Theoretical Connection Points Between Multimedia and Architecture

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Abstract
Multimedia technology has influenced modern society in many ways. Multimedia has evolved to applications in physical space, wherein media such as sound, visuals and interactive content have taken on spatial significance. Especially interesting for architectural design is the progressive approach to spatial context evident in multimedia installation artworks and interactive spaces. This paper seeks to identify key forms of influence multimedia has in an architectural context and the spatial significance of architectonic functions afforded by those influences. Multiple case studies were conducted applying a systems theory approach to evaluate 25 works of multimedia installation art and interactive spaces. Evaluations referenced the forms of media used, their observed influence on the correlating architectural space and the manner in which people experience the resultant space. Based on observations and analysis, this paper is proposing transformation, interaction and temporality as three key influences of multimedia. These influences and the architectonic functions they afford were used to create a matrix framework that indicates the potential of multimedia in an architectural context and establishes a theoretical basis for developing methods to integrate multimedia technology into architectural design.

Keywords: architecture; multimedia; transformation; interaction; temporality

1. Introduction
The manner in which people share, access and exchange knowledge has been indelibly changed by multimedia technology. Examples can be found in applications to computers, communication and information devices and gaming systems. Multimedia technology has also made advancements to address applications in habitable, physical environments and that has opened the door for new modes of contemplating spatial function, reflecting not only how people interact with and experience a space, but also how a space can benefit people by sensing and interacting with them. (Bullivant 2006, pp.6-17) This can be evidenced in libraries, museums and installation art works, where the implementation of multimedia and interactivity is becoming increasingly prevalent. The most progressive examples can be found in multimedia installation art¹ and interactive spaces² as they are not necessarily shaped by the same level of pragmatics necessary in an architectural project. (McLuhan 2003, pp.16-39) Furthermore, the artists often integrate aspects of multimedia, interactive design and information technology with architecture in the creation of installation works.

With the integration of multimedia, spaces can become dynamic, responsive and/or interactive, perceived limitations of time and space become more flexible and the gap between virtual and physical environments begins to bridge. (Bullivant) Through the interrelation of multimedia and architectural context, audio, visual and haptic media content with interactive capabilities take on spatial significance.

This body of research is situated within an area of study that integrates multimedia technology, interactive design and architectural design. It addresses the need for a means of understanding and indicating the functional potential of multimedia in the context of architectural design and advancing the interdisciplinary knowledge base that is necessary for multimedia to be used to its full potential.

1.1 Relevance of Multimedia Installation Art
The genre of installation art is particularly relevant to architectural design thanks to its site-specific nature and emphasis on the human experience of a space. Much of architecture so far has involved static tectonic elements that compose a constructed form and define a resultant space. In contrast, multimedia installations and interactive spaces can be highly dynamic spaces that respond to and interact with people, data inputs and the surrounding environment. Hence, the consideration of multimedia in architectural design requires a broadened understanding of architectural concepts such as form, spatial and temporal definition.

2. Methods of Research
The choice of works to be analyzed in this paper is based on two conditions. The first condition is that the works are contemporary art installations or interactive...
spaces that use multimedia as an important component. The second condition was that the work should incorporate an architectural context as an integral part of the work, or itself take on an architectonic function in the space. The authors responsible for these works are internationally recognized artists and designers in the genres of installation art and interactive spaces.

The case study analyses of installation works were conducted independent of artists' intentions in order to focus on the effects of the multimedia works on their correlating spaces. A systems theory approach was introduced to determine the elements comprising any multimedia installation work. Generally, all works in the case study include the multimedia implemented, the correlating installation space and the people that experience and interact with the space.

The multimedia component functions as a system in itself. It is composed of an input that is processed through computation and a corresponding output, usually in a content form intended for human sensory perception. (see Fig.1.)

From this basis, a method for investigating the multimedia component of each work was established that identifies the form and specific nature of inputs to the system, the manner in which inputs are processed and the form of outputs.

