

## FORMAÇÃO DE ESPAÇOS ADAPTATIVOS: UMA TRANSFORMAÇÃO TECNOLÓGICA DA ARQUITETURA TEATRAL

### Cited as:

Zabalueva, T., & Zakharov, A. (2024). Formation of adaptive spaces: a technological transformation of theater architecture. *Revista Gestão & Tecnologia*, 24, 39–59. <https://doi.org/10.20397/2177-6652/2024.v24.2761>

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## RESUMO

**Objetivo:** O artigo explora a evolução histórica e a transformação tecnológica da arquitetura de teatros. O objetivo principal é analisar como os avanços tecnológicos e as mudanças nas necessidades sociais impactaram o design e a funcionalidade dos teatros ao longo de diferentes períodos e regiões.

**Métodos:** O estudo utiliza uma abordagem retrospectiva histórica, análise comparativa e documentação arquitetônica para traçar a transformação da arquitetura de teatros. Os dados foram coletados por meio de registros históricos, plantas arquitetônicas e projetos de teatros modernos. A integração da arquitetura paramétrica e tecnologias inovadoras nos teatros recentes também é avaliada.

**Resultados:** Os resultados revelam mudanças significativas na arquitetura dos teatros, com layouts tradicionais em camadas sendo substituídos por designs inovadores e não convencionais. Os teatros modernos incorporam tecnologias avançadas, como palcos móveis, interiores acusticamente otimizados e espaços multiuso. Exemplos contemporâneos, como a Sydney Opera House e o Grande Teatro de Harbin, destacam como a tecnologia redefiniu os aspectos estéticos e funcionais dos teatros.

**Contribuição:** Esta pesquisa destaca a interação entre arte e tecnologia na evolução da arquitetura de teatros. Ela mostra como os teatros modernos se adaptam às restrições espaciais nos ambientes urbanos e respondem às crescentes demandas por multifuncionalidade e integração tecnológica.

**Conclusão:** O estudo conclui que a arquitetura teatral tem evoluído continuamente para atender às necessidades tecnológicas e artísticas. Essa transformação contínua reflete a natureza dinâmica do design de teatros, onde estética, funcionalidade e avanços tecnológicos são integrados de forma harmoniosa.

**Palavras-chave:** Edifício teatral. Pisos em balcão. Teatro tradicional. Palco de três portais. Zona de lounge.

Editor Científico: José Edson Lara  
Organização Comitê Científico  
Double Blind Review pelo SEER/OJS  
Recebido em 10.12.2023  
Aprovado em 25.02.2024

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## FORMATION OF ADAPTIVE SPACES: A TECHNOLOGICAL TRANSFORMATION OF THEATER ARCHITECTURE

### ABSTRACT

**Objective:** The article explores the historical evolution and technological transformation of theater architecture. The primary goal is to analyze how technological advancements and changing societal needs have impacted the design and functionality of theaters across different periods and regions.

**Methods:** The study uses a historical retrospective approach, comparative analysis, and architectural documentation to trace the transformation of theater architecture. Data was gathered through the examination of historical records, architectural plans, and modern theater projects. The integration of parametric architecture and innovative technologies in recent theater designs is also evaluated.

**Results:** The findings reveal significant changes in theater architecture, with traditional tiered layouts giving way to innovative, non-traditional designs. Modern theaters incorporate advanced technologies such as movable stages, acoustically optimized interiors, and multi-purpose spaces. Contemporary examples like the Sydney Opera House and the Harbin Grand Theatre highlight how technology has redefined both the aesthetic and functional aspects of theaters.

**Contribution:** This research highlights the interplay between artistry and technology in the evolution of theater architecture. It showcases how modern theaters adapt to spatial constraints in urban settings and respond to the increasing demands for multi-functionality and technological integration.

**Conclusion:** The study concludes that theater architecture has continually evolved to meet technological and artistic needs. This ongoing transformation reflects the dynamic nature of theater design, where aesthetics, functionality, and technological advancements are seamlessly integrated.

