> (date of access: 07.04.2026)
9. Орловський Б. М. Сучасні кіберризики: їх поняття, структура та застосування у сфері торговельного мореплавства. *Правова держава*, 58 (2025). Р. 10–219. <https://doi.org/10.18524/2411-2054.2025.58.331007>

К. Ohurtsova, H. Mudrenko

THE IMPACT OF AUTOMATION AND ROBOTIZATION ON THE LABOR MARKET

One of the key factors transforming the modern labor market is automation and robotization, which are developing within the framework of the digital economy. According to Sydorenko O. V. and Tsishevskiy B. V., the digital transformation of the economy is a process of forming a new system of socio-economic relations in which digital technologies become the basis for organizing production, employment, and labor interactions. The authors emphasize that automation and robotization are a logical result of the development of the digital economy, as they are aimed at increasing labor productivity, optimizing business processes, and reducing the dependence of production on the human factor [3].

Labor automation is manifested primarily in the displacement of jobs associated with the performance of routine, standardized, and low-value operations. Robotization, in turn, deepens this process by replacing physical and partially intellectual labor with machine systems. At the same time, the authors stress that these processes should not be considered exclusively negative, since demand is simultaneously emerging for new professions related to technology management, data analysis, and digital infrastructure. The impact of automation and robotization on the labor market is contradictory. On the one hand, there is a reduction in employment in the low-skilled labor sector, which increases the risks of unemployment and social tension [1]. On the other hand, demand is growing for highly qualified specialists capable of working in the conditions of Industry 4.0, which stimulates the development of education, retraining, and lifelong learning. In our view, it is precisely this asymmetry between labor supply and demand that becomes the central problem of the modern labor market.

In the works of Petrova I. L. and Barash A. Yu., the digital economy is defined as an environment in which automation and robotization form a new employment model based on a combination of technological efficiency and human potential. According to the authors, automation is not limited to technical modernization of production but causes a profound transformation of social and labor relations, changing the role of the worker, the requirements for their competencies, and the nature of interaction with the employer [2, p. 80–81].

Petrova I. L. and Barash A. Yu. believe that robotization of labor in the digital economy forms a new type of interaction between humans and technologies, within which the worker gradually moves from executive functions to functions of control, analysis, and decision-making. The authors emphasize that automated and robotized processes are able to reduce the number of errors and increase the accuracy and speed of task performance, which positively affects the efficiency of the economy as a whole [2, p. 80–81].

A key challenge of automation and robotization is the risk of losing the humanistic dimension of labor. The authors note that without proper regulation and corporate social responsibility, technological progress may lead to an increase in unstable forms

of employment, a decrease in the level of social protection, and an intensification of workers' alienation. We share this position and believe that effective adaptation of the labor market to digital changes requires a combination of economic feasibility with an orientation toward human capital [4].

In our view, automation and robotization should not be considered exclusively as factors of job reduction. Their impact largely depends on the chosen model of socio-economic development. If technologies are implemented with regard to humanistic values, they can contribute to improving job quality, increasing well-being, and fostering human self-realization. Otherwise, there is a risk of forming a labor market focused exclusively on efficiency and control, which intensifies social tension.

Thus, automation and robotization are objective processes in the development of the digital economy that fundamentally transform the labor market. They combine significant potential for economic growth with serious social challenges. Overcoming negative consequences is possible only through a balanced combination of technological progress with the development of human capital, corporate social responsibility, and the active role of the state in shaping a sustainable and inclusive labor market.

REFERENCES

1. Bozhenko V., Pihul Ye. The labor market under the development of Society 4.0 and Society 5.0. 2024. URL: <https://doi.org/10.5281/zenodo.14176457> (accessed: 12.12.2025).
2. Petrova I., Barash A. The impact of the digital economy on the transformation of employment and human resource management strategies. *Actual Problems of Economics*. 2024. Vol. 1, No. 279. Pp. 78–86. URL: <https://doi.org/10.32752/1993-6788-2024-1-279-78-86> (accessed: 12.12.2025).
3. Sydorenko O. V., Tsishevskiy B. V. Basic aspects of digitalization of the labor market in Ukraine. *Problems of Modern Transformations. Series: Economics and Management*. 2024. No. 12. URL: <https://doi.org/10.54929/2786-5738-2024-12-03-01> (accessed: 12.12.2025).
4. Shkurat M., Kushko Z., Shkurat O. Analysis of the state of the global labor market in the context of global digitalization. *Actual Problems of Economics*. 2024. Vol. 1, No. 274. Pp. 66–79. URL: <https://doi.org/10.32752/1993-6788-2024-1-274-66-79> (accessed: 12.12.2025).

DIGITAL TRANSFORMATION OF ENTERPRISES AS A DRIVER OF BUSINESS EFFICIENCY

In today's environment, the digitalization of businesses is one of the key factors in improving business efficiency and ensuring competitiveness. The rapid development of information technology, the securitization of business processes and the use of electronic platforms are transforming traditional management approaches and creating new opportunities to improve business operations. Recent studies by I. Yatskevich and N. Krasnostanov on the role of digital technologies in entrepreneurial activity reflect the process of creating new links in the business process regarding the formation of opportunities for the enterprise's relationships with consumers of its products. They emphasize the undeniable importance of digitalization, demonstrating how it provides enterprises with access to vast amounts of data, enabling them to formulate well-founded strategic decisions. Furthermore, the research delved into the use of data analytics and artificial intelligence, revealing their contribution to accurate forecasting, process optimization and the improvement of customer service standards [1].

Digital transformation of enterprises is one of the key trends in the modern economy that significantly influences the improvement of business efficiency. In the context of globalization and the rapid development of information technologies, companies are compelled to adapt to new realities by integrating digital tools into their operations. First of all, digital transformation promotes the automation of business processes. The use of modern software solutions helps reduce manual labor, minimize errors, and accelerate operations [3]. For example, enterprise resource planning (ERP) systems enable effective planning, accounting, and control of resources, leading to cost optimization. In addition, digital technologies enhance managerial decision-making. Through big data analytics, managers can access up-to-date information in real time, forecast demand, and respond quickly to market changes, which increases business

flexibility and competitiveness. Another important aspect is the improvement of customer interaction. Digital platforms, CRM systems, and social media allow companies to better understand customer needs, personalize offerings, and improve service quality. As a result, customer loyalty and sales volumes increase. At the same time, digital transformation is associated with certain challenges, including the need for substantial investment, cybersecurity risks, and the demand for skilled personnel. However, the benefits of digital transformation outweigh the potential difficulties.

The introduction of digital tools enables the automation of accounting, speeds up data processing, improves the accuracy of analytical calculations and ensures rapid decision-making by management. Digitalization is a key driver of effective development, involving the transformation of traditional information formats into digital ones to improve the efficiency of business processes. This is achieved by increasing the speed of information exchange, ensuring its accessibility, and enhancing the role of automation [2]. Furthermore, digitalization helps reduce business costs by optimizing resources, shortening operation times and increasing labour productivity. The use of modern analytical systems, cloud solutions and big data enables businesses to forecast demand more effectively, analyze market trends and adapt their operations to changes in the external environment. Another key benefit of digitalization is the improvement in the quality of customer interactions via digital communication channels, which helps to raise service standards and strengthen the company's market position. Digitalization enables a better understanding of customer needs and the adaptation of offerings to meet their expectations. To achieve this, companies should focus on:

1. Personalized interactions. Using customer behaviour data in CRM systems enables the creation of personalized offers that boost customer loyalty.

2. Online feedback. Feedback collection tools, such as Google Forms or SurveyMonkey, allow businesses to gather information on service quality and improve their products.

3. Mobile services. Developing mobile apps or optimising websites for smartphones makes it easier for customers to access goods and services [3].

Thus, digitalization boosts business efficiency, streamlines internal processes and improves the quality of management decisions. Digital transformation of enterprises is an important factor in enhancing business efficiency. It ensures process optimization, improves management, strengthens customer relationships, and fosters innovation. In modern conditions, a company's success largely depends on its level of digital maturity. Thanks to modern technologies, companies respond better to market changes and ensure sustained growth in the digital economy.

REFERENCES

1. Бурдяк М. Цифровізація як чинник економічної стійкості та ефективності аграрних підприємств: стратегічні рішення. *Herald of Khmelnytskyi National University. Economic sciences*. 2025. Т. 344, № 4. С. 108–113. URL: <https://doi.org/10.31891/2307-5740-2025-344-4-13>
2. Могильна Л. М., Воробйов І. О. Цифровізація як чинник трансформації механізмів інноваційно-інвестиційного розвитку підприємств. *Електронний журнал "Ефективна економіка"*. 2025. № 5. URL: <https://doi.org/10.32702/2307-2105.2025.5.89>
3. Юринець З., Стрільчук Р., Ковпак А. Масштабування бізнесу як чинник економічного зростання підприємства. *Економіка та суспільство*. 2026. № 83. URL: <https://doi.org/10.32782/2524-0072/2026-83-32>

A. Onopriienko, T. Vorova

THE IMPACT OF ARTIFICIAL INTELLIGENCE ON DIGITAL MARKETING STRATEGIES IN THE MODERN ECONOMY

Artificial intelligence (AI) has become one of the most influential technologies shaping the modern business environment. Today it is difficult to imagine digital marketing without AI tools, as they help companies analyze data faster, understand customer behaviour more precisely and make better strategic decisions. Because marketing is developing extremely quickly, AI has become not just an additional instrument, but a core element that helps brands remain competitive and adapt to constant changes in the digital space.

One of the key advantages of AI in marketing is its ability to work with large volumes of data. Companies receive information from websites, mobile apps, social

media and online purchases every second. For marketers, this creates both opportunities and challenges. AI-based algorithms make it possible to quickly recognize patterns in customer behaviour, identify which segments are the most active and even predict future demand. This helps companies plan campaigns more effectively, choose relevant channels and reduce unnecessary spending.

Another important change that AI brings is deeper personalization. Modern consumers expect brands to communicate with them individually rather than in a generic way. AI allows companies to offer relevant products, personalized recommendations and dynamic content based on user preferences. For example, recommendation systems on e-commerce platforms learn from browsing history and previous purchases to suggest items that a customer is more likely to buy. As a result, personalization not only improves customer experience, but also supports long-term loyalty.

AI has also significantly influenced customer service. Today many businesses use chatbots and virtual assistants to provide customers with quick answers and basic support. Although earlier versions of chatbots were limited, modern AI-based systems can understand the context of a conversation and adjust their responses. This helps companies stay available 24/7 and reduces the workload on support teams. At the same time, it allows customers to receive answers immediately, which positively affects their perception of the brand.

Another area where AI plays an essential role is online advertising. Automated advertising platforms use machine learning to determine which audiences should see specific ads and when it is most effective to show them. AI tools analyze the performance of ads in real time and make adjustments automatically, which saves marketers a significant amount of time. This approach not only increases the efficiency of advertising budgets, but also helps businesses reach more relevant audiences.

However, despite all the benefits, companies also face certain difficulties when implementing AI. One of the main challenges is data privacy. Customers are becoming more aware of how brands use their personal information, so transparency has become

extremely important. The other problem is over-automation. If a company relies entirely on AI, communication may lose its emotional component, which is still important, especially in industries where trust and personal attitude matter a lot.

Additionally, AI requires new competencies from marketing specialists. Marketers need to understand how AI tools work, be able to interpret data and follow ethical principles when using automated systems. Not every company can invest in advanced technologies, so smaller businesses may struggle with implementation. Nevertheless, the long-term benefits often outweigh the initial challenges.

Overall, AI has a strong and mostly positive influence on digital marketing strategies. It helps businesses make decisions based on real data, improve communication with customers and optimize internal processes. As AI technologies continue to evolve, their role in marketing will only grow. It is likely that in the near future AI will allow brands to predict customer needs even more accurately and create personalized content in seconds, significantly transforming the traditional marketing approach.

In conclusion, artificial intelligence is becoming a key driver of change in digital marketing. Companies that actively integrate AI into their strategies receive significant competitive advantages and are better prepared for the demands of the modern economy. While there are challenges connected to ethics and data privacy, AI opens up many opportunities for improving customer experience and building more effective marketing strategies.

REFERENCES

1. Davenport, T., & Ronanki, R. (2018). Artificial Intelligence for the Real World. *Harvard Business Review*, 96(1), 108–116.
2. Chaffey, D. (2022). *Digital Marketing: Strategy, Implementation & Practice*. Pearson.
3. McKinsey & Company. (2023). *The State of AI in 2023: Generative AI's Breakout Year*.

ETHICAL AND ORGANIZATIONAL ASPECTS OF USAGE OF ARTIFICIAL INTELLIGENCE IN CONTROLLING PRACTICE

Implementation of artificial intelligence (AI) technologies in the controlling systems is accompanied not only by technological and economical challenges, but additionally by hard ethical dilemmas and organizational transformations. Unlike the traditional information systems, AI is capable of autonomous decision making, which raises the issues of responsibility, transparency, and justice of algorithmic decisions in the field of management accounting.

Ethical challenges are multifaceted. Zhang et al. [4] reveal conflict of stakeholder's ethical position: accountants may act, operating on their own interests (egoism), while the managers are more keen to make decisions based on utilitarianism, maximizing the common good for all stakeholders. The conflict of these ethical positions gets escalated during the implementation of AI, as this technology can impact interested of various groups differently.

Main ethical issue is transparency of algorithmic decisions. AI system, especially the ones based on deep-learning, often functions as "black boxes", where decision-making logic remains unclear even for the developers. This creates fundamental conflict with the principles of accountants' professional ethic, who demand a possibility of explaining and justifying the taken decisions [2]. Lack of interpretability complicates execution of audit functions and undermines trust in the results of the controlling system.

Algorithmic bias poses another critical ethical challenge. If AI algorithms are taught on historical data that represents past biases and ineffective practices, they can reproduce and amplify these problems. In the context of controlling, this can lead to systematic errors in budgeting, performance evaluation, or resources allocation. [3; 4]. Data privacy and security take on special importance when using AI in management accounting. AI systems require access to large amounts of financial information,

including confidential commercial data. Bani Ahmad's research [1] emphasizes the need to comply with data protection legislation and apply ethical information processing practices. Organizations must ensure transparency in the use of AI in decision-making processes, especially when these decisions have significant consequences for individuals or businesses.

Organizational aspects are related to the transformation of structures, processes, and corporate culture. A key challenge is the separation of responsibility between humans and AI: when a system generates budgeting or pricing recommendations, the question of liability for errors arises [4]. Resistance to change is a common problem: a significant proportion of accountants express discomfort with AI due to lack of knowledge and data confidentiality [3]. Corporate culture plays a crucial role – organizations must cultivate a balance between technological capabilities and ethical standards, encouraging critical thinking about the results of algorithmic work [1; 2].

Practical recommendations include: developing ethical guidelines for the use of AI in accounting; creating oversight structures (ethics committees); implementing regular audits of algorithms for bias; ensuring transparency in the distribution of decisions between AI and humans; investing in staff training programs. Building collaboration between accountants and AI developers is critical to creating technologically advanced and ethically responsible systems [2-4].

The ethical and organizational aspects of using AI in controlling are no less important than the technological capabilities of the system. Transparency of algorithmic decisions, prevention of bias, protection of data privacy, and clear delineation of responsibilities are key ethical challenges that require a systemic solution. Organizational challenges include transforming governance structures, overcoming resistance to change, and creating a culture of ethical use of technology. Successful implementation of AI requires not only technological investments, but also the development of ethical frameworks, governance structures, and staff training programs. Further research should focus on developing specific ethical guidelines for controlling, examining the effectiveness of different approaches to managing AI ethical risks, and analyzing the impact of organizational culture on the ethical use of technology.

REFERENCES

1. Bani Ahmad A.Y.A. Ethical implications of artificial intelligence in accounting: A framework for responsible AI adoption in multinational corporations in Jordan. *International Journal of Data and Network Science*. 2024. Vol. 8. No. 1. P. 401-414. <http://dx.doi.org/10.5267/j.ijdns.2023.9.014>
2. Dell S., Akpan M., Carr A. Aligning artificial intelligence with ethical accountancy: A global perspective on emerging frameworks. *Corporate Ownership & Control*. 2024. Vol. 21. No. 1. P. 47-54. <https://doi.org/10.22495/cocv21i1art5>
3. Vărzaru A. A. Assessing the Impact of AI Solutions' Ethical Issues on Performance in Managerial Accounting. *Electronics*. 2022. Vol. 11. No. 14. Article 2221. <https://doi.org/10.3390/electronics11142221>
4. Zhang C., Zhu W., Dai J., Wu Y., Chen X. Ethical impact of artificial intelligence in managerial accounting. *International Journal of Accounting Information Systems*. 2023. Vol. 49. Article 100619. <https://doi.org/10.1016/j.accinf.2023.100619>

D. Prykhodko, T. Vorova

DIGITAL MARKETING AS A STRATEGIC DRIVER OF TRANSFORMATION IN TRADE ENTERPRISES

In today's highly competitive and dynamic business environment, digitalization has become a decisive factor in the development of trade enterprises. Rapid technological progress, the growing popularity of online communication channels, and fundamental changes in consumer behavior require companies to integrate digital tools and redesign their marketing strategies. Digital marketing has evolved into a critical component of organizational success, enabling real-time interaction with customers, deep personalization, and data-driven decision-making.

Digital marketing encompasses a wide range of modern technologies and instruments that enhance the efficiency of customer engagement and optimize internal business processes. Big data analytics, artificial intelligence, marketing automation systems, social media platforms, content marketing, and personalized advertising form the core of digital transformation in the trade sector. Big data empowers enterprises to process extensive customer information, identify behavioral patterns, forecast demand, and define highly accurate market segments. Artificial intelligence and machine

learning strengthen these capabilities by automating behavioral analysis and generating personalized recommendations.

Marketing automation represents another strategic direction in digital transformation. The use of CRM systems, trigger-based messaging, chatbots, and integrated campaign management platforms significantly reduces routine workloads, optimizes the sales funnel, and improves communication efficiency. These tools ensure continuous customer support and help streamline operational processes at lower costs.

Social media and content marketing play an essential role in shaping brand loyalty and corporate reputation. Platforms such as Facebook, Instagram, TikTok, and YouTube allow enterprises to interact actively with their target audiences, implement precisely targeted advertising, and obtain real-time feedback. Thoughtfully developed content – including articles, videos, infographics, podcasts, and product reviews – serves as a powerful instrument to increase brand recognition and consumer trust.

Personalized advertising occupies a prominent place among digital marketing instruments. Technologies such as remarketing, dynamic ad formats, adaptive banners, and personalized email marketing enhance conversion rates and contribute to more efficient budget allocation. By tailoring marketing messages to individual preferences and behavioral patterns, enterprises can create highly relevant customer experiences. Digitalization in trade is more than the adoption of IT tools; it is a comprehensive transformation of marketing strategies and customer interaction models. It requires a shift from traditional promotion methods toward flexible, adaptive, and customer-oriented approaches. Modern digital strategies aim to create a personalized customer journey covering all stages – from initial online search and social media engagement to purchase decisions and post-purchase service [1].

Data-driven management stands at the core of this transformation. Information collected from websites, social platforms, mobile applications, CRM systems, and offline stores enables companies to gain a holistic understanding of their customers. This analytical foundation allows enterprises to anticipate consumer needs, conduct advanced segmentation, optimize content, forecast demand, manage inventory, and rapidly adjust marketing strategies in response to internal and external changes.

The integration of communication channels into unified omnichannel systems provides customers with a seamless and consistent brand experience across physical and digital touchpoints. This model enhances customer satisfaction, increases loyalty, and encourages repeat purchases, strengthening the enterprise's competitive advantages.

Key directions of digital transformation in marketing include personalization based on machine-learning algorithms, automation of marketing processes using CRM and digital communication tools, and advanced data analytics aimed at real-time performance evaluation and budget optimization. These components collectively support the development of flexible, efficient, and customer-centric business models [2].

In conclusion, digital marketing forms a new strategic paradigm for trade enterprises. The effective use of digital tools allows companies to better understand customer preferences, anticipate future trends, and adapt quickly to market changes. Digital transformation has become a foundation for sustainable competitiveness and long-term growth in the modern trade sector.

The implementation of digital marketing in trade enterprises has become a crucial driver of competitiveness in today's dynamic market environment. The use of data analytics, process automation, personalization, and omnichannel communication not only enhances the effectiveness of marketing activities but also creates a new level of customer interaction. Digital technologies enable companies to respond more quickly to changing demand, accurately forecast trends, and build long-term customer relationships, forming a solid foundation for sustainable growth and development.

REFERENCES

1. Roe M., Spanaki K., Ioannou A., Zamani E., Giannakis M. Drivers and challenges of Internet of Things diffusion in smart stores: a field exploration / M. Roe, K. Spanaki, A. Ioannou, E. Zamani, M. Giannakis // Technological Forecasting and Social Change. 2022. T. 178. Apr. 121593. URL: <https://eprints.whiterose.ac.uk/183208/>
2. Vovk V., Havrylchenko O., Cherkaskyi O. The impact of digitalization on the formation of enterprises' marketing strategies: the use of digital tools. *Economy and Society*, 72, 2025. URL: <https://economyandsociety.in.ua/index.php/journal/article/view/5531/5469>

EVALUATION OF THE DEBT LOAD ON THE PUBLIC SPENDING OF UKRAINE'S NATIONAL BUDGET

Persistent financial gaps within the national treasury forced state borrowings into a primary mechanism for covering current expenditures. Large-scale credit attraction helps maintain macro-financial stability. However, the rapid accumulation of obligations creates severe delayed pressure on the economy. Interest payments on loans generate an irreversible outflow of capital. Consequently, this mechanism deprives national safety and public assistance projects of essential funding [1].

A review of the spending data (table 1) reveals a consistent increase in the expenses required to maintain these liabilities.

Table 1

**Dynamics of Debt Service Expenditures in the Structure of Ukraine's State Budget,
2021-2025, UAH Million**

Indicator	2021	2022	2023	2024	2025	Deviation 2025-2021	
						Abs.	Rel., %
Total state budget expenditures	1490259	2705423	4014418	4486683	5473577	+3983318	+267.29
Debt service expenditures	153052	159723	252166	303038	355820	+202768	+132.48
Share of debt service expenditures, %	10.27	5.90	6.28	6.75	6.50	-3.77	-

Source: developed by the authors based on [3].

The data show that absolute debt service expenditures increased by UAH 202,768 million. In 2025, the government allocates UAH 355,820 million for this purpose. This amount exceeds capital expenditures and withdraws liquidity from the real economy.

Despite a steady increase in actual payments to creditors, their relative share of the national budget fell from 10.27% to 6.50%. This decrease is due to the overall expansion of total expenditures. Total funding rose by 267.29% to reach UAH 5.47 trillion in 2025. Pumping vast amounts into daily expenditures artificially dilutes the relative

debt burden share. The security sector alone accounts for more than 50% of these expenses.

The requirement to accumulate over UAH 350 billion for interest payments strictly limits the state's ability to allocate money. Under martial law, the government cannot radically alter the budget structure. The defense sector absorbs all internal revenues. Optimizing debt obligations remains the only way to preserve financial stability.

Reaching an agreement to rework foreign market debt in 2024 released essential resources. The high cost of servicing internal borrowings still demands systemic solutions. IMF estimates show that covering the financial gap requires restricting commercial loans and relying primarily on subsidized or non-repayable aid [2]. Cutting down the interest burden will allow the state to fund critical needs without risking inflationary processes.

