https://doi.org/10.48417/technolang.2026.02.04
Research article

The Gusli as Instrument for an Artistic Synthesis of Word, Voice, Media, and Technology

Dmitry Kukushkin[1] and Sergei Kurakov[2](✉)
[1] Russian Presidential Academy of National Economy and Public Administration,
82 Vernadsky Avenue, bld. 1, 119571, Moscow, Russia
[2] Bauman Moscow State Technical University, 2nd Baumanskaya st., 5, p.1, 105005, Moscow, Russia,
kurakov@bmstu.ru

Abstract
The article examines the problem of interpreting the gusli in contemporary musicology as a phenomenon that extends beyond the boundaries of traditional organology. The instrument is analyzed not only as an acoustic system but also as a bearer of cultural memory, syncretically combining word, sound, vocals, and performance action, thereby forming a unique cultural code of national consciousness. Special attention is paid to modern stage practice, exemplified by the ethno-performance "The Tale of Igor's Campaign" (Moscow, 2026), which demonstrates the actualization of an ancient sound archetype in the context of 21st-century theatre, where the entire performance is sung with authentic voices in the Old Russian language. The article shows that the integration of the traditional acoustics of the gusli with electronic means, lighting technologies, and elements of artificial intelligence creates a new model of artistic synthesis. The work on the contemporary staging of "The Tale of Igor's Campaign" required the collaboration of specialists with diverse competencies in the humanities and technical fields of scientific knowledge. The article analyzes the constructive modifications of the instrument and the developed technical solutions aimed at expanding its dynamic and sound frequency range, ensuring the historical timbre meets modern stage requirements. The authors present to the reader a two-year period of work on the adaptation of this literary monument of the Old Russian epic, not only from the perspective of mass art-media technologies but also from the viewpoint of restoring the image of the Russian folk musical instrument and its repertoire within musical culture.

Keywords: The Tale of Igor's Campaign; Gusli; Folk musical instrument; Ethno-performance; Artistic synthesis; Acoustic range; Preservation of Cultural Heritage

Acknowledgment The project, dedicated to the stage adaptation of a famous monument of ancient Russian literature *The Tale of Igor's Campaign*, was implemented by the Lyubov Zhuk Center for the Development of Gusel Art *Kupina* with the support of the Presidential Fund for Cultural Initiatives, application PFKI-25-2-014436 dated February 6, 2025.

Citation: Kukushkin D., & Kurakov, S. (2026). The Gusli as Instrument for an Artistic Synthesis of Word, Voice, Media, and Technology. *Technology and Language, 7*(2), 38-56. https://doi.org/10.48417/technolang.2026.02.04

УДК 7.091.5
https://doi.org/10.48417/technolang.2026.02.04
Научная статья

Гусли как инструмент художественного синтеза Слова, Голоса, Медиа и Технологии

Дмитрий Николаевич Кукушкин[1] и Сергей Витальевич Кураков[2] (✉)

[1] Российская академия народного хозяйства и государственной службы, пр-т Вернадского, 82, стр. 1, Москва, 119571, Россия

[2] Московский государственный технический университет им. Н. Э. Баумана, ул. 2-я Бауманская, д. 5, стр. 1, Москва, 105005, Россия

kurakov@bmstu.ru

Аннотация

В статье рассматривается проблема интерпретации гуслей в современном музыкознании как феномена, выходящего за пределы традиционного инструментоведения. Инструмент анализируется не только как акустическая система, но и как носитель культурной памяти, в котором синкретически соединены слово, звук, вокал и исполнительское действие, формируя своеобразный культурный код национального сознания. Особое внимание уделяется современной сценической практике на примере этно-спектакля “Слово о полку Игореве” (Москва, 2026), демонстрирующего актуализацию старинного звукового архетипа в контексте театра XXI века, где весь спектакль исполняется аутентичными голосами на древнерусском языке. В статье показано, что интеграция традиционной акустики гуслей с электронными средствами, световыми технологиями и элементами искусственного интеллекта создает новую модель художественного синтеза. Работа над современной постановкой “Слово о полку Игореве” потребовала взаимодействия специалистов разных компетенций в гуманитарной и технических областях научного знания. В статье анализируются конструктивные модификации инструмента и разработанные технические решения, направленные на расширение его динамического и звукочастотного диапазона, что обеспечивает соответствие исторического тембра современным сценическим требованиям. Авторы представляют читателю двухлетний период работы над адаптацией литературного памятника древнерусского эпоса не только с позиции массовых арт-медиа технологий, но и с точки зрения реставрации образа русского народного музыкального инструмента и его репертуара в музыкальной культуре.

Ключевые слова: Слово о полку Игореве; Гусли; Народный музыкальный инструмент; Этно-спектакль; Художественный синтез; Акустический диапазон; Сохранение культурного наследия

Благодарность Проект, посвященный сценическому воплощению всемирно известного памятника древнерусской литературы “Слово о полку Игореве”, реализован Центром развития гусельного искусства “Купина” имени Любови Жук при поддержке Президентского фонда культурных инициатив, заявка ПФКИ-25-2-014436 от 06.02.2025

Для цитирования: Kukushkin D., Kurakov, S. Gusli as Instrument for an Artistic Synthesis of Word, Voice, Media, and Technology // Technology and Language. 2026. № 7(2). P. 38-56. https://doi.org/10.48417/technolang.2026.02.04

INTRODUCTION

In traditional academic literature, the gusli are described primarily from the perspective of classifying instrument types, analyzing their construction, acoustic properties, and performance techniques. This approach is important, but it captures only one aspect of the phenomenon and does not encompass its cultural-symbolic dimension.

