MIDI PROGRAMMING BASED POSSIBILITIES OF THE THEATER AUTOMATION TECHNOLOGIES ON FOR WORK PRODUCTIVITY: KLAIPĖDA CITY DRAMA THEATER CASE

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Abstract

The article analyzes the impact of MIDI technology integration into theater automation systems on work efficiency. It also examines alternative solutions such as OSC, SMPTE time codes, motion tracking systems, and artificial intelligence integration, which open new dimensions for theater automation and creativity. Based on the results obtained, the article offers insights into future technological trends and provides practical recommendations for improving the productivity of technical theater teams. A review of scientific literature from 2015 to 2025 and the analysis of ten productions at Klaipėda City Drama Theater were conducted. The study's findings confirm that MIDI-based systems optimize resource utilization, and their modular structure provides a 15–20% time saving when preparing new productions. Furthermore, the analysis revealed that the integration of MIDI Show Control (MSC) and MIDI Polyphonic Expression (MPE) technologies significantly expands the possibilities for artistic expression, allowing the creation of interactive and dynamically adaptive scenes. These technologies enable directors to synchronize lighting, sound, and motion elements in real time, while the technical staff benefits from a 4.7-fold reduction in technical errors compared to alternative protocols.

Keywords: MIDI, theatre automation, labor productivity, stage control, artistic technology.

INTRODUCTION

Research topicality and problem. Digitization has strongly affected the difference in creativity. In today's theater, 78% of technical operations involve automatic stage control systems (MIDI Association, 2023). Traditional stage effects management methods no longer meet dynamically changing artistic requirements due to the limited bandwidth of 8-16 channels, 1.2 and 2.4 s delay between command execution (Cooke, 2021). In addition, 92% of modern performances integrate interactive audiovisual systems that require synchronization in three axes (X, Y, Z) with an accuracy of 0.5 ms (Cunha et al., 2024). Thus, it is becoming important to find out how digitalization influences work productivity of the Klaipeda city theater, especially how MIDI programming-based possibilities of the theater automation technologies influence work productivity.

The aim of the research. To analyze the possibilities of applying the MIDI 2.0 protocol in theater automation for labor productivity indicators

Research methodology. An analysis of the scientific literature was performed by selecting 21 scientific articles from Scopus, Web of Science and other databases. Also, an analysis of 10 Klaipėda's drama theater performances, in which stage control systems based on the MIDI 2.0 protocol were used, was performed. Performances were selected according to the following criteria:

1. integrated automated equipment (light, sound, motion control);
2. Real-time implementation of MIDI 2.0 protocol;
3. Documented technical programming flow, allowing the analysis of the automation processes.

The empirical part of the research is based on quantitative research, based on the analysis of technical documents of the performances (programming diagrams, MIDI switching maps, effects tables), rehearsal logs and used software (e.g. *Ableton Live*, *QLab*, *TouchDesigner*) data. The research data was systematized through evaluation analysis, and each performance was evaluated according to three main categories: duration of the work process: estimated time required for the preparation of stage elements, rehearsal and actual execution of the performance; frequency of technical errors: fixed MIDI system glitches, signal losses,

synchronization delays, operator errors; variability of artistic expression: analyzed the extent of MIDI influence in creating dynamic, emotionally expressive and interactive scenography. The analysis made it possible to identify common trends that generalize the impact of MIDI technologies not only on the technical but also on the creative aspects of theater work. Quantitative indicators (e.g., time changes, percentages of error reduction) were evaluated using descriptive statistical analysis, calculating means.

The research results: 1) MIDI Show Control MSC systems reduce scene rearrangement time by 42%; 2) MIDI Polyphonic Expression MPE technology increases the possibilities of artistic expression by 3.1 times; 3) DIN 5 standard ensures 99.7% signal transmission reliability.

Originality/Value of the article. The analysis and methodological combination made it possible to identify the benefits of MIDI technologies not only as a technical optimization tool, but also as a creative tool of dramaturgical structure, integrated into the practice of contemporary theater.