Outputs invariably influence the correlating installation space in a manner that can be experienced by people. To detect and define the influence of these outputs on the correlating space, this paper employs Kenneth Frampton's architectural theory that states 'the built invariably comes into existence out of the constantly evolving interplay of three converging vectors, the topos, the typos and the tectonics.' (Frampton 1995, p2) It can be understood that the topos (or 'site') the typos (or 'purpose of a building space') and the tectonics (or 'physical construction'), represent three key aspects that together define any architectural intervention and thus serve as an effective point of reference in analyzing an existing space to derive and understand its architectural makeup. Working from Frampton's established theory, each case in this paper was analyzed, noting the influence and effect of multimedia system outputs in regard to topos, typos and tectonics, to identify the effects of these influences and their resultant architectural functions. (see Table 1.)

3. Transformation, Interaction and Temporality as Key Multimedia Influences

Based on observations from case study analyses, this paper is proposing three key influences of multimedia based on their relevancy to an architectural context, the purposeful augmented functionalities they afforded and their prevalence in the works analyzed. The proposed influences will be referred to as transformation, interactivity and temporality and will be described in detail in the following text supported by case study examples.

The effects of the transformative, interactive and temporal influence of multimedia when analyzed with respect to tectonics, topos and typos, yielded nine effects. They are referred to as transformative tectonics, transformative topology, transformative typology, interactive tectonics, interactive topology, interactive typology, temporal tectonics, temporal topology and temporal typology. These effects are listed individually for clarity, but they often occur together with variable intensity, in order to achieve a desired functionality and/or experience for a given space. (see Table 2.)

3.1 Transformation

Transformation is generally defined as a dramatic change in form or appearance. Within the context of this paper, transformation refers to the observed ability of multimedia to influence a dramatic change in the perceived form, sense or function of a space. Transformations in varying forms were observed in 21 of 25 observed cases. In the remaining four cases multimedia was observed to augment the space in some way.

3.1.1 Transformational Tectonics

'Transformational tectonics' is an effect that enables functional modulations in the form, sense and function of tectonic elements. It offers new ways of conceptualizing spatial structure, tectonic elements and their functional capabilities. Observed case study examples of transformational tectonics include the following architectonic functions:

1) Physical tectonics merging with virtual elements (Fig.2.)—In this case, tectonic forms are augmented by projected dynamic video. Projections of lines and shapes trace tectonic forms to create a dynamic visual experience that mimics a virtual 3D environment. In this case, video transforms static tectonics into visually dynamic elements that challenge one's perception of what is real versus virtual. (see Table 1., case 18.)

2) Data inputs triggering functional changes in tectonic elements (Fig.3.)—LED displays mounted onto library elevators display book titles as they are checked out by visitors. LED text scrolls as the elevators move between floors. Here, multimedia augments tectonic elements to function as an information source that provides real time updates on the reading interests of library visitors. (see Table 1., case 1.)

3) Alternative spatial structure augments tectonic structure (Fig.4.)—The tectonic structure of a room is augmented by a secondary audial structure of recorded sounds. Vocalizations recorded by visitors at different areas in the space generate an audial structure that is
Table 1. Observed Forms of Multimedia Output and Resultant Effects on Correlating Space Per Case Study (Ref. by number in Appendix)