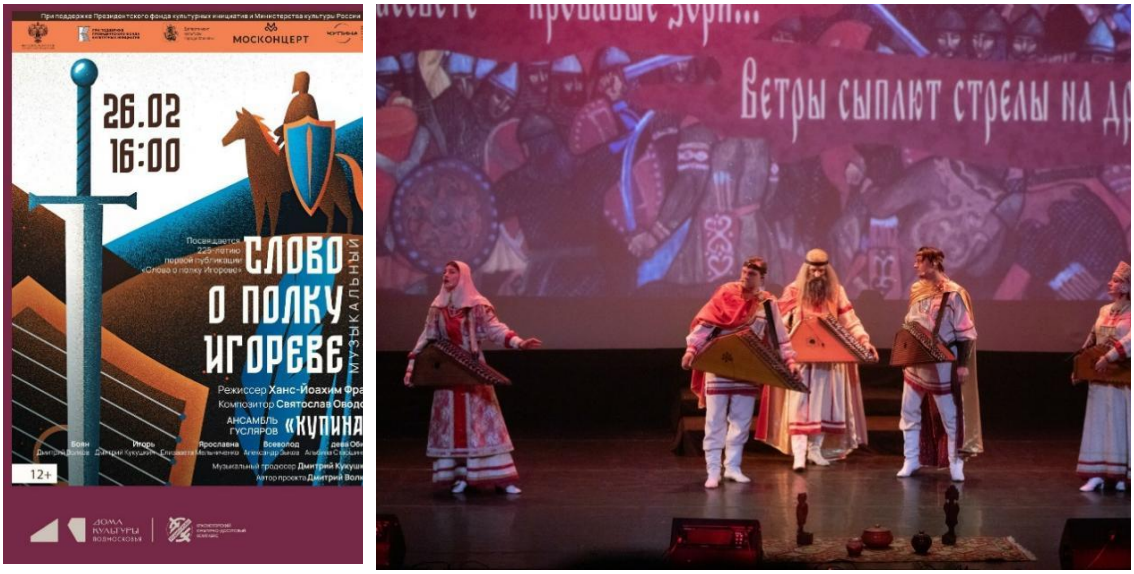
What are gusli? They are the most ancient Russian folk stringed plucked musical instruments. In their design and sound, they are direct relatives of the Finnish kantele, the Estonian kannel, the Mari kyusle, and other folk instruments, having spread across a vast territory of Eurasia following the migrations of ancient peoples and tribes. The gusli are a symbol of ancient musical culture and the embodiment of the heroic epic and bygone antiquity of many peoples. Among the gusli players (guslars) one can count the demiurge Väinämöinen from the Karelian epic "Kalevala," the merchant Sadko from the Novgorod bylina tales (Fig. 1a), and the hunter Saliy from the Mari epic "Yugorno." The Cyrillic letter 'G' ('Glagol') in the Old Church Slavonic alphabet is traditionally illustrated with a depiction of the gusli and a guslar (Fig. 1b).[1]

Figure 1. a) Sadko in the Underwater Kingdom. Ilya Repin's painting *Sadko* in 1876. The Russian Museum, Saint Petersburg (inv. Zh-4002). b) The letter "Glagol." On this page of the E. Bem «ABC», there is a small guslar sitting on a bench in a peasant hut, plucking the strings.

[1] The letter G is called "Глагол/ Glagol" and as a verb „glagol" means "to speak," "to utter words," or "to urge to action." Closely related, "Глас" (glas) is an old Church Slavonic or poetic word for voice. In grammar, voice (active/passive) shows the relationship between the verb's action and its subject – just as the human voice produces sound, the verb's voice produces meaning. (This footnote was generated with the help of AI.)

Meanwhile, in the context of contemporary culture, characterized by an active dialogue between past and present, the gusli becomes not only a source of sound but also a significant visual and dramaturgical element in musical projects. In particular, it offers symbolic and communicative potential in the accompaniment of vocal performances. This necessitates an expansion of analytical tools and a turn toward an interdisciplinary approach, combining elements of musical and engineering cultures. We propose to examine vocal performance with the gusli as a phenomenon that connects the acoustic nature of the instrument and its function as a bearer of cultural memory, augmented by a very recent technical innovation.

The ethno-performance “The Tale of Igor's Campaign” (Moscow, 2026), in which the gusli play a central role in shaping the sound and semantic space of the production serves as a key example for this analysis (Fig. 2).



a) **b)**

Figure 2. a) Official poster of the ethno-performance “The Tale of Igor's Campaign”; b) Premiere of the stage production featuring the ensemble of gusli players “Kupina”.

Examining the gusli in a broad cultural context, it is important to emphasize their connection with the oral tradition, heroic epic, and ritual practices. In historical consciousness, the instrument is persistently associated with the figure of the singer-storyteller, who not only vocalizes the text but also structures the time, space, and emotional state of the listeners. The sound of the gusli in this context fulfills the function of a mediator between the mythological past and the present, translating the narrative from the realm of abstract history into the sphere of lived experience. Thus, the instrument becomes a kind of “repository” of cultural meanings, which are actualized at the moment of performance.

In many cases, we can only speculate about the use of discovered artifacts as sources of sound. How music was made on such an instrument, under what circumstances, whether

these were isolated signals or sounds within some ensemble, whether they accompanied singing or dancing, often remains unknown. How are archaeological finds interpreted? On what basis is a particular artifact identified as a miniature trumpet or a frame drum? The materials obtained during excavations are insufficient here: it is necessary to reconstruct the historical context of the era (Khazdan, 2024; Treister & Ravich, 2021), and the classical scientific approaches associated with comparative metrological assessments of objects are insufficiently effective and clear.

The syncretism of word, sound, and performance action manifests itself in the fact that text, melody, and gesture do not exist in isolation but form a unified utterance in the case of a gusli accompaniment. The performer's manner of sitting, singing styles, the way of holding the instrument, the character of sound production, and even the pauses between phrases form a holistic image in which the aesthetic and semiotic principles are inseparable. For the contemporary researcher, this implies the necessity of considering the gusli player's performance as a complex performative act. In it, the voice and the gusli act not only as a sound source but also a visual sign, connecting the performer with a specific cultural tradition.

This approach allows for the interpretation of the gusli and singing in the Old Russian language within the categories of the cultural code of national consciousness. This code enshrines ideas about heroism, collective trials, spiritual fortitude, and connection to the land. When the instrument appears on the modern stage, it "transfers" these enduring meanings into a new artistic space, even if the specific plot of the production is not a reconstruction of historical events. Thus, the instrumental-vocal tradition proves to be an important means of shaping in the viewer a sense of belonging to a long historical lineage.

THE WORD AND THE GUSLI

The rise of interest in the history of gusli performance is associated with the publication of the text “The Tale of Igor's Campaign” in 1800 and the collection by Kirsha Danilov in 1804. In particular, Gavrila Derzhavin (1984) noted: “in ancient times, the Ode was accompanied by a simple melody; it was sung with a lyre, with a psaltery, with gusli, with a harp, with a zither, and in modern times with other instruments, but mostly, it seems, with stringed ones” (p. 273). As ideas about the Russian epic enriched, a generalized image of the gusli player-musician took shape in Russian culture – one equally mastering word and sound, extolling the glorious history of his native land, a bearer of the ethical and aesthetic norms of society in non-written form, a person elevated by the power of art and elevating others above everyday life.