THEORETICAL ANALYSIS

Theater automation technologies based on MIDI programming are becoming increasingly important for enhancing productivity and enabling greater flexibility in artistic expression within modern theater. As stage technology advances rapidly, there is a growing need to understand how MIDI protocols are transforming stage management practices (MIDI Association, 2023). MIDI (Musical Instrument Digital Interface) is a digital communication protocol developed in the early 1980s to standardize the transmission of information between electronic musical instruments and audio equipment (MIDI Association, 2023). Unlike audio signals, MIDI transmits symbolic information describing musical actions—such as note pitch, duration, and velocity—making it a control language rather than a sound transmission system. This allows one device to control another efficiently without sending bulky audio files. Although MIDI was initially developed for the music industry, its versatility, compactness, and technical flexibility led to its widespread adoption in performing arts. In theater, MIDI is commonly used to synchronize sound effects, lighting, video projections, and other stage processes, enabling seamless and technologically coordinated performances. Its application enhances creative workflows, reduces the likelihood of human error, and ensures repeatable and accurate stage outcomes (MIDI Association, 2023). A MIDI system typically consists of three main components: a sender (e.g., computer or controller), a receiver (e.g., synthesizer, light controller, or sound card), and a communication channel (e.g., MIDI cable, USB, or Bluetooth). Each MIDI message comprises three parts: a command (e.g., note on/off), a channel number, and additional information (e.g., which note to play and at what velocity). This simple structure allows for the rapid transmission of thousands of commands per second, enabling real-time control of multiple stage elements. With the introduction of the MIDI 2.0 specification in 2020, which features a data rate of 10 Mbit/s and a time resolution of 0.1 μs, the control capacity expanded to 256 simultaneous channels (MIDI Association, 2023). Compared to MIDI 1.0, the new protocol increases data transmission efficiency significantly. One of the greatest advantages of MIDI technology is its ability to integrate diverse artistic elements into a unified production design. Directors, choreographers, and composers can precisely plan audio and visual cues, all controlled automatically, reducing technical workload and enhancing the reliability and artistic potential of performances. For example, MIDI Polyphonic Expression (MPE) enables sound designers to control individual sonic parameters for each instrument or effect, allowing for intricate sonic textures that heighten emotional impact (Herremans & Chew, 2019). MIDI Time Code (MTC) synchronizes lighting effects with music, video, or actor movements, creating immersive and dramaturgically coherent experiences.

Integration with motion tracking systems such as Leap Motion or Kinect allows actors to manipulate light or sound effects through body movements, fostering interactive scenography and expanding creative possibilities for directors and choreographers (Hagendoorn, 2004). Furthermore, MIDI technologies enable performances to respond dynamically to actors or audience participation, opening avenues for interactive and participatory theater. MIDI significantly contributes to enhancing audience experiences by synchronizing sound, lighting, and projection effects to create cohesive and immersive environments. Its adaptability also allows performances to be seamlessly modified for different venues or artistic directions, providing flexibility in rehearsals and live shows.

In summary, MIDI technology has become an integral part of contemporary theater production, supporting technical precision, artistic innovation, and interactive engagement. Its continued development promises further advancements in creative expression and automated stagecraft.

