Architectures for artistic performances on the riverbank. Image by authors.

Architectures for immersive performances in the green, digital and inclusive transition

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Abstract: This paper reports studies and project experiments being developed in researches financed by local authorities, the Ministry of University and Research with the support of NextGenerationEU and the European Commission. The work investigates the potential of culture, creativity and natural and built heritage in the green, digital and inclusive transition and is focused on the creation of sustainable, inclusive, beautiful spaces, involving the collaboration among different disciplines (architecture, music and immersive sound, visual arts, social sciences, and neuroscience). The studied spaces aim to create material and immaterial architectures, characterized by circular processes and therefore adaptable, flexible, removable, repositionable and reusable. We foresee the use of material elements (building products) and immaterial elements (sounds, images, colors, lights) to define spaces intended for the diffusion of different cultural forms and to implement the attractiveness of places afflicted by processes of abandonment and social degradation. Ideas, criteria and solutions for architecture and sound and video technologies (aimed at the definition of spaces whose perception involves full use of the senses as well as the application of the extended mind concept) will be presented to promote environmentally, economically and socially sustainable transformations of natural and built habitats for new forms of cultural diffusion.

Keywords: Architectures for Immersive sound and video; Culture for society and natural and built environments redevelopment; Psycho-physical well-being.

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1. Introduction. New material and immaterial dimensions of architecture

Today, even more than in the past, culture, in all its many forms, represents a sector that can have a strategic role in promoting sustainable development processes. For culture to effectively acquire this role it is necessary for it to have appropriate and widespread spaces. The contemporary panorama requires that culture can reach all people according to the principles of social equality, environmental protection and fair economic growth, dictated by the concept of sustainable development. In this direction, the main critical issues identified prior to the work presented and which are believed to need to be resolved are three.

The first concerns the character of the spaces and buildings intended for culture which are still too little widespread and inclusive, especially because they are concentrated in large urbanized areas. The second criticality refers to the inadequacy of spaces and buildings to accommodate solutions and systems to allow a concrete digital transition. The third critical issue concerns the still too weak participation and collaboration between different skills and disciplines in the design activity which often produces poorly performing places especially with reference to the most recent audio and video technologies.

This contribution reports the studies and design experiments being developed as part of researches financed by local authorities (municipalities in the province of Pescara and L'Aquila), by the Ministry of University and Research with the support of NextGenerationEU and by European Commission through contracts and forms of partnership with the Department of Architecture of the G. D'Annunzio University. The study presented in detail in the following paragraphs originates from a graduate laboratory on adaptable and repositionable architecture for the building and environmental recovery of degraded urban areas and the revitalization of internal areas and from research conducted for the municipalities of Pescara, San Valentino in Abruzzo Citeriore and Scontrone. The study is being developed within the TRIALs project (PRIN 2022) and the Pacesetters project (HORIZON-CL2-2023-HERITAGE-01-02).

The work we propose, focused on inclusion, participation and iteration, investigates the concrete circumstances, the possible support mechanisms that can allow culture and creativity to guide the transition processes of natural and built heritage and society. In particular, the research and design experimentation activities are focused on the creation of sustainable, inclusive and beautiful spaces (eco and human-friendly, according to the principles of the New European Bauhaus). These spaces, designed for cultural events, make use of the collaboration between different disciplines (especially architecture, music and immersive sound, but also visual arts, social sciences and neurosciences).

The spaces under study refer to the possibilities of creating material and immaterial architecture capable of promoting the green, digital and inclusive transition, characterized by circular processes and therefore adaptable, flexible, removable, repositionable and reusable. From this perspective, solutions are studied which involve the use of material elements (building products) and immaterial elements (sounds, images, colors, lights) for the definition of spaces intended for the diffusion of different cultural forms (related to sound, visual arts, the exploration of unknown environments, etc.) to enhance the attractiveness of places afflicted by processes of abandonment and social degradation. In this contribution, ideas, criteria and solutions will be presented (the result of collaboration between architecture and sound and video technologies) capable of relating the material elements constituting building systems with the intangible elements provided by sound and video in immersive and three-dimensional formats, favoring experiences related to the concept of the extended mind (Murphy Paul, A., 2022). The expected results envisage processes of transformation of natural and built habitats, which are environmentally, economically and socially sustainable and aimed at the definition of places whose perception involves the full use of the senses (Pallasma, J., 1999). In these places the architectural shells no longer constitute a separation between inside and outside but are the support that allows individuals to look beyond the surface to grow culturally (Mallgrave, 2015).

The study conducted starts from the awareness that architecture, in measuring itself with the needs dictated by the contemporary panorama (Radogna, D., 2022), must maximize its usefulness and its possibilities of use, acquiring new characteristics (such as flexibility, adaptability, repositionability, reusability and predisposition to digitalization), based on a multidisciplinary project. We present examples of adaptable, repositionable and reusable architectures in different contexts, designed specifically for the installation of systems and the performance of immersive audio and video. The considered contexts are abandoned places, such as suburbs or depopulated historic centers, in which the installation of the designed architectures could trigger regeneration processes. The proposed architectures can be positioned both on unconstructed land and in built systems, such as ruins or in between spaces. The studied solutions include ground connections and dry connections between the technical elements to allow extreme flexibility and adaptability of building systems, favoring circular processes. The architectures presented in the following paragraphs allow different scenarios of future reusability both as a whole and in their parts and in different places. Based on the needs of immersive technologies (described in paragraphs 2, 3 and 4), paragraph 5 illustrates the characteristics of the designed architectures. We describe the horizontal and vertical closures and partitions that allow easy, flexible and reversible installation of the systems intended for immersive performances. The study phase currently undergoing further development includes:

- The identification of materials and products for internal coverings intended for the reflection and/or absorption of sound that are increasingly sustainable compared to those commonly used up to now.
- The definition of alternative shapes of building envelopes, other than the parallelepiped, which are more performing for acoustic needs, which allow the projection of videos and which are in any case modular, removable, removable and repositionable.

2. Immersive Audio: Fostering Inclusivity and Extending Perceptual Capabilities

The proposed playback system in this experimentation is in immersive audio in Dolby Atmos format. Immersive formats create an enveloping and realistic sound experience, placing the listener in the center of a multidimensional audio environment. The remarkable potential and impact of immersive audio are evident in several aspects. This technology is capable of representing the spatial characteristics of sound with great precision, including the perception of depth and movement. This results in an amplified sense of realism, engaging and enveloping the listener in a three-dimensional sound environment. The extraordinary sound localization capability offered by immersive formats allows listeners to accurately identify the origin of sounds within the audio field. This further enhances the sensation of realism and engagement in the sound experience.

The ability of immersive audio to create dynamic and realistic soundscapes that mimic real-world environments is of significant interest. This can include a wide range of sounds, from the noise in a bustling city to the effect of wind rustling through tree leaves, to the subtle nuances in a live classical music concert. All of this contributes to making the sound experience more engaging, emotionally rich, and authentically realistic for listeners.

Concerts and live music events have seen significant use of this format, providing audiences with unique and engaging sound experiences, transporting listeners into extraordinarily dynamic sound environments.