**Keywords:** Theater building, Balcony floors. Traditional theater. Three-portal stage. Lounge zone.

## INTRODUCTION

The relationship between theater and human civilization has deep historical roots. Archaeological evidence substantiates the early human inclination towards theatrical experiences, dating back to the Bronze Age and evident in the remains of rudimentary amphitheaters that aimed to stage captivating performances. The Minoan era and even more so ancient Greece produced magnificent developed theater, first in the open air, and later these venues were attempted to be covered with tents (Portnova, 2016). Rome captivated mankind with huge amphitheaters like the Colosseum to hold large crowds of spectators (Portnova, 2020). Theater continued to develop through the Middle Ages and the Renaissance. Yet almost until the end of the 15th century, the ancient traditions of constructing spectacle buildings had been forgotten. Performances were given in squares and fairs by groups of traveling actors. In 15th-century Italy, plays were first performed in castles. It was only at the turn of the 15th-16th centuries that the first theater buildings designed following the principle of the ancient amphitheater appeared. The shape of the hall changed throughout the 15th century. It took the form of a horseshoe, the 17th century saw the appearance of galleries above the usual amphitheater, which were later divided into boxes (Johnson, 2018). Later there were tiers of balconies, turning the interior into a tiered high room, which eventually decided the external appearance of the theater as well (Umanskii, 1937). Major changes in the construction of the stage, especially with the advent of electricity, necessitated and made possible the erection of grates to store the scenery and change it relatively quickly. New technologies fundamentally changed the stage part of the theater. There appeared multi-portal stages, rotating and changeable parts of the floors, and plenty of accompanying technical equipment. Accordingly, the external architecture of the theater changed markedly. It has gone from the ancient theater to the theater that has existed for more than 200 years and is still there today (Kozhevnikov, 2020). However, in recent decades, the attitude toward theater buildings is changing significantly. The theater gets a new reading both in the interior and exterior appearance. Moreover, the architecture of the theater is becoming diverse.

Thus, the purpose of the article is to explore the historical evolution of theater architecture.

## METHODOLOGY

Our methods are rooted in historical research, architectural analysis, and the review of contemporary theater projects, providing a comprehensive overview of theater architecture's evolution and current trends.

**Historical Retrospective:** This study employed a historical retrospective approach to examine the evolution of theater architecture from ancient times to the present day. Historical records, architectural documents, and scholarly works on theater history were extensively reviewed to gather data and insights into the development of theater buildings.

**Comparative Analysis:** To provide a comprehensive view, a comparative analysis was conducted. This involved a detailed examination of theater architecture in various countries, highlighting differences and commonalities in design, layout, and construction techniques. The analysis encompassed theaters from different historical periods and geographical locations.

**Architectural Documentation:** Architectural plans, drawings, and photographs of select theaters were consulted to understand the structural elements, layouts, and artistic features of specific theaters. These documents aided us in illustrating the architectural changes and innovations discussed in the article.

**Review of Contemporary Examples:** The study included a review of contemporary theater buildings worldwide, showcasing examples that exemplify the latest trends in theater architecture. Information about these theaters was gathered from architectural publications, official websites, and architectural databases.

**Parametric Architecture Evaluation:** For modern theaters, the study assessed the utilization of parametric architecture through the examination of recent works by contemporary architects. This evaluation involved an analysis of the design process, digital modeling techniques, and the integration of parametric principles into theater construction.

## RESULTS

### *Traditional theater*

Turning to the 19th century, when theater architecture acquired stable characteristic features, we can refer to most theaters in Europe or Russia built at this time and still in use today. These theater buildings acquired a long-lasting traditional tiered form with a baroque interior (Fig.1a) in a completely enclosed building, a portal stage (Fig.1b), and a classical

portico with a sculpture (Fig. 1c) or a baroque facade on the outside (Fig.2a). A striking example of such a theater is the Bolshoi Opera and Ballet Theatre in Moscow (Khripunov, 1955).