MIDI (Musical Instrument Digital Interface) programming has substantially enhanced efficiency and productivity within theater productions. Its integration into sound, lighting, and multimedia systems enables precise, automated, and flexible control, facilitating both technical and artistic processes. Modern theater increasingly relies on automation technologies to enhance the precision, consistency, and creative flexibility of performances. MIDI (Musical Instrument Digital Interface) is one of the most established protocols in this domain, enabling reliable synchronization of lighting, sound, and stage mechanisms (MIDI Association, 2020). MIDI allows automation of performance events such as triggering sound effects, controlling synthesizers, and managing performance parameters. This automation reduces manual intervention, improving accuracy and streamlining operations during performances (Huber, 2012; Huber, 2013). By automating cues and transitions, technical staff can focus on creative problem-solving rather than repetitive tasks, thereby enhancing overall workflow efficiency. MIDI sequence editors enable detailed input, editing, and output of musical data, supporting various musical styles and incorporating advanced functions such as note input, track creation, and effect processing. This capacity improves sound design quality and efficiency in preparing theater productions (Zhou, 2025). The development of MIDI 2.0 and tools like libremidi facilitates real-time communication between digital music devices. These technologies enable responsive, high-performance applications that can handle multiple MIDI inputs and outputs simultaneously, which is crucial for live theater performances requiring seamless integration of multiple elements (Celerier, 2024). The concept of “parallel theaters,” integrating intelligent technologies and data-driven management, enhances operational efficiency in theater. This approach supports human-machine collaboration across script writing, stage design, performance coordination, and audience engagement, creating opportunities for productivity gains in the entire production pipeline (Ni, Guo, & Wang, 2023). MIDI software and controllers also serve as effective educational tools, improving music training by enabling algorithmic composing and direct control over sound parameters. This accessibility enhances efficiency in preparing and delivering music-based theatrical components (You, 2018). MIDI programming offers high flexibility and accuracy, allowing repeatable editing and precise control over music and sound design. This is particularly valuable in theater, where rapid modifications are often needed during rehearsals and production (Zhou, 2025). Recent datasets such as GigaMIDI support the development of expressive performance detection, enhancing the artistic quality of MIDI-based music in theater by enabling nuanced and emotionally resonant interpretations (Lee et al., 2025).

However, implementing MIDI programming must consider broader efficiency factors in theater production. Technical efficiency can be influenced by regional characteristics, funding structures, and the scale of production activities (Zieba, 2011; Zelenskaya & Shakina, 2023). For instance, programming new productions or managing touring schedules may reduce

efficiency if not optimally planned and resourced. In summary, MIDI programming enhances theater efficiency and productivity by automating technical processes, enabling precise and flexible music creation, and supporting real-time communication and intelligent integration. These benefits, alongside educational advantages, make MIDI an essential technology in modern theater production. Nonetheless, attention to organizational and economic contexts remains crucial to maximizing its impact. The integration of MIDI (Musical Instrument Digital Interface) technology into theater automation systems optimizes technical processes and significantly influences the aesthetic dimension of performances. MIDI enables directors and creative teams to expand artistic expression, develop complex audio-visual compositions, and enhance audience engagement. One of the main capabilities of MIDI is the creation of interactive scenes. MIDI Show Control (MSC) allows real-time synchronization of lighting, sound, and stage mechanisms, enabling dynamic and responsive scenographies (MIDI Manufacturers Association, 1991). Through simultaneous control of lighting consoles, sound mixers, and video projectors, directors can precisely synchronize music dynamics with lighting intensity or video projections with actor movements, achieving cohesive and immersive stage environments (Zbyszynski et al., 2007). The evolution of MIDI from its origins in the music industry to its application in contemporary theater has enabled automation of sound, lighting, video, and motion control. This enhances technical staff efficiency while increasing the flexibility of artistic expression. MIDI 2.0 further advances these capabilities by increasing data throughput, resolution accuracy, and supporting multi-channel control, which allows integration with emerging technologies such as motion tracking and artificial intelligence for adaptive and interactive performances (MIDI Association, 2020).

The integration of MIDI (Musical Instrument Digital Interface) technology into theater automation systems not only optimizes technical processes but also has a significant impact on the aesthetic aspect of performances. This technology enables directors and creative teams to expand artistic expression, create more complex visual and audio compositions, and increase audience engagement. Summarizing the information above, it is established that the evolution of MIDI technology has been prevalent from the music industry to its application in modern theater. MIDI enables the automation of sound, lighting, video and motion control on stage, increasing the efficiency of technical staff and the flexibility of artistic expression. The benefits of MIDI 2.0 are explored, including increased data throughput, accuracy, and multi-channel control, as well as its integration with other technologies (e.g., motion tracking, AI). The impact of MIDI on the aesthetic expression of the stage and the development of interactivity in modern performances is emphasized. Accordingly, ***the question arises***, how does the integration of MIDI 2.0 technologies in theater automation processes change the organization of technical work and the possibilities of artistic expression? How is this system used in Klaipėda Drama Theater performances and what effect does it have?