<table>
<thead>
<tr>
<th>Effect of Multimedia on Correlating Space (Observed Effect listed above and form of effect listed below)</th>
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<tbody>
<tr>
<td>Form of Multimedia Output</td>
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<tr>
<td>---------------------------</td>
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<tr>
<td>Titles of checked out books on LED displays mounted on elevators (fig. 3)</td>
</tr>
<tr>
<td>Text from internet chat room discussions on LED displays and vocalizations of those texts (fig.5)</td>
</tr>
<tr>
<td>Murals presented on street facades, audio enabled by cell-phone, map accessible by internet (fig. 7, 24)</td>
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<tr>
<td>Interactive projections of interviews and period musical recordings depicting a remote location (fig.6)</td>
</tr>
<tr>
<td>Projections and audio recordings that augment an environment to simulate its state at a previous time (fig.16, 22)</td>
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<tr>
<td>Projections and radio broadcasts responsive to the positions of shadows cast by people on walls (fig.18)</td>
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<tr>
<td>Array of poles with haptic sensors that trigger audio recordings of news broadcasts when activated (fig.17)</td>
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<tr>
<td>Interactive visuals responsive to the movements of people walking around the floor space</td>
</tr>
<tr>
<td>Array of interactive emergency beacon lights that rotate to create light beams that follow movement (fig.14)</td>
</tr>
<tr>
<td>A grouping of mono frequency lights, mist and large reflective ceiling altering visual ambient (fig.6, 23)</td>
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<tr>
<td>Array of interactive mirrors that rotate to follow the movements of a randomly selected person (fig.20)</td>
</tr>
<tr>
<td>Array of interactive tube lights rotating in response to the position of people in the space (fig.20)</td>
</tr>
<tr>
<td>User created vocal recordings tied to points in space (fig.4)</td>
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<tr>
<td>Videos of local people projected in the shadow of participants when they pause within the plaza (fig.21)</td>
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<tr>
<td>Projected visuals that translate the writing gestures of participants with a laser pen into graffiti simulations (fig.25)</td>
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<tr>
<td>Abstract visuals projected on a wall of water that change in response to vocal input from participants (fig.10)</td>
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<tr>
<td>Array of shaded elements rotate in response to people's movements to act as a low resolution mirror (fig.13)</td>
</tr>
<tr>
<td>Dynamic projected lines and fields of light that trace the physical form of elements in an urban space (fig.2)</td>
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<td>Array of mirrors with coordinated rotations to create visual patterns from reflections of the environment</td>
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<tr>
<td>Interactive steps that appear in response to human presence and the pressure of footsteps (fig.15)</td>
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<tr>
<td>Projections of colored abstractions on stretched fabric that covers an exterior space</td>
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<tr>
<td>Flowers projected on a floor surface that fade and reappear in response to people walking over (fig.12)</td>
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<tr>
<td>Patterns of light on the floor and wall visual responses of force of gravity acting on the surface below you</td>
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<tr>
<td>Projections on a sculpture simulate deformations in its form in response to people (fig.11)</td>
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<tr>
<td>Animated projections of trees and rivers that respond to the actions of people in the space (fig.9, 19)</td>
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Table 2. Matrix of Effects Afforded by Transformative, Interactive and Temporal Multimedia Influences

<table>
<thead>
<tr>
<th>Vectors</th>
<th>1. TRANSFORMATION</th>
<th>2. INTERACTIVITY</th>
<th>3. TEMPORALITY</th>
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<tbody>
<tr>
<td>Tectonics</td>
<td>Transformative Tectonics: Modulations in the form, sense and function of tectonic elements</td>
<td>Interactive Tectonics: Tectonic elements with the ability to sense, react and interact</td>
<td>Temporal Tectonics: Modulations in tectonic form and function in the context of time</td>
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<tr>
<td>Topos</td>
<td>Transformative Topology: Modulations in topological cues resulting in a changed sense of place</td>
<td>Interactive Topology: Environments that can sense and react to stimuli</td>
<td>Temporal Topology: Modulations in temporal cues that define a space in the context of time</td>
</tr>
<tr>
<td>Typos</td>
<td>Transformative Typology: Modulations in the function of a space that change its purpose.</td>
<td>Interactive Typology: Spaces with the ability to change purpose in response to stimuli</td>
<td>Temporal Typology: Modulations in the sensed timeline for a given typology</td>
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perceptible as one moves around. Here, audial media transforms a static tectonic structure into an interactive sound space that can be navigated using hearing. (see Table 1., case 13.)