Contemporary trends in academic musical culture expanded the gusli‘s significance. In the imaginative sphere of composers' works for the gusli in the late 20th and early 21st centuries it is no longer bound to – or serves only to invoke a reminiscence of – Russian culture. in. In these works, arrangements of dance and lyric folk songs, traditional for folk instruments, began to yield in number to large-scale concert pieces embodying epic byliny narratives, contemplative spiritual-religious, and sometimes stylized gallant aristocratic sound paintings. Evidence of the predominance in earlier times of synthetic instrumental-vocal music-making has led to the revival of recitative singing with gusli accompaniment

(self-accompaniment) –a practice that has only recently gained prevalence alongside solo or ensemble forms of performance. An understanding of contemporary trends in the development of gusli playing is impossible without a careful analysis and in-depth study of the centuries-old traditions associated with the history of this instrument (Volkov, 2019).

A vivid illustration of these trends can be found in a recent large-scale ethno-performance, where the fusion of epic narrative, spiritual contemplation, and stylized vocal-instrumental practice took center stage. The premiere of the ethno-performance *The Tale of Igor's Campaign* took place on February 19, 2026, at the Mosconcert venue.[2]

The ethno-performance serves as an illustrative example of how the ancient Russian sound archetype can be actualized in the theatrical space of the 21st century. The choice of this particular literary monument as the dramaturgical foundation is not accidental: “The Tale” is traditionally interpreted as a symbol of national memory and a reflection on the fate of the land and its people.

“The Tale of Igor's Campaign” was originally created by a cultural singer, authoritative and independent; the sung parts of "The Tale” were apparently created simultaneously with the chant-melos; at that same time (in 1185-1187), the text was written down from the retelling of a person who knew the entire poem by heart, possibly the author himself (Kulakovsky, 1946).

Most Russian folk instrumental cultures in the 20th century faced the problem of adapting to fundamentally new conditions of existence in the academic stage environment. However, while some folk instruments were destined for the first time to travel the path from an unpretentious means of organizing leisure to an instrument capable of realizing musically significant tasks, the gusli throughout their history were connected not only with entertainment and vernacular cultures but also with those cultures oriented toward deeper, more elevated purposes and images. The rich history of the gusli, the conception associated with them in our perception thanks to numerous surviving references and descriptions, distinctly sets them apart from related folk instruments (Zhuk, 2016).

In the cultural tradition that has been evolving over centuries, translations and artistic interpretations refer to one another and function as a single, multidimensional, ideologically charged text, obliging the interpreter to construct coherent versions. Hitting upon the right word for something and discovering its true name is like finding just the right key that fits the lock and opens the door to a new world with new powers. (Nordmann & Bylieva, 2021). Reconstruction is possible only through interaction with tradition. Tradition, however, is active (Yusupova, 2025).[3] The gusli continues itself, selecting those who know how to ask questions and seek answers. It is not enough to gather and present

[2] The director of the production was the German and Russian music manager Hans-Joachim Frey, the composer was Svyatoslav Ovodov, the project author was Dmitry Volkov, Dmitry Kukushkin served as music producer, and the performers were the ensemble of gusli players “Kupina.”

[3] Hermeneutic approaches to the deciphering of dead languages and words are most suitable for the restoration of the image and purpose of the gusli in the absence of reference samples. The ancient gusli are dead – this is a fact. But they carry the necessary information: The revival of this instrument will be associated with the creation of a beautiful, powerful, sonorous and practical sample, using the proportions and functions of the original design which we have carefully studied.

artifacts to the community, arranging them in some conventional order. Time shows that even open fixation (which can also include museum and exhibition displays) does not necessarily lead to understanding: with all due respect to generations of those wishing to gain knowledge without immersing themselves in the culture, this is precisely the case where the text, “if read, is not understood; if understood, is interpreted incorrectly... ” (Tikhomirov et al., 2023).

THE MEDIA CONTEXT

In the performance, the instrument is present not only as musical accompaniment to recitation or vocal episodes but also as an active participant in the stage action. The stage space is organized so that the gusli become the center of visual and acoustic attraction: mise-en-scènes, lighting accents, and sound climaxes are built around them. Due to this, the viewer perceives the instrument as a key symbol through which themes of memory, responsibility, and historical choice are comprehended. The sound image of the gusli, even with their technologically modernized timbre, maintains a connection with the ancient archetype – smooth, melodious, and contemplative.

A distinctive feature of the production was that work with vocals in the Old Russian language and the gusli is conducted on several levels simultaneously. On the one hand, it relied on traditional modal formulas, stable rhythmic patterns, and characteristic register-specific regional accents. On the other hand, these elements were integrated into the complex spatial-sound structure of the performance, which employed electronic processing, multichannel acoustics, and a lighting score. As a result, the instrument became incorporated into a contemporary multi-component media environment without losing its semantic significance (Lianskaya-Lininger, 2025). Thus, the constructive and acoustic properties of the gusli played a crucial role.

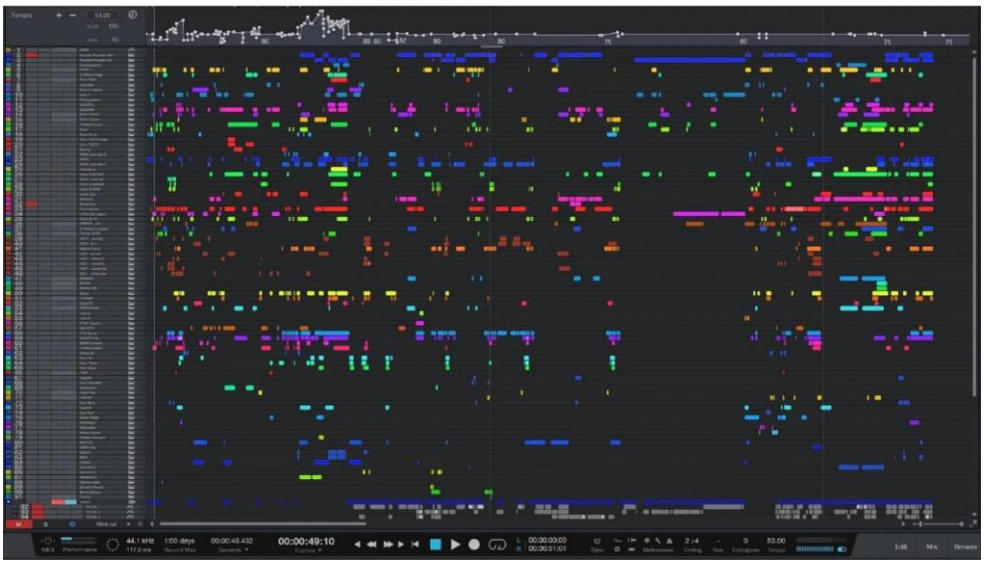


Figure 3. General sound score of the ethno-performance *The Tale of Igor's Campaign*, created in the program PreSonus Studio One 7 Pro.