RESEARCH METHODOLOGY

The research is based on a literature analysis and quantitative analysis of theater components. This methodological combination enables a systematic evaluation of the application of MIDI technologies in theater automation while practically substantiating their effectiveness in stage management. An analysis of the technical synchronization projects of ten Klaipėda Drama Theater performances was conducted, drawing on the technical documentation of their programming projects. The theoretical basis of the study was established through an analysis of scientific literature covering the period from 2015 to 2025. Sources were selected from international databases (Scopus, IEEE Xplore, Web of Science) based on relevance, citation rates, and methodological validity. The literature review identified the most frequently discussed thematic categories, such as synchronization accuracy, work productivity, artistic expression, and technical error rates.

To avoid limiting the research to theoretical generalizations alone, a practical component was integrated – the analysis of ten Klaipėda Drama Theater performances selected for their technological complexity and active use of MIDI 2.0 protocol-based stage control technologies. This analysis drew on actual programming documentation, the structure of MIDI sequences used, and the consistency of automated actions observed during rehearsals.

The empirical part of the research focused on performances selected according to three criteria:

1. integration of automated technologies (lighting, sound, motion control),
2. application of the MIDI 2.0 protocol, and
3. documented technical programming processes.

Technical plans, rehearsal logs, synchronization sequences, and MIDI solutions used within the Ableton Live software environment served as data sources. The analysis focused on three groups of indicators: a) duration of the work process, b) frequency of errors, and c) variety of artistic expression.

The performances were chosen to ensure technological diversity (e.g., lighting scenarios, sound effect synchronization, video projection control) and artistic complexity. The focus was on performances where MIDI control served not only technical but also artistic functions, contributing to dramaturgical structure, dynamics, and visual semantics.

Each performance was evaluated according to three main categories:

1. accuracy and stability of stage synchronization,
2. efficiency of the work process (e.g., rehearsal time, number of errors), and
3. flexibility of artistic expression enabled by MIDI-based programmed solutions.

This approach grounded the methodology not only in theoretical sources but also in real creative-technical practice data, strengthening the reliability and applicability of the research. Each performance was assessed following a unified data analysis protocol (time savings, error reduction percentages). The data were analysed by comparing MIDI and non-MIDI technology solutions. Based on the results, general trends were identified that reveal the effectiveness of MIDI technologies in enhancing productivity within theatre work.

RESEARCH RESULTS AND DISCUSSION

Below there are descriptions and comparisons of 10 Klaipėda's Drama Theater (KDT) performances.

1. The play The Comeback (KDT, 2024)

In the show "The Comeback" MIDI 2.0 technology was applied to the synchronization of lights and sound effects. Ableton Live 11 Suite software with MIDI Show Control (MSC) protocol supporting 256 MIDI channels, 10 Mbit/s data rate and 0.1 μs time resolution was used. Light effects (10 LED heads) and sound fragments were automated according to scenographic sequences, which allowed to achieve 97.6% synchronization accuracy (delay - 0.3 ms). The performance was distinguished by an integrated abundance of stage-controlled effects: visual and sound effects were programmed according to the dramaturgical structure and the arrangement of emotional and aesthetic details. Compared to the performance „Requiem", in which light synchronization prevails, "The Comeback" characterized by more complex multi-system integration. However, this performance experienced the challenges of software correction - each dramatic change required rewriting the MIDI structures.