In past centuries, many works have been conceived considering the localization of sound sources at multiple points and immersing the audience in them as a compositional parameter. Leonard Bernstein's opera "Mass" from 1971, commissioned to celebrate the opening of the Kennedy Center for the Performing Arts in Washington D.C., is one of the most celebrated and innovative compositions by the composer. Its first performance was a significant event in the world of contemporary music and American culture. As Keith Lockhart, conductor and artistic director of the Brevard Music Center's Summer Festival, stated, "Bernstein's idea was to make the audience feel immersed in the live concert experience." In recent years, other artists have experimented with this type of playback system, such as Hans Zimmer, Björk, Soundgarden, Bon Iver, Katy Perry, and Blue Man Group.

One of the most relevant aspects of immersive audio is to promote accessibility and inclusivity. Immersive audio technology stands out for its ability to accommodate the needs of people with hearing impairments. This is possible thanks to the improvement in the perception capabilities of sound direction and position, providing a richer and more useful experience for those who rely on spatial audio cues to fully understand the surrounding sound environment. Additionally, immersive audio technology aims to make experiences accessible to as many individuals as possible, regardless of their specific abilities or needs. This is achievable through the inclusive design incorporated into the technology from the outset, where all features are available to users without the need for additional adaptations or modifications.

Immersive audio technology offers an extraordinary sound experience, as well as a more inclusive and accessible environment for all individuals, ensuring that no one is excluded from enjoying an engaging and high-quality audio experience.

In the ongoing experimentation, it was chosen to adopt the Dolby Atmos format. This is a revolutionary spatial audio technology introduced in 2012 by Dolby Laboratories, allowing sound engineers and artists to precisely position each sound in a three-dimensional space, thus replicating the auditory perception of reality.

Differing from traditional surround audio formats, Dolby Atmos adopts an object-based approach instead of channels. The object-based mix is an approach to audio mixing and production that focuses on the

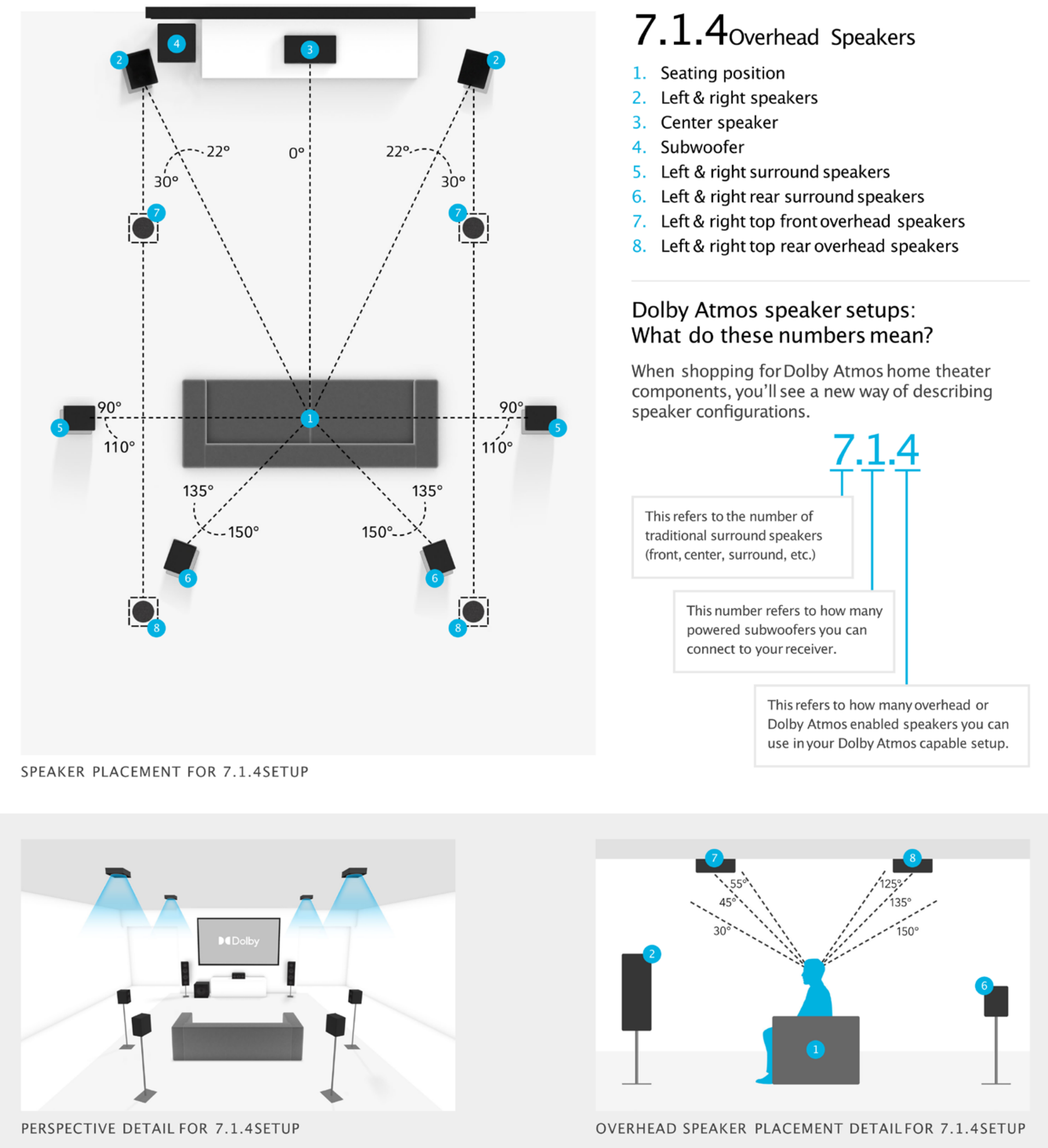

Figure 1 | Speaker placement (Dolby, Home theater Spekers Guide).

individual treatment of each sound "object" rather than traditional audio channels. In this context, an "object" can be any sound element, such as a vocal track, guitar, drums, synthesizer, effect, and much more. In the object-based mix, each of these is treated separately and can be positioned in three-dimensional space, dynamically manipulated, and processed with audio effects independently of other objects. Dolby Atmos allows for the individual management of each sound element, up to a maximum of 128 three-dimensional "audio objects". A distinctive feature of the format is the integration of height dimension into the sound field. This additional