**Figure 1a.** Tiered interiors of the Bolshoi Opera and Ballet Theatre in Moscow. Historic stage



**Figure 1b.** The portal stage of the Bolshoi Opera and Ballet Theatre in Moscow. Historic stage



**Figure 1c.** The main facade of the Bolshoi Opera and Ballet Theatre in Moscow. Historic stage

The Grand Opéra (called Opéra Garnier today) in Paris concludes the predominance of the established classical and pseudo-baroque traditions in theater architecture, clearly overloading both the exterior and interiors with decoration (Fig.2a, b) (Modern Student Encyclopedia, n.d.). Later, such compositional and decorative techniques were used much less often.



**Figure 2a.** The Palais Garnier, or Opéra Garnier, in Paris. The main facade



**Figure 2b.** Interior of Opéra Garnier in Paris

*New theaters of the 20th-21st centuries*

This shape was retained by the theater building as a prominent object of urban planning until the 20th century when turning points in the social order demanded a new attitude to theater art (Portnova, 2012). There were the first attempts at theaters with the stage in the center of the auditorium, an oval-shaped stage, large stage pockets, a three-portal connection between the stage and the auditorium, the obligatory back stage, and efforts to transform the stage area. Henry van de Velde (1914), Auguste Perret (1925), Walter Gropius, and Russian avant-gardists proposed solutions in which they sought to break the established stereotype.

The heaviest blow to the traditional classical construction and perception of a theater building was dealt by the Sydney Opera House (built 1956-1973) by Danish architect Jørn Utzon (Fig.3a) (Anisimov et al., 2022). On the one hand, the object became a symbol not only of the city but also of the country overall, while on the other hand, its image was not compatible with the perception of the building as a theater.

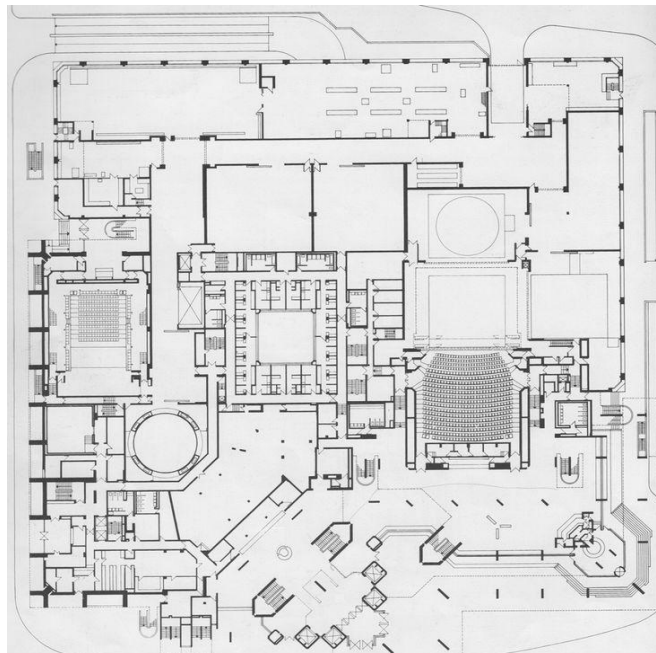


**Figure 3a.** The Sydney Opera House. Architect J. Utzon

The three-hall Royal National Theatre in London, built in 1976, was not keenly received by both the public and the architectural community (Fig.3b). The presence of three complete halls was a new phenomenon in the architecture of theater buildings. The theater is a large complex, more of a cultural center. Fig.3c shows the lower level of the building.



**Figure 3b.** Exterior of the Royal National Theater in London



**Figure 3c.** Plan of the ground floor of the Royal National Theatre in London

In the second half of the 20th century, transformable halls with movable stages, elevating platforms, and orchestra pits appeared everywhere in almost all theaters. In opera theaters, special movable flooring with a high degree of surface treatment was introduced for ballet performances. The requirements for the equipment and technical facilities of both the

stage pockets and the backstage increased. High requirements were imposed on the natural acoustics of the halls. Theaters gained small rehearsal halls or halls for chamber performances. In modern theaters, the B zone, the theater's backstage area, has become significantly larger than the A zone, available to the audience.