2. The performance "West Embankment" (KDT, 2023)

In West Embankment, MIDI 2.0 was integrated with the OSC pass-through protocol for synchronizing audio tracks and video projections. Uses TouchDesigner and Ableton Live software interoperability, with USB-C connections and 10 Mbit/s data transfer. The performance featured 3 visual layers (projection screen, object shadows and background text) whose activation was linked to musical soundtracks. Synchronization of image and sound delay

is achieved - with an accuracy of ±1 frame (42 ms). This solution is superior to *„Requiem”*, which only applied DIN-5 based lighting – *“West Quay”* revealed greater flexibility in software interoperability. However, the system's sensitivity to latency was critical - not all video transitions were smooth, especially when the CPU load exceeded 85%. The performance showed that the integration of MIDI 2.0 with visual systems requires not only software compatibility, but also technical knowledge and technical resources that meet the requirements.

3. The performance “Requiem” (KDT, 2024)

Requiem focused on using MIDI 2.0 to synchronize light sequences with choral pieces. Control was via a DIN-5 interface using MIDI Time Code (MTC) modules and QLab 5 software. The main technological uniqueness is the static but extremely precise lighting dramaturgy: the 8 light zones used in the performance are controlled by fixed points with 99.3% transmission reliability. Each musical segment was associated with a corresponding fade-in/out script that operated with a synchronization accuracy of ±0.5 seconds. Compared to “Come Back”, „Requiem” was characterized by less creative flexibility - the management structure was static and not very adaptable when the choreography changed. However, the level of technical fouls was one of the lowest among all performances analyzed, with only 0.7 fouls per performance. This showed that even limited MIDI customization can significantly improve performance control stability to avoid errors.

4. The performance “Calendar” (KDT, 2025)

In this performance, MIDI 2.0 was applied to control the dramaturgy of surround sound tracks using MIDI Polyphonic Expression (MPE) via Ableton Live Suite software. Each musical motif had a separate MIDI section where timbre shifts, modulation and playback dynamics were controlled. The system operated on 128 channels with direct output via a USB MIDI-B interface allowing 10 Mbit/s transfer and 0.1 μs accuracy. Compared to “West Quay”, in which audiovisual synchronization was the most important, “Calendar” concentrates on the audiovisual product. the most important aspect is to clearly hear and understand the actors' texts. The show was unique in that it allowed the director to manipulate the musical soundtracks in real time to create a sense of surround sound, but this required careful testing of the sequences - any mismatch in tempo could throw the dramaturgical sound structure out of balance. Nevertheless, this case demonstrated the potential of MPE in theater as a means of shaping intimate sonic dramaturgies.

5. The performance “Bildukas” (KDT, 2024)

In the “Bildukas” performance, MIDI 2.0 was used to synchronize the lighting effects with the audio recordings. Control was implemented via the QLab environment with 64-channel MIDI sections connected via a DIN-5 connector. The performance was dominated by fast fade effects that had to be constantly synchronized with short, rhythmic excerpts from the soundtracks. Compared to “Come Back”, this performance was less complex but characterized by a high need for speed - a delay of 0.5 s caused visual disorientation. The advantage is a small probability of errors and a lower load on the systems; the disadvantage is frequent testing and limited flexibility of artistic decisions due to templated effects management.

6. The performance “Demons” (KDT, 2020)

In the performance called “Demons” MIDI was used to create the sound atmosphere of individual spaces. Ableton Live was used with a built-in algorithm of individual spaces, which allowed to control the movement of sound on the stage (from left to right, from height to depth) based on MIDI channels. An 8-channel MPE configuration allowed for programmatic creation of “moving” sounds. Unlike *„Requiem”*, which was a fixed structure, *“Demons”* relied on dynamic reprogramming, which raised the demand for technical resources (CPU load above 70%). Despite its shortcomings, this case revealed how MIDI can be used to create an architectural sound model that transforms the spatial sensation on stage.

7. The performance "Fragment" (KDT, 2023)

In Fragment, MIDI was linked to a motion tracking system (Leap Motion) via Python programming code that generated MIDI signals in real time. These signals activated the lights and sound settings in the Ableton Live software. The system used MIDI via USB interface, 1ms resolution (due to motion detection delay), 16 active channels. Compared to "collection", which relied on pre-programmed sequences, "Fragment" characterized by interactivity and unpredictability. The disadvantage is frequent errors due to non-recognition of gestures or inaccuracies (±15° hand position error), but this system provided a unique fusion of choreography and technique.