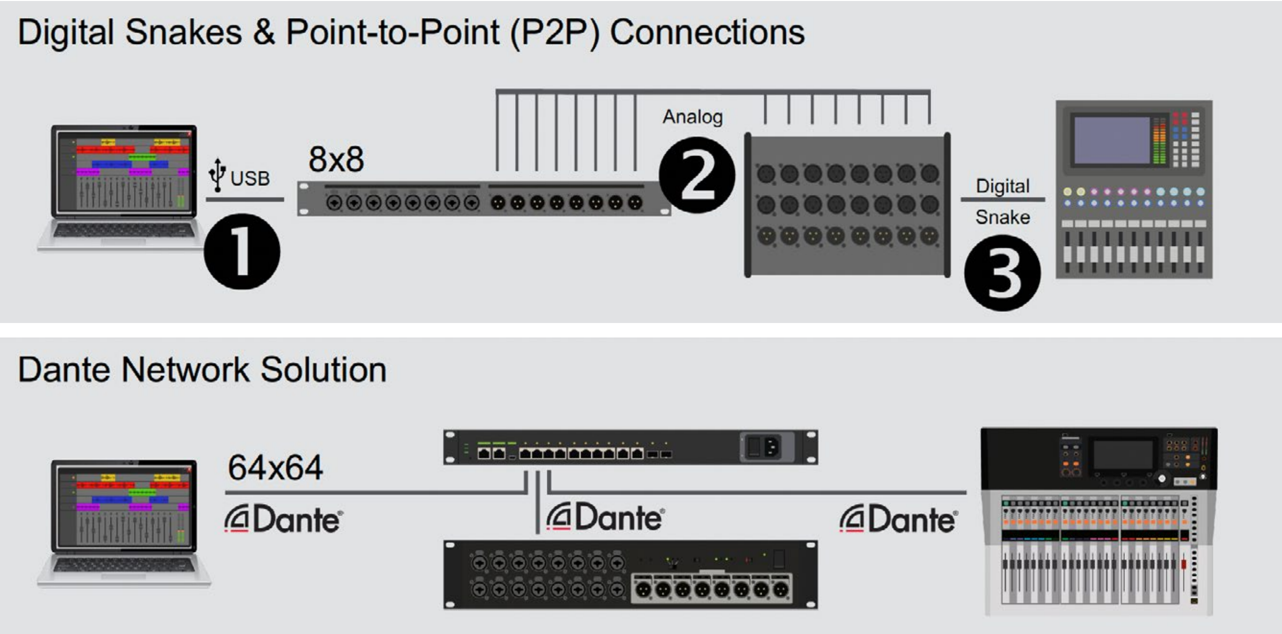

Figure 2 | Comparison between signal transport in Digital Snake versus Dante AV.

characteristic allows for the creation of an audio environment where sounds can come not only from the front and rear but also from above.

Dolby Atmos has found applications in cinema, as well as the consumer market, transforming the entertainment experience for films, music, and video games (creating effects like audio elements seeming to fall from the sky). Considering the specific Atmos 7.1.4 format and following Dolby's guidelines for Home Theater, the following speaker arrangement was hypothesized in the conducted experimentation.

3. Set-up audio and digital network

The audio playback setup is structured for the capture and diffusion of any acoustic and electronic instruments. In the control room, there is a mixer capable of handling both analog and digital audio sources.

The console used is the DM3 produced by Yamaha Corporation. Transporting and setting up a sound amplification system in a location can be one of the most complex tasks to tackle. The DM3 console requires less space and time for physical configuration due to its flexible patching along with Quick Pro presets, Editor and StageMix software, and compatibility with the Dante protocol. This significantly reduces setup and configuration times for the system. The DM3 Series console is compact, robust, and easy to transport. It features an optimized routing system for the location, including 6 mixes, 2 matrices, and 2 effect processors. With excellent integration with various DAW,[1] this console allows for use as a matrix, player, and for recording sessions.

The signal transport system is digital and is based on Dante, an audio-over-IP (Internet Protocol) network protocol developed by Audinate. Dante is designed for transporting low-latency digital audio signals over standard Ethernet networks, allowing flexible and scalable sound distribution in professional environments such as recording studios, conference halls, theaters, places of worship, and more. Dante operates on standard Ethernet networks and can be implemented on existing network infrastructures, thus reducing wiring costs and simplifying installation. This protocol uses a switched network topology to ensure reliable transmission of audio signals, also allowing centralized configuration and management of audio devices connected to the network. Dante is supported by a wide range of audio devices, including digital mixers, signal processors, amplifiers, and speakers, and offers advanced features such as flexible signal routing, remote control, and precise time synchronization. Compared to other digital audio signal transport systems, Dante is the most flexible, offering possible implementations even in the field of video.

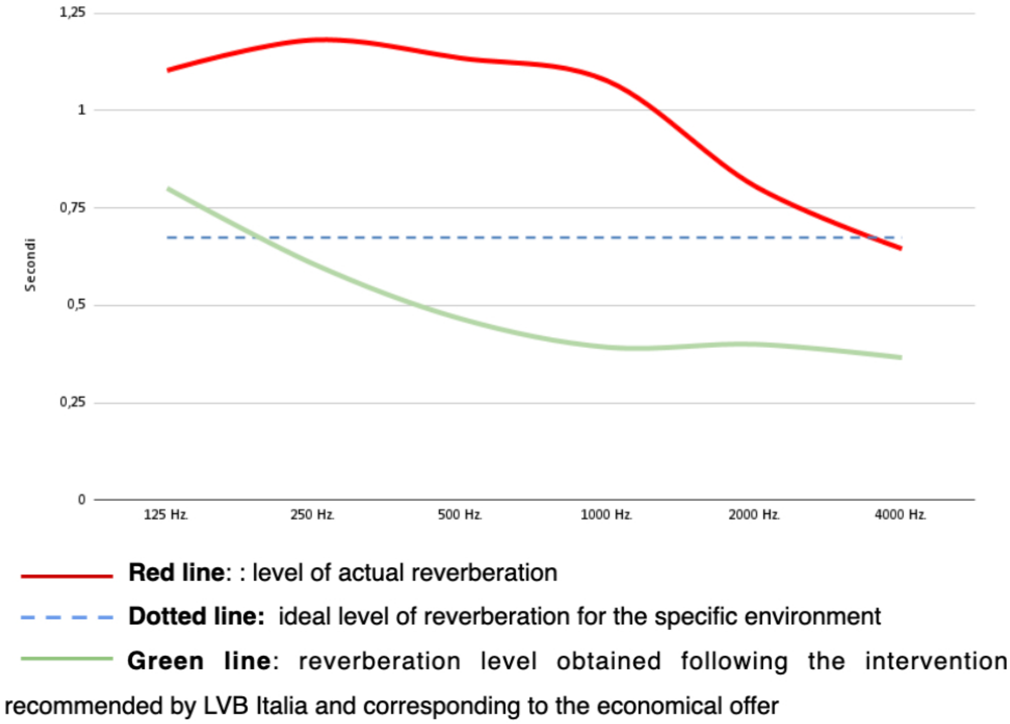

Figure 3 | Main room acoustic calculation.

The speakers planned for the system include audio output devices with adjustable horns for variable high-frequency diffusion. The setup choices aim to combine important performance with levels of versatility and functional flexibility tailored to the location. The system also involves the use of a DAW for recording sessions and for the management and distribution of audio and video signals. The proposed software is Nuendo made by Steinberg Media Technologies. Nuendo, chosen by professionals in the film, television, and immersive audio industries worldwide, also supports MPEG-H and numerous surround formats, allowing for significant flexibility in distribution systems.