The most vivid example of saturation with various technical equipment is the Opéra Bastille in Paris (Fig.4) (Urfalino, 1990; WikibriF, n.d.). Even in a compact photographic representation, it becomes evident that the stage area is intricately outfitted with advanced technical apparatus, extending prominently into the background of the rear stage. This theatrical setting exemplifies an advanced level of stage mechanization, characterized by the deployment of highly mobile platforms and equipment.



**Figure 4a.** Opéra Bastille in Paris. Exterior.



**Figure 4b.** Opéra Bastille in Paris. The stage as viewed from spectator seats.

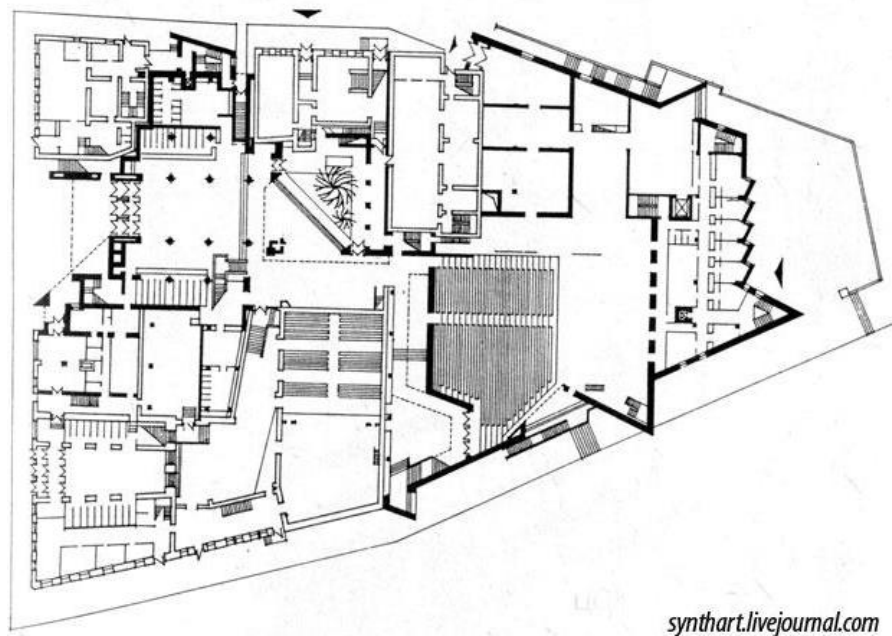
Moscow architects also created new non-traditional solutions for theater buildings in this period (Anisimov, 2017). The Natalya Sats Children's Musical Theater in Moscow immediately stood out with its original architecture, unusual for theaters, and the presence of a concert hall and a three-portal stage, demonstrating a very special new technological layout of the entire planning structure of the building (Fig.5).



**Figure 5.** The Natalya Sats Musical Theater in Moscow



A theater building entirely new in composition, architectural plasticity, and exterior decoration was built on Taganskaya Square in Moscow, which included three halls, one of them with a transformable planning structure, as well as four stages (Fig.6) (Anisimov, 2021). This part of the theater is tied into the courtyard with a sculpture of Vladimir Vysotsky. The aesthetics of the brick walls, new to the viewer's experience, both in the external appearance of the theater and in the interiors, instantly distinguished the new building from its kind.