REFERENCES

1. Chuhunov I. Ya., Kucher G. V., Liubchak I. S. State debt management in the system of socio-economic transformations. *Economy and society*. 2024. Issue 68. URL: <https://economyandsociety.in.ua/index.php/journal/article/view/4902>
2. International Monetary Fund. Ukraine: request for an extended arrangement under the extended fund facility. *IMF Country Report*. 2023. No. 23/132. 154 p. URL: <https://www.imf.org/en/Publications/CR/Issues/2023/03/31/Ukraine-Request-for-an-Extended-Arrangement-Under-the-Extended-Fund-Facility-and-Review-of-531687>
3. State budget of Ukraine expenditures. Ministry of finance of Ukraine. URL: <https://index.minfin.com.ua/ua/finance/budget/gov/expense/>

Y. Shatova, T. Vorova

THE IMPACT OF DIGITAL TECHNOLOGIES ON SOCIAL INTERACTION AND COMMUNICATION

In modern society, digital technologies have become a decisive factor in the transformation of social interaction and communication processes [1; 3]. Their development has led to significant changes in the ways information is exchanged, social ties are formed, and mechanisms of interaction between individuals, social groups, and institutions

are established. Communication increasingly takes place in a digital environment, which eliminates spatial and temporal constraints and forms new rules of social presence and engagement, changing the very nature of social interaction [2].

Digital platforms, social networks, and messengers expand the possibilities for maintaining social ties and facilitate the rapid dissemination of information. They allow people to join communities based on interests, professional characteristics, or value orientations, strengthening horizontal communication [3]. At the same time, such interaction often becomes fragmented, as simplified forms of feedback gradually replace deeper communication practices based on prolonged dialogue [4].

An important aspect of digital communication is its algorithmic mediation. Information flows are shaped by algorithms that determine the visibility of content and the priority of topics, contributing to the personalisation of the information space [1]. At the same time, this creates risks of forming information bubbles, narrowing worldviews and increasing the polarisation of public opinion, complicating constructive dialogue between different social groups [3; 4].

Digital technologies have a significant impact on the processes of social identity formation and self-presentation. The online space provides opportunities for self-expression and the creation of a personal or professional image, but the focus on public reaction increases dependence on external evaluation and gradually changes social norms of communication and perceptions of privacy boundaries [4].

In the socio-economic dimension, digital communications play an important role in the transformation of the labour market, education and the business environment, contributing to the development of remote employment, online education and new formats of interaction [2]. At the same time, the problem of digital inequality is becoming more acute, manifesting itself not only in differences in access to technology, but also in the level of digital literacy [1].

Along with their positive effects, digital technologies give rise to social risks, including information overload, the spread of misinformation and a decline in the quality

of public discourse [3; 4]. At the same time, in crisis situations, digital communication channels demonstrate significant potential for social mobilisation, mutual assistance and support for social cohesion [2].

Thus, digital technologies have a comprehensive impact on social interaction and communication, combining the expansion of social opportunities with the emergence of new challenges. Awareness of these transformations and the development of digital literacy and ethical norms of online communication are necessary conditions for maintaining the quality of social connections in the digital age.

REFERENCES

1. Горбань О. М. Цифрова трансформація суспільства: соціально-комунікаційний вимір // Соціальні технології: актуальні проблеми теорії та практики. – 2021. – № 90. – С. 45–53.
2. Дрешпак В. М. Цифрові комунікації в умовах трансформації соціальних процесів // Державне управління та місцеве самоврядування. – 2020. – № 2. – С. 112–119.
3. Коваль О. А., Шевченко Л. С. Вплив цифрових технологій на соціальну взаємодію в сучасному суспільстві // Гуманітарний вісник Запорізької державної інженерної академії. – 2019. – № 78. – С. 98–105.
4. Почепцов Г. Г. Смисли і комунікації в цифрову епоху. – Київ : Видавничий дім «Кисво-Могилянська академія», 2020. – 220 с.

A. Shylo, T. Vorova

THE ROLE OF MARKETING INNOVATIONS IN BUSINESS DEVELOPMENT

Digital marketing innovation has gained significant traction in recent years as businesses and consumers increasingly rely on digital channels for communication. As digital technologies become more widespread and people spend more time online, companies must adjust to these changes in consumer behavior by adopting innovative digital marketing approaches. Such innovations provide businesses with new ways to reach and interact with their target audiences, collect meaningful data, and maintain a competitive edge. Consequently, many organizations are investing in digital marketing

innovation and integrating it into their broader marketing strategies to stay relevant and competitive in the digital environment [3].

The relationship between digital marketing innovation and marketing capability is multifaceted and influenced by many factors, such as an organization's specific context and the type of innovation being implemented. Digital marketing innovations can strengthen marketing capabilities by giving companies new and more effective ways to reach and engage customers. For instance, tools like social media marketing and search engine optimization allow organizations to broaden their audience and interact with customers in more personalized and targeted ways. Likewise, leveraging data analytics and artificial intelligence helps companies gain deeper insights into customer behavior and preferences, enabling them to adjust their marketing strategies to better align with customer needs [3].

To successfully drive innovation, a strong customer orientation is essential. Customer orientation is defined as a business's willingness to understand and fulfill the needs and desires of its customers. It involves continuously assessing customer needs and wants, linking the creation of value to customer satisfaction. In today's highly competitive "new normal" era, businesses face intense rivalry. Transitioning from a product- or sales-focused mindset to a holistic marketing philosophy provides companies with a better chance of gaining a competitive edge. The foundation of a well-developed marketing orientation lies in cultivating strong customer relationships. Marketers must engage with customers—informing, involving, and sometimes even encouraging them to participate in the process. Research indicates a positive relationship between customer orientation and business performance. Specifically, Wulandari found that customer orientation significantly influences business performance. Similarly, studies by Maurya et al. confirm that customer orientation has a notable impact on business outcomes [1].

Mobile devices have significantly influenced consumer behaviors and preferences regarding online shopping, making them an integral part of the value creation process. Furthermore, mobility, combined with other digital technologies, provides firms with opportunities to transform their operations, affecting purchasing processes and distribution activities. Mobile apps act as omni-channel retail platforms, allowing

consumers to access products through multiple channels – e-commerce, modern retail, and traditional stores thus streamlining and integrating the shopping experience across channels [2].

So, digital marketing innovation allows businesses to adapt to changing consumer behavior and gain a competitive edge. Success depends on a strong customer focus, which helps tailor strategies to real needs and preferences. Mobile technologies and omni-channel platforms further enhance engagement and streamline the shopping experience. Companies that integrate innovation with customer-centric practices are more likely to achieve better performance and sustained growth.

REFERENCES

1. Bima Nur Riedqhie, Indarto Indarto, Paulus Wardoyo, The Effect of Innovation, Customer Orientation and Digital Marketing on Business Performance Through Competitive Advantage as An Intervening Variable (Study on UMKM Fashion and Crafts in Central Java), *BUSINESS: Scientific Journal of Business and Entrepreneurship*, Volume 1 Nomor 2 Tahun 2023, URL: <https://journal.csspublishing/index.php/business>
2. Marco Cioppi, Ilaria Curina, Barbara Francioni, Elisabetta Savelli, Digital transformation and marketing: a systematic and thematic literature review, *Ital. J. Mark.* 2023 Mar 15; 2023(2): 207–288. URL: 10.1007/s43039-023-00067-2
3. Sang-Uk, Valeriia Shegai, The Impact of Digital Marketing Innovation on Firm Performance: Mediation by Marketing Capability and Moderation by Firm Size, *Sustainability* 2023, 15(7), 5711; URL: <https://doi.org/10.3390/su15075711>

E. Simukova, N. Yakovlieva-Melnuk, O. Aliseienko

THE IMPACT OF DIGITAL TECHNOLOGIES ON ECONOMIC DEVELOPMENT

Digital technologies are electronic technologies that use data in digital form to create, store, process, and share information. Today, people use computers, smartphones, the Internet, and other digital tools to work with information quickly and effectively [4]. This is very important because the modern world is changing fast, and a huge amount of new information appears every day. Without digital technologies, it would be very difficult to manage and understand all this information.

The digital economy includes economic activities that are based on digital technologies and electronic communication. In many countries, high-tech solutions play a key role in economic development. As a result, the digital economy is growing and expanding quickly [3]. In addition, the development of smart technologies has a strong influence on economic results in different sectors.

According to research on the benefits and possible costs of the digital economy, digitalization has many advantages [1]. It has increased the speed of globalization and improved productivity. It has also made information more accessible, faster to share, and easier to process. As a result, businesses can work more efficiently and make better decisions.

Digital technologies are also very important for the tourism industry. Modern tools such as social networks, artificial intelligence, blockchain, and augmented reality help improve marketing, customer service, and safety of transactions [2; 3]. For example, in 2021 many countries showed both economic growth and growth in tourism. China had economic growth of 6.5% and tourism growth of 33%, while the USA had 6.4% and 25% respectively. This shows that the development of digital tourism has a positive effect on the economy.

Table 1

Growth of the tourism industry (%), Economic growth (%) in various countries with digital economic tourism for 2021 [3]

Country	Economic growth (%)	Growth of the Tourism Industry (%)
China	6.5	33.0
America	6.4	25.0
Japan	2.8	20.0
Brazil	4.1	22.0
England	4.1	15.0
Germany	3.6	22.0

However, digital technologies also have some disadvantages. Many jobs are being replaced by machines and automated systems, which leads to unemployment. This can negatively affect the economy because fewer people pay taxes, and more people need financial support. Another problem is the growing dependence on

technology. If systems fail or there is a cyberattack, it can cause serious problems. Also, since most information is stored digitally, it can be lost if something goes wrong.

In conclusion, digital technologies play an important role in economic development. They help companies automate processes, reduce costs, and work faster. At the same time, they can cause job losses and create risks related to system failures. Therefore, it is important to use digital technologies carefully and be prepared for possible challenges.

REFERENCES

1. Lau L.J. The Benefits and Potential Costs of a Digital Economy, Telecommunications Policy, vol. 47, no. 8, September 2023, Article 102594. <https://www.sciencedirect.com/science/article/pii/S0308596123001052>
2. UNWTO, "UN Tourism World Tourism Barometer Data," UN Tourism. <https://www.untourism.int/un-tourism-world-tourism-barometer-data>
3. Xia, L., Baghaie, S., & Mohammad Sajadi, S. The Digital Economy: Challenges and Opportunities in the New Era of Technology and Electronic Communications, Ain Shams Engineering Journal, vol. 15, no. 2, February 2024, Article 102411. <https://www.sciencedirect.com/science/article/pii/S2090447923003003>
4. Yazar K. What is Digital Transformation? Everything You Need to Know. Twitch Target, November 1, 2023. <https://www.techtargt.com/whatis/definition/digital>

D. Smoliak, H. Mudrenko

STRATEGIC ROLE OF INFORMATION TECHNOLOGIES IN PERSONAL FINANCE MANAGEMENT AND ECONOMIC LITERACY

The global transformation of the financial sector is inextricably linked with the rapid development of information technologies. For modern youth, and especially for first-year university students, the ability to manage personal finances using digital tools is becoming not just a convenience, but a strategic necessity. This study examines how mobile applications and specialized software change economic behavior and contribute to the formation of financial stability in the digital age.

One of the key aspects of IT integration into the economic sphere is the automation of financial accounting. Traditional methods of recording expenses are being replaced by high-tech platforms that allow for real-time monitoring of cash flows. Modern

applications use cloud computing to synchronize data across multiple devices providing the user with constant access to their financial status. Furthermore, the implementation of data visualization tools – such as interactive charts and diagrams – helps students better understand the structure of their budget. This visual approach makes it easier to identify “financial leaks” and optimize consumption patterns.

From a macroeconomic perspective, the mass use of financial IT tools stimulates the development of the “cashless economy”. Electronic payments and digital wallets reduce transaction costs and increase the transparency of the financial system. For a student, this means not only the speed of transfers but also a higher level of security, provided that the rules of cybersecurity are followed. However, the psychological aspect is also important: the ease of digital payments can lead to impulsive spending. Therefore, the information technology of the future should not only facilitate transactions but also include “smart” limit systems that warn the user about exceeding their planned budget.

Moreover, the role of IT in education cannot be overestimated. Digital platforms provide access to investment simulators and educational resources that were previously available only to professionals. Ukrainian researchers emphasize that the digitalization of financial services is a powerful tool for increasing the financial literacy of the population. By using these technologies, students gain practical experience in planning, which is the foundation of their future economic well-being.

In conclusion, the synthesis of information technology and economic principles creates a new environment for personal finance management. While these tools offer immense opportunities for efficiency and growth, they also require a high level of digital responsibility. Further research should focus on the development of personalized financial assistants based on artificial intelligence to provide even more accurate economic forecasting for individual users.

REFERENCES

1. Hlibko, S. (2019). Legal regulation of financial technologies and their impact on the economy of Ukraine. *Journal of Kyiv University of Law*, 3, 112–117.

2. Lykova, O., & Smoliak, V. (2021). Digital Transformation of Financial Services: Challenges and Opportunities. Kyiv: Akadem-Press.
3. Poliakh, S. (2022). Information technologies in the management of personal financial resources of students. Bulletin of the National Bank of Ukraine, 254, 40–48.
4. Shaikh, A. A., & Karjaluto, H. (2015). Mobile banking adoption: A literature review. Telematics and Informatics, 32(1), 129–142.

I. Tishkov, T. Vorova

ROLE OF E-COMMERCE IN THE DEVELOPMENT OF LOCAL ENTERPRISES

In the context of global digital transformation, e-commerce has become one of the key drivers of economic development, especially for local enterprises operating within small communities and regional markets. The increasing accessibility of digital technologies, the spread of mobile Internet, and changes in consumer purchasing behavior have created new opportunities for businesses that previously relied exclusively on offline sales. According to the OECD, the integration of digital tools has reshaped the competitive landscape, allowing small and medium-sized enterprises (SMEs) to reach broader markets and improve their resilience [1].

The shift toward digital trade is not only a transition to online sales, but also a modernization of internal business processes. E-commerce provides local enterprises with access to wider audiences, enhances the visibility of local brands, and supports the financial stability of regional economies. A World Bank report highlights that e-commerce fosters economic inclusion and strengthens the competitiveness of small businesses by lowering market entry barriers and enabling them to scale more efficiently [2].

A central advantage of e-commerce is the access to ready-made technological infrastructure. Marketplaces such as Amazon, Etsy, or regional platforms offer tools for product presentation, order management, and communication with customers. For local enterprises with limited resources, such platforms reduce the costs of launching online sales and allow them to enter both national and international markets.

Digital technologies also significantly improve operational efficiency. Online payment systems, CRM platforms, and inventory management software help optimize logistics, reduce administrative workload, and support real-time decision-making. Many enterprises use data analytics to track customer behavior, adjust product assortments, and plan marketing campaigns. McKinsey emphasizes that data-driven strategies enhance customer retention and increase revenue predictability by allowing businesses to tailor their offerings more precisely [3].

Marketing activities undergo substantial transformation in the context of e-commerce. Social media platforms such as Facebook, Instagram, TikTok, and YouTube provide new opportunities for targeted communication with consumers. High-quality digital content, including videos, product reviews, and interactive posts, helps strengthen brand identity and build long-term customer loyalty. According to PwC, a well-structured digital customer experience significantly increases consumer trust and influences their decision to make repeat purchases [4].

Personalization plays an increasingly important role in modern e-commerce. Automated recommendations, dynamic advertising formats, and personalized email marketing help enterprises create highly relevant customer experiences. These tools improve conversion rates and contribute to more efficient marketing budget allocation. For local enterprises, personalization becomes a strategic advantage, enabling them to compete with larger companies by offering customized products and services.

Omnichannel strategies further reinforce business competitiveness. By integrating online and offline channels, enterprises provide customers with a seamless experience – from online search and ordering to in-store pickup and post-purchase support. This hybrid approach increases convenience and strengthens customer loyalty, which is particularly important for small businesses operating in highly competitive markets.

In conclusion, e-commerce significantly influences the development of local enterprises by expanding their market opportunities, increasing operational efficiency, and supporting customer-oriented business models. Digital tools help businesses adapt to rapid changes in consumer expectations and market conditions while strengthening

their long-term competitiveness. The strategic use of e-commerce contributes to sustainable growth, economic resilience, and the overall development of local communities.

REFERENCES

1. OECD. The Digital Transformation of SMEs. OECD Publishing, 2021. URL: https://www.oecd.org/en/publications/the-digital-transformation-of-smes_bdb9256a-en.html
2. World Bank. E-Commerce Development: Experience from China, 2019. URL: <https://documents1.worldbank.org/curated/en/552791574361533437/pdf/E-commerce-Development-Experience-from-China.pdf>
3. McKinsey & Company. Becoming indispensable: Moving past e-commerce to NeXT commerce, 2022. URL: [https://www.mckinsey.com/capabilities/growth-marketing-and-sales/our-insights/becoming-indispensable-moving-past-e-commerce-to-next-commerce#/#/](https://www.mckinsey.com/capabilities/growth-marketing-and-sales/our-insights/becoming-indispensable-moving-past-e-commerce-to-next-commerce#/)
4. PwC. Global Consumer Insights Survey, 2023. URL: <https://www.pwc.com/gx/en/industries/consumer-markets/consumer-insights-survey.html>

N. Tiuria, H. Mudrenko

THE IMPACT OF DIGITAL COMMUNICATION TOOLS ON BUSINESS MANAGEMENT EFFICIENCY

In today's digital economy, communication technologies have become the basis for determining business competitiveness and the efficiency of management processes. The development of digital platforms has led to the emergence of new approaches to organizational interaction, where information is distributed instantly, and management decisions are based on current and reliable data. The use of digital communication allows you to integrate structural units of the enterprise, reduce time costs and optimize planning, monitoring and coordination processes. The particular relevance of this issue lies in the fact that under the influence of digital technologies, the very approach to management is transformed: traditional vertical models are giving way to flexible and adaptive systems that focus on operational information exchange and team cooperation.

The introduction of digital tools into the management system makes it possible to significantly accelerate data processing and increase their accuracy. Corporate

messengers, e-mail, cloud office platforms and video conferencing tools create a multi-level communication space. In this environment, managers can monitor the progress of work processes in real time, delegate tasks, track performance results and respond promptly to risks or deviations. Compared with traditional modalities, digital technologies ensure not only a significantly higher speed of interaction but also an increased degree of communicative transparency, which, in turn, contributes to the substantiation and overall quality of managerial decision-making [1].

One of the key benefits of digital communication systems is their ability to facilitate an interactive, collaborative working environment. These systems provide teams with integrated tools for co-authoring documents, operating shared databases, and conducting coordinated planning and analytical processes. This helps preserve corporate knowledge and minimizes the risks of information loss. Analytical tools and data visualization tools provide managers with a basis for making informed decisions based on actual indicators, rather than intuitive assumptions. As a result, this increases the accuracy of forecasting and the effectiveness of strategic planning.

In today's globalized business environment, digital communications play a key role in overcoming geographical barriers. Thanks to such tools, companies operating in different countries and time zones can effectively coordinate their processes without the need for physical presence. The implementation of virtual meetings, online presentations, and remote negotiations expands opportunities for business activity while simultaneously reducing travel and logistics expenditures. This approach not only optimizes organizational processes but also contributes to the development of a more sustainable and environmentally responsible model of cooperation.

Nevertheless, alongside their benefits, digital communication technologies generate specific risks. Excessive informational input, persistent notification streams, and the intensification of work rhythms can collectively increase the likelihood of employee emotional fatigue and burnout. Digitalization also blurs the lines between work and personal life, which makes it difficult to achieve a harmonious balance. Additionally, it is worth noting the risks associated with cybersecurity: data leaks, fraud or technical failures can have serious consequences for the organization. Therefore, there is a need

to implement reliable information protection systems, increase employee digital awareness and develop detailed rules for the use of corporate digital tools [2].

In general, the integration of digital technologies significantly increases the efficiency of business management. They contribute to the formation of a stronger corporate culture, ensure the flexibility of operational processes and support the long-term strategic growth of enterprises. In today's dynamic environment, the use of such tools is not just technological progress, but a necessary condition for the competitiveness of companies. The rational, balanced and secure application of digital solutions becomes the basis for increasing productivity, stimulating innovation and strengthening business positions in the market.

REFERENCES

1. Glebova A.O., Kravchenko V.V. Development of digital communications in the context of digitalization of the Ukrainian economy: problems and opportunities. *Effective Economy*. 2021. No. 9.
2. Sagaydak M.P., Andryushchenko A.R. Digital communications in the business organization management system / Strategic imperatives of modern management: collection of materials of the VI International Scientific and Practical Conference (October 21, 2022) / Ministry of Education and Science of Ukraine, Kyiv. Vadym Hetman National Economic University; [org. com.: Luk'yanenko D. G. (chairman) and others]. – Electronic text data. Kyiv: KNEU, 2022. pp. 169–171.

Y. Zakabluk, O. Bovkunova

THE ROLE OF ARTIFICIAL INTELLIGENCE IN THE DEVELOPMENT OF TOURISM IN UKRAINE

Artificial Intelligence (AI) is radically transforming the global tourism industry, becoming one of the key drivers of its digitalization and recovery. In the conditions of post-war reconstruction of Ukraine, the implementation of AI technologies opens new opportunities for rapid restoration and innovative development of the tourism sector.

According to global forecasts, the AI in tourism market is expected to grow significantly, reaching billions of dollars by 2030. The main applications of AI include

AI-powered personalization, chatbots and virtual assistants, predictive analytics, virtual tours and agentic AI. These tools allow creating individualized travel experiences, optimizing operational processes and increasing customer satisfaction.

In Ukraine, despite the challenges of wartime, there is active development of the national AI ecosystem. The country has adopted the Concept for the Development of Artificial Intelligence until 2030 and the Action Plan for 2025–2026. The launch of Diia.AI – the world’s first national AI assistant for public services – demonstrates high readiness for the integration of AI technologies. This experience can be successfully applied in tourism: for example, for creating chatbots that provide 24/7 support, dynamic pricing, and personalized itinerary planning. Ukrainian tech hubs (Kyiv, Ivano-Frankivsk) are already developing solutions in tourism tech, including sustainable travel platforms and AI for destination management.

The main motives for implementing AI in Ukrainian tourism are:

- 1) Expansion of foreign markets through personalized marketing and virtual tours of cultural and natural heritage (especially for destroyed or temporarily inaccessible objects);
- 2) Increasing operational efficiency – predictive analytics for demand forecasting, resource management in hotels and restaurants, and optimization of staff schedules;
- 3) Access to new resources – integration of AI with big data for better understanding of tourist behavior;
- 4) Creation of fundamentally new assets – development of regenerative and inclusive tourism products using AI (for people with disabilities, psychological rehabilitation, eco-routes).

However, there are challenges: insufficient digital infrastructure in some regions, the need for staff training (AI literacy), data privacy issues, and compliance with the EU AI Act (high-risk systems in tourism require careful regulation).

Despite this, positive trends are evident. AI can become a powerful tool for post-war recovery: accelerating the return of international tourists, supporting small businesses in the hospitality sector, and promoting Ukraine as an innovative destination.

In conclusion, the integration of artificial intelligence into the tourism industry of Ukraine is not only a technological necessity but also a strategic opportunity. Coordinated efforts of the state, business, and educational institutions, including the development of national AI solutions and international partnerships, will allow the tourism sector to reach a qualitatively new level of competitiveness.

REFERENCES

1. Grand View Research. Artificial Intelligence in Tourism Market Size & Share | Industry Report, 2030. 2025. URL: <https://www.grandviewresearch.com/industry-analysis/artificial-intelligence-ai-tourism-market-report> (date of access: 10.04.2026).
2. OECD.AI. Action Plan for the Implementation of the Concept for the Development of Artificial Intelligence in Ukraine for 2025–2026. 2025.
3. IDC. Agentic AI will redefine travel and hospitality in 2026. 2026. URL: <https://www.idc.com/resource-center/blog/agentic-ai-will-redefine-travel-and-hospitality-in-2026/> (date of access: 10.04.2026).
4. Forbes. The Future of Travel: AI, Chatbots, VR and Agents. 2026. URL: <https://www.forbes.com/sites/bernardmarr/2026/01/01/the-future-of-travel-ai-chatbots-vr-and-agents/> (date of access: 10.04.2026).