4. Signal Absorption and Acoustic Insulation of the Building System[2]

In this experience, the acoustic project was developed parallel to the architectural project, in order to operate in highly suitable enclosures for the installation of systems intended for immersive audio performances.

To controll the acoustic performance in the proposed architectures, treatment for absorption and insulation is hypothesized. In an optimal environment for speech intelligibility and enjoyment of artistic events based on audio, it is essential to manage sound waves that can cause significant reverberation phenomena.

Reverberation, besides compromising sound clarity, can make correct music perception difficult. An effective solution consists of using sound-absorbing panels positioned along the walls and ceiling of the room to intercept secondary sound waves (main causes of reverberation). Based on the acoustic calculation (Figure 3), the layout of the sound-absorbing panels (Figure 4) was elaborated.

The materials used for sound absorption comply with UNI EN standards both in terms of fire response and acoustic aspects. The surfaces of the panels are covered with recycled and fully recyclable fabrics, while inside there is polyester fiber with percentages of recycled material ranging from 63% to 90%.

Regarding the works for acoustic insulation, it is planned to block acoustic energy considering that the insulation level of a material or a wall depends mainly on its mass per square meter (kg/m^2). The mass law states that by doubling the mass of a surface, the insulation increases by 6 dB. Insulating materials are therefore naturally heavy and high-density materials (kg/m^3).

Considering that for high acoustic insulation, very thick walls should be built, a system composed of mass, sound-absorbing materials, mass is opted for. This solution allows overcoming the limits imposed by the mass law and achieving better structural decoupling.

The floating floor involves the use of U-Boats elements made of super-elastic EPDM rubber. These allow decoupling of the supporting structure and the creation of a floating floor. The result is an excellent insulation of the main room with a drastic reduction in the transmission of vibrations to the outside.

Vertical closures require an additional layer with a regular structure in galvanized iron spaced 3-5 cm from the wall through elastic suspension. Inside the additional layer, there is a sound-absorbing element (rock wool 70 kg/m³ or hemp fiber), a plasterboard element, FlatBarrier 10A acoustic barrier,[3] and additional plasterboard (Figure 6).

Similarly, the upper closure requires a floating false ceiling by preparing a structure similar to that of the walls additional layer but suspended by means of elastic decoupling clips (Figure 7).

Regarding the opening systems, fixtures with a 42 dB reduction are hypothesized. For higher acoustic insulation, a double-door system can be provided.

The technical solutions just described for acoustic insulation and absorption are the most commonly used. These solutions provide the basic guidelines for the development of more sustainable technical solutions in the conducted experimentation.

5. Technological and environmental systems for immersive performances and for different future uses

The architectures under research measure themselves with the needs of immersive performances, above all adopting principles of flexibility, reversibility, modularity and low environmental impact.

The main needs implemented by immersive technologies and considered in the environmental and technological project are:

- The dry stratification and the presence of cavities in closures and vertical and horizontal partitions for the passage of plants systems.

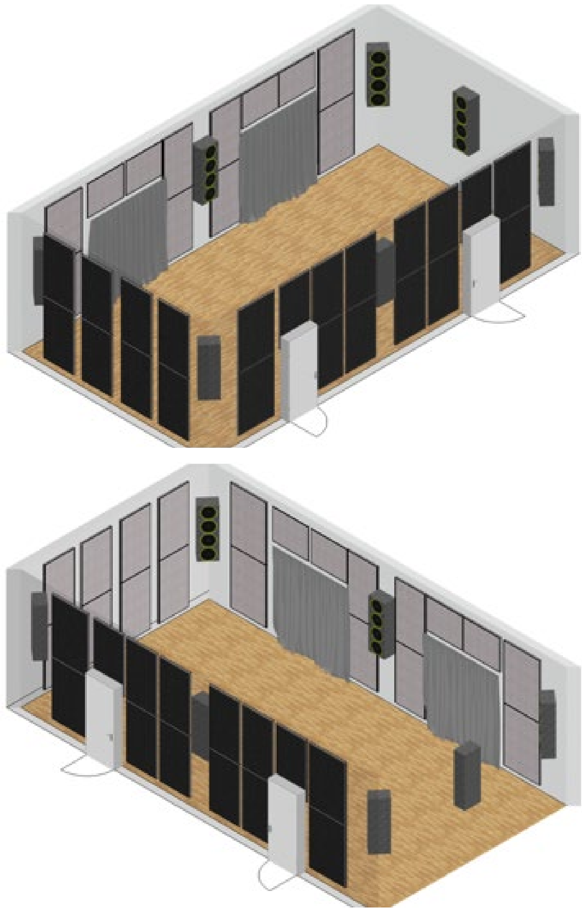

Figure 4 | Layout of the sound-absorbing panels.

- The double anticlastic curvature morphology of the internal finishing surface of the upper closure for an optimal acoustic response.
- The sizing and distribution of environmental units for performances and the control room.
- The predisposition and flexibility of the electrical system to respond to different use needs.
- The positioning of audio source diffusion systems for immersive formats.

The design of the proposed building system considers the entire life cycle from the choice of materials and products to the decommissioning phase.

The use of materials from renewable natural resources is envisaged, considering the principles of Life Cycle Assessment and the directives for the Minimum Environmental Criteria.

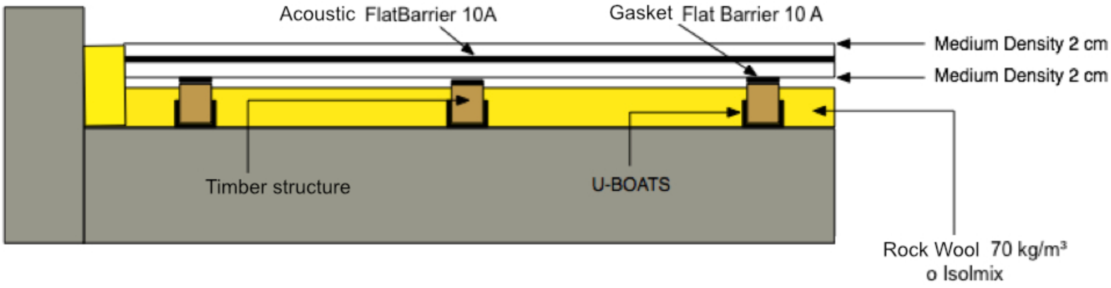

Figure 5 | Reference system for isolating the floor slab.

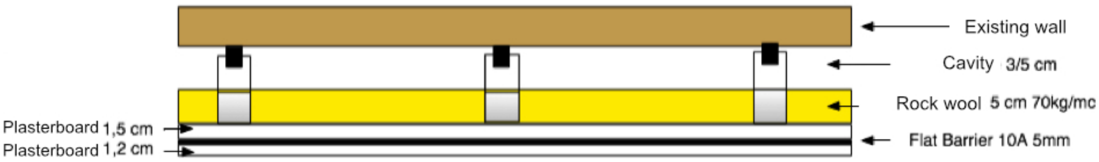

Figure 6 | Diagram of additional layer for vertical closures.

Figure 7 | Diagram of the floating ceiling.