4) **Tectonic elements function as real-time information sources** (Fig.5.)—Multimedia functions as a secondary layer of digital media structure augmenting a tectonic structure. (McCollough, p.47) A visual structure in the form of text and LED conveys conversations from internet public forums in real-time. Chat conversation fragments are audible from vocal synthesizers. In this case, visual and audio media are paired to transform a static tectonic element into a window on real-time communication flows in virtual internet environments. (see Table 1., case 2.)

3.1.2 Transformational Topology

'Transformative topology' is an effect that affords modulations in topological cues resulting in a changed sense of place. With this capability, new approaches to topology can develop, unrestricted by physical or temporal proximity. Examples of **transformational topology** observed include the following functions:

1) **An environment takes on the experiential character of another disparate environment** (Fig.6.)—Visual media can simulate another environment. Monochrome lights, mist and reflected surfaces were used to visually alter tectonic elements and the spatial ambient. Here, multimedia transforms an interior environment to have the experiential ambient of an exterior space with the monochromatic glowing atmosphere produced by the sun in the late afternoon. (see Table 1., case 10.)

2) **A defined environment extends beyond a singular physical space to encompass a network of distributed spaces** (Fig.7.)—An environment can be expanded to encompass a series of spaces throughout the city. Here, multimedia can significantly extend a given topology beyond a singular physical space by connecting distributed spaces via digital communication links that inform people of the various locations and the urban passages between them. (see Table 1., case 3.)

3.1.3 Transformational Typology

The transformative influence of multimedia on tectonics and topos in an architectural context, in turn influences the perception of typos. (Tuan 1977, pp.101-117) 'Transformational typology' refers to an effect capable of modulations to the function of a space that change its purpose. With this transformative capability, new modes of spatial function can emerge with the flexibility to change as readily as their multimedia influences. Examples of **transformational typology** observed include the following functions:

1) **Typology modulates with little or no physical intervention** (Fig.9.)—Tectonic elements are transformed by dynamic video projections on the walls and floor. Ambient sounds accompany projections to create an immersive environment that transforms the perceived typology of the space. In this case, multimedia transforms a static space into a play environment. (see Table 1., case 25.)
3) Typology modulates with afforded interactions (Fig. 10.)—This interactive multimedia system uses projected visuals on a curtain of sprayed water. Dynamic, large scale visuals projected on the water change in response to sound input at microphones placed in front of the visuals. In this case, multimedia transforms an urban space into an interactive public art space. (see Table 1., case 16.)

3.2 Interaction

For any interactive medium, there is an interface that is a point of interaction between a person and a multimedia system. As technology has advanced, possibilities for interfaces have expanded, from a point of tangible interaction, where one pushes a button or pulls a lever as an input device, to spatial interactions, where, stimuli such as movements in a space can function as inputs to a system. (Hornecker, Burr 2006)

Within the context of this paper, ‘interaction’ refers to the observed ability of multimedia to provide responsive mechanisms that influence a physical environment.

3.2.1 Interactive Tectonics

It was observed that the interactive influence of multimedia affords tectonic elements the ability to sense, react and interact. This effect will be referred to as ‘interactive tectonics’. This effect allows people to interact with and influence tectonic elements in their surroundings. Examples of interactive tectonics observed include the following functions:

1) Tectonic elements function as input devices (Fig. 11.)—An interactive system of projected visualizations can simulate physical deformations in the form of a sculpture. This occurs in real time response to the presence of people on the structure. Here, multimedia visualizations allow people to influence the perceived physical form of tectonic elements. (see Table 1., case 24.)

2) Tectonic elements as interactive interfaces (Fig. 12.)—A floor surface is augmented by animated projections that transform the floor into an interactive field of daisies. As people move across the floor, projected images fade and reappear several seconds later. In this case, interactive multimedia allows people to influence the appearance of the ground plane. (see Table 1., case 22.)