PANEL 4

Actual Problems of Engineering and Technical Sciences and Modern Information Technologies

(DNU, Zoom)

O. Bahlai, S. Bilogurov, O. Hurko

ENERGY CONSUMPTION ANALYSIS OF A FEED SYSTEM FOR GREEN PROPULSION OF CUBESAT SPACECRAFT

The rapid development of small spacecraft has led to increasing demands on the efficiency of their onboard systems, particularly propulsion systems. CubeSat-type spacecraft [1] are characterized by strict limitations in mass, dimensions, and especially energy consumption, making energy efficiency one of the key factors in the design of propulsion systems.

Modern propulsion systems must provide not only the required thrust characteristics, but also comply with the safety requirements of launch operators [3]. In particular, the use of high-pressure vessels and toxic fuel components is restricted [4], which stimulates the development of propulsion systems using “green” monopropellants, such as HAN- and ADN-based compounds.

Previous studies have proposed an improved feed system for the working medium, based on the use of solid chemical compounds capable of releasing gas when heated. This approach enables on-demand generation of pressurizing gas and eliminates the need for traditional methods [3] of storing gas under high pressure. However, the implementation of such a solution introduces a new important requirement – the assessment of energy expenditure for its implementation.

The main objective of this work is to analyze and assess the energy consumption of the proposed feed system. Total energy expenditure is determined by several components: the energy required to heat the solid substance to the decomposition

temperature, the energy of the chemical decomposition process itself, as well as heat losses to the environment.

A simplified thermodynamic model is used to assess energy consumption, in which the required energy is defined as the sum of the heat for heating and the energy of decomposition [5]. The main parameters affecting energy consumption are the mass of the substance, its heat capacity, activation temperature, and heat transfer efficiency.

Among the compounds considered, particular attention is given to ammonium carbonate ((NH₄)₂CO₃), which has low decomposition temperature (approximately 36–60 °C) and a high gas yield [2]. This makes it possible to reduce the energy expenditure for system activation compared to other substances and makes it promising for use in energy-limited CubeSat platforms.

Compared to traditional feed systems, such as those using saturated vapours (isobutane) or high-pressure tanks [3], the proposed approach avoids the need for constant thermostating of the working medium vessel and reduces energy consumption in the standby mode. Although the initial activation stage may require increased power, the overall energy balance of the system during the mission may be more efficient due to the pulsed operating mode.

The results obtained indicate the promise of using gas generation systems based on solid chemical compounds as an energy-efficient and safe alternative for propulsion systems of CubeSat-type spacecraft.

Further research will be aimed at refining calculation models, experimental verification of the obtained results, and optimisation of the system's thermal operating modes in order to reduce energy losses.

REFERENCES

1. ISO 17770:2017. Space systems – Cube satellites (CubeSats).
2. Haynes, W. M., Lide, D. R., & Bruno, T. J. (2016). CRC handbook of chemistry and physics: a ready-reference book of chemical and physical data. 2016-2017, 97th Edition / Boca Raton, Florida, CRC Press.
3. V. Durachenko, E. Komeko, O. Bahlai (Dnipro). Results of project work on the development of a propulsion system utilizing low-toxic, single-component fuel for CubeSat-type spacecraft. Presented at the XXIII International Congress of Engine Builders, September 4-9, 2018.
4. CUBESAT SESSION VI: PROPULSION. Small Satellite Conference 2016. Utah State University. Logan, Utah.
5. Çengel, Y. A., Boles, M. A. Thermodynamics: An Engineering Approach. McGraw-Hill, 2015.

ANALYTICAL METHODS OF TANDEM WING AIRCRAFT AERODYNAMICS

While the so-called “normal” or conventional aerodynamic scheme of aircraft has been studied in detail, modern aviation materials and numerical methods of aerodynamic optimization give a chance to rehabilitate unconventional configurations, in particular, with a tandem arrangement of the wings. This aerodynamic scheme is defined by the presence of forward wings and rear wings of comparable areas [1, p. 1].

This aerodynamic scheme is defined by the presence of forward wings and rear wings of comparable areas. At the very beginning of aircraft history, people did not know about adverse wing-wing interference, and projects with many wings (polyplanes) were very popular, including those with two pairs of wings spaced along the horizontal line of the fuselage. Tandem configuration is a typical solution for ground-effect vehicles (GEV) as it allows to ensure longitudinal stability, which is often problematic for these aircraft, and takes full advantage of ground effect for high-efficiency operations. For a convertiplane, it is easier to provide stability and controllability during takeoff and landing with not two but four propellers, and then it is reasonable to place them on four wings of comparable areas [2, p. 12].

A feature of the tandem scheme, which must be taken into account by analytical or numerical methods, is wing-wing interference represented in three aspects on the rear wing: 1. Flow retardation (deceleration); 2. Flow turbulization. 3. Downwash and upwash (less significant on forward wing from rear wing). The first two effects are significant then and only then if the rear wings are placed directly in the wake (trace or slipstream) of the forward wings. In this case, the rear wings generate smaller lift (because of low initial flow speed) and bigger drag (turbulent boundary layer from its leading edge). This configuration would be poor.

A primitive representation of the wing vortex system is given in Fig. 1. According to Joukowski theorem, wings can be replaced by attached vortex (also called bound

vortex) that together with two tip vortices (or free vortices) creates horseshoe vortex. It is more accurate to describe the shape of the tip vortices taking into account their contraction to the symmetry plane. But for two pairs of wings (forward and rear), the real vortex picture becomes even more comprehensive because of interaction of the vortices, i.e., mainly the repulsion of unidirectional vortices on the same side from the symmetry plane. A distance to oppositely directed vortices on the other side of the symmetry plane is an order of magnitude greater, so the interaction with them can be neglected [1, p. 32].

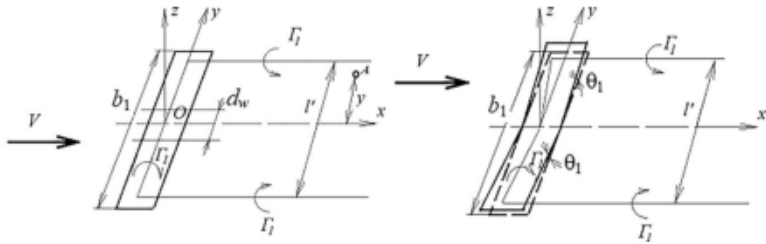


Fig. 2 – A simplified scheme to determine velocities induced by bound and tip vortices

Flow Turbulization. The effect of flow turbulence on rear wings is challenging to determine accurately through analytical approaches. In general, many studies have been conducted on the effect of the turbulence intensity on airfoils' aerodynamic characteristics, but even with a given geometry, the turbulence intensity behind the forward wings is uneven and depends on angle of attack. However, with rationally selected parameters, i.e., with a vertical spacing of the wings (e.g., high wing + low wing), the rear wings are not in the area of increased turbulence, so this factor can be neglected [1, p. 36].

Downwash and Upwash. The main aspect of wing-wing interference is a change in actual angles of attack of the rear wing, and for any real tandem scheme aircraft, it must always be considered. Hereafter, we determine only the vertical component of the flow wash V_z as the most important, neglecting longitudinal V_x and lateral V_y component [1, p. 38].

Drag Coefficient The main difficulty in determining drag coefficient of a tandem wing aircraft is the calculation of the induced component appreciating the mutual influence of the forward and rear wings. The induced drag of true tandem wings (not canard or biplane) is dominated by the downwash effect generated by the forward wings on the rear wings. It is not correct for canard case when the forward lifting surface is few times smaller than the rear one. Some experiments show that for proper configurations, the aerodynamic interference between the wing and canard increases the $C_{l \max}$ of the canard and does not degrade the $C_{l \max}$ of the wing [1, p. 52].

Pitching Moment Coefficient Determination of longitudinal static stability is based on determining the lift coefficients on the linear dependence versus AoA. Nose-up pitch moment is considered positive (the right-hand rule for y-axis directed to the right wing). An issue occurs for swept wings as it is problematic to find the longitudinal moment arm for the lift distributed spanwise [1, p. 57].

Rolling Moment Coefficient. Determination of the lateral static stability of the tandem wing or canard aircraft has a specificity compared to conventional scheme: for a nonzero sideslip angle, vortex zone from the forward lifting surface (a canard or a wing) creates additional rolling moment [1, p. 61].

Yawing Moment Coefficient. In general, these are forces along x-axis on z-arms and forces along z-axis on x-arms [1, p. 68].

Control Surface Effectiveness. In this section, ailerons and elevators are considered as the most common control surfaces. Many UAVs have no rudders, but if they are placed on the tail fins of a tandem wing aircraft, then their effectiveness determination has no difference compared to a conventional aircraft. Original way of pitch and roll control lies in changing of the wings' sweep angles. Despite viability of this approach being shown, it is still risky and not an effective substitution for ailerons. The safety problem of using the whole lifting surface as control is that in case of one mechanism failure nothing can compensate the rolling moment from the wing, and the vehicle loss is practically inevitable (unlike only partial loss of controllability in case of the usual aileron failure). Also, sweep angle variation from initial position changes rolling moment proportional to cosine squared, so quite slowly in the first moments of time [1, p.71].

Damping Moments. An aircraft will be dynamically stable only if it is statically stable (positive increment of angle leads to negative increment of corresponding moment) and oscillations, provoked by any disturbance, are damped (their amplitude is decreasing with time) [1, p. 81-82].

REFERENCES

1. Kryvokhatko I. Aerodynamics of Tandem Wing Aircraft. From Dinosaurs to UAVs and Supersonic Planes. Switzerland: Springer, 2023. P. 228.
2. Henderson, W.P., and Huffman, J.K. Aerodynamic Characteristics of a Tandem Wing Configuration of a Mach Number of 0.30, 1975.

O. Bykhno, S. Mamchur, T. Nosova, O. Novikova

CURRENT CHALLENGES IN SCIENTIFIC RESEARCH ON DISSIMILAR MATERIAL WELDING IN MODERN MECHANICAL ENGINEERING

In modern mechanical engineering, structures composed of dissimilar materials are widely utilized. The combination of various metals and alloys significantly enhances the operational characteristics of products, facilitates weight reduction, and increases structural durability. Among the most in-demand are joints involving aluminum, titanium, and steel alloys, which are extensively applied in aerospace, transportation, and power engineering.

The widespread adoption of dissimilar materials necessitates comprehensive scientific research aimed at investigating the formation processes of welded joints. A fundamental scientific challenge lies in the study of the physicochemical processes occurring within the joining zone of materials with divergent thermophysical and metallurgical characteristics. Significant disparities in melting temperatures, coefficients of thermal expansion, and the chemical reactivity of the metals being joined result in complex structural interactions within the weld zone.

A critical area of research involves examining the mechanisms of intermetallic phase formation at the joint interface. The development of compounds such as Al_3Ti , $FeAl_3$,

and other phases can substantially degrade the mechanical properties of the welded joint. Consequently, an urgent scientific task is the development of methods to control the interfacial zone structure and mitigate the adverse effects of intermetallic compounds on the strength and ductility of the joints.

Promising directions in contemporary research include the advancement of solid-state welding technologies, specifically Friction Stir Welding (FSW) and diffusion bonding. These techniques facilitate the formation of joints without complete melting of the base materials, providing more favorable conditions for the development of the weld structure. However, their effective application requires further investigation into the influence of technological parameters on the resulting microstructure and mechanical properties.

In summary, current scientific research in the field of dissimilar material welding is focused on establishing the regularities of joint structure formation, developing innovative technological approaches, and enhancing structural reliability. Addressing these scientific problems is of paramount importance for the further evolution of modern mechanical engineering and the creation of highly efficient engineering systems.

REFERENCES

1. Patel V., Li W., Wang G., Wang F., Vairis A., Niu P. Friction Stir Welding of Dissimilar Aluminum Alloy Combinations: State-of-the-Art. *Metals*. 2019. Vol. 9(3). P. 270.
2. Sharma C., Dwivedi D., Kumar P. A Literature Review on Friction Stir Welding of Dissimilar Materials. *Materials Today: Proceedings*. 2021. Vol. 47. P. 286–291.
3. Zhang H., Liu H., Fujii H. Microstructure and Mechanical Properties of Dissimilar Aluminum–Titanium Joints by Friction Stir Welding. *Materials & Design*. 2019. Vol. 165. P. 107597.
4. Зяхор І. В., Антіпін С. В., Дідковський О. В. Сучасні технології зварювання рейок. Автоматичне зварювання. 2023. №5. С. 5–17.
5. Німко М. О., Скульський В. Ю., Іваненко Т. В. Матеріали і технологічні підходи до зварювання комбінованих з'єднань між мартенситними і аустенітними сталями. Автоматичне зварювання. 2023. №5. С. 27–36.

CHANGE POINT DETECTION METHODS FOR TIME SERIES

Specialists from various fields, such as economics, medicine, and hydrometeorology, often need to analyze processes that evolve over time. When represented numerically, such data are referred to as time series. Real-world time series often exhibit structural changes, meaning that their parameters or statistical properties may change under the influence of internal or external factors. These changes can be classified as follows: level (or regime) changes, changes in trend, changes in variance, and the presence of outliers. An important task in time series analysis is to detect points at which the structural changes occur. These points are called change points.

Many methods and their modifications have been proposed for detecting change points. Some of the most commonly used methods, such as CUSUM [4], Pettitt [5], PELT [2] and piecewise linear regression methods [1], were analyzed in this study using real-world time series. Based on the obtained results, the following conclusions were drawn:

- The CUSUM method involves recursive computation of a cumulative sum; when this sum exceeds a predefined threshold, a change point is detected. The CUSUM is effective at detecting shifts in the mean, but it is not effective when the time series contains a trend – in such cases it may interpret the trend as a change in the mean of the series.

- The Pettitt method is a rank-based method and is therefore less sensitive to the distribution of the series values before and after the change point. As with the previous method, a drawback of the Pettitt method is that it works effectively only in cases where the change is a shift in the mean, that is, when the series is piecewise stationary. Another limitation is that it detects only a single change point at a time.

- The PELT method is an exact change point detection method that allows identifying multiple change points at once and does not require prior knowledge of their number. By using an appropriate cost function, this method can detect change points associated with changes in both mean and variance; however, it remains primarily intended for use with piecewise stationary data.

– Piecewise linear regression methods are based on fitting a piecewise linear regression model. They divide the time series into segments, each of which is approximated by a linear function. The knots at which the transition from one segment to another occurs can be considered change points. Thus, these methods can detect change points in time series with a complex trend.

In addition to the methods listed above, neural network-based approaches have been proposed [3], but they were not considered in this study.

Future work aims to integrate these methods into forecasting models to improve forecasting accuracy.

REFERENCES

1. Jekel C. F., Venter G. *pwlf: a python library for fitting 1D continuous piecewise linear functions*. 2019. DOI: <https://doi.org/10.13140/RG.2.2.28530.56007>.
2. Killick R., Fearnhead P., Eckley I. A. Optimal detection of changepoints with a linear computational cost. *Journal of the American Statistical Association*. 2012. Vol. 107(500). P. 1590–1598. DOI: <https://doi.org/10.1080/01621459.2012.737745>.
3. Li J., Fearnhead P., Fryzlewicz P., Wang T., Automatic change-point detection in time series via deep learning. *Journal of the Royal Statistical Society Series B: Statistical Methodology*. 2024. Vol. 86 (2), P. 273–285. DOI: <https://doi.org/10.1093/jrsssb/qkae004>.
4. Page E. S. Continuous inspection schemes. *Biometrika*. 1954, Vol. 41 (1). P. 100–115. DOI: <https://doi.org/10.2307/2333009>.
5. Pettitt A. N. A non-parametric approach to the change-point problem. *Journal of the Royal Statistical Society: Series C (Applied Statistics)*. 1979. Vol. 28 (2). P. 126–135. DOI: <https://doi.org/10.2307/2346729>.

H. Diadchenko, M. Khorolskyi, N. Kaliberda

RUBBER DIAPHRAGMS AS ONE OF THE EFFECTIVE TYPES OF PRODUCTS FOR ROCKET AND SPACE ENGINEERING OBJECTS

The use of elastomeric materials, in particular rubbers, as structural materials for manufacturing rubber technical products (RTPs), is a widespread practice in rocket and space technology (RST) and its components. Properly designed RTPs are reliable, efficient, and durable products, playing an important role in the development of new engineering solutions, which in many cases become the basis for creating

advanced RST systems, their components, and new technologies [1, p. 130; 2, p. 144; 3, p. 574–576].

The aim of this work is to study the effectiveness of using rubber technical products in rocket and space technology, using rubber diaphragms as an example.

Rubbers as structural materials exhibit a wide range of technical properties (physical, chemical, mechanical, and technological), depending on the type of elastomer (rubber) from which they are made. These properties significantly affect the performance of products manufactured from them under specific operating conditions. The mentioned groups of technical properties are analogous in name to those of metallic structural materials but differ substantially in their structure and values. This contributes to the widespread use of rubbers for specific RTP applications [4, p. 125–133].

Modern aerospace vehicles incorporate a large number of RTP types performing various functions. They are used as sealing, load-bearing, dust-protective, vibration and acoustic insulating, compensating, and other structural elements. In most cases, they perform multiple functions simultaneously, which makes it impossible to replace them with other structural materials.

Compared to other structural materials, rubbers exhibit high reversible deformation. For example, under tensile deformation, they can elongate up to 1000% or more, whereas metals typically deform only up to about 0.2% before transitioning to a plastic state. Unlike metals, rubbers can exist in three states depending on temperature: glassy, highly elastic, and degradation (failure) states. Metals exhibit two types of deformation—elastic and plastic—whereas rubbers exhibit three: elastic, plastic, and highly elastic (not to be confused with deformation behavior). In rubbers, the elastic state is similar to that of metals, with recovery occurring within (10^{-5} – 10^{-6}) seconds after load removal, whereas the highly elastic state may persist for days, months, or even years depending on temperature, load type, and duration [5, p. 11–20]. It is in this state that rubber RTPs ensure reliable and long-term operation, considering the stress-strain state at the installation site and other operating conditions. Rubbers also have lower density than metals, which is important for RST applications.

One example of such RTPs is rubber diaphragms of hemispherical or parabolic shape. In RST, they simultaneously perform several functions: ensuring sealing of the working medium, separating different cavities within a structure, transferring the working medium from one cavity to another, and displacing it as required by changing their configuration by 180° (transitioning into another plane), etc. Such diaphragms have a structural element along the outer diameter in the form of a semicircular ring with a circular cross-section or a rectangular gasket connected to the hemisphere. These elements ensure reliable sealing and secure positioning of the diaphragm without loss of its hemispherical shape during movement (inversion) from one plane to another and vice versa. Considering that rubber is an incompressible material, the minimum installation volume is achieved when this structural element is made in the form of a semicircular ring with a circular cross-section [6, p. 295–335].

It should be noted that RTPs, including diaphragms, do not have an independent function in RST systems. However, they ensure the operability of various devices only when rubber is properly selected according to operating conditions, including optimal diaphragm design, installation location, and manufacturing quality of all sealing system components. Therefore, before designing and manufacturing a sealing device, it is necessary to perform all engineering calculations taking into account the specific features of rubber as a structural material and the product based on it, as well as its stress-strain state throughout the entire guaranteed service life and storage period.

REFERENCES

1. Шістдесят років у ракетобудуванні та космонавтиці / За заг. ред. А.В. Дегтярьова. Дніпропетровськ: АРТ-ПРЕС, 2014. 540 с.
2. Ракети та космічні апарати конструкторського бюро «Південне» / За заг. ред. С.М. Конюхова. Д.: ТОВ «КолорГраф», ТОВ ПА «Гандем – У». 2001. 240 с.
3. Смирнов Л.В. У витоків ракетобудування / До 100-річчя від дня народження Л.В. Смирнова / Упорядники: Н.А. Мітрахов, В.П. Платонов, А.Я. Стеценко, В.Д. Ткаченко. За заг. ред. А.В. Дегтярьова. Київ: Спейс-Інформ, 2016. 584 с.
4. Хорольський М.С. Високоякісні знання здобувачам освіти як один із напрямків розвитку економіки України. *Вісник Дніпровського університету*. Серія Ракетно-космічна техніка. Випуск 27, 2024, т. 33, № 4, С. 125–133.
5. Хорольський М.С., Бігун С.О. Роботоздатність рукавів стикування системи термостатування космічної ракети «Циклон-4 в екстремальних умовах» // *Космічна наука і технологія*. 2021. Випуск 27, № 4 (131). С. 11–20.
6. Хорольський М.С. Стандартні ущільнювачі / Великий довідник спеціаліста з гуми. У двох частинах. Ч. 2. Гума та гумотехнічні вироби / За ред. С.В. Рєзніченка, Ю.Л. Морозова. Д.: ТОВ «Видавничий центр «Техінформ»», 2012. 648 с.

VORONOI DIAGRAM AS A TOOL FOR SPATIAL ANALYSIS

In modern mathematics, computer science, and engineering, methods related to the geometric analysis of space are increasingly used. One of the fundamental concepts underlying such methods is the Voronoi diagram. This construction belongs to the classical objects of computational geometry and is widely used for modeling, spatial analysis, and optimization problems. The idea of the diagram is to divide space into regions, each of which corresponds to the set of points that are closest to a specific fixed element from a given set of generators.

Mathematical definition and basic properties.

Let $S = \{p_1, p_2, \dots, p_n\} \subset \mathbb{R}^2$ be a finite set of points. For each point $p_i \in S$, we define the Voronoi cell as the set of all points in the plane for which the distance to p_i is no greater than to any other point in S :

$$V(p_i) = \{x \in \mathbb{R}^2 \mid d(x, p_i) \leq d(x, p_j) \forall j \neq i\}.$$

Here $d(x, p)$ is a metric, usually Euclidean. In the simplest case, the Euclidean metric is used

$$d(x, y) = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2}.$$

It has the following properties:

- $\{V(p_i)\}_{i=1}^n$ form a partition of \mathbb{R}^2 into convex polygons [2, p. 239].
- The cell boundaries are segments or rays of the medians to the segments $p_i p_j$.
- Each cell is a convex polygon whose boundaries are parts of the medians between pairs of points.

The Voronoi diagram is closely related to another important geometric structure, the *Delaunay triangulation*. These objects are dual: if three points form a triangle in the Delaunay triangulation, then the corresponding Voronoi cells have a common vertex. Such an interconnected construction is often used in computational geometry algorithms, numerical modeling, and computer graphics.

Algorithmic aspects of construction. The problem of constructing a Voronoi diagram for a large number of points is important in computational mathematics. One of the well-known approaches is Fortune's algorithm, which has a time complexity of $O(n \log n)$. The idea of the method is based on the notion of "waves" that simultaneously expand from each point. The cell boundaries are formed where these waves meet.

An alternative approach involves constructing a Delaunay triangulation for the set S , after which the median perpendiculars to the edges of the triangles determine the boundaries of the Voronoi cells. This method is often convenient for numerical implementation, since many libraries and software packages already contain efficient algorithms for constructing Delaunay triangulations [1, p. 51].

Generalization and metric modifications. The Voronoi diagram can be generalized for different types of metric spaces. The so-called L_p -metrics are most often considered:

$$d_p(x, y) = (|x_1 - y_1|^p + |x_2 - y_2|^p)^{\frac{1}{p}},$$

where $p \geq 1$. In such spaces, the cells are no longer necessarily convex polygons, but retain the property of spatial partitioning.