The building system can be easily assembled, transported, removed and reassembled elsewhere thanks to the use of dry devices and minimally invasive ground connections.

A highly maintainable lightweight construction is proposed to […] rationalize the technical and economic management of the interventions necessary to maintain the quality level of a building unchanged over time and to re-establish the levels of efficiency and reliability of the works subject to the phenomena of obsolescence and degradation […] (Di Giulio, 2007). A renewable and long-lasting architecture was thus designed, adaptable to any context.

The light, dismantled and transportable system is designed to temporarily occupy a public space in which to give rise to immersive performances. A compact, box-like volume made up of five prefabricated modules, joined together using easy-to-assemble connections, facilitates and speeds up construction times. The space system includes a main room of approximately 70 m2 and two service blocks for users, a technical environment dedicated to the control room and a service room dedicated to the storage of equipment. The main room, with the possibility of holding a maximum capacity of around 50 people, was conceived as a single environment in which to insert a cutting-edge system from a digital point of view (Figure 8).

To meet acoustic needs, the internal lining of the roof closure includes a double anticlastic curved membrane tensile structure, which allows the optimal channeling of sound pressure and the control of its diffusion. The tensile structure also provides support for video projections.

The construction system is dry, and includes mechanical joints (screws, bolts, plates) between the technical elements. This choice makes it possible to

Figure 8 | The distribution of spaces and sound sources.

reduce timescales and economic and environmental costs, both during the construction phase and after the commissioning of the building, maintaining its efficiency over time.[4]

The lightweight construction involves a system of indirect foundations on screw piles, in case of installation in environments with green ground, or with mobile/ballasted plinths, in case of installations in already paved contexts. This allows the entire construction to be raised above ground level to avoid rising humidity. The building system is made up of 5 prefabricated modules measuring 2.5x10x4 meters each, designed to be easily transported by road and positioned in different contexts.

The use of prefabricated modules simplifies the installation and configuration of the internal spaces. The symmetrical arrangement of modules A, B and C, following a specific scheme, optimizes the accessibility and the functionality of the environments.

The building's assembly scheme is based on a modular arrangement that effectively combines functionality and symmetry along the central axis. This approach allows for an optimal distribution of the internal spaces and specific functions of each module.

Modules A and A1 are the head elements of the building and are intended for sanitation services.

Modules B and B1 are located between the head elements and the central core of the project (C). Module B contains the main access point to the main hall at the front and a control room at the rear. Module B1, symmetrically opposite to B, contains a service room with equipment dedicated to assisting the activities carried out. This layout optimizes accessibility and flow between the service areas and the main room.

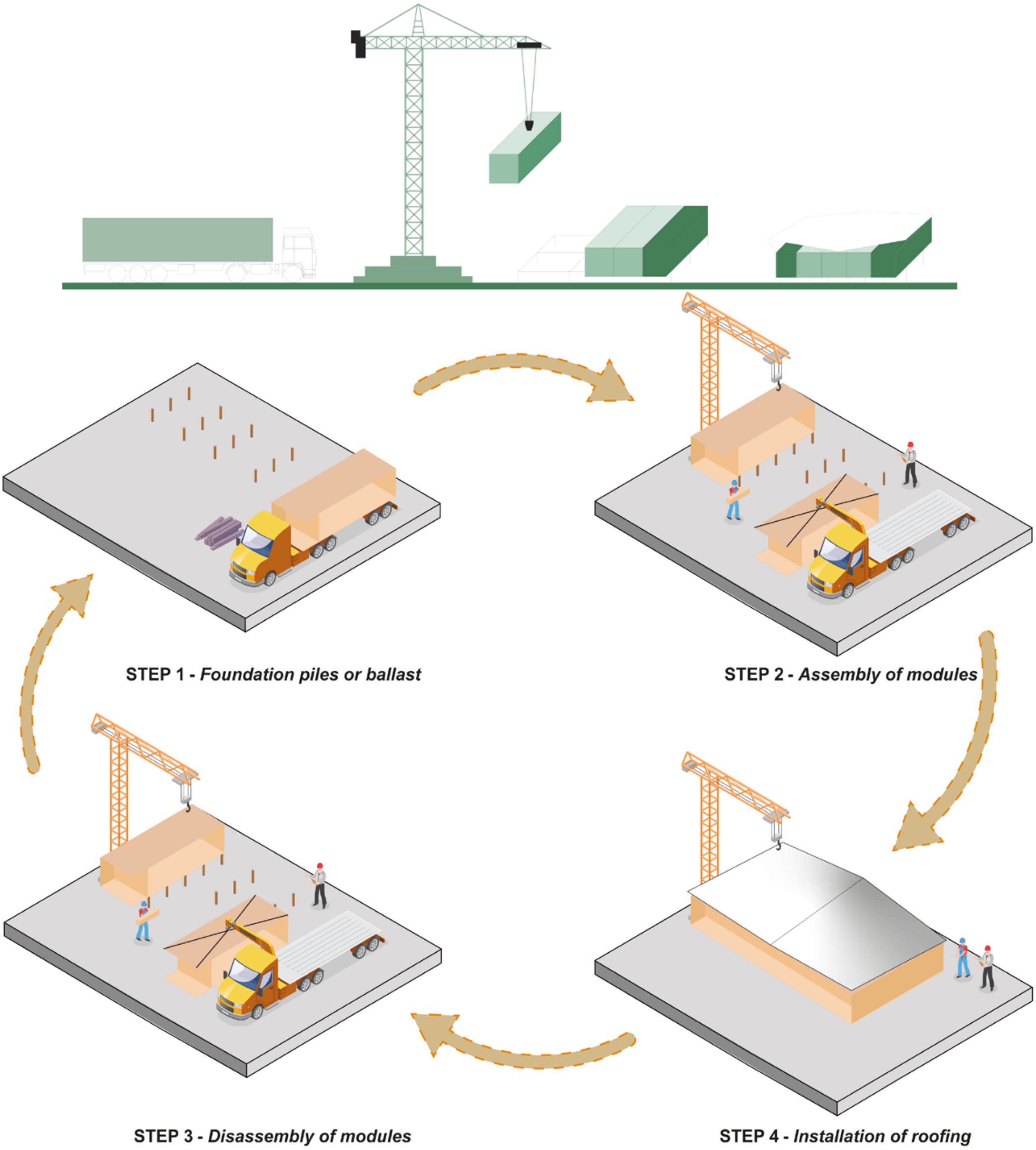

Figure 9 | Transportability of the modules.

Module C constitutes the central core of the building and plays a fundamental role in defining the symmetry and distribution of the systems. The plant lines are positioned inside module C, under the floating floor. Furthermore, the central core is equipped with a mechanical lifting platform to ensure universal accessibility, breaking down architectural barriers and facilitating the transport of machinery and equipment.