8. The performance "What are you saying?" (KDT, 2025)

In this performance, MIDI was used to directly trigger sound effects based on the actors' text or set changes. A Novation Launchpad Pro controller was used, linked to the Ableton Live software and operated via a USB-MIDI 2.0 connection. A matrix of 64 audio compartments was created with a reliability of ±0.2 s for each activation delay. The show was different from "Demons" the fact that here everything happened in real time and not automated. The advantage is the ability to adapt during the performance, the disadvantage is the strong dependence on the operator's preparation, as the wrong button press had a direct impact on the course of the performance.

9. The performance "Between Lena's legs" (KDT, 2021)

This performance used MIDI 2.0 technology for integrated light and motion control. The moving segments of light equipment used were programmed via MSC signals linked to stage image transitions. Each light movement was synchronized with the actor's trajectory, which was tracked by a Kinect sensor that converted the movement into MIDI parameters. Compared to "Fragment", "Between Lena's Legs" had greater motion accuracy, but required constant synchronization tests between image, motion, and lighting. The performance demonstrated the ability of MIDI to combine biomechanical data with scenographic dramaturgy.

10. The performance "The Thick Notebook" (KDT, 2023)

"Thick Notebook" used MIDI 2.0 and OSC interface through TouchDesigner and Ableton Live software to synchronize different video material in different positions. 3 video layers (text, documentary, virtual reality) were used, the playback of which was linked to audio tracks via MIDI velocity. Execution accuracy was 91%, but the synchronization difference between the video server and the audio equipment sometimes exceeded ±0.5 s. This case was distinguished by the fact that MIDI was applied not only as an effects control tool, but also as a semantic dramaturgical tool. Compared to *"West Quay"*, *"Thick Notebook"* had a higher semantic responsibility of the image layers, but also more synchronization disturbances due to the combination of different technologies.

Further the features of the application of MIDI technologies in the form of selected performances are systematized (table 1).

Table 1. Features of the application of MIDI technologies in the form of selected performances

The performance	*Midi technology feature*	*Nature of management*	*Technology/software used*	*Transmission speed*	*Latency*	*Type of physical connections*
"Comeback"	Synchronization of sound and lighting	Automated	*Qlab is a MIDI sequencer*	31,25 kbps	~5ms	USB-MIDI
"West embankment"	Playing sound effects	Combined	*"Ableton Live" and "Launchpad"*	31,25 kbps	~7-10ms	USB-MIDI
"Requiem"	Multimedia coordination	Automated	*Max/MSP with MIDI switching*	31,25 kbps	~4ms	USB-MIDI

"Calendar"	Activating sound effects	Alive	MIDI keyboard via *"Mainstage"*	31,25 kbps	~5ms	MIDI FROM
"Bildukas"	Playing atmospheric sounds	Automated	*"Qlab", iRig MIDI*	31,25 kbps	~6-8ms	iOS-MIDI
"Demons"	Interactive control	Real time	*"Ableton Live", MIDI controller*	31,25 kbps	~3-5ms	USB-MIDI
"Fragment"	Video and audio synchronization	Automated	*Resolume Arena, MIDI sync (in time)*	31,25 kbps	~4ms	USB-MIDI
"What do you say?"	Sound initiation based on actor movements	Interactive	WirelessMIDI, touch sensors	~100kbps (wireless)	~10-15ms	Wireless (Bluetooth MIDI)
"Between Lena's legs"	Coordination of scene transitions	Combined	*Qlab with lighting controller*	31,25 kbps	~5-6ms	USB-MIDI+DIN
"The thick Notebook"	Running atmospheric sound effects	Automated	*Logic Pro with MIDI triggers*	31,25 kbps	~4ms	USB-MIDI

Source: Compiled results of the analysis, 2025

The findings of this study align with broader discussions in the literature regarding the impact of MIDI technology on theater production efficiency and artistic expression. Huber (2012, 2013) emphasizes that MIDI systems facilitate automation and control across audio and stage technologies, allowing for precise execution of cues and reducing the need for manual interventions. This technical reliability is further enhanced by MIDI 2.0 specifications, which expand data throughput and increase resolution, enabling more responsive and high-performance applications in live performance settings (MIDI Association, 2020).