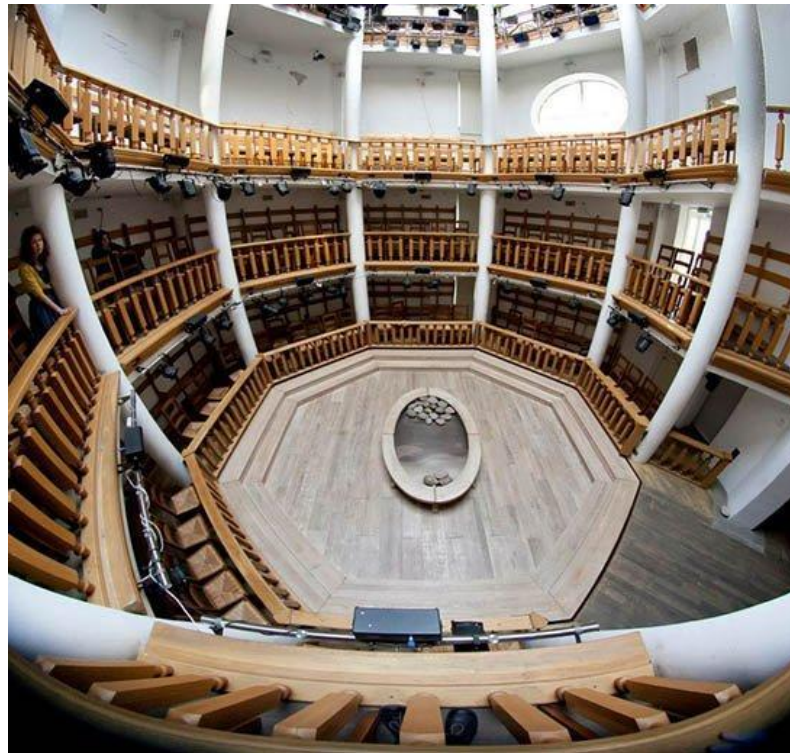


**Figure 6a.** The Taganka Theater in Moscow. Plan of the theater building.



**Figure 6b.** The Taganka Theater in Moscow. The new part of the theater building

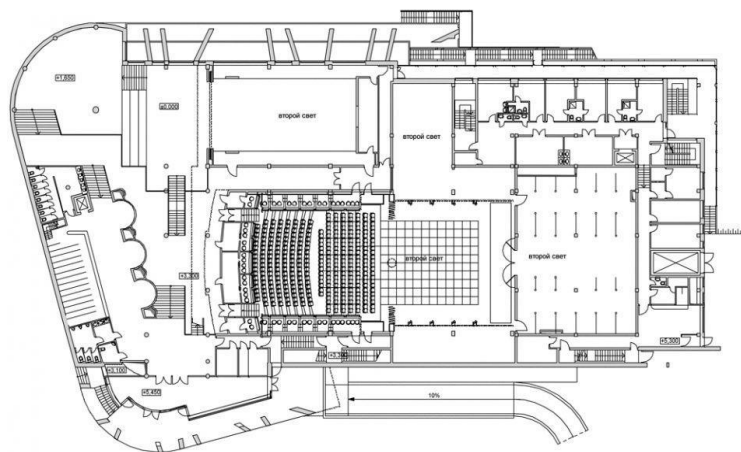
A relatively recent development is the Theater School of Dramatic Art on Sretenka Street in Moscow. Its non-traditional solution of the auditorium and stage space and the correspondingly original technology set the building apart from the ranks of even small theaters right away (Fig.7).



**Figure 7.** Theater School of Dramatic Art on Sretenka Street in Moscow. Hall interior.

Pyotr Fomenko Workshop Theater is situated on a slope down to the water. Its creator, architect Yury Gnedovsky, decided to arrange the entrance and loading of the hall from the top. This shaped the unusual structure of the hall plan and its technical equipment (Fig.8).



**Figure 8a.** Pyotr Fomenko Workshop Theater in Moscow**Figure 8b.** Pyotr Fomenko Workshop Theater. Moscow**Figure 8c.** Plan of the Pyotr Fomenko Workshop Theater. Moscow

The plan clearly shows how the movement of spectators is organized from the upper level with the entrance hall and cloakroom to the lower level with entrances to the hall. The auditorium, in turn, descends towards the stage through an amphitheater. A prominent example of new approaches to entertainment buildings is the Moscow International House of Music (built in 2001), which is a true creative complex that was given not only two music halls equipped as per the state-of-the-art requirements to acoustics but also a theater hall (Fig.9). In 2011, after an onerous reconstruction, a new underground hall of the Bolshoi Theater in Moscow opened, lowered six floors below ground level. Along with grand and prominent constructions of theater buildings, the beginning of the 21st century brought many renovations and adaptations of smaller theaters. Former movie theaters and clubs, outbuildings, and basements were modified for these purposes, housing small theaters of various uses.