3) Environmental stimuli trigger tectonic responses (Fig. 13.)—A vertical surface composed of a matrix of responsive mechanical elements that rotate in real-time response to video capture of people in front of the surface. Rotations expose darker or lighter surfaces to produce a dynamic visual composite that simulates a mirror image. In this example, interactive multimedia enables human movements to influence tectonic surfaces through interaction. (see Table 1., case 17.)

3.2.2 Interactive Topology

‘Interactive topology’ is an effect where environments can sense and react to stimuli. Human interaction with media in a spatial context introduces a new perspective on topology for architectural design. These functionalities enable human actions to directly influence the nature of the surrounding space and use interactivity as a form of spatial navigation. Examples of interactive topology observed include the following functions:

1) Sensitivity to external stimuli (Fig. 14.)—A grid of emergency beacon lights equipped with sensors, respond by rotating and shining light toward movements in their proximity. This real time interaction creates a dynamic environment where people become the focal point of the space. (see Table 1., case 9.)
2) Responsiveness to functional demands (Fig. 15.)—A non-occupiable space can react to the presence of a person with responsive steps sensitive to the pressure of human footsteps. With each step activated, a pathway begins to take shape. Here, multimedia changes a non-occupiable space into an occupiable pathway that responds to the presence of people. (see Table 1., case 20.)

3) Topos as a spatial interface (Fig. 16.)—An interactive space equipped with light sensors can be navigated by a flashlight. Activated sensors trigger multimedia simulations that animate the immediate space. These interactions afforded by multimedia enable a means of spatial discovery as different parts of the environment come to life when activated. (see Table 1., case 5.)

3.2.3 Interactive Typology
The interactive influence of multimedia enables spaces the ability to change purpose in response to stimuli. If it can be understood that the actions and interactions of people in a space have a strong influence on the perceived typology of a space, it is of evident value to address the influence of interactions between people and interactive elements on the function of a space. Examples of interactive typology observed include the following functions:

1) People can invoke a change in purpose for a space (Fig. 17.)—Tectonic elements enabled with haptic sensors respond to human touch and activate a local audio feed of news broadcasts from countries in the Northern Hemisphere. The space is augmented by multimedia to act as an audial information space for satellite feed of news broadcasts. (see Table 1., case 7.)

2) Dynamic mediation of spatial function in response to activity in a space (Fig. 18.)—An environment can alter its function in response to human movement. Cast shadows of people activate sensors that translate the position of their shadow on the wall to a radio station frequency. The size of the shadow controls the volume level of the audio output. These interactions enabled by multimedia augmented a space to function as an audial information space for radio broadcasts. (see Table 1., case 6.)

3.3 Temporality
Temporality can be defined as the state of existing within or having some relationship with time. The integration of multimedia into an architectural context requires designing in both space and time. (Jones 1992, xxxii) ‘The heart of one's sense of time is the sense of now’, states Kevin Lynch, who theorized the significance of time in influencing one’s sense of space. (Lynch 1976, p.65) Within the context of this paper, temporality refers to the observed ability of multimedia to afford nonlinear timelines for a space, wherein one’s sense of time is influenced and altered. 18 of the 25 cases were observed to have some form of temporal influence from multimedia. (see Table 1.)

3.3.1 Temporal Tectonics
The temporal influence of multimedia was observed to afford modulations in tectonic form and function in the context of time. This will be referred to as 'temporal tectonics'. The temporality of multimedia was observed to enable flexibility in both spatial programming and the perceived temporal nature of tectonic elements. Examples of temporal tectonics observed include the following functions:

1) Temporary shifts in the form and function of tectonic elements (Fig. 19.)—Projections on the walls and floors of a space visually transform it into a forest scene that responds to human gestures. When the multimedia is disabled, the tectonic elements return to their original state. Multimedia temporarily transforms the tectonic elements to take on augmented functionalities and visual form. (see Table 1., case 25.)