A substantial part of the performance's artistic effect is associated with the integration of traditional singing (Ryzhinsky & Shao, 2024) and the acoustics of the gusli with electronic means, lighting technologies, and elements of artificial intelligence (Fig. 3). This integration makes it possible to transcend the boundaries of conventional concert sound and transform the performative act into a multilayered audiovisual event.[4]

It is important that the electronic processing does not replace the sound of the instrument but rather expands it, emphasizing specific timbral and dynamic qualities. Thanks to this, the recognizability of the gusli is preserved, while simultaneously creating a sense of their "revitalization" within a new technological context

In this tradition, the use of electronic means opens up the possibility of a multichannel spatial distribution of sound, where the original signal of the instrument is dispersed to different acoustic points in the hall. This creates the effect of a sound field in which the traditional timbre of the gusli is, as it were, "expanded" and envelops the viewer from all sides (Ryzhinsky, 2024).

Such solutions enhance the immersive nature of the performance and make the perception of the ancient material more personal and emotionally rich (Fig. 4). The viewers do not simply hear the gusli as part of the musical accompaniment but find themselves inside a sound space shaped by their intonations.

Figure 4. The Lament of Yaroslavna performed by Elizaveta Melnichenko – the climactic lyrical center of *The Tale of Igor's Campaign*, embodying the theme of love, fidelity, and grief of the entire Russian Land.[5]

[4] The mention of the use of artificial intelligence applies only to the creation of the musical accompaniment (playback) for this project, where AI performs tuning of the secondary voice accompanying the soloists. During the live performance of the ethno-performance, AI is not used in the musical track – only in the realization of the visual sequence on the video projector.

[5] Here, the absence of musical accompaniment, like zero, is an important indicator of traditional gusli performance. Firstly, it's a gender factor – women did not play the gusli in the general sense. Secondly,

The integration of artificial intelligence elements into the project enables the implementation of a flexible model of interaction between live performance and the digital system. Algorithms can respond to the musician's playing in real time, modifying parameters of reverberation, filtering, or spatial sound distribution. This makes each performance of the production unique and emphasizes the performative nature of the event. Importantly, in such a model, the gusli retain their status as the original sound source and semantic core, while technologies serve as tools for the variable unfolding of their acoustic and symbolic potential.

Lighting technologies complement this synthesis by visualizing sound processes and linking them to the dramaturgy of the performance. Changes in the lighting palette, intensity, and direction of beams can be synchronized with changes in registers, dynamics, and texture of the gusli playing. Due to this, a unified audiovisual fabric is created in which sound and light mutually reinforce each other. In such a system, the instrument is perceived as a source not only of sound but also of light, which metaphorically correlates with the idea of the enlightening power of cultural memory.

THE VOICE AND THE GUSLI

Several factors can be highlighted that influence the effect of the gusli on the performer's voice (Table 1). The vocalist's voice provides a smooth, continuous line with the ability for dynamic increase, vibrato, and the finest intonational nuances, whereas the gusli can deliver an instantaneous but decaying attack. This difference creates an ideal complementarity: the voice 'leads' the melodic line, while the gusli accentuate the meaningful beats, enhance dynamics, enrich the timbre of the voice, they can fill the pauses between breaths and play the part of secondary voices. At the same time, the instrument lacks natural vibrato, which paradoxically accentuates the singing voice to good effect. As soon as the voice takes a long note with vibration, the cold, direct sound of the strings underscores the warmth and living pulsation of the voice.

Table 1. Correspondence of the acoustic interaction between the performer's voice and the playing of the gusli

Parameter	Voice	Gusli
Sound production	Soft or firm, but always controlled: increasing air pressure allows for a smooth onset of sound	Instantaneous, sharp: plucking the string produces a "flash" with maximum amplitude in the first milliseconds
Duration of sound	Limited only by breath	Not limited when using the *tremolo* technique.

Yaroslavna's lament is a prayer (with elements of paganism, characteristic of early Christian beliefs), in the Russian tradition without musical accompaniment, a cappella. However, this climactic moment of the play does not contradict the presence and influence of the gusli as an instrument in musical terms. It is like a long jump. Emotionally and stylistically, the director has organically played out this moment. The gusli are not present, but they condition the moment.

Decay	Controlled decay: the vocalist can sustain the tone evenly, increase volume, or stop the sound abruptly/smoothly	Natural exponential decay of the string or damping
Basic timbre	Individual: can be velvety, piercing, dark, bright depending on voice type (soprano, tenor, bass, etc.)	Has a metallic overtone when playing with a *plectrum*, and a soft tone when playing *pizzicato*. Timbre also depends on the string type – with copper winding (alto) or without winding (prima).
Timbre variation	Extremely rich: changing vowel rounding, raising/lowering the larynx, using head/chest resonance, covering, *vibrato*.	Depends on the point and method of contact with the string.
Intonation / Tuning	Constant: due to precise coordination of the laryngeal muscles, the vocalist can adjust intonation within milliseconds.	The instrument is tuned with a tuning key before playing. In rare cases, tuning with the key is used during performance.
Pitch control	Natural or conscious – periodic fluctuation of pitch and volume.	Pitch can be adjusted during performance using semitone eccentric switches. These allow changing the key while playing, thereby reducing or increasing the pitch range.

It should be noted that the instrument provides timbral and harmonic support to the performer's voice. The gusli serve as a 'supporting sound field' for the voice. Their rich sound and even tone across all registers allow the vocalist to freely experiment with timbre without fear of losing tonal orientation. Furthermore, the metal strings effectively 'cut through' the orchestral or noise texture (in the given example, this refers to the soundtrack of the ethno-performance *The Tale of Igor's Campaign* playing through the performer's monitors), maintaining the harmonic framework while the voice focuses on finer phrasing and semantic accents. Thus, the gusli do not compete with the voice but rather create a clear rhythmic-harmonic grid for it, highlighting the natural plasticity and emotional richness of the singing sound.