**Figure 9.** Svetlanov Hall of the Moscow International House of Music

Recently, there has been a new trend of accommodating theaters in multifunctional complexes along with trade, restaurants, and other forms of pastime (Anisimov, 2021; Makarova & Anisimov, 2019). Thus, in 2015, a theater called Vishnevyy Sad appeared at 10 Sukharevskaya Square. The eight-story high building is taken up only 40% by the theater spaces on the lower four floors. The space of the theater progresses vertically. The lower level houses the entrance group with checkrooms and a lobby. A 345-seat auditorium occupies the second, third, and partly fourth floors. Upstairs there are two more halls, a chamber hall with 75 seats and a small hall of 50 seats, which is also used as a rehearsal hall. The high stage box is integrated into the overall volume of the building, making it completely invisible. The three-portal stage makes it possible to enlarge the stage space using oblique pockets.



**Figure 10.** The Vishnevyy Sad theater on Sukharevskaya Square in a shopping and entertainment center

Theatrical venues characterized by remarkable and innovative architectural designs emerged at the onset of the new millennium (Khrupin, 2022). A prime example of this trend is the Theater and Concert Complex situated within the City of Science and Art in Valencia, meticulously crafted by the distinguished architect Santiago Calatrava. This architectural masterpiece is distinguished by a distinctive circular structure enveloped in concrete, featuring an avant-garde protruding element, a testament to its intricate engineering complexity. Within this singular edifice, a multifaceted array of performance spaces finds its home, including an opera house, a concert hall, a petite theater, and a studio theater (Fig.11).



**Figure 11.** The Queen Sofia Palace of Arts theater and performing complex in Valencia. Architect S. Calatrava. 1996-2005

An equally striking solution, especially in the interiors, is the opera house in Santa Cruz de Tenerife. The 1,558-seat opera hall has a folding curtain that turns the theater into a concert hall. The volume also includes a small hall with 428 seats. The folding structures soaring to great heights create an exceptionally expressive interior (Fig.12).



**Figure 12a.** Auditorio de Tenerife in Santa Cruz. General view. Architect S. Calatrava. 1991 – 2003.



**Figure 12b.** Interior of the Auditorio de Tenerife in Santa Cruz. Architect S. Calatrava

Another solution for the theater complex is the building of the Grand National Theater by architect Paul André, which is located next to the Forbidden City in Beijing. This huge egg of glass and metal seems to float up from the depths of a lake. Under its transparent shell, it houses three theaters at once: an opera house, a concert hall, and a small drama theater, along with restaurants, cafes, and service facilities. The building is connected to the city by an underwater tunnel (Fig.13).



**Figure 13.** The National Centre for the Performing Arts in Beijing. Architect Paul Andreu.

The winged theater in Wuxi, China, built in 2009-2010, is yet another shining example of non-standard solutions for theater buildings. Its roofs, like the wings of a butterfly, lift it above the surface of the picturesque lake on whose shore it is erected. The project belongs to the Finnish studio PTS Architects. The building stands on an artificial peninsula and is oriented

towards the lake with its roof wings, creating the image of a butterfly taking off over the water's surface. The wings have a myriad of LEDs that change light and color, giving a magical feel to the object (Fig.14).



**Figure 14.** Wuxi Grand Theatre. China. Architecture studio PTS Architects.

In 2010-2015, an opera theater was built in Harbin (Kirichkov, 2017). The lively plasticity of the two volumes flowing seamlessly into each other seems to reflect the riverbank close by. The idea was given by Zaha Hadid and realized by architect Ma Yansong. The building consists of two volumes. One includes a hall for 1,800 spectators, the other has 400 seats. A river with its winding banks flows nearby, and Zaha Hadid's idea to portray two boulders lying next to each other was successfully brought to life by the architect of this building (Fig.15).