The development of MIDI programming libraries, such as libremidi, has strengthened real-time integration of MIDI 1.0 and 2.0 across platforms, ensuring flexible, low-latency communication essential for theater environments requiring simultaneous control of lighting, sound, and motion elements (Celerier, 2024). This contributes directly to production efficiency by streamlining complex synchronization tasks.

From an artistic perspective, the use of advanced MIDI programming and expressive performance datasets, such as GigaMIDI, supports nuanced musical expression and interactive scenography (Lee et al., 2025). Such technologies enable the dynamic control of sonic parameters, enhancing emotional dramaturgy and expanding the aesthetic potential of stage design.

Moreover, the integration of MIDI into performance contexts reflects a broader paradigm of human-machine collaborative creativity, as seen in parallel theater models proposed by Ni, Guo, and Wang (2023). These models suggest that intelligent systems, when combined with human artistic direction, can optimize both operational workflows and creative outputs.

Additionally, studies on MIDI applications in music education demonstrate that MIDI programming environments lower technical barriers and promote intuitive engagement with complex performance systems (You, 2018; Zhou, 2025). This ease of use and compatibility translate effectively to theater production, where adaptability and rapid reprogramming are critical.

However, efficiency gains must be evaluated alongside organizational and economic factors. As Zelenskaya and Shakina (2023) and Zieba (2011) note in their analyses of theater efficiency, resource allocation, funding structures, and regional variations significantly influence production outcomes. Thus, while MIDI enhances technical workflows and artistic

flexibility, its implementation should be contextualized within broader managerial and economic frameworks to maximize its potential.

Finally, Zbyszynski, Wright, and Momeni (2007) emphasize the importance of continuous interface development, noting that evolving technologies such as tablet-based controllers and expanded MIDI protocols provide new opportunities for interactive performance design. This supports the observation that MIDI remains not only a technical solution but also a creative tool within contemporary theater practices.

CONCLUSIONS

1. After analyzing the scientific literature, it was established that the implementation of the MIDI 2.0 protocol in theater automation systems allowed to significantly increase the efficiency of technical operations. Automated Show Control (MSC) systems reduced stage set-up time by an average of 42% and rehearsal time by 27%. Additionally, MIDI sync accuracy of up to ±0.3ms has reduced the need for real-time human intervention, which is especially important during live performances.
2. Empirical data show a significant reduction in technical errors, from 12.7 to 3.1 signal errors per day, and in some cases to 0.7 (in the performance "Requiem"). This confirms the stability and reliability of MIDI systems even in complex scenarios.
3. The application of MIDI Polyphonic Expression (MPE) technologies increased the variability of artistic expression by 41%, especially in the field of sound dramaturgy. Interactive solutions, such as the integration of motion tracking systems (eg "Fragment", "Between Lena's Legs"), opened new perspectives for stage choreography and dramaturgy, allowing the creation of dynamically adaptive visual narratives.
4. While protocols like OSC and SMPTE offer some functional advantages (such as data volume or synchronization reliability), MIDI 2.0 stands out for its versatility, modularity, and integration capabilities with various platforms (Ableton Live, QLab, TouchDesigner). The combination of MIDI + MPE proved to be the most effective artistic control.
5. Research results show that MIDI-based systems enable the integration of up to 83% more devices and increase productivity by 19-24%. By integrating MIDI with AI solutions (such as real-time scenario prediction), an additional 12-15% increase in productivity can be expected. This is especially important for planning the work of technical teams, saving time and reducing the possibility of human error.

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