In order for the historical timbre of the gusli to fit organically into the demands of contemporary stage practice, a revision of the instrument's constructive parameters is required (Fig. 5).[6] One of the most important tasks becomes the expansion of the dynamic range, making it possible to achieve both delicate, almost whisper-like sounds and

[6] On the one hand, the classical reconstructive sound of the gusli would disappoint the listener with its boredom and monotony. Our perception of sound and voice has changed. Secondly, in the modern format of a play or musical, a wider palette of sound accompaniment is required as a rich background for vocals.

powerful, dramatically saturated climaxes. This can be achieved through the use of new types of wood, changes in the thickness of the soundboard, the construction of supporting elements, the type of strings, and additional elements such as semitone eccentric switches. As a result, the instrument acquires a more flexible response to touch, allows for quick retuning from one key to another, while preserving its characteristic timbral coloration.

Figure 5. Recording graph of the acoustic range of the gusli from the score of the ethno-performance *The Tale of Igor's Campaign* in the program PreSonus Studio One 7 Pro. The change in the front of the sound amplitude on the graph displays the change in playing technique and key after retuning via the semitone eccentric tensioners, which is impossible for the standard construction of the instrument.

An equally significant task is the expansion of the sound frequency range, necessary for the interaction of the gusli with playback, electronics, and vocal parts across a wide register field. Constructive solutions in this direction include increasing the number of strings, optimizing their arrangement, and developing tuning systems that ensure the stability of the tuning under intensive stage use. This creates the possibility of more precisely aligning the instrument's modal organization with contemporary harmonic structures, without destroying its traditional intonational characteristics. Thus, the gusli retain a connection with the historical sound but become more versatile in ensemble and stage conditions.

Technical innovations can also affect methods of sound reinforcement, where hidden sensors, piezo elements, and contact microphones are integrated into the instrument's body. This allows for capturing the sound with high detail and transmitting it

to the electronic system without losing the subtle nuances of attack and decay. At the same time, the task for the designers is to preserve the visual authenticity of the gusli: externally, the instrument remains close to the traditional model, and the technological additions remain invisible to the viewer. In combination with thoughtful stage direction, this creates the effect of the “natural” presence of an ancient instrument within a high-tech theatrical space.

MECHANICS AND THE GUSLI

To solve the problem of rapidly mechanical key switching a musical instrument's string during the process of sound production, we had to turn to the scientific experience accumulated in *Applied Mechanics* and the *Theory of Machines and Mechanisms*, as well as to illustrative examples from the collection of Franz Reuleaux (Kotelnikov & Kurakov, 2025) and earlier mathematical devices (Tikhomirov et al., 2024). At the same time, in addition to functional characteristics, the performing musicians imposed high ergonomic and aesthetic requirements on the device being designed.

When producing sound, the construction of the gusli does not have a fret system like the neck of a guitar, where the player presses a string against the wooden surface of the neck at a specific point to obtain the desired pitch. If the gusli has 17 strings, they are permanently tuned to the required notes, like on a piano. To obtain, for example, a semitone, you would need 34 strings, which significantly increases the instrument's size, making the design absurdly gigantic (e.g., the "Wonder Gusli"). Of course, the gusli player can use their free hand to press their fingers onto the string at an imaginary fret and touch it. And they do so. However, this damps the vibrating string, reduces the amplitude of the sound, and the sound becomes dull, quiet, and inexpressive. The solution is to create a mechanical switch on each gusli string, operated and controlled by the performer.

The newly designed device should be simple and easy to use, lightweight and compact, reliable under high loads, as well as visually neutral, blending seamlessly with the wooden structure of the gusli. For mechanical string tensioning, a cam controller is used as a simple and reliable device. Cam control is well known in the history of science and technology; its disadvantage is relatively low speed. At high switching speeds, the system loses rigidity, and errors or failures may occur. However, in the case of manual switching in a musical instrument, this is more than sufficient.

Tensioning devices based on an eccentric belong to cam mechanisms and are widely used as a rigid control apparatus for executing movement in a single plane (Fig. 6). Numerous examples of using an eccentric for clamping/tensioning can be found in the fields of mechanical engineering and machine tool accessories, in the textile industry, and elsewhere. In the manufacture of musical instruments, there is a common plate-type tension system (for example, patent RU2745139C2C, 2021).

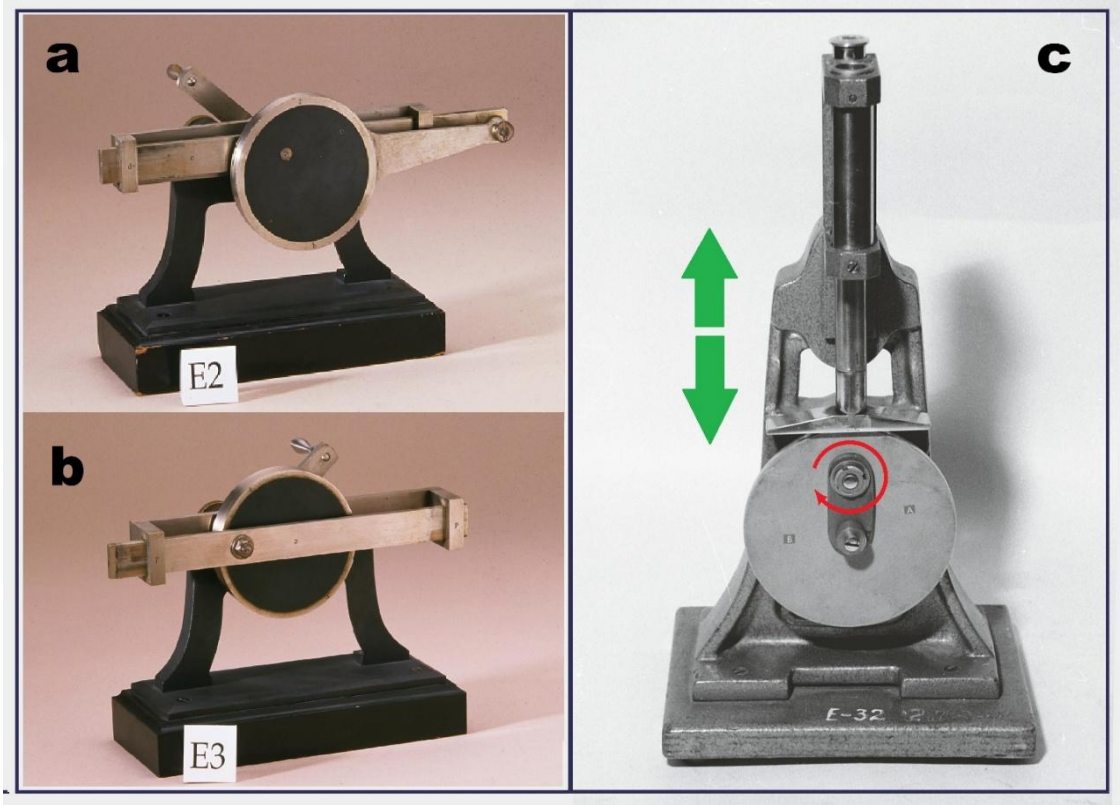


Figure 6. a, b) Models of kinematic mechanisms with eccentric cams from the Franz Reuleaux collection (KMODDL, 2026); c) The model of a cam mechanism with a flat follower and variable eccentricity served as a prototype for the new string tensioner (source: Fund of Bauman Moscow State Technical University's Museum).