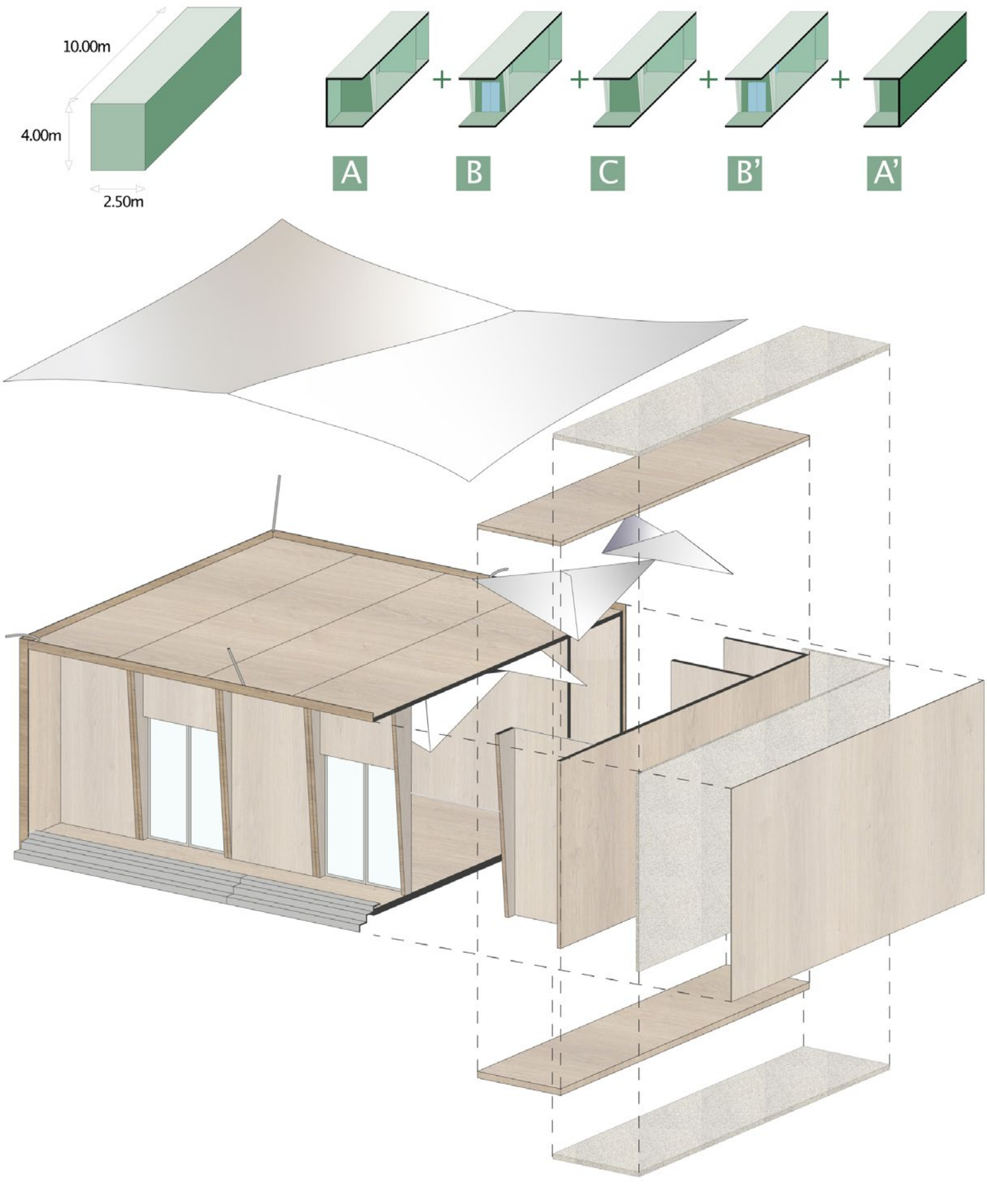

Figure 10 | A, B, C, B1, A1 modules dimensions and assembly.

The overall assembly scheme, following the order A-B-C-B1-A1, optimizes the efficiency of the spaces and the functionality of the building.[5] This modular approach allows for flexible design that can be adapted to specific use needs, while ensuring optimal configuration of spaces and functions.

The covering consists of three distinct levels. The outermost level consists of a membrane tensile structure that exploits the double anticlastic curvature as a natural form for the outflow of rainwater to be conveyed into accumulation systems located in the lower cavity to supply the sanitary water systems. The intermediate level constitutes

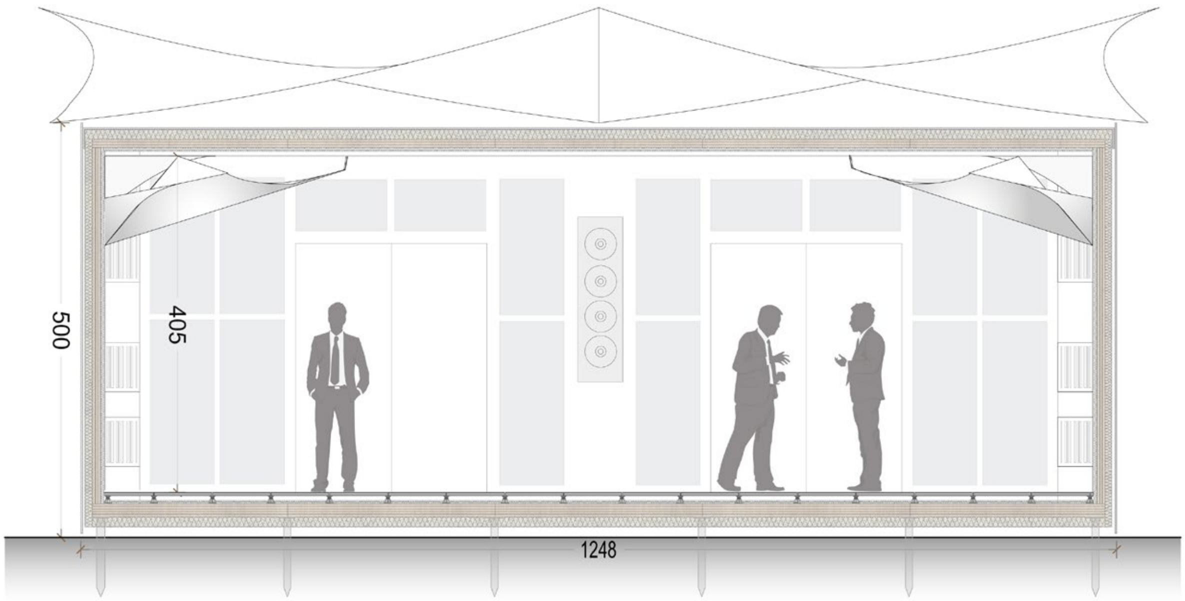

Figure 11 | Transversal section.

the main flat closure so as not to cause problems during transport and facilitate assembly. The innermost level consists of the membrane technostructure designed to meet acoustic needs.

The proposed architectural project involves the use of innovative and sustainable materials, selected to ensure optimal structural performance, room comfort and reduced environmental footprint.

X-lam panels offer a unique combination of safety, environmental safeguard, well-being and usability performance.

The wood comes from responsibly managed forests and the production of the panels requires less energy consumption than conventional building materials such as concrete and steel. Furthermore, X-lam panels have a high capacity to store carbon, thus contributing to the reduction of greenhouse gas emissions.