**Figure 15.** The Harbin Grand Theatre. Architect Ma Yansong

The volumes resemble the rolled pebbles of a shoreline, and the light apertures carved into different parts of the building reflect the intricately winding river flow. The great acoustic properties of the large hall, in the opinion of musicians, helped the theater win the audience's appreciation. The small hall has an arena stage and is transformable. Adhering to his aesthetic preferences, the author has created a man-made landscape with the help of plastic forms made of glass and concrete. The two volumes flow softly into each other. The plastic forms of the concrete surfaces are cut through by large glazed openings through which natural sunlight illuminates the central hall and rehearsal spaces, as well as the lounge and service areas. One of the walls, made of glass, allows the audience to enjoy a view of the river landscape during intermissions. The interiors are designed either in contrasting combinations of black and white or in soft pastel-beige colors.

#### *The site for theater building construction*

With all the variety of architectural solutions for theater buildings, there is an important feature that brings them together. All buildings are erected in urban areas, preferably in the central parts of cities. This is perfectly understandable. As significant objects of the urban fabric, attracting spectators from all over the city, such objects are placed within the most convenient transportation accessibility for all citizens. Naturally, such areas in any city are the central districts. The sites chosen for theaters are also those that are connected with the seacoast, rivers, or lakes, that is, with beautiful pieces of nature in cities that provide striking expressive compositional architectural solutions of these objects. However, at present, large cities in most cases experience a great shortage of vacant land for new development in general, and especially

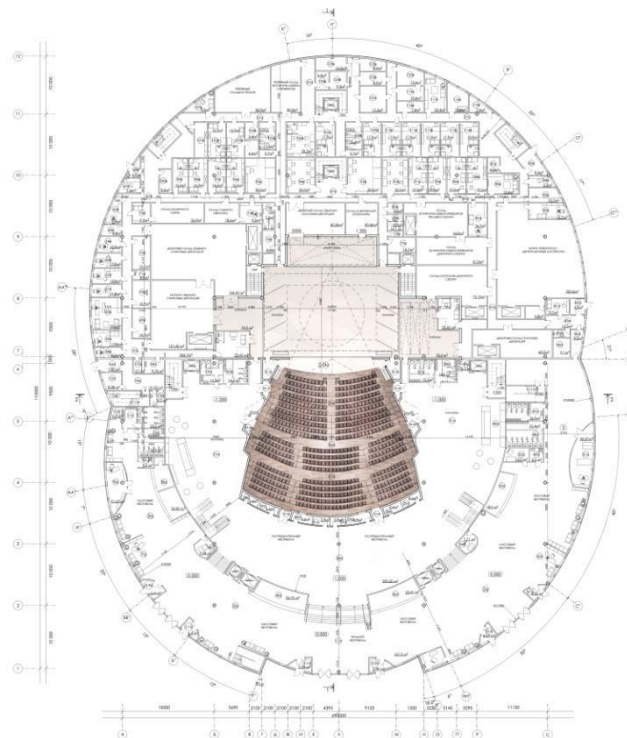


in the central districts. A new approach to the second use of already occupied territories allows largely resolving this issue through the construction of platform buildings (Kharkovskaia & Zabalueva, 2017). The proposed platform buildings, i.e., buildings raised above the ground over the territories already taken for certain needs of the city (railroads and roads, various inconvenient areas, industrial areas, etc.), largely solve the problem of expanding the area for new development. In addition to the fact that the volume of platform buildings accommodates a variety of different areas, almost any kind of building, including theater buildings, can be erected on their upper level. Such a design project was realized by the Moscow State University of Civil Engineering. It was proposed to erect a drama theater on the upper level of the platform building above the railway tracks of the Belorussky railway station in Moscow (Fig.16).



**Figure 16.** Drama theater on the upper level of the platform building above the railroad tracks of the Belorussky Railway Station in Moscow.

The platform building itself is long, hence we cannot present its graphic representation in this text. The platform building has several levels, the volume of which accommodates both through transportation passages, urban infrastructure objects, and urban engineering networks. The theater stands on the upper level. In this case, the drama theater, which has a traditional planning solution (Fig.17), in addition to meeting modern functional and technological requirements for such buildings, gets any amount of parking spaces due to the internal volume of the platform building, which addresses a serious problem faced today in central city districts.

