

INTERDISCIPLINARY APPROACHES IN THE DESIGN OF MUSIC PERFORMANCE SPACES: INSIGHTS FROM THE ATHENS PROGRAMME

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Abstract

The design of spaces for music is an inherently interdisciplinary field that affects all stages of the design and construction process, as well as the different technical disciplines involved. While a basic understanding of acoustics is essential, it is equally important to integrate knowledge of structures, building services, lighting, and venue planning.

Within the framework of the ATHENS program—a network of 16 European higher education institutions, including the Technical University of Madrid—a one-week intensive workshop was held in March 2026. The workshop provided introductory training in acoustics, lighting, venue planning, building services, and structures, complemented by technical visits, including the National Auditorium, with the aim of equipping students with practical tools for the design of such spaces.

The purpose of this paper is to present the interdisciplinary approach adopted, as well as the main findings derived from the analysis of five European concert halls selected during the workshop.

Keywords: *acoustic education, interdisciplinary learning, concert hall design, experimental learning*

1. Introduction

The design of spaces for music performance constitutes an inherently interdisciplinary field that conditions all phases of the design and construction process. While a

solid understanding of acoustic principles is essential, the technical complexity of these venues requires a synergistic integration of multiple disciplines, including structural engineering, building services, lighting design, and venue planning [1] [2].

Within this framework, the present study analyses the educational experience developed during the ATHENS intensive workshop held in March 2026. This program, which brings together sixteen European higher education institutions, promotes experiential learning and specialized technical training.

Through the study of five representative European concert halls and the inclusion of technical visits—such as the one conducted at the National Auditorium in Madrid—this work proposes a pedagogical approach aimed at providing future professionals with integrated and practice-oriented design tools.

2. Educational Framework: The ATHENS Program and the European Cooperation Context

The framework of this study is the ATHENS (Advanced Technology Higher Education Network / Socrates) program, a strategic network that brings together 16 European higher education institutions.

Under the coordination of the Technical University of Madrid, a one-week intensive workshop was developed in March 2026, based on Project-Based Learning (PBL) and experiential learning approaches [3][4].

The pedagogical structure of the workshop was organized into three progressive phases:

- **Transversal** **Technical** **Immersion:**
Introductory sessions addressing acoustics, lighting, venue planning, building services, and structures, emphasizing both conflicts and synergies between disciplines.

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- Guided Technical Visits: On-site sessions aimed at observing the real implementation of complex engineering solutions.
- Empirical Case Study Analysis: Critical and comparative evaluation of high-performance cultural infrastructures.

Within this context, the workshop titled Venue Design (UPM195) provided an alternative to traditional teaching models by focusing on experiential learning. Students from different nationalities collaboratively addressed the technical complexity of music performance spaces.

The integration of core topics—including acoustics, lighting, venue planning, building services, and structures—demonstrates that international cooperation is a key driver for interdisciplinary education in contemporary acoustic design.

Students from different academic backgrounds—including architecture and engineering—participated in the workshop, creating a heterogeneous learning environment that fostered interdisciplinary exchange. The international context further enriched the experience, promoting diverse perspectives in the analysis and design processes.

The workshop included 15 students from different institutions: Warsaw University of Technology (6), Politecnico di Milano (4), Technical University of Madrid (2), Delft University of Technology (1), and Czech Technical University in Prague (2).

3. Methodology

The main objective of the workshop was to provide students with practical tools that go beyond purely theoretical knowledge. The methodology moves away from traditional disciplinary compartmentalisation and instead focuses on the interfaces between technical domains.

3.1 Workshop structure

The workshop was structured over five consecutive days, following a progressive pedagogical sequence that combined theoretical input, practical application, and critical evaluation.

The first day was devoted to an initial immersion through a site visit and introductory sessions on venue design, allowing students to establish a contextual understanding of performance spaces. During the second and third days, specific disciplinary modules were introduced, including venue planning, acoustics, lighting, and structures. These sessions were complemented by workshop activities in which students began to apply the acquired knowledge. On the fourth day, the focus shifted towards building services and integrated workshop development, reinforcing the interaction between disciplines. Finally, the fifth day was dedicated to the completion of group work and its presentation before a jury, consolidating the learning process through critical discussion. This temporal structure ensured a gradual transition from theoretical understanding to applied interdisciplinary analysis.

3.2 Interdisciplinary teaching modules

The teaching content was organized into five main disciplinary areas: acoustics, structures, lighting, building services (MEP), and venue planning. Each module was delivered by a specialist, providing students with fundamental knowledge while highlighting the interdependencies between systems.

Rather than treating these disciplines as isolated domains, the workshop emphasized their interaction within the design process. Acoustic requirements were continuously linked to structural constraints and spatial configurations, while lighting and building services were addressed as integral components influencing both performance conditions and user experience.

This integrated approach aimed to shift students from a fragmented understanding of design towards a systemic perspective.

Table 1. Relation of lecturers.

Lecture (2 hours)	Lecturer
Evolution of venue design	Alexander Díaz-Chyla
Venue planning	Alexander Díaz-Chyla
Acoustics	Alexander Díaz-Chyla & Teresa Carrascal
Lighting	Beatriz Arranz
Structures	Paula Villanueva
Mechanical	Miguel Ángel Gálvez
Jury	Alexander Díaz-Chyla / Teresa Carrascal / Alejandro Gonzalez Cruz
Evolution of venue design	Alexander Díaz-Chyla

3.3 Technical visit

A key component of the workshop was the technical visit to the National Auditorium of Music in Madrid, which functioned as a real-scale learning environment within the experiential learning framework.