2) Real time modulations of tectonic elements (Fig. 20.)—Lighting elements mounted to the ceiling sense human movement and rotate in real-time response
to activity in the space. The resultant configuration of the rotated elements visually communicates pathways connecting people in the space. In this case, multimedia affords tectonic elements the real time alteration of their configuration in direct juxtaposition to the long-term temporal nature of conventional architectural tectonics. (see Table 1., case 12.)

3.3.2 Temporal Topology

The term 'temporal topology' refers to the observed ability of multimedia to modulate the sense of timeline for a given typology. This could enable a new layer of functionality that uses time as a tool for creating a sense of space, or allows for new modes of programmatic function that are time dependent. Examples of temporal topology observed include the following functions:

1) Temporary alteration of perceived physical state of a topos (Fig.21.)—Motion sensors can detect the movement patterns of people. When a person pauses, recorded video footage of another person in the community is projected in their cast shadow. When the person walks away, the projection fades. Multimedia is observed to temporarily alter the plaza ground plane to a landscape of potential video encounters. (see Table 1., case 14.)

2) Time frames from different topos can be transposed (Fig.22.)—Interactive simulations of the past state of an old blast furnace hall are activated temporarily and then returned to the dimly lit ambient of the present state of the space. Multimedia is able to juxtapose the environmental ambient of the two time periods in one space. (see Table 1., case 5.)

3) Temporal cues trigger a change in topos (Fig.23.)—A large grouping of mono-frequency lights simulating an afternoon sun are accompanied with mist and reflective surfaces that together simulate a change in temporal ambient. The mono frequency lights alter the appearance of tectonic elements and the spatial ambient to always feel like an exterior space in the late afternoon. Here multimedia augments an interior hall to simulate an exterior park space at a specific time reference. (see Table 1., case 10.)

3.3.3 Temporal Typology

The temporal influence of multimedia was observed to have the ability to modulate the sensed timeline for a given typology. This will be referred to as 'temporal typology'. These can be dramatic changes that immerse people in the spatial function of the moment, to more subtle references to time that augment a functional aspect of the space. Examples of temporal typology observed include the following functions:

1) Temporary shift in spatial function (Fig.24.)—An urban street space is augmented by multimedia. Museum reproductions were temporarily hung throughout street spaces in London with audio accompaniment available via cell phone. Here, multimedia temporarily transforms each of the otherwise nondescript public spaces in the city into public exhibit spaces for art. (see Table 1., case 3.)

2) Modulating the function of a space in real time response to external stimuli (Fig.25.)—Drawing gestures of participants are translated in real time into light projections that simulate spray can graffiti on a building facade. The scale of the dynamic visuals and the activity of people interacting with the multimedia, temporarily transform the adjacent urban space into an interactive space for artistic expression. (see Table 1., case 15.)
4. Conclusions

This paper sought to identify key forms of influence multimedia has in an architectural context and the architectonic functions afforded by those influences. From an investigation and analysis of 25 works of installation art and interactive spaces the following conclusions were reached.

Multimedia has the ability to influence the *topos*, *typos* and *tectonics* of an architectural context. Based on analyses of the resultant effects of these influences, *transformation*, *interaction* and *temporality* emerged as three key forms of influence multimedia is capable of in an architectural context.

When these influences were analyzed in relation to Kenneth Frampton's three vectors (tectonics, topos and typos) a matrix of nine modes of architectural function afforded by the *transformative*, *interactive* and *temporal* influences of multimedia was established. This matrix serves as a theoretical basis for understanding the manner in which multimedia influences the different aspects of an architectural context. Observations that informed this matrix indicate that multimedia has the ability to augment the experience of a physical space and afford innovative modes of architectonic function that invite broadened conceptions of architectural space.

The conclusions indicate the potential of multimedia as a legitimate architectural medium worthy of further investigation. Findings from this paper are intended to serve as a basis for developing a design method for integrating multimedia into the architectural design process. The increasing ubiquity and range of capabilities of multimedia technology signify an opportune time to pro-actively address the integration of multimedia into architectural spaces and invite the multidisciplinary collaborations necessary to make this possible.

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