Of particular interest are weighted Voronoi diagrams, in which each point p_i is assigned a weight ω_i . The distance is modified according to the rule: $d(x, p_i) - \omega_i$.

Such models allow us to take into account the heterogeneity of the space – for example, the different importance or power of certain objects.

In addition, the construction of Voronoi diagrams is generalized to spaces of higher dimensions \mathbb{R}^n .

Mathematical applications. Voronoi diagrams have a wide range of applications in mathematics and related disciplines.

Clustering and partitioning of sets: when solving the problem of minimizing the energy functional of the form

$$E = \sum_i \int_{V(p_i)} \|x - p_i\|^2 dx,$$

the so-called centroid Voronoi diagrams are obtained, which play an important role in the Lloyd problem and the theory of optimal partitions.

Approximation and interpolation: using Voronoi diagrams, it is possible to construct functions that approximate given data according to the "nearest neighbor" principle.

Geometric and topological analysis of sets: Voronoi diagrams allow us to investigate the structure of sets in metric spaces, describe their convex hulls, and study local properties of spatial distributions.

Optimization problems: based on the properties of Voronoi diagrams, problems of placing objects in space with minimization of the total distance are formulated, which has applications in network planning, logistics, and physical models of resource distribution.

Conclusions. Voronoi diagrams are one of the basic tools of modern geometry, combining mathematical rigor with practical versatility. Their structure provides a natural partitioning of space according to the proximity principle, which makes them indispensable in spatial optimization, data analysis, and numerical modeling tasks.

Mathematical generalizations of Voronoi diagrams open up wide opportunities for further research – from analytical study of the properties of metric spaces to application in information processing tasks. It is the combination of deep geometric ideas with algorithmic efficiency that makes the Voronoi diagram one of the most interesting and important structures in modern applied mathematics.

REFERENCES

1. Ivanov A., Kryvonos O. (2023). *Features of the Implementation of Fortune's Algorithm for Constructing the Voronoi Diagram in the Python Programming Language*. In: State, Achievements and Prospects of Information Systems and Technologies. Odesa, 2023, pp. 50-51.
2. Finucane, H. (2013). *Finite Voronoi decompositions of infinite vertex transitive graphs*. Journal of Topology and Analysis, 5(02), 239-250.

**ANALYSIS OF TRENDS IN THE DEVELOPMENT
IN GROUND-BASED ORBITAL OBJECT SURVEILLANCE SYSTEMS
AND INTELLIGENT CONTROL METHODS**

The rapid growth in the number of artificial objects in near-Earth orbits is transforming space into an increasingly congested and potentially contested environment. According to Novaspaces forecasts, an average of over 3,700 satellites will be launched annually during 2024–2033, equivalent to ten launches per day. This trend necessitates the development of advanced Space Situational Awareness (SSA) systems capable of effectively tracking, cataloguing, and characterizing resident space objects (RSOs), including active satellites, spent rocket stages, and orbital debris. The evolution of SSA toward Space Domain Awareness (SDA) reflects a paradigm shift from simple object tracking to a comprehensive understanding of object characteristics, ownership, and intent [1; 2; 3].

The existing surveillance infrastructure encompasses four principal categories of sensors. Ground-based optical telescopes, such as the GEODSS network, remain the primary means for observing objects on high orbits (GEO, HEO), though they are limited to nighttime operation and clear sky conditions. Radar systems, including Space Fence (S-band) and LeoLabs' network of 11 phased-array radars, are indispensable for LEO object tracking with capabilities extending to objects as small as 2 cm. Space-based sensors, exemplified by GSSAP and Sapphire, overcome the fundamental limitations of ground-based systems regarding weather dependence and geographical constraints. Passive radiofrequency sensors provide unique identification data by detecting satellites' own emissions without active illumination [4; 6; 8].

The architecture of leading surveillance networks demonstrates a trend toward public-private partnerships. The US Space Surveillance Network (SSN) integrates over 30 ground and space sensors and maintains the authoritative RSO catalogue, while actively incorporating commercial data through the Unified Data Library program.

The EU Space Surveillance and Tracking (EU SST) system unites sensor networks of 15 member states and provides collision avoidance, re-entry analysis, and fragmentation analysis services. Commercial providers such as LeoLabs, ExoAnalytic Solutions, and Slingshot Aerospace are expanding the SSA ecosystem, with the global SSA data fusion market projected to reach \$906M by 2033 [4; 5; 9].

The sensor tasking optimization problem for SSA belongs to the class of NP-hard combinatorial optimization problems. It can be formulated as a Job-Shop Scheduling Problem with directed acyclic graph (DAG) interpretation. Exact mathematical programming methods (Branch-and-Bound, MIP) guarantee global optimality but are computationally intractable for realistic scenarios with hundreds of objects and dozens of sensors. Metaheuristic algorithms – genetic algorithms (GA, NSGA-II), particle swarm optimization (PSO), ant colony optimization, and simulated annealing – provide high-quality solutions in polynomial time, typically achieving 90–95% of the optimal value [6; 7].

Deep Reinforcement Learning (DRL) represents the most promising direction for overcoming the “curse of dimensionality” in SSA sensor planning. Since the pioneering work of Linares and Furfaro (2016) on RL-based dynamic sensor tasking, subsequent research by Siew and Linares demonstrated that DRL can achieve 95–98% of optimal performance with near-instant inference. Recent advances include the Priority Construction Model (PCM) for agile satellite scheduling and the RH-MAPPO method for distributed satellite systems using multi-agent reinforcement learning [4; 8]. The key advantage of DRL is generalization: a model trained on one set of scenarios can be applied to new ones without retraining.

In conclusion, despite significant progress, several fundamental problems remain unresolved: integration of heterogeneous sensors with unified data fusion frameworks, accounting for orbital prediction uncertainty through stochastic and robust optimization, coordination of ground and space surveillance systems, and standardization of SSA data exchange protocols for effective global cooperation [6; 9]. These directions define the priorities for further research aimed at developing quasi-optimal methods for coordinated control of orbital object surveillance systems.

REFERENCES

1. ESA. Scanning and Observing Space Debris. European Space Agency Technical Reports. 2024. https://www.esa.int/Space_Safety/Space_Debris/ESA_Space_Environment_Report_2024
2. Katalyst Space Technologies. Space Domain Awareness. 2024. <https://www.katalystspace.com/space-domain-awareness>
3. Look Up Space. Why ground-based radar is a key technology for Space Surveillance. 2025. <https://www.lookupspace.com/blog/why-ground-based-radar-is-a-key-technology-for-space-surveillance>
4. Koenig A., et al. Space-Based Sensor Tasking Using Deep Reinforcement Learning. The Journal of the Astronautical Sciences. 2022. https://dspace.mit.edu/bitstream/handle/1721.1/146368/40295_2022_Article_354.pdf?sequence=1&isAllowed=y
5. Space Insider. Space Domain Awareness: The New Orbital Foundation. 2025. <https://spaceinsider.tech/2025/08/22/ground-truth-why-the-sda-market-is-becoming-foundational-to-space-operations/>
6. Shimane Y., Ho K. Multi-Sensor Tasking for Ground-Based Space Situational Awareness via Job-Shop Scheduling Problem. The Journal of the Astronautical Sciences. 2025. №96. 61. <https://repository.gatech.edu/server/api/core/bitstreams/ae645c6e-654b-4a28-8d2c-58b245389450/content>
7. Siew P. M., Linares R. Optimal Tasking of Ground-Based Sensors for Space Situational Awareness Using Deep Reinforcement Learning. Sensors. 2022. <https://www.mdpi.com/1424-8220/22/20/7847>
8. Bloom J., et al. Space and Ground-Based SDA Sensor Performance Comparisons. AMOS Conference. 2022. <https://amostech.com/TechnicalPapers/2022/Poster/Bloom.pdf>
9. +OSC & EU SST. Comparison of EU Space Surveillance & Tracking and TraCSS. 75th International Astronautical Congress, Milan, Italy. 2024. <https://www.space.commerce.gov/wp-content/uploads/2024-10-comparison-EUSST-TraCSS-IAC.pdf>

K. Dzhura, M. Tkachenko, N. Kaliberda

CROWDSOURCING IN THE SCHOOL ENVIRONMENT AS AN INNOVATIVE APPROACH TO LEARNING

The term “crowdsourcing” originates from the English words “crowd” and “resource” and refers to the process of searching for and collecting resources. The term emerged in the early 2000s and “characterizes the process of gathering various resources through the efforts of a large number of people” [1, p. 118], although the idea of using collective participation to solve problems had existed earlier.

In the context of education, as noted by the authors in, crowdsourcing is an innovative way of organizing the educational process that enables the involvement of

a wide range of participants (students, teachers, parents) in the joint solution of educational tasks, idea generation, and the creation of educational content.

Matviienko L. and Khomenko L. conducted research on the application of crowdsourcing in higher education institutions abroad and emphasize that “crowdsourcing in the educational process of higher education institutions is aimed at solving the following interrelated tasks:

- collection and processing of information;
- analysis of constructive ideas;
- identification of proposals for creating projects related to the researched problem;
- formation of a circle of independent experts” [1, p. 119].

The modern system of general secondary education is undergoing active transformations caused by the digitalization of society, changes in educational paradigms, and a focus on the development of students’ key competencies. Traditional approaches to organizing the educational process are increasingly proving insufficient to meet the needs of modern learners, which actualizes the search for new pedagogical technologies and models of interaction. One of such innovative mechanisms is crowdsourcing.

An important factor in the development of crowdsourcing platforms in educational institutions is informational activity, namely the dissemination of information among pupils, students, researchers, teachers, and lecturers, as well as the involvement of representatives of local authorities and young people who are willing to invest their time and effort in development.

“It is precisely in this context that crowdsourcing is viewed as a socio-pedagogical phenomenon based on engaging collective intelligence to solve educational, organizational, and creative tasks” [3].

Unlike traditional forms of education, which are dominated by one-way knowledge transmission, the crowdsourcing approach involves the active participation of all subjects of the educational process – students, teachers, school administration, and in some cases parents. In the school context, crowdsourcing takes the form of open collaboration aimed at jointly creating educational products and making collective decisions.

The use of crowdsourcing mechanisms in the school environment contributes to the formation of a new type of educational environment that is dynamic, interactive, and oriented toward partnership-based interaction. Students are involved in the development of learning materials, project creation, preparation of presentations, research work, digital content production, as well as in discussing relevant issues of academic and extracurricular activities. Such an approach not only activates cognitive activity but also fosters a sense of involvement in the educational process and responsibility for its outcomes.

In the process of collective activity, students learn to argue their own viewpoints, critically evaluate the ideas of others, reach compromises, and work in teams. In addition, crowdsourcing promotes the development of critical thinking, as it involves analyzing information, selecting the most justified solutions, and reflecting on the results of joint work.

The practical implementation of crowdsourcing in the school environment is possible through the use of digital educational platforms, social networks, educational forums, cloud-based collaboration services, and internal school online communities. The use of such tools expands the boundaries of the educational process, ensures access to educational resources, and creates conditions for continuous interaction among participants both within and beyond the school.

One of the most effective areas of mathematical crowdsourcing is the organization of a shared problem bank, where students are involved not only in solving tasks proposed by the teacher but also in creating their own problems based on the studied topics. For example, while studying the topic “Solving Problems Using Linear Equations”, students may propose applied problems related to real-life situations. Collective discussion of problem conditions and solution methods contributes to a deeper understanding of mathematical concepts and the development of logical thinking.

Crowdsourcing can also be used to create collective mathematical resources such as electronic formula handbooks, tables, algorithms, or explanatory guides for complex topics. For instance, while studying “Derivatives and Their Applications,” students may collaboratively develop a generalized reference guide, with each student responsible for explaining a specific rule or its application. This promotes knowledge systematization and the development of self-organization skills.

The use of online collaborative environments makes it possible to implement crowdsourcing mechanisms in an asynchronous mode. Students can add solutions, comments, questions, and suggestions for improving materials. For example, creating a shared digital space for exam or final assessment preparation fosters peer learning and increases learning motivation.

At the same time, the implementation of crowdsourcing approaches in the school environment is accompanied by certain difficulties and risks, such as:

- the need to control the quality of created content;
- ensuring academic integrity;
- compliance with ethical norms of interaction;
- protection of students' personal data in the digital environment.

Addressing these issues requires a well-thought-out pedagogical strategy, a clear definition of the teacher's role as a moderator and coordinator of crowdsourcing activities, and an increase in the level of digital competence of all participants in the educational process.

Thus, crowdsourcing in the school environment emerges as a promising tool for the innovative development of education, contributing to increased learning effectiveness, the democratization of educational relations, and the formation of active and responsible individuals. Its systematic implementation, supported by pedagogical guidance and methodological assistance, creates prerequisites for transforming schools into modern educational environments capable of meeting the challenges of the digital society.

REFERENCES

1. Матвієнко Л., Хоменко Л. Застосування краудсорсингу під час викладання філологічних дисциплін у системі вищої освіти: монографія / Педагогічні науки: теорія, історія, інноваційні технології, 2020, № 5–6 (99–100), с. 117–126.
2. Петренко Л. М., Шевченко В. П., Зеліковська О. О. Використання педагогічних крауд-технологій у професійній підготовці студентів ІТ-спеціальностей // Інформаційні технології і засоби навчання. 2020. Том 76, № 2. С. 213–235.
3. Химиця Н. О., Устиянович Т. О. Краудсорсинг як механізм оптимізації навчально-наукового процесу у вищій школі: матеріали 10-ї науково-технічної конференції «Інноваційні комп'ютерні технології у вищій школі», Львів, 2018.

**INVESTIGATION OF THE INTERNAL STRUCTURE OF LEIBNIZ
STRUCTURES AND THEIR MODELING
IN COMPUTER ALGEBRA SYSTEMS**

The mathematical transition from field-based classical Lie algebras to non-associative topological spaces necessitates the operational study of Leibniz structures. The defining architectural characteristic of a classical Lie algebra is the presence of a bilinear bracket operation that strictly enforces antisymmetry. Leibniz algebras fundamentally relax this rigid constraint while preserving a non-commutative iteration of the Jacobi identity, universally classified as the Leibniz identity. The total absence of antisymmetry mathematically demands the introduction of specific algebraic ideals to stabilize the structure, primarily the abelian ideal generated by elements of the explicit form $[x, x]$, which dictates the topological deviation of the Leibniz algebra from a classical Lie geometry [2, p. 45].

Let an algebra over a specified field be equipped with the binary bracket operation. The structure is mathematically classified as a left Leibniz algebra if the bracket inherently satisfies the explicit fundamental identity for all elements:

$$[x, [y, z]] = [[x, y], z] + [y, [x, z]]. \quad (1)$$

Derivations exclusively govern how the internal geometric structure of such an algebra formally evolves under applied linear mapping transformations. Within the context of Leibniz algebras, inner derivations command a decisive theoretical function regarding the absolute mathematical characterization of complete structures. The total algebra of inner derivations belonging to a specific Leibniz algebra can be mathematically decomposed into the direct sum of the designated algebra of left multiplications and a localized internal ideal [1, p. 8]. A highly advanced natural extension of standard derivation theory is the study of biderivations, which consist of coupled pairs of linear maps strictly adhering to mathematical compatibility constraints. For multidimensional

nilpotent complex Leibniz algebras, biderivations determine exactly how the algebra dynamically reacts under coupled linear mappings [5, p. 12].

The mathematical process of affinization translates these classical algebraic structures into continuous affine-space structures. The direct affinization of Leibniz algebras yields complex structures termed Leibniz affgebras. A Leibniz affgebra integrates a continuous affine space directly with a bi-affine mathematical operation explicitly termed the affine Leibniz bracket [3, p. 331]. Furthermore, advanced theoretical physics strictly requires algebras capable of continuous mathematical deformation. The highly specialized δ -Leibniz algebras function as a direct parametric generalization of classical Leibniz algebras, governed by a defining scalar field variable [1, p. 14].

Table 1

Structural Comparison of Generalized Non-Associative Algebras

Algebraic Typology	Core Identity Mechanism	Primary Operadic Dual	Structural Symmetry Constraint
Leibniz Algebra	Non-antisymmetric	Zinbiel Algebra	Modulated Symmetry
Lie Algebra	Strictly Antisymmetric	Commutative Algebra	Absolute Constraint
δ -Leibniz Algebra	Parametric scalar deformation	δ -Zinbiel Algebra	Scalar-Governed
Ternary Leibniz	Trilinear n-ary derivation	n-Zinbiel Operads	Centroid-Bounded

The categorical data rigorously presented in Table 1 explicitly demonstrates the strict hierarchical progression of structural complexity inherent in non-associative geometry. The classical Lie algebra demands absolute antisymmetry, which immediately constrains the topological phase space. The standard Leibniz algebra removes this constraint, actively shifting the operative dual to the Zinbiel operad. The transition to parametric δ -Leibniz algebras introduces a modulated symmetry constraint governed entirely by the scalar field, directly manipulating the behavior of the internal biderivations. Finally, the ternary Leibniz structure expands the identity mechanism to a trilinear field, forcing all geometric symmetry constraints to be strictly governed by the dimensionality of the centroid and quasi-centroid [2, p. 112]. This specific hierarchical mapping dictates the precise matrix logic required to process these structures algorithmically.

The sheer geometric and combinatorial density of abstract structure constants residing within high-dimensional Leibniz algebras renders entirely manual mathematical computation intractable. This establishes an absolute operational necessity for robust Computer Algebra Systems (CAS). The primary computational environments currently utilized globally for computational discrete algebra include the GAP system, Maple software, and Mathematica natively powered by Wolfram technologies.

GAP is purposefully optimized from its foundational codebase for computational discrete algebra and complex group theory. Its internal operational programming language processes finite-dimensional algebras strictly via explicitly declared structure constants. When operating on fluid Leibniz algebras, the absolute lack of associative mathematical guarantees requires the CAS to transition through specific functions, such as Mutable Basis Of Closure Under Action, to definitively prevent recursive memory overflow caused by infinite bracket expansions [4, p. 21].

Conversely, Maple provides highly structural, purely symbolic libraries engineered explicitly for applied algebraic combinatorics and tensor mechanics. The rigorous algorithmic processing of paired biderivations for nilpotent complex Leibniz algebras heavily utilizes Maple's advanced tensor manipulation environments. The software systematically solves massive paired matrix equations rigidly relative to strictly fixed functional bases and expertly handles overdetermined partial differential equation systems [5, p. 14].

Mathematica approaches complex non-associative geometry entirely through the integration of highly specialized digital architectures. The globally recognized NCAAlgebra package natively facilitates the direct computational manipulation of strictly non-commutative algebraic variables. Testing massive multiplication tables explicitly for multi-dimensional Leibniz δ -algebras consistently utilizes Mathematica's capability to construct exact Gröbner bases functioning strictly within noncommutative associative algebras [1, p. 18].

Despite these advanced functionalities, absolutely no single native CAS environment provides a unified, structurally complete software framework for executing full-spectrum Leibniz algebra modeling. GAP dominates discrete classification processing

tasks over finite fields, Maple natively resolves continuously variable matrix equations for mapping biderivations, and Mathematica generates universal enveloping algebras via Gröbner bases. The explicit algorithmic resolution of dense matrix equations engineered for computing biderivations and executing invariant isomorphism testing categorically requires complex computational workarounds bridging across these disjointed platforms.

The algorithmic methodologies strictly necessary to compute abstract derivations accurately and classify multi-dimensional nilpotent Leibniz algebras unequivocally demand the architectural construction of a completely unified CAS software package. Implementing bespoke multidimensional non-symmetric array memory structures will definitively eliminate the massive processing bottlenecks inherent to current digital methodologies, exclusively permitting the algebraic classification of extremely high-dimensional symmetric Leibniz algebras.

REFERENCES

1. Adashev J., Kaygorodov I. δ -Leibniz algebras and related δ -type algebras. arXiv preprint arXiv:2602.21210. 2026. 22 p.
2. Ayupov S., Omirov B., Rakhimov I. Leibniz Algebras: Structure and Classification. Taylor & Francis. 2024. 320 p.
3. Brzeziński T., Radziszewski K., Ramos Pérez B. Affinization of algebraic structures: Leibniz algebras. Journal of Algebra. 2026. Vol. 693. P. 329–361.
4. GAP System. LOOPS package for nonassociative structure computation. Version 3.4.4. 2024. 45 p.
5. Zahari Abdou A., Mosbahi B. Computational methods for biderivations of 4-dimensional nilpotent complex Leibniz algebras. arXiv preprint arXiv:2501.10887. 2025. 24 p.

S. Fisun, S. Klymenko, N. Kaliberda

THE IMPACT OF CYBERCRIME ON THE NATIONAL ECONOMY AND BUSINESS

Cybercrime encompasses a wide range of illegal activities carried out using digital devices or networks. Such criminals exploit vulnerabilities in computer networks and systems to gain unauthorized access, steal confidential information, disrupt services, and cause financial or reputational harm to individuals, organizations,

and governments. Cybercrime is an illegal act committed by a person in cyberspace using computer networks, which is prohibited by current legislation.

According to the FBI's Internet Crime Complaint Center in 2024, over 859,000 cybercrime complaints were reported, and total losses exceeded USD 16 billion, which shows a 33% increase in losses from that of 2023. According to the IC3, the total loss in the last five years was 3.5 billion, 4.2 billion, 6.9 billion, 10.3 billion, and 12.5 billion, respectively. As technology advances incrementally, so do the associated attacks, like AI-generated attacks, deep fakes, 5G network vulnerabilities, and crypto-jacking. Therefore, to get around this dynamic nature of cybercrimes, proactive measures should be opted for [1, p. 1]. Digital threats have developed into a serious crisis for the private sector and government agencies. As the number of state-sponsored hackers continues to climb and they now target national infrastructure, we are witnessing a shift in which cyber warfare directly undermines national sovereignty.

Loss of GDP and economic growth slowdown. In 2014, taking into account the full range of costs, The Center for Strategic and International Studies estimated that cybercrime cost the world between \$345 billion and \$445 billion. As a percentage of global GDP, cybercrime cost the global economy 0.62% of GDP in 2014. Using the same methods, CSIS now believes the range is now between \$445 billion and \$600 billion. Second effort at a global estimate suggests that as a percentage of global GDP, cybercrime cost the global economy 0.8% in 2016, [4, p.6]. The cost of cybercrime is unevenly distributed among all the countries of the world. CSIS found variations by region, income levels and level of cybersecurity maturity. Unsurprisingly, the richer the country, the greater its loss to cybercrime is likely to be. The relationship of the developing world to cybercrime is complex, as the mobile connections that have brought the internet to millions are easily exploitable, but the value that can be extracted from these connections remains relatively low, and weak defenses in wealthier countries mean that is where criminals focus their attention. The countries with the greatest losses from cybercrime (as a percentage of national income) – are digitized but not yet fully capable in cybersecurity [4, p.7].

Increased government spending on cybersecurity. Governments are facing rising costs associated with responding to cyber incidents, implementing security measures,

and carrying out recovery efforts. The “WannaCry” cyberattack in 2017 cost the UK National Health Service 92 million pounds. Similar attacks in European Union countries resulted in public spending of several billion euros. A 2023 IMF econometric study using data from 32 OECD countries found that cybercrime exposure correlates with a measurable drag on productivity growth, contributing to a 0.3 percent annual reduction in total factor productivity across high-income economies. Over a decade, this cumulative loss approaches 3 percent of GDP—equivalent to erasing a full year of economic expansion. Similarly, a 2024 Harvard Kennedy School working paper calculated that if global cybercrime losses continue at current rates, they could shave up to \$10 trillion from global GDP by 2030, roughly equal to the combined economies of Japan and Germany [3].