The module is made up of a resistant core of fir wood panels, of the 3-layer X-lam type, with a 10 cm section in the vertical and covering components and a larger 16 cm section in the lower horizontal closure to increase the solidity. The choice of crossed fiber panels favors, in the presence of seismic actions, the absence of a "hierarchy of resistance" which leads the structure to develop a plastic collapse mechanism.[6] Continuing towards the external layer there is a perimeter insulation in natural Douglas fibre, with a section varying between 8 and 14 cm and a mass of 120kg/m^3, measured to comply with the legislation in force in Italy regarding energy saving and designed to be adapted to each climate zone in which the installation must be mounted.[7]

Douglas fir wood is a highly effective solution for the thermal and acoustic insulation of buildings and the environmental safeguard. Douglas wood fiber has an average density of approximately 120 kg/m^3, which guarantees an excellent compromise between lightness and insulating capacity. This density allows for high thermal transmittance (λ) values with a typical value of approximately 0.040 W/(m·K), indicating excellent resistance to the passage of heat through the material.

Douglas fir wood is characterized by a structure that effectively retains air, creating effective thermal insulation that reduces heat loss through the walls. This helps to maintain a constant and comfortable internal temperature, while reducing energy consumption for heating and cooling. Furthermore, Douglas fir has excellent acoustic properties and it is resistant to humidity and mold, thanks to its intrinsic ability to regulate environmental humidity. This makes the material also suitable for applications in humid environments or subject to adverse climatic conditions.

An air gap promotes natural ventilation, preserving healthy conditions and avoiding surface condensation.

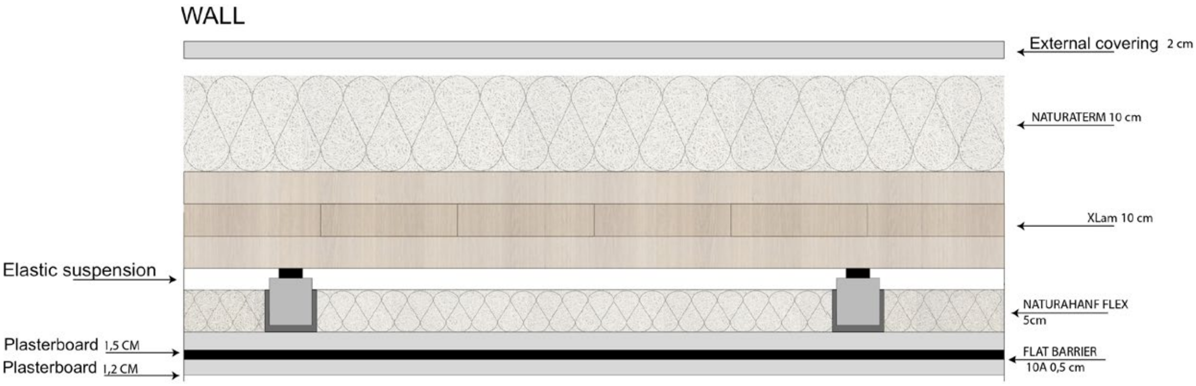

Figure 12 | The functional layers of the roof closure.

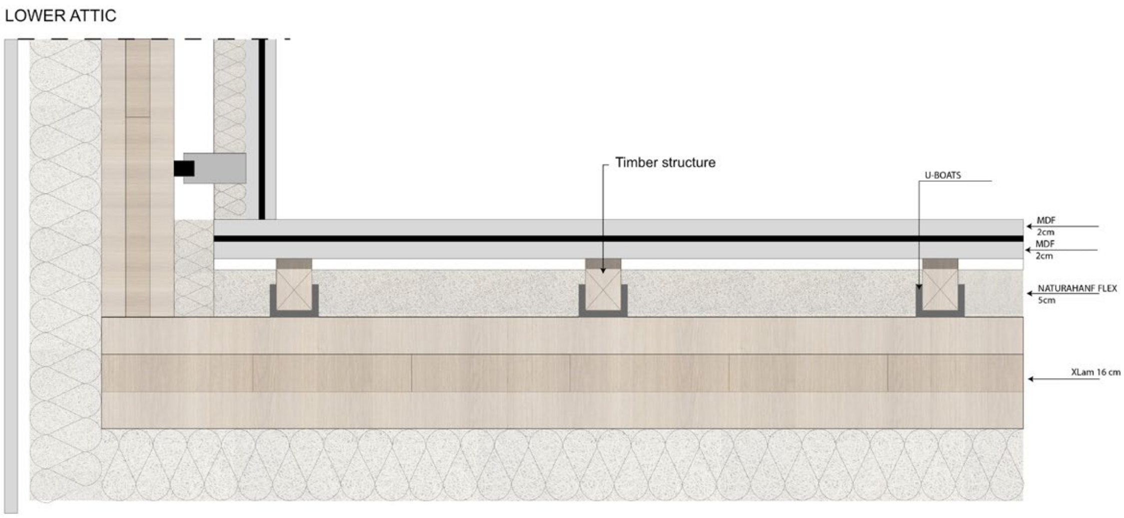

Figure 13 | The functional layers of the vertical closure.

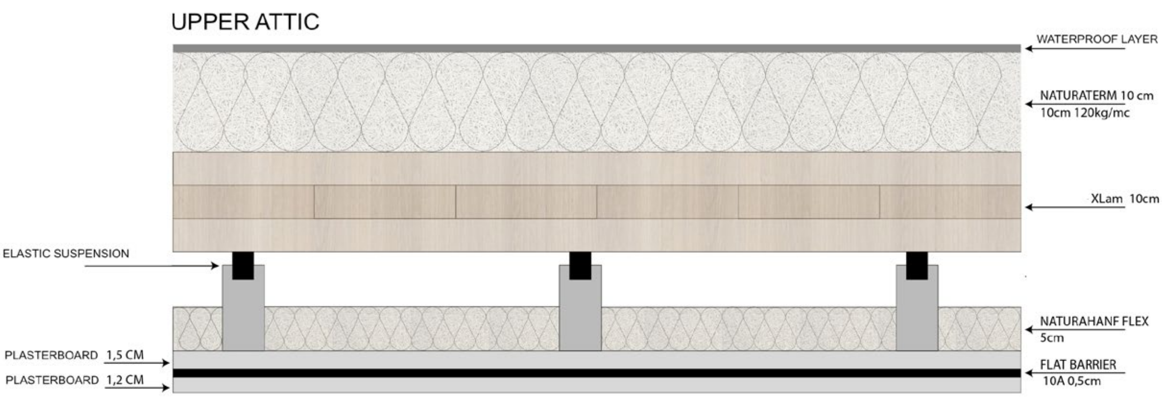

Figure 14 | The functional layers of the roof closure.