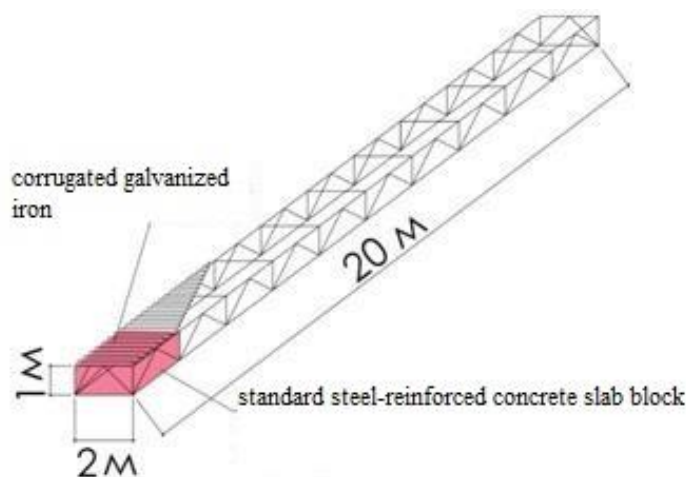


**Figure 17.** Plan of the first floor of the drama theater on the upper level of the platform building above the railroad tracks of the Belorussky Railway Station in Moscow.

*New constructive possibilities in designing a modern theater*

Examining the formative constructive solutions of modern theaters, we can highlight the use of shell structures. Examples of this include the Harbin Grand Theatre, the National Centre for the Performing Arts in Beijing, Auditorio de Tenerife in Santa Cruz, and the Sydney Opera House. Understandably, architects seek the most expressive forms for such significant objects. However, it must be said that in the interiors of halls such curvilinear and dome-shaped forms do not correspond to the organization of the acoustic mode, because they create sound focusing in the audience seats, thus impairing its perception. For these purposes, a more suitable option is a flat covering with suspended panels with adjustable height and inclination of the suspension, which allows performing quality acoustic tuning of the auditorium. This, in turn, makes it possible to use plane large-span structures such as traditional trusses and structural elements, as well as modern structural solutions of steel-reinforced concrete slabs (Fig.18) (Zakharov, 2020). Figure 18 shows the steel part of a steel-reinforced concrete slab block, on which corrugated galvanized steel decking is laid and covered with a thin layer of concrete. Such a steel-reinforced concrete structure, in which the concrete layer works together with the steel part, can cover not only the minimum span of 20 m but also reach the significant

dimensions required for the flooring of theater halls by increasing the height of longitudinal and transverse ribs. This lightweight structure allows the necessary engineering networks to be laid inside, such as ventilation ducts, which are vital in halls with a large capacity of spectators. The structure can be easily attached to any suspended ceiling of any profile to ensure acoustic comfort.



**Figure 18.** Steel part of the reinforced concrete slab block

## CONCLUSION

The new information age with its technologies gives the widest possibilities for shaping forms in architecture. However, any stylistic direction determined by the demands of society and technical capabilities of the time has been born, developed, and ultimately replaced by new architectural trends. Stylistic epochs come with new aesthetic preferences.

As seen from the presented analysis, theaters can be very diverse in terms of architectural design, technological equipment, etc. They can be located in the city at ground level, and it is also possible to use the upper levels of platform buildings to house them. A theater can be placed inside the volume of a multi-level platform building as well. Thus, architects have unlimited possibilities in this respect.

A significant factor in the creation of a modern theater, like any large-span building, is the structural solution, which is often dictated by the formative design. However, it should be noted that in pursuit of the expressive image of the theater object, it is important to bear in mind the functional features of these buildings, which are directly linked to creating an acoustically comfortable environment. Despite the fact that today hall acoustics are often supported by electroacoustic means, technical means alone cannot suffice. A competently shaped hall, the

profile of the acoustic suspended ceiling, and the finishing materials used in the interior should create a good acoustic environment. For this purpose, it is likely possible to refrain from such formative constructions in favor of more technologically advanced ones. This is especially important and acceptable in drama theaters. Opera and ballet theaters continue to be seen by architects as vivid objects that allow the use of prominent formative structures in creating their external appearance at the expense of higher costs of construction. In turn, the acoustic comfort of the inner environment can be ensured by the required independent technical solutions.

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