Impact on Businesses. The growth of remote work and cloud technologies has increased the vulnerability of small businesses to cyberattacks. For smallest businesses, cyber risks such as phishing and ransomware are major concerns, as they cannot invest as much in cybersecurity as large companies. In response, many small businesses are taking proactive measures to combat these threats. While some are improving their supply chains and developing emergency plans, others are investing in cybersecurity tools and services to protect themselves against potential attacks.

Conclusion. In summary, cybercrime represents a serious and growing threat to both national economies and businesses worldwide. Its impact goes well beyond direct financial losses and affects economic stability, innovation, and public trust. From data breaches and industrial espionage to large-scale attacks on critical infrastructure, cyber threats disrupt normal operations and force governments and organizations to dedicate significant resources to security and recovery. Furthermore, the indirect consequences – a reduction in investment in development sectors, slower technological progress, and reputational damage – further highlight the seriousness of the problem.

REFERENCES

1. 6 Biggest Cybercrime Cases of All Time. *Overt Software Solutions*. URL: <https://www.overtsoftware.com/6-biggest-cybercrime-cases-of-all-time/> (date of access: 24.03.2026).

2. Abdullah, M.; Nawaz, M.M.; Saleem, B.; Zahra, M.; Ashfaq, E.b.; Muhammad, Z. Evolution Cybercrime – Key Trends, Cybersecurity Threats, and Mitigation Strategies from Historical Data. *Analytics* 2025, 4, 25. DOI: <https://doi.org/10.3390/analytics4030025>
3. How Cybercrime Drains Global Growth. *Institute of Internet Economics*. URL: <https://instituteofinterneteconomics.org/how-cybercrime-drains-global-growth> (date of access: 24.03.2026).
4. Lewis J. Economic Impact of Cybercrime – No Slowing Down. *Center for Strategic and International Studies*. 2018. URL: <https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/economic-impact-cybercrime.pdf> (date of access: 23.03.2026).
5. Top Cyber Security Case Studies in Europe. *London School of Management and Technology*. URL: <https://lsmt.org.uk/blog/top-cyber-security-case-studies-in-europe> (date of access: 24.03.2026).

P. Hovorukha, O. Trofimov, O. Novikova

GALERKIN FINITE ELEMENT AND MULTIGRID METHODS FOR THE DYNAMIC LAMÉ SYSTEM ON CURVILINEAR DOMAINS

The numerical treatment of the dynamic Lamé system in elastic solids is commonly based on a Galerkin finite element discretization [1]. In linear elastodynamics, the weak formulation derived from the principle of virtual work leads to a semi-discrete system involving the mass and stiffness matrices [1]. For implicit time-integration schemes, such as the implicit variant of the Newmark method, the unknown displacement at each new time level is obtained by solving a linear algebraic system [1]. For domains with curved or otherwise geometrically complex boundaries, boundary-conforming curvilinear meshes are important because they simplify the imposition of boundary conditions; moreover, structured boundary-conforming grids may be generated either algebraically from the boundary or by solving auxiliary partial differential equations [2]. In this setting, multigrid methods provide a natural framework for accelerating the solution of the linear systems arising from the implicit discretization. Historically, the coarse-grid correction idea is commonly traced to Fedorenko [3], while Brandt developed the modern systematic multilevel framework based on discretizations on several grids or finite-element spaces of different mesh sizes [4]. In the context of elasticity, this direction was developed, for example, by Brenner, who constructed an optimal-order

multigrid method for the pure displacement problem in two-dimensional linear elasticity [5].

The aim of the present work is to study the application of Galerkin finite element discretization and multigrid solution methods to the numerical solution of the dynamic Lamé system in a geometrically complex domain represented by a boundary-fitted curvilinear mesh. The specific objectives are to construct an appropriate spatial discretization of the problem, to investigate mesh-refinement convergence of the numerical solution in the L^2 norm and in an energy norm, to perform an error analysis with respect to the mesh parameter h , and to assess computational efficiency by analyzing wall-clock time as a function of the mesh size and the total number of degrees of freedom.

REFERENCES

1. A. F. Bower, *Applied Mechanics of Solids*. Boca Raton, FL: CRC Press, 2009, Chapter 8.2.
2. J. F. Thompson and N. P. Weatherill, "Fundamental Concepts and Approaches," in *Handbook of Grid Generation*, J. F. Thompson, B. K. Soni, and N. P. Weatherill, Eds. Boca Raton, FL: CRC Press, 1999, Chapter 1, Sec. 1.2.
3. R. P. Fedorenko, "The speed of convergence of one iterative process," *U.S.S.R. Computational Mathematics and Mathematical Physics*, vol. 4, no. 3, pp. 227–235, 1964.
4. A. Brandt, "Multi-Level Adaptive Solutions to Boundary-Value Problems," *Mathematics of Computation*, vol. 31, no. 138, pp. 333–390, 1977.
5. S. C. Brenner, "A Nonconforming Mixed Multigrid Method for the Pure Displacement Problem in Planar Linear Elasticity," *SIAM Journal on Numerical Analysis*, vol. 30, no. 1, pp. 116–135, 1993.

V. Hrytsenko, A. Kutovy

THE ETHICAL CHALLENGES OF USING AI IN EDUCATION

The rapid spread of artificial intelligence into the educational environment has created a new landscape in which learning is increasingly shaped by algorithms. While AI-based systems offer impressive advantages – such as personalized feedback, adaptive learning pathways, and efficient organization of classes – their integration also raises several difficult ethical questions. Many of these challenges are connected to how AI models function, what data they rely on, and how educational institutions

choose to use them. Education is particularly sensitive because it deals with children, long-term developmental processes, and highly personal information.

One of the central ethical issues is data privacy. AI systems in schools often require detailed information about students: their performance patterns, behavior during tasks, and even emotional reactions captured through interactive platforms. If this data is mishandled or insufficiently protected, students may face long-term risks – particularly if sensitive information is not anonymized or retained longer than necessary. Publicly available research notes that the implementation of AI comes with several ethical challenges, “such as data protection, algorithmic bias, deepening social inequality, replacement of the human factor, and questions of accountability” [3]. This emphasizes that privacy is only one of many interconnected concerns when introducing AI into classrooms.

Closely connected to data privacy is the problem of algorithmic bias. Machine-learning models often reproduce patterns present in their training data, which can lead to unfair or distorted outcomes. In education, this may affect automated essay scoring, placement decisions, recommendation systems, or personalized learning paths. Research on algorithmic fairness in educational settings stresses the importance of transparency and explainability. However, many platforms used in schools do not disclose how their models make decisions or what data they rely on. This creates a situation where students may be evaluated by systems whose internal logic is not accessible or verifiable, raising concerns about equity and justice.

Another important ethical challenge concerns accountability. When an AI system offers incorrect feedback, misjudges a student’s ability, or produces an unfair prediction, it is not obvious who should be responsible. Algorithms, despite their apparent autonomy, lack the moral judgment and contextual understanding inherent to human decision-makers. This means that responsibility ultimately falls on institutions and developers – but in practice, clear accountability structures are often missing. Educational environments adopt AI tools faster than policies are created, leading to uncertainty about how to address errors or disputes involving automated systems.

The question of academic integrity has also become increasingly relevant. With the emergence of generative tools capable of producing texts, solving tasks, or explaining material, students may be tempted to rely on AI instead of engaging in meaningful learning. Analysts describe this as a form of cognitive outsourcing, where thinking and writing are delegated to machines. The long-term effect may be a weakening of students' analytical and expressive abilities. This creates a dilemma for educators: AI can significantly support learning, but excessive use risks undermining the very purpose of education. Schools now need clearer definitions of legitimate assistance versus academic misconduct.

Ethical considerations extend further into the sphere of emotional and social development. Education is not solely the transfer of knowledge; it is also grounded in communication, empathy, and the teacher-student relationship. AI-driven tutoring systems, even when effective, lack the emotional sensitivity and contextual awareness that human educators naturally provide. Some systems attempt to analyze emotions through voice or facial expressions, but the accuracy and reliability of such technologies remain highly questionable. Misinterpretation of a student's emotional state can lead to inappropriate feedback or interventions, highlighting the risks of overrelying on automated emotional analytics.

Another critical point concerns the changing role of teachers. AI is often introduced as a tool to reduce workload, automate grading, or provide individualized instruction. While this can free teachers from repetitive tasks, it may also shift the balance of authority in the classroom. If algorithms become central to assessment or planning, educators risk losing influence over core pedagogical decisions. Many analyses emphasize that AI should function as an assistant rather than a replacement. Maintaining the human component of education is essential, because teachers contribute empathy, cultural awareness, and ethical judgment – qualities that AI cannot replicate.

AI in education offers powerful opportunities but also introduces ethical challenges that require careful consideration. Issues of privacy, bias, accountability, academic integrity, emotional well-being, and the future structure of teaching must be addressed before such systems can be widely and responsibly adopted. Responsible adoption

requires transparency from developers, strict data-protection standards, continuous auditing of algorithms, and clear guidelines for educators. AI can support and enhance learning – but only when its use aligns with the fundamental values of fairness, autonomy, and human-centered education.

REFERENCES

1. AI Superpowers: China, Silicon Valley, and the New World Order / Kai-Fu Lee. *AI Superpowers: China, Silicon Valley, and the New World Order*. Boston: Houghton Mifflin Harcourt, 2018. 272 p.
2. UNESCO. *Guidance for Generative AI in Education and Research*. Paris: UNESCO, 2023. 64 p.
3. Eurasian Science Review. Ethical Challenges of AI in Education. *Eurasian Science Review*. 2023. №3. P. 45–52.
4. MIT Technology Review. AI in Education: Risks and Possibilities. *MIT Technology Review*. 2023. URL: <https://www.technologyreview.com/> (дата звернення: 09.04.2026).

A. Husiev, V. Klym, O. Novikova

ISSUES OF IMPROVING THE EFFICIENCY OF EMBEDDED CONTROL SYSTEMS WITH A COMPUTER VISION MODULE

The rapid development of autonomous robotics and unmanned aerial vehicles (UAVs) requires advanced computer vision (CV) modules. Today, these algorithms are increasingly deployed directly on edge devices using Edge Computing and TinyML concepts [1]. This allows systems to operate independently without relying on cloud servers, which is crucial for real-time applications.

Globally, the deployment of such systems emphasizes the critical trade-off between inference accuracy and latency [3]. In Ukraine, this research has reached a level of critical national importance, particularly for the development of autonomous UAVs and target-tracking ground robotic platforms. While Ukrainian scientists have achieved significant results in machine learning and image processing [4], these tasks are predominantly addressed in the context of offline analysis or data transmission, leaving a gap in real-time dynamic control integration.

However, integrating complex neural networks into microcontrollers with limited memory and processing power is a challenging task. To make models run faster and fit into these devices, developers use compression techniques like quantization and pruning [2]. While compression significantly reduces the inference time (latency), it introduces a critical issue: it creates stochastic noise, often observed as high-frequency jitter in the objects detected coordinates. This jitter becomes a major problem when the vision module is connected to a closed-loop control system.

In classical automatic control theory, a video sensor acts as a delay link. To prevent the system from becoming unstable due to this delay, developers compress the model. However, the resulting quantization noise (the mentioned jitter) severely disrupts the control algorithms. Because the control system rapidly reacts to these false coordinate fluctuations, it causes chaotic movements of the actuators and destabilizes the autonomous object. Therefore, optimizing neural networks using only machine learning metrics, without considering the physical dynamics of the object, is not effective. As highlighted in recent studies [5], quantized models become significantly less robust to external disturbances, posing a direct threat to the physical safety and stability of the control system.

To solve this issue, we propose a comprehensive and practical approach. Instead of analyzing the neural network and the control system separately, we focus on a step-by-step evaluation combining Data Science and control theory. This approach includes the following practical steps:

1. Creating a digital twin of the object using physical engines (such as MuJoCo) in simulation environments (like Unity) to ensure realistic physics.
2. Synthesizing ideal control parameters using virtual sensors to obtain reference data.
3. Simulating the system with an uncompressed neural network (Vision-in-the-loop) to evaluate the impact of pure inference delay.
4. Emulating the compressed TinyML models to test their performance before hardware deployment.
5. Conducting Hardware-in-the-loop (HIL) testing on real controllers (e.g., NVIDIA Jetson, Raspberry Pi, or STM32) with a physical object.

6. Performing a comprehensive comparative analysis of the experimental results against the reference data to evaluate the impact of neural network compression on control quality metrics, such as overshoot, settling time, and stability margins.

This practical step-by-step approach allows engineers to find the optimal trade-off between the neural networks computational speed and the control systems stability. By testing the compressed models in a simulated physical environment before real-world deployment, developers can significantly improve the overall reliability, safety, and efficiency of embedded control systems in autonomous devices.

REFERENCES

1. El Zeinaty, C., Hamidouche, W., Herrou, G., & Menard, D. (2024). Designing object detection models for TinyML: Foundations, comparative analysis, challenges, and emerging solutions. *ACM Computing Surveys*, 56(8), 1–46. <https://doi.org/10.1145/3744339>
2. Jiang, B., Chen, J., & Liu, Y. (2023). Single-shot pruning and quantization for hardware-friendly neural network acceleration. *Engineering Applications of Artificial Intelligence*, 126(Part B), Article 106816. <https://doi.org/10.1016/j.engappai.2023.106816>
3. Park, J., Kim, P., & Ko, D. (2025). Real-time open-vocabulary perception for mobile robots on edge devices: A systematic analysis of the accuracy-latency trade-off. *Frontiers in Robotics and AI*, 12, Article 1693988. <https://doi.org/10.3389/frobt.2025.1693988>
4. Kashtan, V., Hnatushenko, V., Udovyk, I., & Shevtsova, O. (2023). Rozpiznavannia ta monitorynh vodnykh ob'ektiv na optychnykh sputnykovykh zobrazhenniakh iz vykorystanniam mashynnoho navchannia [Recognition and monitoring of water objects on optical satellite images using machine learning]. *Information Technology: Computer Science, Software Engineering and Cyber Security*, 3, 32–42. <https://doi.org/10.32782/IT/2023-3-4>
5. De Prado, M., Rusci, M., Capotondi, A., Donze, R., Benini, L., & Pazos, N. (2021). Robustifying the deployment of tinyML models for autonomous mini-vehicles. *Sensors*, 21(4), Article 1339. <https://doi.org/10.3390/s21041339>

K. Kornieva, T. Vorova

MODERN TRENDS IN WEB DESIGN

Modern web design constantly evolves in response to technological innovations, user expectations, and the rapid expansion of digital communication. In recent years, the focus has shifted from purely aesthetic solutions to creating highly functional, accessible, and user-centered interfaces. These changes encourage designers to integrate simplicity, efficiency, and emotional engagement into modern web products.

One of the leading trends is the dominance of minimalistic design. It prioritizes clarity, structured layouts, and the reduction of unnecessary elements, making digital platforms intuitive and easy to navigate. Minimalism not only improves visual perception, but also enhances performance by reducing loading time, which is crucial for retaining users in the digital environment.

Another important direction is the integration of accessibility principles. Inclusive design aims to ensure that websites are usable for people with visual, auditory, motor, or cognitive impairments. According to modern guidelines, accessible interfaces must include clear typography, sufficient color contrast, alternative text for images, keyboard navigation, and correct semantic markup [1, p. 22]. The implementation of these principles improves usability for all categories of users.

A significant trend is the growing importance of responsive and adaptive design. With the increasing variety of devices and screen sizes, websites must automatically adjust to provide a seamless user experience. Flexible grids, scalable images, and fluid typography help achieve consistent functionality across smartphones, laptops, and large displays.

Additionally, modern web design relies on data-driven decision-making. Designers analyze user behavior, heatmaps, scroll depth, and interaction patterns to improve interface efficiency. Artificial intelligence tools support personalization and automate the creation of layouts, significantly accelerating development processes [2, p. 41].

Another noteworthy trend is the growing role of animation and microinteractions in enhancing user engagement. Subtle motion effects, such as hover states, button feedback, smooth page transitions, and animated icons, provide users with immediate visual responses to their actions. These elements create a sense of continuity and support intuitive navigation. Properly implemented microinteractions help guide user attention, reduce cognitive load, and make the interface feel more dynamic and responsive without overwhelming the visual composition [3, p. 57]. Motion design has therefore become an essential tool for improving both functionality and emotional appeal in modern web environments.

In conclusion, modern trends in web design reflect a move toward simplicity, inclusiveness, and technological optimization. These tendencies enhance the usability,

accessibility, and emotional appeal of digital platforms, ensuring that web resources remain relevant and efficient in the rapidly changing digital world.

REFERENCES

1. Caldwell B., Cooper M., Reid L. Web Content Accessibility Guidelines (WCAG) 2.1. W3C Recommendation, 2018. 45 p.
2. McDowell E. Data-Driven UX: How Analytics Improve User Experience. London: UX Press, 2020. 156 p.
3. Patel R. *Motion Design for the Web: Enhancing User Experience Through Microinteractions*. New York: Digital Design Press, 2021. 128 p.

N. Korziukov, V. Pererva, O. Novikova

COMPARATIVE ANALYSIS OF ELECTRON BEAM SINTERING WITH OTHER TECHNOLOGIES FOR CREATING RCT PARTS AND COMPONENTS

The paper considers the potential application of electron beam melting for manufacturing components used in aerospace engineering. A comparative analysis of this technology with conventional manufacturing methods and other additive technologies, particularly selective laser melting and selective laser sintering, is carried out. It is shown that the use of a vacuum environment during the electron beam melting process provides more favorable conditions for processing reactive materials such as titanium alloys, which are widely used in aerospace applications. The main advantages and limitations of the technology are identified, and its position among modern additive manufacturing methods for producing complex geometry components is defined.

With each decade, the range of challenges facing the aerospace industry continues to expand. This necessitates the introduction of advanced manufacturing technologies capable of ensuring high precision, mechanical strength, and weight reduction of structures, as well as the optimization of production processes. One of the most promising areas is the use of additive manufacturing technologies, which enable

the fabrication of components with complex geometries without the need for traditional technological equipment. Among these technologies, particular attention is given to electron beam melting (EBM), which enables the formation of parts through the layer-by-layer consolidation of powder materials using a focused electron beam [2].

A distinctive feature of EBM technology is that the fabrication process is carried out in a vacuum environment. This significantly reduces oxidation and gas absorption during processing, which is critically important for reactive metals, particularly titanium and its alloys, widely used in rocket and space technology [3]. In addition, the process involves preheating of the powder bed, which reduces thermal gradients, lowers residual stresses, and enhances the stability of the fabrication process. As a result, components with high material density and favorable mechanical properties can be obtained. However, EBM also has certain limitations, including high equipment cost, the requirement for vacuum operation, strict constraints on part dimensions, limited material availability, and higher demands on personnel qualifications [5].

Compared to conventional manufacturing methods such as casting, machining, and powder metallurgy, additive technologies enable the production of components with complex geometries, including internal channels, porous structures, and topology-optimized designs, while minimizing material waste. The additive technologies most closely related to EBM are selective laser melting (SLM) and selective laser sintering (SLS), which are typically performed in an inert gas atmosphere [4]. However, the use of laser energy sources is associated with significant thermal gradients, which may lead to the development of residual stresses and distortions in manufactured parts. In contrast, EBM employs a high-energy electron beam in a vacuum environment, providing more favorable conditions for processing titanium and heat-resistant alloys. At the same time, the technology has certain limitations related to high equipment cost, the necessity of vacuum conditions, restrictions on part size, and the need for post-processing.

Thus, electron beam sintering occupies an important niche among modern additive manufacturing technologies for aerospace components [1]. The use of a vacuum environment provides favorable conditions for processing reactive materials, making

this method particularly promising for the production of components from titanium and heat-resistant alloys. Further research in this area will contribute to expanding the range of materials and applications, optimizing processing parameters, and improving the quality of manufactured aerospace components.

REFERENCES

1. Векілов С. Ш., Ліповський В. І. Особливості розвитку методів адитивного виробництва у застосуванні до РПД. *Journal of Rocket-Space Technology*. 2023. Т. 32, № 4. С. 23–38. DOI: <https://doi.org/10.15421/452326>
2. Сонець О., Воронцов Б. Особливості виготовлення деталей адитивними технологіями з металевих сплавів: аналітичний огляд. *Mech. Adv. Technol.* 2025. Т. 9, № 2(105). С. 185–194. DOI: [https://doi.org/10.20535/2521-1943.2025.9.2\(105\).326824](https://doi.org/10.20535/2521-1943.2025.9.2(105).326824)
3. Froes F., Boyer R. *Additive Manufacturing for the Aerospace Industry*. Amsterdam : Elsevier, 2019. 464 p.
4. Hiemenz J. Electron Beam Melting. *Advanced Materials and Processes*. 2007. Vol. 165. P. 45–46.
5. Körner C. Additive manufacturing of metallic components by selective electron beam melting – a review. *International Materials Reviews*. 2016. P. 361–377. DOI: <https://doi.org/10.1080/09506608.2016.1176289>

A. Kostiuchenko, V. Gerasymov, O. Novikova

DEEP LEARNING MODEL FOR TIME SERIES FORECASTING

Deep learning has fundamentally transformed the landscape of time series forecasting by shifting the focus from linear statistical approaches to flexible neural architectures capable of capturing non-linear temporal dynamics. The evolution of these models began prominently with the Long Short Term Memory network which became the standard for many years because it effectively addressed the vanishing gradient problem. By utilizing a sophisticated gating mechanism to regulate the flow of information, LSTMs allowed the model to decide which past observations were critical to retain and which could be discarded. This was followed by the development of the Gated Recurrent Unit or GRU, which offered a more robust architecture. By merging the cell state and hidden state and reducing the number of gates, GRUs provided a computationally efficient alternative that often achieved comparable

performance to LSTMs, making them a popular choice for real time applications where resource constraints were a factor.

As the field progressed, the limitations of recurrent architectures regarding parallelization and long-range dependencies led to the adoption of the Transformer framework. The Transformers utilize self-attention mechanisms to weigh the significance of every previous time point simultaneously. Mentioned shift allowed for significantly deeper models that could identify complex seasonal patterns and trends across much larger windows of historical data. Recent studies show that generative pre-trained models for numerical sequences, especially the TimeGPT architecture, now represent the most impactful advancement and considered to be the cutting-edge technology in this trajectory [2, 3]. While previous models like LSTMs or standard Transformers required extensive training on a specific dataset to produce accurate results, TimeGPT is trained on a massive diverse corpus of over one hundred billion data points.

The architecture of TimeGPT is built upon a large-scale decoder-only Transformer structure that enables zero shot inference. This means the model can produce highly accurate forecasts on entirely new datasets it has never seen before during training, without requiring the user to undergo the computationally expensive process of fine tuning. TimeGPT identifies underlying temporal hierarchies and global patterns by treating time series data similarly to how Large Language Models treat text. This capability addresses one of the primary challenges in deep learning for time series, which is the scarcity of high-quality labelled data in certain domains. Instead of building a model to face every end, practitioners can now leverage a pre-trained global model that understands the general properties of seasonality, trend, and noise.

Despite the power of these advanced architectures, the transition to deep learning in advanced forecasting requires careful consideration of data stationarity and normalization. Neural networks are highly sensitive to the scale of input data, and while foundation models like TimeGPT incorporate robust internal scaling, traditional deep learning approaches still require rigorous preprocessing. The future of the field appears to be moving toward a total integration of these foundation models, where the primary

task shifts from designing architecture to optimizing the prompts and historical windows provided to global models.