The external cladding, being dry mounted, is a variable element that can be chosen depending on the surrounding context, adapting according to the natural or built contexts (to also avoid problems due to any constraints). For the external finishing of vertical closures, in addition to the most common coverings such as wood and reconstructed stone, the possibility of applying Wall-Led (which includes a series of Leyard LUO-1.2 panels) is envisaged to project images also on the outside of the building. The wall-LED screen can be used as a giant screen for the reproduction of videos and images relating to the planned events. The modules of this maxiscreen are fixed to each other using quick fixing couplings and are powered and controlled via power and network cables bridged between modules. The Leyard LUO-1.2 panels, measuring 500×500 mm, are equipped with advanced microLED technology that consumes less energy, provides more light without reflections and offers an extremely wide viewing angle of 160° in all directions with a resolution capable of rendering clear images even outdoors and in direct sunlight. The displays are IP65 rated and therefore dustproof and protected from water.

For the electricity supply system, the installation of a photovoltaic system is planned on the west-facing wall, composed of ECTIVE SSP 200 panels, rigid and light monocrystalline solar modules with a peak power of 200 W each, which guarantee high efficiency even in case of partial shading. The maximum power developed, considering an assembly scheme of 14 panels, would produce a total of 2.8 kW/h to be conveyed into the storage system coupled to the system.

Per To meet the acoustic insulation needs, a layer of insulation is inserted in the cavity of the walls, composed of hemp fiber (66%), jute fiber (22%), 100% recycled PET polymer reinforcing fibers (8 %), soda as a natural flame retardant and natural salt (4%).

Hemp and jute fibers provide excellent acoustic properties. Hemp fiber is characterized by long, and flexible fibers that act as an effective sound absorber, reducing noise transmission through walls. Jute fibre helps to attenuate sound waves, improving the acoustic comfort.

Recycled PET polymer reinforcing fibers provide additional strength and stability to the insulation structure, while maintaining a small ecological footprint. These combined materials guarantee high efficiency in sound insulation.

The presence of soda as a natural flame retardant and natural salt gives the material an additional safety property against fires.

The use of natural and recycled materials reduces the overall environmental impact of the acoustic insulation.

The internal finish of the vertical closures includes panels with a different surface treatment for each side:

- Side A has a wooden surface, chosen for its anisotropic characteristics and low mass density, chosen for its acoustic frequency reflection properties.
- Side B has a surface in recycled fabric, chosen to increase the sound-absorbing treatment of the wall and to regulate the frequencies.

La The composition of the walls, therefore, depending on the needs required by the planned activities, can be arranged with multiple assembly schemes by rotating the faces of the panels, to increase and/or decrease the absorption of sound waves and calibrating the intelligibility and reverberation of sound.

For example, we could redistribute a layout with a majority of the type A panel in the external part in the case of activities in which the requirement of speech intelligibility is required to increase understanding and to ensure that the target's attention is focused on the interlocutor, on the other hand, a layout with a majority of the type B panel will be used to be able to absorb the sound frequencies deriving from musical instruments in the case of live concerts.[8]

As regards the immersive experience from a visual point of view, the environment will be set up with 4K resolution projectors positioned on the false ceiling oriented towards the walls in order to create a 360° immersive scenography, creating a unique impression on the users. The choice of projection from above prevents the image from being intercepted by obstacles in the room and preventing the projection of shadows.

Future developments in this study are mainly aimed at:

- An ever-increasing reduction of environmental impacts through the search for appropriate materials, products and construction systems capable of triggering sustainable development processes.
- The search for alternative morphologies of architectural envelopes that combine the needs dictated by the intended use (in this specific case immersive performances) with those of psycho-physical well-being and with those of future usability and reusability.

Figure 15 | Insertion of the designed system in a built environment for cultural and educational events.

6. Conclusions

The study presented is a phase of a broader research and experimental work still in progress and aims to provide ideas and food for thought regarding new research perspectives on which the architectural disciplines could engage. With particular reference to the specificities of the topics covered, it is believed that there are at least three aspects that can stimulate other studies. The first concerns the characteristics that places intended for the diffusion of culture in its many forms should have. More precisely, reference is made to the need to separate cultural events and activities from valuable buildings, concentrated in the central areas of the largest and most populous cities, allowing their wider diffusion through "measured" architecture (Radogna, 2022), which can be positioned in different contexts (even and above all marginal), accessible and inclusive.

The second aspect to be explored in depth concerns the material-constructive characteristics of these architectures. As proposed with the presented work, these characteristics should be based eminently on:

- Control of the life cycle of building systems, providing for the use of low impact materials and products.
- Minimally invasive and easily repositionable ground attack systems.
- Dry stratifications capable of allowing flexibility, adaptability, repositionability and reusability of the technological units of the closures, partitions and systems.
- The project of the future reusability of building systems as a whole.

The third aspect to consider is the need to develop the architectural project in a multidisciplinary and participatory manner. The multidisciplinary activity should determine a close and effective interaction between the skills of the architectural project and those of the intended uses considered. Furthermore, the role of users should be reconsidered, giving greater effectiveness and usefulness to participatory planning through the definition of new tools and methodologies.

Figure 16 | The possibility of using the designed system for other functions and in other contexts such as natural environments.

With this experience, we wanted to experiment with the possibility of designing with material and immaterial elements to satisfy the needs of psycho-physical well-being and development of individuals (Ruzzon, 2022).

The proposed architectures can be placed onto natural environments as well as on built ones. In particular, the modular, reversibility, adaptability and flexibility characteristics of these architectures allow their inclusion in different typologies that can characterize the built heritage. The architectures can be also placed, for example, into large disused envelopes, on in between spaces as well as in ruins.

Thanks to immersive audio and video performances, in addition to acquiring a profound and conscious cultural growth, people can perceive the surfaces that define architecture no longer as a separation between internal and external spaces or between artificial spaces and natural spaces but as means to amplify the habitat and the mind.

The architectural envelopes conceived in this way, in addition to promoting transition processes, become the support through which, in any context, all people can grow culturally, travel and, more generally, explore unknown dimensions through audio and video immersive formats.

Notes

1 DAW stands for Digital Audio Workstation. These are software dedicated to the recording, editing, mixing, and production of music, sounds, and other digital audio content.

2 The elaboration of this study benefited from the consultancy of Engineer Giulio Curà.

3 FLAT BARRIER 10A is a high-density adhesive soundproofing acoustic barrier made by Masacoustics.

4 The Presidential Decree 554/1999 defines maintenance as: “Combination of all technical, specialist and administrative actions, including supervision actions, aimed at maintaining or restoring a work or plant to the condition of carrying out the function envisaged by the project provision”.

5 Decree of the Ministry for Cultural Heritage and Activities 114 of 16/05/2008. Guidelines for overcoming architectural barriers in places of cultural interest.

6 Critical event linked to the exhaustion of the resources of the material, section, element or structure in terms of resistance and/or ductility as a function of the triggering of fragile and/or ductile mechanisms.

7 Presidential Decree n. 412 of 1993 updated to 2016. Regulation containing rules for the design, installation, operation and maintenance of heating systems in buildings for the purposes of containing energy consumption, in implementation of art. 4, paragraph 4, of law 9 January 1991, n. 10.

8 Materials, products and systems for acoustic control are being studied in greater detail with regard to the reduction of environmental impacts.

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