The closest analogue in terms of the principle of regulating the pitch of a string is the lever mechanism on a harp – it has two positions, the difference between the upper and lower positions being a semitone. However, the classical design of the lever mechanism has significant differences: firstly, although the lever may employ a cam apparatus for tension, it is not adjustable on the harp; that is, the displacement of the string occurs strictly within a range of 0-2 mm (only 0 and only 2 mm). In our version with the eccentric, however, displacement is incrementally variable from 0 to 2 mm, including all intermediate values. Secondly, the tension force of nylon harp strings is up to 200 N (20 kg), whereas for the gusli it is 600-1000 N (60-100 kg) – which significantly impacts the design and dynamic calculation of the tensioner. Thirdly, from a musicological perspective, the harp and the gusli are fundamentally different types of musical instruments.

Analogues of eccentric tensioners for the gusli exist only in isolated instances, created in various workshops, but all of them possess low rigidity, are cumbersome, have a low level of reliability, and represent homemade devices similar to the lever mechanisms of a harp.

Thus, the goal of the development was to create a reliable and easily adjustable device that meets the requirements of high string tension, increases the operational lifespan of the musical instrument as a whole, provides convenient installation of the tensioner at different string heights through the use of an angled joint, and also offers the performer the possibility of expanding the frequency (note) range of the musical repertoire, taking into account the traditions of those who play close analogues of the gusli in their cultures.

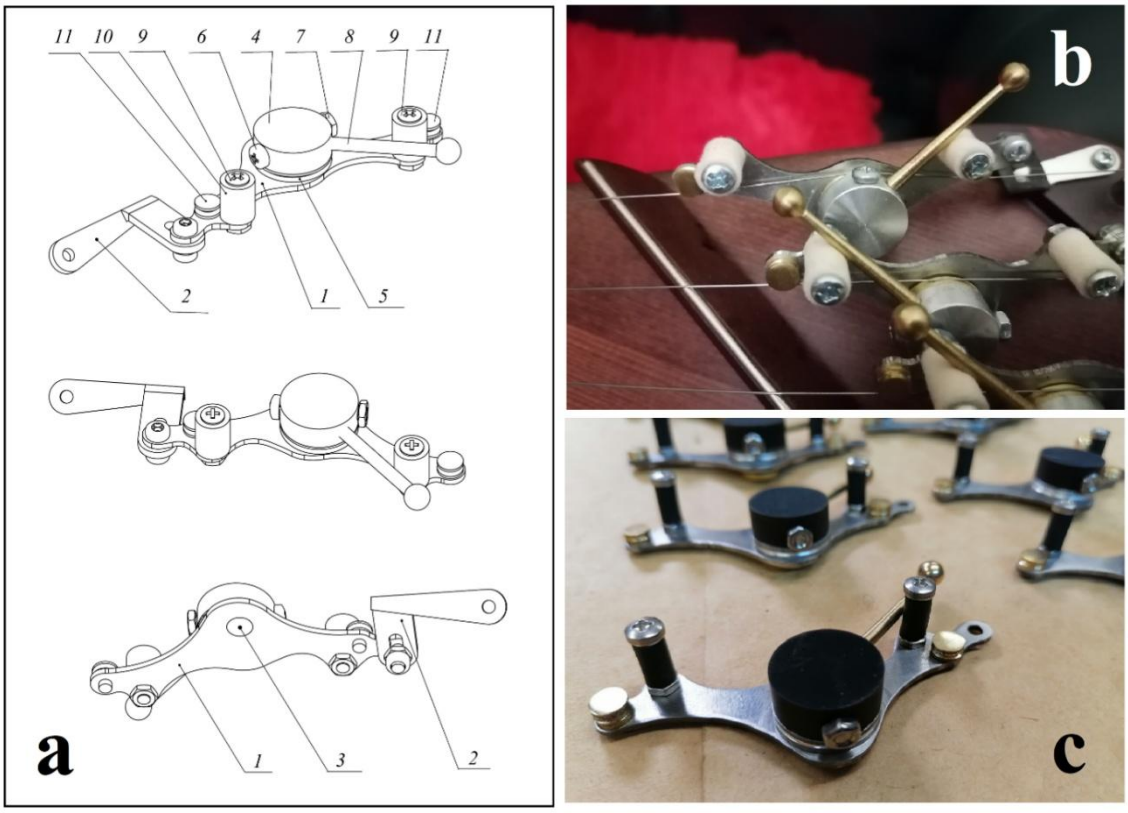


Figure 7. a) Assembly drawing of the general view of the eccentric string tensioner; b) Example of installed tensioners in working and non-working position; c) Tensioner with a carbon fiber eccentric made using additive technologies.

The key distinction from analogues lies in the improved universal design of the device, which allows it to be installed fin various types of folk musical instruments of the gusli family to double the acoustic range (the pitch of each string changes by a semitone) during the performer's interpretation of the musical repertoire (Fig. 7). The device consists of a base plate, produced by laser cutting (Biryukov et al, 2019), onto which all other parts are mounted, and a movable angle joint that enables adjustment of the device's installation height relative to the string's distance from the instrument's soundboard – a distinctive difference to other approaches. The eccentric shaft and the eccentric with a ring are mounted onto the base plate by means of a bolt and nut, which regulates the axial displacement of the eccentric from 0 to 6 mm with intermediate values. This eccentricity causes the lateral surface of the eccentric to rise in the extreme right position of the handle

from 0 to 3 mm (Fig. 6b). To secure the eccentric handle, there are two limit stops – the difference between the left and right positions of the eccentric handle corresponds to a semitone. There are two stationary string supports, riveted into the base plate; thus, the device contacts the string at three points – the two stationary supports from above and the eccentric ring from below – ensuring reliable force tension (Kukushkin et al., 2025).