REFERENCES

1. Kostiuchenko A.D. & Gerasymov V.V. (2025). Computer models for time series forecasting. DOI: [https://doi.org/10.30837/bi.2025.2\(103\).02](https://doi.org/10.30837/bi.2025.2(103).02)
2. Garza, A., Challu, C., & Mergenthaler-Canseco, M. (2023). TimeGPT-1. arXiv preprint arXiv:2310.03589.
3. Liu, Y., Zhang, H., Li, C., Huang, X., Wang, J., & Long, M. (2024). Timer: Generative pre-trained transformers are large time series models. arXiv preprint arXiv:2402.02368.

M. Koverzhenko, M. Tkachenko, N. Kaliberda

MATHEMATICS AS A TOOL FOR DEVELOPING CRITICAL THINKING IN STUDENTS

In modern education, it is crucial to help students develop the ability to think critically. This means being able to analyze information, verify its reliability, draw independent conclusions, and make well-grounded decisions. We live in a time when information is abundant and rapidly changing. Therefore, the development of critical thinking becomes not only an educational goal but also a necessary condition for shaping an active and responsible personality.

Mathematics, in this context, serves as the universal language of science, combining accuracy, logic, and consistency. It not only equips students with technical skills but also fosters the ability to think sequentially, recognize patterns, build reasoned conclusions, and apply abstract models to explain real phenomena.

Solving mathematical problems, constructing proofs, and working with formulas contribute to the development of analytical thinking, the ability to ask questions, and to find answers – which is the foundation of a critical approach to any information.

An important component of modern interdisciplinary education is the formation of critical thinking skills. This type of thinking relies on the ability to objectively

analyze data, evaluate evidence, identify patterns, and make reasoned conclusions. Its structure includes various cognitive skills: interpretation, analysis, evaluation, inference, explanation, and self-regulation [1, p. 9].

Critical thinking can be viewed as a purposeful process, the main task of which is problem-solving and overcoming challenges. Its essence lies in the use of specific cognitive operations and techniques, such as analysis, synthesis, and evaluation. These skills are applied both to one's own thoughts and results of activity, as well as to the comprehension of information related to the reasoning and actions of others [2, p. 196].

Critical thinking is an integral part of many educational processes that ensure their effectiveness. Teachers who improve their pedagogical practice so that students not only acquire knowledge but also develop as individuals capable of critical thinking are moving in the right direction. Their goal is for students not to limit themselves to rote memorization of textbook material but to form their own conclusions, carry out analysis, and strive to discuss the learning content with teachers or peers. This approach is considered one of the most effective in modern education [3, p. 23].

Despite the substantive importance of mathematics in shaping critical thinking, logic, and various cognitive abilities, students often perceive it as difficult and confusing. A lack of understanding of basic mathematical concepts may lead young people to stop analyzing information deeply, fail to calculate even simple expressions, and be unable to apply logic to solve practical tasks in life.

One of the reasons for this situation is the stereotypical perception of mathematics as a set of formulas and rules to be memorized. As a result, students often fail to see the connection between mathematical knowledge and real life, not realizing that each problem or theorem is an exercise in critical thinking – in asking questions and finding reasoned answers.

Since mathematics covers many different topics and concepts, it is worth focusing on several that are particularly important for the development of students' critical thinking.

Examples of tasks that directly contribute to the development of critical thinking include solving word problems that require careful analysis of conditions and the search

for logical connections between data. Equally important are problems involving percentages, as they have practical applications in finance and everyday life. Systems of linear equations are also significant, as they develop skills in working with multiple variables simultaneously and teach students to find optimal solutions. Addition and subtraction of fractions, seemingly simple operations, foster accuracy, attentiveness, and the ability to work with abstract concepts – which form the basis of logical thinking.

Thus, critical thinking is one of the key competencies of modern education, without which it is impossible to form an active, responsible, and independent personality. Mathematics plays a special role in this process, as it combines precision, logic, and consistency, and develops the ability to analyze, argue, and build well-founded conclusions. Solving problems of various types – from word problems to systems of linear equations – contributes to the development of analytical thinking, attentiveness, and the ability to apply knowledge in practical situations.

Although mathematics is often perceived by students as a complex and abstract discipline, it is in fact a powerful tool for developing critical thinking. Overcoming stereotypes about its “detachment from life” and using practically oriented tasks makes learning more meaningful and closer to the real needs of students.

REFERENCES

1. Фолкьян В. В., Мочалов О. О. Развитие критического мышления учнів 5-х класів на уроках математики: теоретико-методологічний аспект // Topical aspects of modern scientific research. Proceedings of the 12th International scientific and practical conference. CPN Publishing Group. Tokyo, Japan. 2024. P. 196-202.
2. Коршевнік Т. В., Абрамчук О. М., Добротка О. В. Стратегії інтеграції міждисциплінарних підходів у викладанні біології для підвищення критичного мислення здобувачів освіти // Педагогічна академія: Наукові записки. Теорія та методика навчання. 2025. DOI: <https://doi.org/10.5281/zenodo.12820105>
3. Захаров А. В. Развитие критического мышления учнів базової школи на основі інтеграції фізико-математичних знань: кваліфікаційна робота магістра / наук. керівник: Міцаєв Ю. П. Запорізький національний університет, кафедра загальної та прикладної фізики. Запоріжжя, 2021.

FLIGHT SIMULATION SOFTWARE FOR STRAPDOWN INS OF LIGHT LAUNCH VEHICLES

Modern light launch vehicles (LTVs) have strict requirements for onboard navigation accuracy. Without a mathematical model of the inertial navigation system (INS), it is impossible to correctly configure the flight algorithm before the flight. At all stages of flight, the Strap-down Inertial Navigation System receives and integrates data from sensors. After processing, it transmits the aircraft's center-of-mass (CM) state vector, specifically its position, speed, and flight angles. In real flight, each sensor introduces its own errors, these errors accumulate over time, making pre-flight simulation necessary [2].

Mathematical formulation. The physical basis of the program code is a set of mathematical equations for inertial navigation. The velocity and position of the LTV are propagated by integrating the apparent acceleration corrected for gravity (measured by accelerometers), while the yaw angle is controlled using quaternion kinematics. Apparent acceleration and angular velocity measurements are compensated for by error terms that simulate gyroscopic drift, accelerometer drift, scale factor bias, and displacement angles. Keeping the equations in an inertial reference frame allows for avoiding singularities associated with the Euler angle representation and simplifies gravity calculations [3].

Program architecture. The code is written in C++17 [4] and compiled with OpenMP support for multithreaded execution. Four loosely coupled modules perform different tasks. The numerical integration module uses a classical 4th-order Runge–Kutta scheme; at each step, the direction quaternion is renormalized to prevent unit norm constraint drift. The gravity module takes into account the Earth's polar flattening and implements a normalized gravitational field with J_2 region harmonics sufficient for the accuracy of the orbital input [1]. The telemetry reader analyzes the flight

cyclograms in CSV format, containing the speed and angular acceleration recorded during the actual test, in a comma-separated format. Finally, the two-sensor error module inserts the simulated apparent acceleration and angular velocity errors into the integration cycle. The use of the C++ model and object-oriented design principles [4] ensures the scalability of the code base and maintains the high throughput required for batch operation using the Monte Carlo method.

Orbital element computation. After the engine flight is completed, the program converts the inertial state vector into Kepler elements: semi-major axis, eccentricity, inclination, longitude of the ascending node, and perigee argument. The conversion is performed using the standard cross product of the angular momentum vector, after which the remaining elements are obtained algebraically. The built-in reporting module compares the calculated elements with the mission project goals and displays deviations exceeding the specified input accuracy budget.

Verification and conclusions. Experimental work on reference track data has shown that the numerical error of the Runge-Kutta integrator is at least half the navigation error due to the sensors, so the integration scheme does not limit the overall accuracy [2]. The program reproduces the full phase of powered flight without any external commercial tools, and the modular design allows for easy replacement of error models with higher accuracy or the addition of GNSS correction channels later. Current work is focused on integrating the updated direction of the star trackers to limit the heading error over long coastal arcs.

REFERENCES

1. Hofmann-Wellenhof B., Moritz H. Physical Geodesy. 2nd ed. Vienna: Springer, 2006. 403 p.
2. Titterton D.H., Weston J.L. Strapdown Inertial Navigation Technology. 2nd ed. London: The Institution of Electrical Engineers, 2004. 581 p.
3. Groves P.D. Principles of GNSS, Inertial, and Multisensor Integrated Navigation Systems. 2nd ed. Boston: Artech House, 2013. 776 p.
4. Stroustrup B. The C++ Programming Language. 4th ed. Boston: Addison-Wesley, 2013. 1360 p.

THE CURRENT STAGE OF SPACE ACTIVITY DEVELOPMENT

The active development of satellite telecommunication systems, Earth observation programs, navigation constellations, as well as the emergence of numerous commercial projects in the field of small spacecraft launches, has led to a significant complication of the orbital environment. The current stage of human space activity development is characterized by a sharp increase in the number of artificial objects operating in low Earth orbits, including space debris [1]. Low Earth orbits, covering altitudes from approximately 160 to 2000 kilometers above the Earth's surface, have become the most congested zone of near-Earth space [2]. It is here that the vast majority of operational satellites are concentrated, along with a significant portion of defunct spacecraft and fragments formed as a result of accidents, collisions, or structural degradation during long-term operation.

The growth in the number of space objects without proper control poses a serious threat to the safety of spaceflight. Even small fragments of space debris, measuring only a few millimeters, are capable of causing catastrophic damage to operational spacecraft due to extremely high orbital velocities reaching seven to eight kilometers per second. Under such conditions, any collision is accompanied by the release of enormous kinetic energy, which can result in the complete destruction of a satellite and the formation of a large number of new fragments. This process, known as the Kessler syndrome, involves a chain reaction of collisions that could potentially render certain orbital altitudes unusable for further operations.

In response to this threat, the international space community is increasingly focusing on the development and implementation of systems for removing space objects from low Earth orbits. Such systems are understood as a set of technical solutions, engineering means, and operational procedures aimed at the controlled or semi-controlled removal of defunct, non-operational, or hazardous space objects from

orbital space [2]. The primary goal of such systems is to reduce the amount of long-lived space debris, minimize collision risks, and ensure the sustainable use of near-Earth space in the long term.

One of the simplest and most widely used approaches to removing space objects from low orbits is the utilization of natural atmospheric drag. Although the Earth's atmosphere at altitudes of several hundred kilometers is extremely rarefied, it still produces a certain aerodynamic resistance for objects moving at orbital velocity. This resistance gradually reduces the kinetic energy of a spacecraft, leading to orbital decay and, eventually, re-entry into denser atmospheric layers, where complete or nearly complete burn-up of the structure occurs. To accelerate this process, modern satellites are increasingly equipped with special aerodynamic elements, such as deployable membranes or drag sails, which significantly increase the effective cross-sectional area of the spacecraft after the completion of its primary mission.

The use of atmospheric drag as a disposal system offers several significant advantages, including simplicity of implementation, relatively low additional mass, and the absence of fuel consumption requirements. This makes the approach particularly attractive for small satellites, including CubeSats, which have strict mass and power constraints. At the same time, the effectiveness of this method strongly depends on orbital altitude, spacecraft mass, and solar activity, which affects the density of the upper atmosphere. At altitudes above 700–800 kilometers, atmospheric drag becomes extremely weak, and orbital decay times may extend to several decades, which does not meet modern requirements for the environmental safety of space activities.

A more controlled and technologically reliable method of removing space objects involves the use of onboard propulsion systems to perform a de-orbiting maneuver [3,4]. In this case, after completing its primary mission, the spacecraft executes a dedicated braking impulse that transfers it to an orbit with a perigee located within dense atmospheric layers. This approach has been widely applied for the controlled de-orbiting of large spacecraft and orbital stations, and is planned for the future de-orbit of

the International Space Station. Controlled re-entry makes it possible to accurately determine the impact area of surviving fragments, typically over uninhabited regions of the ocean, thereby significantly reducing risks to the population and infrastructure on the Earth's surface.

At the same time, the use of propulsion systems for disposal has its drawbacks. The need to retain fuel reserves until the end of the mission reduces the available payload capacity or shortens the operational lifetime of the spacecraft. In addition, in the event of a failure of the control system or propulsion units, a satellite may lose the ability to perform the de-orbit maneuver, thus becoming an uncontrolled piece of space debris. For this reason, modern engineering approaches emphasize redundancy of critical disposal system components or the combination of active and passive methods [5].

A separate group of technologies consists of active space debris removal systems, which involve the use of specialized spacecraft to capture and remove existing objects. Such systems are considered one of the few realistic ways to reduce the number of large uncontrolled objects already present in orbit and posing an increased threat. The operating principle of active systems involves rendezvous with a target object, its stabilization, mechanical capture, and subsequent towing to a decay orbit or into dense atmospheric layers. Robotic manipulators, dedicated capture devices, or even flexible nets may be used for this purpose.

Despite significant technological progress, active space debris removal remains a complex and costly task. The main challenges are associated with the need for high-precision orbital maneuvering, control of relative motion, and stabilization of uncontrolled bodies that may rotate at high angular velocities. In addition, there are legal and political issues related to ownership of space objects and liability for interference with their trajectories. Nevertheless, experimental missions and demonstration projects carried out by leading space agencies indicate that such systems are gradually approaching practical application.

A promising, though still largely experimental, direction involves the use of laser systems to influence the orbital motion of space objects. The concept is based on

directing short pulses of high-energy laser radiation onto the surface of an object, causing localized material ablation and generating a reactive impulse that alters the object's velocity. Through repeated application of such impulses, it may be possible to gradually lower the orbits of small debris fragments to levels where atmospheric drag ensures their re-entry. The advantage of this method lies in the absence of physical contact with the object; however, its implementation requires extremely precise targeting systems, substantial energy resources, and careful control to avoid damaging operational satellites.

An analysis of various systems for removing space objects from low Earth orbit shows that no single approach can be considered a universal solution for all possible scenarios. Passive methods [5]. are effective for newly designed spacecraft when implemented at the design stage, but they are poorly suited for addressing existing debris. Active systems are capable of solving the most complex tasks but require significant financial and technological resources. Laser and other contactless methods have great potential but remain at the research stage and require further development.

In view of this, the most justified and promising approach to the problem of removing space objects from low Earth orbit is a comprehensive strategy that combines multiple methods [6]. For new satellites, it is advisable to mandatorily implement passive or hybrid de-orbiting systems that guarantee removal from orbit within a limited time after mission completion. For large and hazardous objects already present in orbit, active removal systems aimed at targeted risk reduction should be developed. In the long term, laser and other innovative technologies may play an additional role by addressing small debris fragments that cannot be captured mechanically.

Thus, systems for removing space objects from low Earth orbit constitute an integral element of modern space infrastructure. Their further development and implementation will determine the feasibility of safe and sustainable use of near-Earth space under conditions of continuous growth in the number of space missions. At the present stage, the optimal solution should be considered an integrated approach that combines technical reliability, economic feasibility, and a responsible attitude toward the space environment as a shared resource of humanity.

REFERENCES

1. Orbital Debris. *Quarterly News JSC Houston*. 2025. Vol. 28. P. 14.
2. Inter-Agency Space Debris Coordination Committee (IADC). IADC Space Debris Mitigation Guidelines. Issued by IADC Steering Group and Working Group 4. 2025. 18 p.
3. Zolotko O. Ye., Zolotko O. V., Sosnovska O. V., Aksonov O. S., Savchenko I. S. Detonation engine for de-orbiting a separated rocket stage from space orbit. *Space Science and Technology*. 2021. vol. 27. no. 4 (131), pp. 32–41. <https://doi.org/10.15407/knit.2021.04.032>
4. Dosogne T., Beaumet G., Delmas F. SPOT 5 End-of-Life. *Space Ops Conferences*. Marseille, France, 28 May – 1 June 2018.
5. Dron M. M., Dubovyk L. H., Holubek O. V., Dreus A. Yu., Yemets V. V., Pashkov A. V. *Systems for removing space objects from low Earth orbits: monograph*. Dnipro: LIRA, 2019. 2018 p.
6. Dron M. M., Holubek O. V., Dreus A. Yu., Dubovyk L. H. Prospects for using a combined method of cleaning near-Earth space from large-sized space debris. *Space Science and Technology*. 2019. Vol. 25. No. 6. pp. 61-69. <https://doi.org/10.15407/knit2019.06.061>

K. Maksymenko, R. Bilichenko, N. Kaliberda

ARTIFICIAL INTELLIGENCE: THREATS AND OPPORTUNITIES

In the era of digital technologies, daily immersion in technology has become an integral part of our lives. This progress has been achieved thanks to the development of artificial intelligence.

Artificial intelligence (AI) has quickly integrated into our modern lives and is widely used in the applications we use every day. It helps us save time by delegating the performance of routine and sometimes complex specific tasks to automated processes and algorithms. Artificial intelligence is one of the most transformative technologies of our time, significantly changing various aspects of human life. What was recently perceived as a promising idea has today become an integral part of everyday life – from digital assistants and medical systems to financial algorithms and autonomous transport. The rapid development of AI technologies has a mostly positive impact, but also entails certain dangers and threats [2].

These include the risks of job losses, threats to security and privacy, the decline of human cognitive skills, and the problem of algorithmic bias. These aspects are not

only technological or economic in nature, but also affect the social, psychological, and philosophical spheres of society [6].

Artificial intelligence (AI) has rapidly evolved from an experimental technology to the basis of modern industries and everyday life – from generative systems and digital services to autonomous transportation and robotics. At the same time, its development raises a key question: does AI pose a threat to humanity, or does it open up new opportunities for its progress [4]?

The reality is a balance between threat and opportunity. For AI developers, policymakers, and society at large, the challenge is to maximize the benefits of AI while minimizing its risks.

Artificial intelligence can help people improve healthcare, create safer cars and other transportation systems, and create personalized, cheaper, and more durable products and services. It can also facilitate access to information, education, and training.

An algorithm in artificial intelligence systems is a set of rules that a system uses to process data and make decisions. They automate calculations, learn from results, and become more accurate and efficient over time, adapting to human needs.[9]

Artificial intelligence helps improve workplace safety by replacing humans in hazardous tasks, and creates new jobs as industries grow and change in today's changing environment.

It helps businesses develop new products and services in a variety of industries, including manufacturing, agriculture, and services. It also increases production efficiency, improves service quality, and optimizes resource use. At the same time, the automation of routine processes and the development of generative technologies are transforming the labor market, causing both the decline of certain professions and the emergence of new ones [2].

Artificial intelligence used in public services can reduce costs and offer new opportunities in public transport, education, energy, and can improve the sustainability of products.

AI helps people quickly process large amounts of information and can improve the efficiency of decision-making. AI stimulates human creativity and the innovative

spirit. For example, in the field of art, artists can collaborate with AI to create unique works of art, combining diverse elements and styles. Stimulating the spirit of inquiry in human nature through this technology helps people dig up and analyze large amounts of data, question human assumptions and cognition, and expand new areas of human research [8]. In the past, searching for such information in a browser took much longer. However, it is important to remember that any information obtained using artificial intelligence must be verified. The development of artificial intelligence has a significant impact on the IT sector, increasing the efficiency of programming, automating project management and accelerating the process of creating code. In particular, generative systems contribute to improving the quality of development and changing the role of specialists, especially at the entry-level and intermediate levels.

At the same time, these changes are also affecting the education system: curricula are increasingly integrating the use of artificial intelligence, which allows for increased learning productivity and a focus on more complex tasks.

It is increasingly being used in the security and criminal justice sectors, providing rapid processing of large data sets, risk prediction and crime prevention. It is also used by online platforms to detect illegal behavior. In the military, AI can be used for both defensive and offensive actions, in particular in cyberwarfare, including hacking and interference in critical systems [1].

Along with the advantages, there are also challenges, including issues of confidentiality and data security. The use of AI involves the processing of user information, which requires caution and awareness of the possible risks of its further use. In addition, the results obtained with the help of AI require critical evaluation and verification of reliability [4]. Particular attention should be paid to psychological and socio-ethical aspects, as the increase in dependence on technology can affect human behavior and thinking [2].

Artificial intelligence can cause a loss of self and a weakening of thinking. Modern technology negatively affects our critical thinking and ability to analyze information. We stop doubting the data we receive from artificial intelligence [3].

It can still help with creativity, but its excessive use can lead to a loss of skills and dependence. This raises concerns about the future of humanity and its creative abilities.

It is important to remain creative and develop your skills so that AI serves as a tool, not a replacement.

AI applications that physically contact people or are integrated into the human body can pose a security threat, as they can be poorly designed or misused [1].

Artificial intelligence, learning from human data, can reproduce prejudices and contribute to the spread of disinformation and manipulation, including through fake content and influencing public opinion. At the same time, the development of recognition and surveillance technologies creates risks of mass surveillance, which threatens privacy and civil liberties [4].

Artificial intelligence is significantly transforming the labor market, causing the automation of processes and the displacement of some professions, especially in the service, manufacturing and administrative sectors. At the same time, it creates risks for security and privacy, as it is able to collect and analyze large amounts of personal data. The threat of cybercrime and the use of technology is also growing [3].

A separate problem is the cognitive dependence of people on AI, which can lead to a decrease in critical thinking, memory and the ability to make independent decisions. Algorithmic bias can exacerbate social inequalities in areas such as employment, credit, and justice.

In addition, AI is affecting social relationships, human psychology, and the education system, changing approaches to learning and communication. At the same time, the development of autonomous technologies and military applications of AI pose serious ethical and security challenges for society. Effective regulation, data protection, and responsible implementation of the technology are necessary to minimize risks [6].

AI developers bear a huge responsibility. Decisions made today about code, training data, and deployment policies will affect the future of humanity. For AI to be a tool of opportunity, not destruction, developers must focus on five key areas:

1. Alignment with human values.
2. Robust safeguards and automatic switches (safety mechanisms).
3. Reducing bias.
4. Collaboration with policymakers and educators.
5. Long-term responsibility.

Implementing these principles is a prerequisite for creating a safe and ethical environment for the use of artificial intelligence. Only by taking a responsible approach to the development and implementation of AI technologies can risks be minimized and their direction for the benefit of society be ensured [4].

Conclusion. Thus, artificial intelligence acts both as a powerful tool for progress and a source of new challenges. Its impact covers all key areas of life – economy, education, security, social relations and culture. Along with increasing efficiency and automation of processes, risks associated with unemployment, violation of confidentiality, information manipulation and ethical dilemmas are growing.

Further development of artificial intelligence should be based on the principles of transparency, security and human-centeredness. It is important to ensure a balance between technological progress and the protection of human rights, as well as to raise public awareness of the opportunities and risks of AI. Only under such conditions will artificial intelligence become a tool for sustainable development, and not a source of threats to humanity.