The visit took place on March 16 and included guidance from the Technical Director of the auditorium and a representative of INAEM (National Institute for Performing Arts and Music). The session lasted approximately three hours.

During the visit, students were able to observe in situ construction solutions related to acoustic treatment, spatial organization, building services integration, lighting systems, and large-scale structural elements. They also gained access to areas typically restricted to the public, including control rooms, technical spaces, broadcasting facilities, the organ, and back-of-house areas.

This experience reinforced the understanding that the design of concert halls requires a high level of coordination between disciplines.



Figure 1. Technical site visit to National Auditorium

3.4 Case study approach: analysis of concert halls

Students were organized into groups of three and assigned the task of analyzing real-world projects through a multi-criteria framework. The evaluation included acoustics, structural systems, building services, lighting, and spatial organization. Each group developed its own analytical methodology, fostering autonomy and critical thinking. The process concluded with a final 20-minute presentation before a jury.

To validate the pedagogical approach, students conducted a comparative analysis of five European concert halls:

- Elbphilharmonie Hamburg (Herzog & de Meuron)
- TAP Auditorium Poitiers (Carrilho da Graça)
- Philharmonie Szczecin (Barozzi Veiga)
- CKK Jordanki (Fernando Menis)
- Eldborg Concert Hall, Harpa (Henning Larsen)

These case studies were selected to represent diverse architectural typologies, acoustic strategies, and operational requirements, enabling students to develop a broader understanding of performance space design.

3.5 Student survey and evaluation methodology

To assess the educational effectiveness of the workshop, a post-course survey was conducted among participants. The questionnaire, designed with Google Forms, included both quantitative Likert-scale questions and qualitative feedback, focusing on student satisfaction, perceived learning outcomes, and the effectiveness of the interdisciplinary approach.

A total of eight responses were collected. Although limited in size, the dataset provides valuable insights into the impact of the workshop format.

4. Results

The results presented in this section are derived from student analyses, final presentations, and survey feedback.

Rather than describing each case study individually, the results are structured around recurring patterns identified across the analyzed concert halls, enabling a comparative understanding of interdisciplinary design

processes. Student work consistently demonstrated the ability to identify interactions between architectural form, acoustic performance, and technical systems. The findings confirm that successful concert hall design emerges from the integration of multiple parameters rather than a single dominant discipline.

The following key themes were identified:

- Strong relationships between spatial geometry and acoustic behavior.
- Importance of circulation and functional zoning, particularly in front-of-house and back-of-house organization.
- Integration of lighting as both a perceptual and architectural tool.
- Increasing structural complexity linked to architectural expression and acoustic requirements.

Students also identified the influence of typology and materiality on acoustic performance. Shoebox configurations were initially associated with favorable acoustic conditions [5], while more complex geometries required additional design strategies.

Adaptability emerged as another key factor, with adjustable acoustic systems and flexible stage configurations playing a crucial role in contemporary concert hall design.

From an educational perspective, the methodology enabled students to move beyond descriptive analysis and develop a critical and integrative understanding of design.

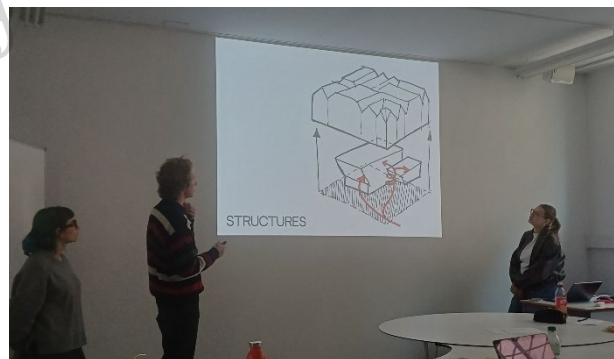


Figure 2. Presentation slide

4.1 Student feedback and evaluation

The survey results provide an overview of student motivation, satisfaction, and perceived learning outcomes.

The primary motivation for enrolling in the course was academic interest (62.5%), while 37.5% of participants reported external motivations, such as the opportunity to visit Madrid. This indicates a predominantly intrinsically motivated group.

The Likert-scale responses show a generally high level of satisfaction across content, organization, and teaching methodology. The results suggest that the interdisciplinary and intensive format enhances student

engagement and promotes a holistic understanding of performance space design.

Students highlighted the value of integrating multiple disciplines within a single workflow, which helped them better understand real-world complexity. The combination of lectures, workshops, and technical visits reinforced this learning process.

The group-based approach encouraged collaboration and knowledge exchange among students from different backgrounds.

However, limitations were also identified. The short duration of the workshop constrained the depth of analysis, indicating the need for extended formats or follow-up activities.

5. Conclusions

The results confirm that the design of music performance spaces requires an integrated approach that reflects the interdependencies between acoustics, architecture, structures, and building services.

The interdisciplinary and case-based methodology proved effective in enabling students to identify key design relationships and understand concert halls as complex systems rather than isolated technical problems.

The use of real case studies enhanced learning by allowing students to recognize recurring design strategies and their practical implementation.

The intensive format fostered engagement and collaborative learning, although its short duration limited the depth of analysis.

Future work should focus on extending the duration of such programs and incorporating quantitative assessment methods.

Overall, this study supports the implementation of interdisciplinary, practice-oriented teaching models in architectural acoustics, contributing to bridging the gap between academic training and professional practice.

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