To increase production efficiency and ensure a low product cost, a model of the eccentric was developed using durable carbon fiber-reinforced plastic (Kotelnikov et al., 2024), manufactured by methods of additive technologies (Kurakov et al., 2025; Supchinsky et al., 2023). The high precision of 3D printing and the absence of finishing mechanical processing made it relatively simple to carry out assembly operations, ensuring functional clearances in the operation of the mechanical system (Sinitsa, Korzhenkov et al., 2022; Sinitsa, Tumakova et al., 2022). Subsequently, it was discovered that, unlike the metal eccentric, the plastic eccentric proved to be less stable during the switching of tensioners under higher and cyclic loads, for example on alto gusli (Pronyakin et al., 2021; Volkov et al., 2024).

Finally, the aesthetics of such mechanical devices (Deng & Liggieri, 2025) play a significant role, encompassing ergonomics, light weight, reliability and simplicity, precision of assembly, and the minimalist quality of modern materials.

CONCLUSION

If we consider the gusli only within the context of contemporary musicology and theatrical practice, it becomes evident that this instrument cannot be described exclusively in categories of acoustics and constructive features. The Russian folk instrument emerges as a complex cultural phenomenon, in which the functions of a sound source, a visual symbol, and a bearer of historical-poetic memory are combined. In the ethno-performance *The Tale of Igor's Campaign* this multilayered nature manifests itself with particular clarity: the gusli becomes the foundation of an artistic space where an ancient Russian sound archetype and the possibilities of 21st-century theatre intersect.

The integration of traditional singing and the acoustics of the gusli with electronic means, lighting technologies, and elements of artificial intelligence forms a new model of artistic synthesis. In this model, technologies do not supplant tradition but serve as a tool for its actualization and expansion. Constructive modifications of the instrument, aimed at expanding its dynamic and sound frequency range, ensure that the historical timbre meets modern stage requirements without destroying its authenticity. As a result, the gusli appear not only as a sign of the past but also as an actively developing artistic resource capable of setting new directions in the development of national theatre and musical culture.

The implementation of such projects would simply be impossible without collaborative humanitarian and technical approaches, interdisciplinary subject connections that must be taken into account in modern educational methodologies when training specialists in engineering and humanitarian fields of scientific knowledge (Bazanchuk & Kurakov, 2021; Chicherina, 2024).

Analysis of stage practice shows that singing accompanied by the gusli in contemporary theatre can fulfill the function of a core element in a complex artistic synthesis. Various levels of expressiveness are built around the instrument: word, plasticity, light, electronic sound, visual projection. At the same time, it is the gusli that ensure the internal coherence of these components, since at the level of cultural memory they are associated with an integral, syncretic type of artistic thinking. It can be said that singing accompanied by a folk instrument becomes a model through which the possibility of connecting tradition and innovation within a unified artistic space is conceptualized.

This approach allows for a new perspective on the role of traditional instruments in contemporary culture. They cease to be perceived as museum exhibits or markers of folkloric reconstruction and become active participants in the current artistic process. In the case of the gusli, this is particularly noticeable, as the very image of the instrument is associated with the idea of narration, reflection, and spiritual quest. Contemporary technologies, integrating into this framework, do not negate it but, on the contrary, expand the field of utterance, translating ancient intonations into a language understandable to a 21st-century audience.

It is important to emphasize that such a synthesis requires a high degree of responsibility from directors and composers, as well as from designers and performers. If the technological component begins to dominate and displaces the live sound of the instrument, the key semantic center of the production is lost. At the same time, the careful and thoughtful use of electronic and lighting means can highlight the uniqueness of the gusli's timbre and the performer's voice, deepening the perception of the cultural memory associated with them. This constitutes one of the main creative challenges for contemporary projects that engage with traditional instruments.

REFERENCES

Bazanchuk, G. & Kurakov, S. (2021). My vybrali temu tvorchestva Al'brekhta Dyurera, potomu chto on byl matematikom i inzhenerom. [We Chose the Theme of Albrecht Dürer's Work Because He Was a Mathematician and Engineer]. *Devices, 11*(257), 49-55.

Biryukov, V., Shmelev, S., Bogdanov, A., Taxants, M., Stamm, V., & Uspensky, S. (2019). Laser Hardening of Steels with a Rectangular Spot to Increase Their Service Life. *Photonics Russia*, *13*(6), 532-537. https://doi.org/10.22184/1993-7296.FRos.2019.13.6.532.537

Brockhaus and Efron Encyclopedic Dictionary. Bayan, pevets. [Bayan, singer] URL: https://ru.wikisource.org/wiki/ ЭСБЕ/Баян,_певец

Chicherina, N. V. (2024). Higher Education Futures: On the Diversity of Scenarios. In: Bylieva, D., Nordmann, A. (Eds.) *Scenarios, Fictions, and Imagined Possibilities in Science, Engineering, and Education. PCSF 2024. Lecture Notes in Networks and Systems* (vol. 1203, pp. 161-170). Springer. https://doi.org/10.1007/978-3-031-76797-5_13

Deng, P., & Liggieri, K. (2025). The Language and Poetics of Machines. *Technology and Language*, *6*(3), 1-9. https://doi.org/10.48417/technolang.2025.03.01

Derzhavin, G. R. (1984). *Rassuzhdeniya o liricheskoy poezii ili ob ode*. [Reflections on Lyric Poetry or the Ode]. Selected Prose. Sovetskaya Rossiy.

Digital library. Kinematic Models for Design. Cornell University College of Engineering. (2026). URL: https://digital.library.cornell.edu/collections/kmoddl

Khazdan, E. V. (2024). Ot muzeynogo eksponata k zhivomu zvuku: puti rekonstruktsii. [From Museum Exhibit to Live Sound: Ways of Reconstruction]. *Kunstkamera*, 3(25), 57 –69. https://doi.org/10.31250/2618-8619-2024-3(25)-57-69

Kotelnikov, P. N., Kurakov, S. V., & Samoilov, V. B. (2024). Sravneniye additivnykh sposobov 3D-pechati prozrachnykh polimerov v restavratsii utrat predmetov politekhnicheskogo tipa. [Comparison of additive methods for 3d printing transparent polymers in the restoration of polytechnic type objects]. *Art Heritage. Research. Storage. Conservation, 4*(12), 60-73.