REFERENCES

1. AI threat to humans vs AI opportunity to humans: what AI developers should consider? [Electronic resource]. URL: <https://www.linkedin.com/pulse/ai-threat-humans-vs-opportunity-what-developers-should-consider-jyaxc>
2. Artificial intelligence technology: threat or opportunity for humans? 2024. [Electronic resource]. URL: <https://feb.uinjkt.ac.id/en/artificial-intelligence-technology-threat-or-opportunity-for-humans#>
3. Artificial intelligence: threats and opportunities [Electronic resource]. <https://www.europarl.europa.eu/topics/en/article/20200918STO87404/artificial-intelligence-threats-and-opportunities>
4. Artificial intelligence: threats and opportunities, 2023. [Electronic resource]. URL: <https://devoxx.com.ua/artificial-intelligence-threats-and-opportunities/>
5. Caballar R. D. 10 AI dangers and risks and how to manage them [Electronic resource]. URL: <https://www.ibm.com/think/insights/10-ai-dangers-and-risks-and-how-to-manage-them>

6. Era of Artificial Intelligence, 2025 [Electronic resource]. URL: <https://www.geeksforgeeks.org/artificial-intelligence/era-of-artificial-intelligence-1/>
7. Negative Impacts of Artificial Intelligence on Humans: Challenges and Threats Facing Humanity, 2025, [Electronic resource]. URL: <https://deepfa.it/en/blog/negative-impacts-of-artificial-intelligence-on-humans>
8. Sun W. The ai era: reshaping how we think and work. *Людина і світ на роздоріжжі: технології, ресурси, соціальні інституції. Практичні студії: матеріали 4-го міжнар. наук.-метод. семінару, 15-17 травня 2024 р. Харків: НТУ "ХПІ", 2024. С. 37-38. URL: <https://repository.kpi.kharkov.ua/server/api/core/bitstreams/5b96aef3-1626-414a-8aa3-b3b18184e39f/content>*
9. The era of artificial intelligence, 2025, [Electronic resource]. URL: <https://www.geeksacademy.it/en-en/article-276/the-era-of-artificial-intelligence/>

A. Mohyliuk, T. Labutkina, O. Novikova

ROUTING IN SATELLITE NETWORKS OF PACKET SWITCHING: THE DEVELOPEMENT OF TRADITIONAL APPROACHES AND INTELLIGENT METHODS

Packet-switched networks form the basis of modern communication systems because they provide efficient data transmission, scalability, and flexible traffic distribution between network nodes. One of the central problems in such networks is routing, which determines the paths for packet delivery from source to destination according to selected performance criteria. Routing methods of conventional ground packet-switched networks have evolved from methods of choosing the shortest path to methods that are adaptive to network processes and methods that provide multipath solutions. In satellite packet-switched networks this problem becomes much more difficult due to the movement of satellites, dynamic of topology, variable inter-satellite distances, and demand for delay constraints. However, the predictability of spacecraft movement makes it possible to predict the dynamics of the network topology [1; 2].

One of the main challenges in network management is to ensure efficient and stable routing in a rapidly changing network structure. In this regard, software-defined networks (SDN) are considered a promising approach, as they provide flexible data-decoupled control of network processes and dynamic route configuration [1–3].

This approach is especially important for low-Earth orbits satellite constellations, where routing decisions must be rapidly adapted to changes in topology and network load.

This paper is devoted to the analysis of modern approaches to routing in software-defined satellite networks and to identify the most promising directions for further research. Among them are SDN-based dynamic multipath routing [3], contact graph routing for space communications [4], deterministic multi-criteria routing [5], and intelligent routing based on graph neural networks and deep reinforcement learning [6].

The purpose of this work is to determine the main features and limitations of routing in packet-switched satellite networks and to substantiate the feasibility of combining software-defined control with intelligent routing methods. Such solutions can improve route stability, reduce transmission delay, and increase the overall efficiency of satellite communication systems.

REFERENCES

1. W. Jiang. Software Defined Satellite Networks: A Survey. *Digital Communications and Networks*, vol. 9, no. 6, pp. 1243–1264, 2023. <https://doi.org/10.1016/j.dcan.2023.01.016>
2. S. Xu, X.-W. Wang, and M. Huang. Software-Defined Next-Generation Satellite Networks: Architecture, Challenges, and Solutions. *IEEE Access*, 2018. (*Digital Object Identifier*) <https://doi.org/10.1109/ACCESS.2018.2793237>
3. Y. Guo, D. Hou, Z. Xing, W. Ren, L. Cong, and X. Di. SDN-based Dynamic Multi-path Routing Strategy for Satellite Networks. *Future Generation Computer Systems*, vol. 133, pp. 254–265, 2022. <https://doi.org/10.1016/j.future.2022.03.012>
4. J. A. Fraire, O. De Jonckère, and S. C. Burleigh. Routing in the Space Internet: A Contact Graph Routing Tutorial. *Journal of Network and Computer Applications*, vol. 174, Art. 102884, 2021. <https://doi.org/10.1016/j.jnca.2020.102884>
5. X. Li, H. Li, Y. He, and H. Ma, “Towards Deterministic-Delay Data Delivery Using Multi-Criteria Routing over Satellite Networks,” *Electronics*, vol. 13, no. 23, Art. 4822, 2024. <https://doi.org/10.3390/electronics13234822>
6. Y. Shi, W. Wang, X. Zhu, and H. Zhu, “Low Earth Orbit Satellite Network Routing Algorithm Based on Graph Neural Networks and Deep Q-Network,” *Applied Sciences*, vol. 14, no. 9, Art. 3840, 2024. <https://doi.org/10.3390/app14093840>

**MATHEMATICS AS AN ECONOMIC STRATEGY:
GAMIFICATION IN LEARNING FRACTIONS
AND PERCENTAGES**

The modern education system is undergoing a period of active transformation driven by the need to prepare students for life in a rapidly changing informational and economic environment. Traditional teaching methods, largely based on passive perception of information, are increasingly proving to be insufficiently effective. This is especially true for subjects such as mathematics, which, despite its fundamental importance, is often perceived by students as difficult, abstract, and disconnected from real life. Therefore, the search for new approaches that can make learning more engaging, understandable, and practically oriented becomes highly relevant.

One such approach is gamification – the use of game elements in a non-game educational environment. It involves the implementation of point systems, levels, achievements, rankings, as well as the creation of learning situations in a game format. In the context of learning mathematics, gamification opens up wide opportunities to increase student motivation and develop a deeper understanding of the material. It is particularly valuable when studying topics such as fractions and percentages, which form the basis for further financial literacy [2, p. 12].

The essence of the proposed approach lies in modeling real economic processes within the educational process. For example, the study of fractions can be organized through business simulations, where students act as entrepreneurs or investors. In this case, fractions cease to be merely mathematical objects – they become shares of ownership, parts of profit, or resources that need to be distributed among participants. This approach contributes not only to a better understanding of mathematical concepts but also to the development of logical thinking and decision-making skills [1, p. 123].

Gamification also allows the creation of an “immersion” experience, where the student becomes an active participant in the learning process. For instance, a virtual

currency can be used in the game, which students earn for correct answers or effective decisions. They can then spend this currency on developing their “business”, acquiring resources, or accessing new levels of the game. Such a system creates additional motivation and stimulates interest in learning [3, p.160].

The use of game mechanics is especially effective when studying percentages. Percentages are an integral part of everyday life: they are used in calculating discounts, taxes, loans, investments, and other financial operations. In a gamified environment, these concepts can be presented through realistic scenarios, such as budget management, profit and loss analysis, or trading in a simulated market. When a student faces the need to determine how their capital will change after a 20% increase or how much tax must be paid, they begin to perceive percentages not as an abstract formula, but as a practical tool for achieving specific goals [1, p.123].

This approach implements the principle of “learning by doing”, which is one of the most effective in pedagogy. The student does not simply memorize formulas but applies them in practical situations, which significantly increases the level of comprehension. In addition, gamification promotes the development of important skills such as critical thinking, information analysis, planning, and teamwork [5, p. 156].

The social aspect of gamification is also important. The use of competitive elements (such as rankings or student competitions) stimulates activity and engagement. At the same time, it is important to maintain a balance between competition and collaboration to ensure a comfortable learning environment for all participants. Team-based games, in which students collaboratively solve economic problems, help develop communication and interaction skills [6, p.160].

It is also worth noting that gamification does not replace traditional teaching but complements it, making it more diverse and effective. It allows for consideration of students’ individual characteristics, their learning pace, and level of preparation. As a result, each student has the opportunity to achieve success and experience a sense of competence [4, p.16].

In conclusion, the use of gamification in learning fractions and percentages transforms mathematics from an abstract discipline into a practical tool necessary for

everyday life. This approach not only facilitates the understanding of complex topics but also fosters financial literacy, which is an essential component of modern education. The integration of economic scenarios into the learning process contributes to the development of financial intuition, responsibility, and the ability to make informed decisions.

Thus, mathematics as an economic strategy, implemented through gamification, opens new prospects for improving the quality of education. It ensures a deeper understanding of the material, increases student motivation, and prepares them for real life, where mathematical knowledge is an integral part of successful activity.

REFERENCES

1. Burda, M. I., & Tarasenkova, N. A. *Methods of Teaching Mathematics in School*. Kyiv: Osvita, 2018.
2. Deterding, S., Dixon, D., Khaled, R., & Nacke, L. "From Game Design Elements to Gamefulness: Defining 'Gamification.'" In *Proceedings of the 15th International Academic MindTrek Conference*, 9–15, 2011.
3. Kapp, K. M. *The Gamification of Learning and Instruction: Game-Based Methods and Strategies for Training and Education*. San Francisco: Pfeiffer, 2012.
4. Ministry of Education and Science of Ukraine. *New Ukrainian School: Conceptual Principles of Secondary Education Reform*. Kyiv, 2016.
5. OECD. *PISA 2022 Results (Volume I): The State of Learning and Equity in Education*. Paris: OECD Publishing, 2023.
6. Prensky, M. *Digital Game-Based Learning*. New York: McGraw-Hill, 2001.

O. Sianov, O. Kachura

MATHEMATICAL MODEL OF SEMICONDUCTOR STRUCTURE BASED ON VANADIUM DIOXIDE

The occurrence of significant starting currents when electronic devices are connected to the power supply network can lead to the transition of the latter to a critical mode with subsequent failure. In order to prevent these processes, protective devices are used, which allow reducing peak current values and extending the service life of electronic equipment. Among the various protective devices, structures based on vanadium dioxide are used, which are switched on in series with the load. Critical thermistors (criteistors) are effective for these purposes [1].

The paper develops a numerical mathematical model of a thermistor based on the finite element method for studying conductive properties in static and dynamic modes.

For a mathematical description of the processes occurring in the structure, we will use the well-known mathematical transformations [1]:

$$\frac{\partial}{\partial x}\left(\varepsilon_a \frac{\partial \varphi}{\partial x}\right) + \frac{\partial}{\partial y}\left(\varepsilon_a \frac{\partial \varphi}{\partial y}\right) + \frac{\partial}{\partial z}\left(\varepsilon_a \frac{\partial \varphi}{\partial z}\right) = -\rho, \quad (1)$$

where ε_a is the absolute dielectric constant of the material; φ is the electric potential; ρ is the volumetric charge density; x, y, z are the coordinate axes.

Equation (1) must be supplemented with the Laplace equation for the air gap surrounding the thermistor:

$$\frac{\partial}{\partial x}\left(\varepsilon_a \frac{\partial \varphi}{\partial x}\right) + \frac{\partial}{\partial y}\left(\varepsilon_a \frac{\partial \varphi}{\partial y}\right) + \frac{\partial}{\partial z}\left(\varepsilon_a \frac{\partial \varphi}{\partial z}\right) = 0. \quad (2)$$

The solution of system (1)-(2) is connected with the study of a multiphysical three-dimensional field problem. The coefficients ε_a, ρ, C_p are nonlinear, depend on the magnitude and frequency of the current flowing in the volume of the thermistor structure. To solve (1), (2) we will use the finite element method. Fig. 1, a shows the boundary conditions of the studied model, its discrete part is presented in Fig. 1, b.

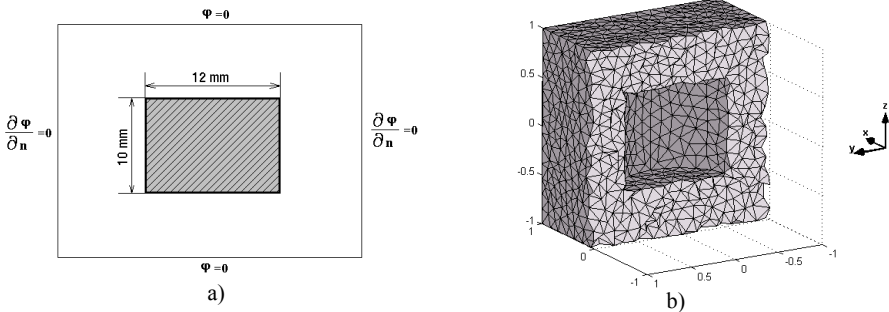


Fig. 1. Boundary conditions and discrete model of the studied sample

As a result of the calculation, graphs of the electric field strength in the cross-section of the sample were obtained (Fig. 2).

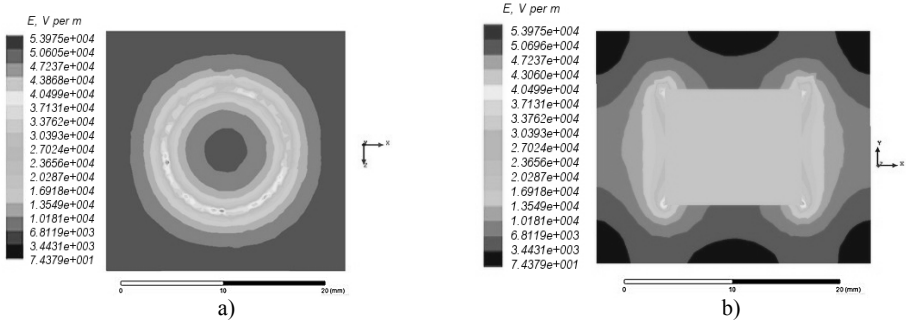


Fig. 2. Graphs of the electric field strength of the structure

In the work, a three-dimensional mathematical model of a thermistor has been created, which allows us to study the electrical parameters of the structure based on VO_2 . The developed model is universal and allows us to take into account both the physical properties of thermistors and their geometric features.

REFERENCES

1. O. Kachura, V. Kuznetsov, M. Tryputen, V. Kuznetsov, S. Kolychev. Artur Rojek. P. Hubsyki. Mathematical Model of a Semiconductor Structure Based on Vanadium Dioxide for the Mode of a Conductive Phase. *Electronics* 2025, 14(14), 2884; <https://doi.org/10.3390/electronics14142884>
2. Rini M., Hao Z., Schoenlein R.W. [et all]. Optical switching in VO_2 films by below-gap excitation // *Applied Phys. Letters*. 2008. V. 92. P.181904.

MODEL OF A THREE-PHASE INDUCTION MICROMOTOR OF AUTOMATION SYSTEMS FOR THE STUDY OF DYNAMIC MODES

The introduction of automated production lines in various areas of industrial production requires an assessment of the quality and operating conditions of electric drives of actuators. This leads to an expansion of requirements for electric motors, which must maintain functionality in wide temperature ranges in conditions of high humidity, vibrations, fluctuations in supply voltage, etc.

Today, induction motors are the most widely used for driving automated lines and industrial mechanisms due to such advantages as simplicity, reliability, and low cost. Among them, a special place is occupied by induction micromotors (MIM) with an operating power range from several watts to several hundred watts, which are mainly used in robotics, medicine, machine tool mechanisms, etc.

Despite the fact that micromotors are characterized by a relatively simple design of the electromechanical part, issues related to their design often cause difficulties. Existing methods, as a rule, are tied to the type of micromachines and are focused on a specific design. This often leads to the need for a radical revision of approaches to calculations even with minimal design changes.

In this regard, numerical methods are becoming an important tool for the analysis of MIM, among which the finite element method (FEM) can be distinguished [1].

The paper proposes a universal mathematical model of a three-phase MIM based on the combination of electromagnetic field equations and electrical circuit equations using FEM, which allows studying both electromagnetic and electromechanical processes in dynamic modes.

Having performed a number of well-known mathematical transformations of the system of Maxwell's equations [2], we obtain a general equation describing the electromagnetic field

A REVIEW OF MACHINE LEARNING APPROACHES IN LASER VISION CORRECTION

Modern progress in medical informatics is characterized by a transition from basic analytical calculations to intelligent decision support systems. The implementation of such systems is highly relevant in the field of laser vision correction. Traditionally, surgical laser settings are based on standardized nomograms and simplified analytical models derived from optical equations. Although these approaches are widely used in clinical practice, they often fail to fully account for the complex non-linear relationships between biometric parameters of the eye and postoperative visual outcomes. Consequently, achieving a high level of personalized surgical planning remains a challenging task.

The growing availability of clinical data opens new opportunities for the application of machine learning methods in the field of laser vision correction. Data-driven approaches enable the analysis of large datasets of patients' preoperative and surgical parameters to identify complex patterns that may affect postoperative results.

Recent studies have actively investigated the effectiveness of various machine learning models for predicting laser vision correction outcomes and personalizing surgical nomogram parameters. A number of studies demonstrate that ensemble algorithms, particularly Random Forest and XGBoost, as well as neural networks, are able to provide accurate predictions of refractive outcomes after SMILE. Thus, they can serve as valuable tools for clinical decision support systems and assist in adjusting surgical nomograms [2; 3; 6]. Approaches based on large clinical datasets have also proven their efficacy across a wider range of refractive interventions, such as LASIK and PRK [1]. However, some studies indicate that the increase in predictability compared with standard nomograms is relatively moderate, and the accuracy of preoperative manifest refraction measurement remains one of the key factors impacting prediction quality [4; 5].

In conclusion, the integration of machine learning models into the laser vision correction process can improve the accuracy of surgical nomograms and promote treatment

personalization based on the patients' individual biometric parameters. Nevertheless, the effectiveness of such approaches largely depends on the quality and completeness of clinical data.

REFERENCES

1. Achiron A., Gur Z., Aviv U. et al. Predicting Refractive Surgery Outcome: Machine Learning Approach with Big Data. *Journal of Refractive Surgery*. 2017. Vol. 33, No. 9. P. 592–597. DOI: <https://doi.org/10.3928/1081597X-20170616-03>
2. Cui T., Wang Y., Ji S. et al. Applying machine learning techniques in nomogram prediction and analysis for SMILE treatment. *American Journal of Ophthalmology*. 2020. Vol. 210. P. 71–77. DOI: <https://doi.org/10.1016/j.ajo.2019.10.015>
3. Liu P., Gu X., Jiao Y. et al. Adopting machine learning to predict nomogram for small incision lenticule extraction (SMILE). *International Ophthalmology*. 2025. Vol. 45, No. 1. 175. DOI: <https://doi.org/10.1007/s10792-025-03520-7>
4. Luft N., Mohr N., Spiegel E. et al. Optimizing Refractive Outcomes of SMILE: Artificial Intelligence versus Conventional State-of-the-Art Nomograms. *Current Eye Research*. 2024. Vol. 49, No. 3. P. 252–259. DOI: <https://doi.org/10.1080/02713683.2023.2282938>
5. Park S., Kim H., Kim L. et al. Artificial intelligence-based nomogram for small-incision lenticule extraction. *BioMedical Engineering OnLine*. 2021. Vol. 20. 38. DOI: <https://doi.org/10.1186/s12938-021-00867-7>
6. Zhai J., Hu M., Tan Q., Long Z., Wang H. Personalized prediction of post-SMILE refractive outcomes using a machine-learning nomogram. *Medicine*. 2026. Vol. 105, No 2. e46950. DOI: <https://doi.org/10.1097/MD.0000000000046950>

I. Yakobchuk, N. Ashchepkova, O. Novikova

KINEMATIC MODELING AND AI- BASED CONTROL OF A SIX- DOF ROBOTIC MANIPULATOR

Robotic manipulators with six degrees of freedom are widely used in modern industrial automation due to their ability to perform complex spatial movements. Recent developments in artificial intelligence improve safety and adaptability of robotic systems.

The purpose of this work is to develop a kinematic model of a six-DOF robotic manipulator and implement its simulation in the MATLAB/Simscape environment. An experimental prototype has also been developed to validate the proposed model.

The object of research is a six-degree-of-freedom anthropomorphic robotic manipulator with a serial kinematic structure (RRRRRR configuration). The generalized coordinate vector is defined as

$$\mathbf{q} = [\theta_1 \ \theta_2 \ \theta_3 \ \theta_4 \ \theta_5 \ \theta_6]^T, \quad (1)$$

where θ_i is the rotation angle of the i -th joint.

The kinematic model of the manipulator is constructed using the Denavit–Hartenberg method. The transformation from the base coordinate system to the gripper is obtained by multiplying homogeneous transformation matrices of individual links. The model serves as a basis for the development of control algorithms and further system improvement.

The simulation model was developed in MATLAB using the Simscape Multibody package. The CAD model was imported to generate a multibody system consisting of rigid links and revolute joints.

Artificial intelligence methods can be integrated into the control architecture to enable collision prediction, adaptive trajectory planning and safe human-robot interaction. Simulation results are consistent with the behavior of the experimental prototype, confirming the applicability of the model. The structure of the manipulator is illustrated in Fig. 1.



Fig. 1. 3D model of the six- DOF robotic manipulator

A kinematic model of a six-DOF robotic manipulator was developed and implemented in MATLAB/Simscape. An experimental prototype was created to validate the proposed approach.

Simulation results confirmed the correctness of the kinematic model and its consistency with the behavior of the experimental prototype. The model can be used for further research on intelligent control, trajectory planning and safe human-robot interaction.

REFERENCES

1. H. N. Ghafil, K. Jármai. Optimization for Robot Modelling with MATLAB. 2020.
2. R. Balasubramanian. The Denavit Hartenberg Convention. USA: Robotics Insitute Carnegie Mellon University. 2011.
3. Xiao Junming, Han Wei, et al. Kinematic analysis and simulation study of six-degree-of-freedom robotic arm. 2018.