Kotelnikov, P., & Kurakov, S. (2025). Scientific Restoration of Polytechnic Heritage: The Case of the Franz Reuleaux Collection. *Technology and Language*, *6*(3), 64-79. https://doi.org/10.48417/technolang.2025.03.05

Kukushkin, D. N., Kurakov, S. V., & Tikhomirov, G. V. (2025). Ekstsentrikovyy natyazhitel' dlya strun russkogo natsional'nogo instrumenta gusli [Eccentric Tensioner for Strings of the Russian National Instrument Gusli] Patent for Utility Model No. 232207 U1 Russian Federation, IPC G10D 3/147, G10C 3/10.

Kulakovsky, L.V. (1946). Pesn' o polku Igoreve. Problema vossozdaniya muzyki. [The Song of Igor's Campaign. The Problem of Recreating the Music]. *Soviet Music*, *12*, 77-89.

Kurakov, S. V., Melnikova, M. A., Bogdanov, A. V., Tikhomirov, G. V., & Kotelnikov, P. N. (2025). Restoration, Current Approaches Using the Additive Technologies: Issues of Transparency. *Proceedings of the 2025 7th International Youth Conference on Radio Electronics, Electrical and Power Engineering (REEPE), 474*, 1-6. https://doi.org/10.1109/REEPE63962.2025.10971027

Lianskaya-Lininger, E. (2025). From Eisenstein to Einstein: The Ultimate Guide to Mediaopera. *Technology and Language*, *6*(1), 28-41. https://doi.org/10.48417/technolang.2025.01.04

Nordmann, A., & Bylieva D. (2021). In the Beginning was the Word. *Technology and Language*, *2*(1), 1-11. https://doi.org/10.48417/technolang.2021.01.01

Pronyakin, V. I., Skrypka, V. L., & Abykanova, B. T. (2021). Surface microgeometry monitoring of large-sized aircraft elements. *IOP Conference Series: Materials Science and Engineering*, *1027*(1), 2243. https://doi.org/10.1088/1757-899X/1027/1/012024

Ryzhinsky, A. S. (2024) Luigi Nono's Works from the Late 1950s: The Emergence of a New Choral Style, *Music Scholarship*, *2*, 148-165. https://doi.org/10.56620/2782-3598.2024.2.148-165

Ryzhinsky, A. S. & Shao, S. (2024). Khor kak “vokal'nyy orkestr” v tvorchestve sovremennykh rossiyskikh kompozitorov. [Choir as a “vocal orchestra” in the works of contemporary Russian composers]. *Scientific Notes of the Gnessin Russian Academy of Music, 3*(50), 29-41. https://doi.org/10.56620/2227-9997-2024-3-29-41

Sinitsa, M. O., Tumakova, E. V., & Komshin, A. S. (2022). Some Features of Measurements of Dynamic Characteristics of Heavy Machinery Objects During Operation in the Far North. *Lecture Notes in Mechanical Engineering* (pp. 592-602). Springer. https://doi.org/10.1007/978-3-030-85233-7_70

Sinitsa, M., Korzhenkov, I., & Komshin, A. (2022). Development of a System for Controlling the Geometry of Products in Heavy and General Engineering by Non-Contact Methods. *AIP Conference Proceedings*, 2503. https://doi.org/10.1063/5.0099471

Supchinsky, O., Melnikova, M., Kholopov, A., Melnikov, D., & Bogdanov, A. (2023). Additive Technologies Features for Manufacturing Metal Products from Powder Materials by Direct Laser Deposition. *Lecture Notes in Networks and Systems*, *510*, 393-401. https://doi.org/10.1007/978-3-031-11051-1_38

Tikhomirov, G. V., Egorova, O. V., Bazanchuk, G. A., & Kurakov, S. V. (2023). Humanitarian Techniques in the Teaching of Technical Sciences. *Mechanisms and Machine Science*, *134*, 343-349. https://doi.org/10.1007/978-3-031-32439-0_39

Tikhomirov, G. V., Egorova. O. V., Bazanchuk. G. A., & Kurakov, S. V. (2024). The Pantograph: Rare Models and Application. *History of Mechanism and Machine Science*, *47*, 305-313. https://doi.org/10.1007/978-3-031-54876-5_22

Treister, M. & Ravich, I. (2021). Chinese mirrors from the burials of the nomads of Eastern Europe of the second half of the 1st millennium BC-first centuries AD: Typology, chronology, distribution and technology of manufacture. *Advances in Archaeomaterials*. *2*(1), 24-48. https://doi.org/10.1016/j.aia.2021.07.001

Volkov D. V. (2019). Ranniye traditsii igry na guslyakh i sovremennyy status instrumenta. [Early Traditions of Playing the Gusli and the Modern Status of This Instrument]. *Man and Culture, 5*, 11–26. https://doi.org/10.25136/2409-8744.2019.5.30847

Volkov, D. R., Komshin, A. S., Pronyakin, V. I., Rudenko, A. L., Fomin, A. E., & Nurgatin, B. I. (2024). System for the Prevention of Critical Operating Modes of a Hydraulic Unit Based on the Phase-Chronometric Method. *Power Technology and Engineering*. *58*(3), 453-457. https://doi.org/10.1007/s10749-024-01832-9

Yusupova, I. (2025). Everything You Wanted and Didn't Want to Know about Mediaopera: A Cryptophonic Memoir. *Technology and Language*, *6*(1), 14-27. https://doi.org/ 10.48417/technolang.2025.01.03

Zhuk L. Ya. (2016). Sokhraneniye kul'turnogo naslediya Rossii. [Preservation of Cultural Heritage of Russia]. *Gusli, special issue*, 38-41, http://issuu.com/ansamblkupina/docs/gusli_01_2015_1

СВЕДЕНИЯ ОБ АВТОРАХ / THE AUTHORS

Кукушкин Дмитрий Николаевич,
kukushkin.dn@gmail.com, 0009-0008-6730-9172

Кураков Сергей Витальевич,
kurakov@bmstu.ru, 0009-0006-9834-630X

Dmitry Kukushkin, kukushkin.dn@gmail.com
0009-0008-6730-9172

Sergei Kurakov, kurakov@bmstu.ru,
0009-0006-9834-630X

Статья поступила 10 марта 2026
одобрена после рецензирования 25 мая 2026
принята к публикации 10 июня 2026

Received: 10 March 2026
Revised: 25 May 2026
Accepted: 10 June 2026