CONTENTS

<i>S. Okovytyy</i> WELCOMING SPEECH OF THE RECTOR OF OLES HONCHAR DNIPRO NATIONAL UNIVERSITY	3
<i>I. Popova</i> WELCOMING SPEECH OF THE DEAN OF THE FACULTY OF UKRAINIAN AND FOREIGN PHILOLOGY AND STUDY OF ARTS	6
<i>O. Hurko</i> WELCOMING SPEECH OF THE HEAD OF THE DEPARTMENT OF ENGLISH LANGUAGE FOR NON-PHILOLOGICAL SPECIALITIES	9

PANEL 1

Modern Studies in the Sphere of Natural Sciences

<i>D. Anutdinova, T. Ostanina, O. Aliseienko</i> LABORATORY ASSESSMENT OF KIDNEY FUNCTIONAL STATUS: TRADITIONAL AND MODERN METHODS	11
<i>M. Bakushina, Yu. Voronkova, O. Aliseienko</i> INFLAMMATION BIOMARKERS IN CHRONIC DISEASES	20
<i>I. Baranenko, K. Holoborodko, O. Hurko</i> THE IMPACT OF ROBINIA PSEUDOACACIA ON CHERNOZEM TRANSFORMATION IN ANTI-EROSION PLANTATIONS OF THE STEPPE ZONE	22
<i>I. Chumakov, N. Yesipova, O. Osadcha</i> EXPOSURE OF COPPER ON REPRODUCTIVE SYSTEMS OF FISH	24
<i>D. Fedorchuk, O. Aliseienko</i> ENGLISH IN BUSINESS COMMUNICATION AND INTERNATIONAL ECONOMIC RELATIONS	26
<i>N. Gaponova, O. Osadcha</i> MODERN PARADIGMS OF THE IMPACT OF VITAMIN D ON HUMAN HEALTH	28
<i>B. Harbuz, N. Kondratiuk, O. Posudiiievaska</i> INNOVATIVE APPROACHES TO FOOD PROCESSING TECHNOLOGIES: ENHANCING QUALITY, SAFETY AND SUSTAINABILITY	30
<i>Yu. Homik, K. Lavrentieva, O. Osadcha</i> VIRUSES IN THE SERVICE OF HUMANITY: FROM PATHOGENS TO BIOTECHNOLOGY TOOLS	32
<i>T. Hulciaeva, T. Denysenko, O. Posudiiievaska</i> CHOLESTEROL: METABOLISM, FUNCTIONS AND RISKS	33
<i>A. Kaliberda, R. Dolinski, N. Kaliberda</i> EPIDEMIOLOGY AND ECONOMIC BURDEN OF MENTAL DISORDERS IN THE STRUCTURE OF PUBLIC HEALTH	36

<i>I. Karamushka, A. Alekseeva, O. Osadcha</i> ECOLOGICAL-AESTHETIC POTENTIAL OF STRUCTURAL GRASSES IN WINTER LANDSCAPES OF URBANIZED TERRITORIES	39
<i>O. Kobets, I. Kofan, O. Hurko</i> ROLE OF THE ANTIOXIDANT SYSTEM IN <i>PRUNUS</i> PLANT ADAPTATION TO ABIOTIC STRESS	42
<i>T. Kobozeva, O. Aliseienko</i> ROLE OF LABORATORY TESTS IN MONITORING CHRONIC DISEASES (DIABETES, CARDIOVASCULAR DISORDERS)	45
<i>K. Martirosyan, N. Kondratiuk, O. Posudiiivska</i> PSYCHOLOGICAL FACTORS OF CONSUMER CHOICE IN THE FUNCTIONAL FOOD MARKET	48
<i>V. Melnichuk, O. Osadcha</i> METHODS OF ASSESSING MUSCLE STRENGTH IN PHYSICAL THERAPY	50
<i>M. Nedotopa, O. Osadcha</i> POST-TRAUMATIC STRESS DISORDER	52
<i>K. Nevolova, T. Sharamok, O. Osadcha</i> BIOASSAY AS A METHOD FOR ASSESSING THE TOXICITY OF FRESHWATER BODIES IN KYIV REGION	53
<i>A. Oskalenko, H. Novik, O. Posudiiivska</i> IMPROVEMENT OF CHOCOLATE-GLAZED FONDANT-FILLED CANDIES FOR PEOPLE WITH DIABETES	57
<i>S. Roitman, T. Sklyar, O. Osadcha</i> RECENT ADVANCES IN PROTEIN ENGINEERING: MODIFICATION OF ENZYME PROPERTIES	60
<i>P. Tishchenko, O. Osadcha</i> THE IMPACT OF PHYSICAL ACTIVITY ON THE BODY OF A YOUNG PERSON DURING STRESS	61
<i>O. Trukhym, O. Vinnyk, O. Osadcha</i> MODERN REHABILITATION APPROACHES IN THE MANAGEMENT OF PHANTOM LIMB PAIN	64
<i>D. Vlokh, O. Chernushenko, O. Posudiiivska</i> NATURAL SALAD DRESSING AS A WAY TO UTILIZE SECONDARY PLANT RAW MATERIALS AND SUPPORT HEALTH	67
<i>M. Volkov, A. Farisieiev, O. Posudiiivska</i> PROSPECTS FOR THE DEVELOPMENT OF LACTOSE-FREE YOGURTS USING INULIN AND STEVIA EXTRACT	68
<i>A. Zhdankin, I. Kofan, O. Hurko</i> ECOPHYSIOLOGICAL MECHANISMS OF ADAPTATION AND DISPERSAL OF ARALIACEAE (JUSS.) SPECIES IN THE STEPPE DNIPRO REGION	71
<i>D. Zheleznov, N. Kondratiuk, O. Posudiiivska</i> MODIFICATION OF GELLAN GUM AS AN APPROACH TO REGULATING ITS RHEOLOGICAL, MECHANICAL AND THERMAL PROPERTIES	73

PANEL 2	
Topical Issues of Social Sciences and Humanities	
<i>A. Bonhar, R. Velychko, O. Osadcha</i> FEATURES OF THE FORMATION OF COPING STRATEGIES IN ADOLESCENTS DURING MARTIAL LAW	75
<i>M. Demchenko, V. Yashkina</i> CHANGES IN LEXICAL DIVERSITY IN THE WORKS OF TERRY PRATCHETT	77
<i>H. Drywall, O. Bovkunova</i> THE TRANSFORMATION OF CINEMATIC AESTHETICS AND STYLE IN THE DIGITAL ERA	81
<i>K. Halich, N. Zimivets, O. Osadcha</i> SPEECH DEVELOPMENT SUPPORT FOR UKRAINIAN CHILDREN IN IRELAND	83
<i>K. Kocherzhyna, S. Riaboval</i> SMALL TALK PHRASES AS A PART OF EFFECTIVE COMMUNICATION	84
<i>D. Kolisnyk, M. Tkachenko, N. Kaliberda</i> APPLIED ORIENTATION OF MATHEMATICS EDUCATION AS A MEANS OF FORMING STUDENTS' LIFE COMPETENCIES	87
<i>Y. Komysaryk, H. Mudrenko</i> PSYCHOLOGICAL FACTORS OF STRESS RESILIENCE IN YOUNG PEOPLE IN CONDITIONS OF SOCIAL INSTABILITY	90
<i>V. Korniienko, O. Osetrova, O. Aliseienko</i> PSYCHOSOCIAL ADAPTATION OF UKRAINIANS AFTER RETURNING FROM ABROAD	91
<i>O. Krechyk, O. Aliseienko</i> SOCIAL WELFARE OF MILITARY PERSONNEL, INTERNALLY DISPLACED PEOPLE AND UKRAINIANS ABROAD IN THE CONTEXT OF CURRENT WAR CHALLENGES	94
<i>K. Krupiy, H. Mudrenko</i> BARRIERS TO SOCIAL INCLUSION OF PEOPLE WITH DISABILITIES AND WAYS TO OVERCOME THEM	96
<i>K. Krut, N. Styrnik</i> THE IMPACT OF SOCIAL MEDIA AND "BRAIN ROT" PHENOMENA ON STUDENTS' MOTIVATION: SPOTIFY EDITS AND PLAYLISTS AS LEARNING STIMULUS	99
<i>T. Kyrpyta</i> HUMAN-AI COLLABORATION IN TRANSLATION: FROM POST-EDITING TO CO-CREATION	103
<i>A. Makarevich, O. Besarab</i> MODERN AESTHETICS AND THE PROBLEM OF ANTHROPOCENTRIC DOMINANCE OVER NATURE	105
<i>I. Pastukh, T. Pryshchepa</i> COGNITIVE AND PRAGMATIC ASPECTS OF PERSUASION IN ADVERTISING DISCOURSE	107

<i>V. Petkov, O. Dyomshyna</i> BIOCHEMICAL MECHANISMS OF ACTION OF NATURAL XENOBIOTICS AND ADAPTOGENS IN THE CONTEXT OF ENHANCING STRESS RESISTANCE: ETHICAL AND EVIDENCE-BASED DIMENSIONS OF CONTEMPORARY RESEARCH	109
<i>M. Petrenko, N. Styrnik</i> GREEN THEORY IN INTERNATIONAL RELATIONS: EXPANDING AND CHALLENGING TRADITIONAL PERSPECTIVES	112
<i>M. Prysiashniuk, N. Parfinovych, N. Kaliberda</i> PEDAGOGY IS A SCIENCE NOT OF TEACHING, BUT OF UNDERSTANDING	115
<i>N. Reyes, O. Bovkunova</i> THEATRICAL SPACE ON THE SCREEN	121
<i>V. Riazanov, O. Shatalovych</i> DAVID BENTLEY HART'S THEODICY IN THE CONTEXT OF FORMATION OF THE SPIRITUAL AND VALUE SPHERE OF CONTEMPORARY SOCIETY	124
<i>M. Serezhchenko, N. Diachok</i> CONTEMPORARY TRANSLATION STANDARD IN THE AI ERA	127
<i>O. Shvydkyj, N. Styrnik</i> NEUTRALITY AS A COUNTRY'S FOREIGN POLICY: ADVANTAGE OR DRAWBACK?	129
<i>O. Shyrochkin, O. Osadcha</i> THE EFFECTIVENESS OF MODERN APPROACHES IN NEUROLOGICAL REHABILITATION OF POST-STROKE PATIENTS	132
<i>D. Smytska, S. Riabovol</i> COLOUR AS METAPHOR: A VISUAL ANALYSIS OF ENGLISH IDIOMS	134
<i>V. Striukova, O. Panchenko</i> EQUIVALENCE AND ADEQUACY IN TRANSLATING R. KIPLING'S POETRY	136
<i>D. Svystun, O. Osadcha</i> THE USE OF INTERACTIVE EDUCATIONAL MATERIALS IN SPEECH THERAPY WITH PRESCHOOL-AGED CHILDREN	138
<i>K. Syrko, N. Styrnik</i> SOFT POWER AS A TOOL OF MODERN DIPLOMACY: A COMPARATIVE STUDY OF THE EU, THE USA AND CHINA	140
<i>O. Verbonol, O. Aliseienko</i> MANAGING UNESCO WORLD HERITAGE SITES UNDER CLIMATE CHANGE AND ENVIRONMENTAL RISK	145
<i>A. Okata, I. Kofan, O. Osadcha</i> INTERACTIVE LEARNING TECHNOLOGIES AS A TOOL FOR OVERCOMING COGNITIVE PASSIVITY OF LEARNERS IN THE CONTEXT OF DIGITAL TRANSFORMATION OF THE EDUCATIONAL PROCESS	148

PANEL 3 Modern Research in the Sphere of Socio-Economic Sciences and Information Technologies	
<i>I. Anikin, T. Vorova</i> MODERN RESEARCH IN SOCIO-ECONOMIC SCIENCES AND INFORMATION TECHNOLOGIES	152
<i>D. Bilan, T. Vorova</i> EMERGING TRENDS IN DIGITAL MARKETING: AI, PERSONALIZATION AND OMNICHANNEL INTEGRATION	154
<i>V. Bovkunov, O. Bovkunova</i> INTERNATIONALIZATION OF GLOBAL ECONOMIC AND POLITICAL SPACE	156
<i>K. Chelovan, O. Aliseienko</i> INTERNATIONAL MARKETING TOOLS IN THE XXIST CENTURY	159
<i>Y. Deineka, O. Aliseienko</i> CRYPTOCURRENCY ADOPTION IN UK COMMERCIAL BANKING: OPPORTUNITIES, CHALLENGES AND REGULATORY PERSPECTIVES	164
<i>E. Deineka, O. Aliseienko</i> SUSTAINABLE COMPETITIVE ADVANTAGE IN PREMIUM ATHLEISURE RETAIL: A CASE STUDY OF LULULEMON CAMBRIDGE	168
<i>M. Drozdov, N. Matveeva, O. Novikova</i> USAGE OF A SYSTEM BASED ON ARTIFICIAL INTELLEGENGE IN EDUCATIONAL SYSTEMS OF UKRAINE AND EUROPE	171
<i>A. Hrynenko, O. Kondratieva</i> THE IMPACT OF MESSAGING APPS ON YOUTH COMMUNICATION SKILLS	174
<i>K. Kriachok, S. Klymenko, N. Kaliberda</i> THE ROLE OF DIGITAL LITERACY OF THE POPULATION IN REDUCING CYBER RISKS	176
<i>K. Ohurtsova, H. Mudrenko</i> THE IMPACT OF AUTOMATION AND ROBOTIZATION ON THE LABOR MARKET	178
<i>N. Onishchuk, H. Mudrenko</i> DIGITAL TRANSFORMATION OF ENTERPRISES AS A DRIVER OF BUSINESS EFFICIENCY	181
<i>A. Onopriienko, T. Vorova</i> THE IMPACT OF ARTIFICIAL INTELLIGENCE ON DIGITAL MARKETING STRATEGIES IN THE MODERN ECONOMY	183
<i>I. Panasenko, T. Gviniashvili</i> ETHICAL AND ORGANIZATIONAL ASPECTS OF USAGE OF ARTIFICIAL INTELLIGENCE IN CONTROLLING PRACTICE	186
<i>D. Prykhodko, T. Vorova</i> DIGITAL MARKETING AS A STRATEGIC DRIVER OF TRANSFORMATION IN TRADE ENTERPRISES	188

<i>K. Savchenko, S. Adonin, V. Osypenko</i> EVALUATION OF THE DEBT LOAD ON THE PUBLIC SPENDING OF UKRAINE'S NATIONAL BUDGET	191
<i>Y. Shatova, T. Vorova</i> THE IMPACT OF DIGITAL TECHNOLOGIES ON SOCIAL INTERACTION AND COMMUNICATION	192
<i>A. Shylo, T. Vorova</i> THE ROLE OF MARKETING INNOVATIONS IN BUSINESS DEVELOPMENT	194
<i>E. Simukova, N. Yakovlieva-Melnuk, O. Aliseienko</i> THE IMPACT OF DIGITAL TECHNOLOGIES ON ECONOMIC DEVELOPMENT	196
<i>D. Smoliak, H. Mudrenko</i> STRATEGIC ROLE OF INFORMATION TECHNOLOGIES IN PERSONAL FINANCE MANAGEMENT AND ECONOMIC LITERACY	198
<i>I. Tishkov, T. Vorova</i> ROLE OF E-COMMERCE IN THE DEVELOPMENT OF LOCAL ENTERPRISES	200
<i>N. Tiuria, H. Mudrenko</i> THE IMPACT OF DIGITAL COMMUNICATION TOOLS ON BUSINESS MANAGEMENT EFFICIENCY	202
<i>Y. Zakabluk, O. Bovkunova</i> THE ROLE OF ARTIFICIAL INTELLIGENCE IN THE DEVELOPMENT OF TOURISM IN UKRAINE	204
PANEL 4 Actual Problems of Engineering and Technical Sciences and Modern Information Technologies	
<i>O. Bahlai, S. Bilogurov, O. Hurko</i> ENERGY CONSUMPTION ANALYSIS OF A FEED SYSTEM FOR GREEN PROPULSION OF CUBESAT SPACECRAFT	207
<i>B. Bakun, N. Nosova, N. Kaliberda</i> ANALYTICAL METHODS OF TANDEM WING AIRCRAFT AERODYNAMICS	209
<i>O. Bykhno, S. Mamchur, T. Nosova, O. Novikova</i> CURRENT CHALLENGES IN SCIENTIFIC RESEARCH ON DISSIMILAR MATERIAL WELDING IN MODERN MECHANICAL ENGINEERING	212
<i>Y. Chaikovskiy, O. Matsuga, O. Novikova</i> CHANGE POINT DETECTION METHODS FOR TIME SERIES	214
<i>H. Diadchenko, M. Khorolskiy, N. Kaliberda</i> RUBBER DIAPHRAGMS AS ONE OF THE EFFECTIVE TYPES OF PRODUCTS FOR ROCKET AND SPACE ENGINEERING OBJECTS	215
<i>D. Doroshenko, R. Bilichenko, N. Kaliberda</i> VORONOI DIAGRAM AS A TOOL FOR SPATIAL ANALYSIS	218
<i>V. Dudinkin, T. Labutkina, O. Novikova</i> ANALYSIS OF TRENDS IN THE DEVELOPMENT IN GROUND-BASED ORBITAL OBJECT SURVEILLANCE SYSTEMS AND INTELLIGENT CONTROL METHODS	221

<i>K. Dzhura, M. Tkachenko, N. Kaliberda</i> CROWDSOURCING IN THE SCHOOL ENVIRONMENT AS AN INNOVATIVE APPROACH TO LEARNING	223
<i>I. Falendysh, O. Hurko</i> INVESTIGATION OF THE INTERNAL STRUCTURE OF LEIBNIZ STRUCTURES AND THEIR MODELING IN COMPUTER ALGEBRA SYSTEMS	227
<i>S. Fisun, S. Klymenko, N. Kaliberda</i> THE IMPACT OF CYBERCRIME ON THE NATIONAL ECONOMY AND BUSINESS	230
<i>P. Hovorukha, O. Trofimov, O. Novikova</i> GALERKIN FINITE ELEMENT AND MULTIGRID METHODS FOR THE DYNAMIC LAMÉ SYSTEM ON CURVILINEAR DOMAINS	233
<i>V. Hrytsenko, A. Kutovyi</i> THE ETHICAL CHALLENGES OF USING AI IN EDUCATION	234
<i>A. Husiev, V. Klym, O. Novikova</i> ISSUES OF IMPROVING THE EFFICIENCY OF EMBEDDED CONTROL SYSTEMS WITH A COMPUTER VISION MODULE	237
<i>K. Kornieva, T. Vorova</i> MODERN TRENDS IN WEB DESIGN	239
<i>N. Korziukov, V. Pererva, O. Novikova</i> COMPARATIVE ANALYSIS OF ELECTRON BEAM SINTERING WITH OTHER TECHNOLOGIES FOR CREATING RCT PARTS AND COMPONENTS	241
<i>A. Kostiuchenko, V. Gerasymov, O. Novikova</i> DEEP LEARNING MODEL FOR TIME SERIES FORECASTING	243
<i>M. Koverzhenko, M. Tkachenko, N. Kaliberda</i> MATHEMATICS AS A TOOL FOR DEVELOPING CRITICAL THINKING IN STUDENTS	245
<i>V. Kryvenko, A. Golubek, O. Novikova</i> FLIGHT SIMULATION SOFTWARE FOR STRAPDOWN INS OF LIGHT LAUNCH VEHICLES	248
<i>O. Lysenko, O. Zolotko, N. Kaliberda</i> THE CURRENT STAGE OF SPACE ACTIVITY DEVELOPMENT	250
<i>K. Maksymenko, R. Bilichenko, N. Kaliberda</i> ARTIFICIAL INTELLIGENCE: THREATS AND OPPORTUNITIES	254
<i>A. Mohyliuk, T. Labutkina, O. Novikova</i> ROUTING IN SATELLITE NETWORKS OF PACKET SWITCHING: THE DEVELOPMENT OF TRADITIONAL APPROACHES AND INTELLIGENT METHODS	259
<i>V. Olkhovska, Yu. Halaiko, N. Kaliberda</i> MATHEMATICS AS AN ECONOMIC STRATEGY: GAMIFICATION IN LEARNING FRACTIONS AND PERCENTAGES	261
<i>O. Sianov, O. Kachura</i> MATHEMATICAL MODEL OF SEMICONDUCTOR STRUCTURE BASED ON VANADIUM DIOXIDE	263

<i>O. Sianov, O. Kachura</i> MODEL OF A THREE-PHASE INDUCTION MICROMOTOR OF AUTOMATION SYSTEMS FOR THE STUDY OF DYNAMIC MODES	266
<i>Y. Verbenko, O. Matsuga, O. Novikova</i> A REVIEW OF MACHINE LEARNING APPROACHES IN LASER VISION CORRECTION	268
<i>I. Yakobchuk, N. Ashchepkova, O. Novikova</i> KINEMATIC MODELING AND AI-BASED CONTROL OF A SIX-DOF ROBOTIC MANIPULATOR	269

*Рекомендовано до друку на засіданні вченої ради
факультету української й іноземної філології та мистецтвознавства
Дніпровського національного університету імені Олеся Гончара
(протокол № 7 від 24 березня 2026 року)*

Рецензенти:

Бобух Н. М., д-р філол. наук, проф., завідувач кафедри української, іноземних мов та перекладу Полтавського університету економіки і торгівлі;

Бірюкова Д. В., канд. філол. наук, доцент кафедри іноземної філології, перекладу та професійної мовної підготовки Університету митної справи та фінансів;

Кирпича Т. В., канд. філол. наук, доцент кафедри перекладу та іноземних мов Українського державного університету науки і технологій

*Матеріали опубліковано в авторській редакції.
Відповідальність за зміст матеріалів несуть автори*

РЕДАКЦІЙНА КОЛЕГІЯ

Члени редакційної колегії:

д-р філол. наук, проф., декан факультету української й іноземної філології та мистецтвознавства **І. С. Попова**; д-р філол. наук, проф., завідувач кафедри англійської мови для нефілологічних спеціальностей **О. В. Гурко**; канд. філол. наук, доц. кафедри англійської мови для нефілологічних спеціальностей **О. М. Алісеєнко**; канд. пед. наук, доц. кафедри англійської мови для нефілологічних спеціальностей **О. М. Кондратьєва**; д-р філософії з філології, доц. кафедри англійської мови для нефілологічних спеціальностей **В. Ю. Осипенко**; канд. філол. наук, доц. кафедри англійської мови для нефілологічних спеціальностей **О. Р. Посудівська** (відп. секретар); канд. філол. наук, доц. кафедри англійської мови для нефілологічних спеціальностей **Т. В. Прищепя**; канд. філол. наук, доц. кафедри англійської мови для нефілологічних спеціальностей **І. П. Суїма**; канд. філол. наук, доц. кафедри англійської мови для нефілологічних спеціальностей **Т. В. Ворова**; ст. викл. кафедри англійської мови для нефілологічних спеціальностей **О. В. Осадча**; викл. кафедри англійської мови для нефілологічних спеціальностей **О. В. Бовкунова**; викл. кафедри англійської мови для нефілологічних спеціальностей **Н. В. Каліберда**; викл. кафедри англійської мови для нефілологічних спеціальностей **Г. А. Мудренко**

С 91 Сучасні науково-технічні дослідження у контексті мовного простору (англійською мовою) : матеріали V Всеукр. наук.-практ. конф. молодих науковців та здобувачів вищої освіти. – Дніпро, 14 травня 2026 р. – Дніпро: Видавець Біла К. О., 2026. – 282 с.

ISBN 978-617-645-542-4

У збірнику надруковано наукові праці V Всеукраїнської науково-практичної конференції молодих науковців та здобувачів вищої освіти “Сучасні науково-технічні дослідження у контексті мовного простору (англійською мовою)” з природничих, гуманітарних, соціально-економічних, інженерно-технічних студій та новітніх інформаційних технологій.

Для студентів, аспірантів, викладачів закладів вищої освіти та науковців.

УДК 81'243'276.6(043.2)

ISBN 978-617-645-542-4

© Колектив авторів, 2026

Наукове видання

Мова видання: англійська

СУЧАСНІ НАУКОВО-ТЕХНІЧНІ ДОСЛІДЖЕННЯ
У КОНТЕКСТІ МОВНОГО ПРОСТОРУ
(АНГЛІЙСЬКОЮ МОВОЮ)

Матеріали

V Всеукраїнської науково-практичної конференції

молодих науковців та здобувачів вищої освіти

м. Дніпро, 14 травня 2026 року

Відповідальний редактор *Посудієвська О. Р.*

Технічний редактор *Біла К. О.*

Здано до друку 27.04.26. Підп. до друку 14.05.26.
Папір – офсетний. Формат 60x84^{1/16}. Спосіб друку – плоский.
Ум. др. арк. 14,5. Тираж 90 пр. Зам. № 0426-03/11.

Видавець СПД Біла К. О.

Свідоцтво про внесення до Державного реєстру
суб'єктів видавничої справи ДК № 3618 від 06.11.09

Надруковано на поліграфічній базі видавця Білої К. О.
Україна, 49000, м. Дніпро, пр. Д. Яворницького, 111, оф. 1
тел. +38 (067) 972-90-71 www.confcontact.com e-mail: conf@confcontact.com

Academic publication

Language of publication: English

MODERN SCIENTIFIC AND TECHNICAL RESEARCH
IN THE CONTEXT OF LINGUISTIC SPACE (IN ENGLISH)

*Conference materials
of the V All-Ukrainian scientific and practical conference
of young scholars and higher education applicants*

Dnipro, May 14, 2026

Executive editor *Posudiiivska O. R.*
Technical editor *Bila K. O.*

Sent for print April 27, 2026. Signed for print May 14, 2026. Format 60×84 1/16.
Printing paper. Print flat. Obl. the arch 14.5. Circulation 90. Pr. No. 0426-03/11.

Publisher *Bila K. O.*
Printed on Publishing base of *Bila K. O.*

Ukraine, 49000, Dnipro, D. Yavornytsky av., 111/1

Certificate of entering into the State Register Series DK No. 3618 of 06.11.2009
+38 (067) 972-90-71 www.confcontact.com e-mail: conf@confcontact.com

ISBN 978-617-645-542-4



9 786176 455424