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Implementation of Fluid Architecture and Topographical Integration: A Case Study of the City of Culture of Galicia

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ABSTRACT

This study examines the implementation of Fluid Architecture principles in contemporary architecture, focusing on The City of Culture of Galicia in Santiago de Compostela, Spain, designed by Eisenman Architects. The shift from rigid geometric forms toward dynamic and context-responsive architecture highlights the relevance of fluid design approaches in contemporary practice. This research aims to analyze how fluid architectural principles are applied through the integration of form, geometry, and topography in a large-scale cultural complex. The study employs a qualitative descriptive method using a case study approach. Data were collected through a literature review of fluid architecture theories and visual observations of architectural documentation, including drawings, photographs, and diagrams. Data analysis followed an interactive model consisting of data reduction, data display, and conclusion drawing. The analytical framework is based on three main principles of fluid architecture: flowing design, integrated geometry, and non-rigid design. The findings reveal that fluidity in The City of Culture of Galicia is achieved through a strong topological response to the site's contours. Flowing design is expressed through undulating roof forms that follow the natural topography. Integrated geometry results from the superimposition of square and trapezoidal grids onto the terrain. Non-rigid design is manifested in continuous roof and façade surfaces that avoid rigid Euclidean forms. Overall, the study demonstrates that fluid architecture can emerge from the synthesis of geometry, landscape, and contextual design strategies.

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1. INTRODUCTION

The development of contemporary architecture has demonstrated a significant shift from conventional geometric forms toward more dynamic, fluid, and adaptive spatial expressions. This transformation is closely associated with advancements in digital technology as well as the growing awareness of the importance of the relationship between buildings, their context, site conditions, and spatial experience (Gheisari & Iordanova, 2020; Schumacher, 2011). One design approach that has become increasingly prominent within this trend is fluid architecture, which emphasizes formal continuity, geometric flexibility, and flowing spatial relationships without rigid boundaries (Asadi & Greiza, 2021; Negm & Abdel, 2021).

The concept of fluid architecture is grounded in the understanding that architecture should not be perceived merely as a static object but rather as a system that responds to physical, social, and cultural contexts. From this perspective, fluidity refers to the capacity of architectural form to transform, adapt, and integrate with its environment both visually and conceptually (Yilmaz & Cikis, 2020). This principle corresponds with (Schumacher, 2011) proposition of parametricism as a new architectural paradigm, in which spatial continuity and differentiation function as the primary elements shaping architectural experience.

Previous studies examining the application of fluid architecture across various building typologies, including shopping centers and museums, indicate that fluid design principles are capable of enhancing spatial experience, visitor orientation, and the visual identity of buildings (Anggrayni & Ashadi, 2025; Fauzi & Herindiyati, 2022; Syah & Taufik, 2021). In shopping centers, fluidity is commonly manifested through dynamic façades, non-linear circulation patterns, and fluid transitional spaces that accommodate complex user activities (Primadani & Nurhasan, 2020). Furthermore, similar design approaches can be observed in iconic contemporary buildings that emphasize organic forms as representations of movement and spatial continuity (Yilmaz & Cikis, 2020).

The application of fluid architecture is inseparable from the role of parametric design and digital technologies. Parametric design enables architects to translate abstract concepts such as flow, deformation, and continuity into complex geometries that are mathematically controlled and systematically generated (Barge, 2021; Gheisari & Iordanova, 2020). Through this approach, as articulated in the BFM concept, the relationship between form, function, and meaning can be synthesized in a more adaptive and contextual manner (Ashadi, 2019, 2021).

In addition to issues of form and technology, the integration of buildings with site conditions, particularly topography, constitutes a critical concern in fluid architecture. An understanding of landscape characteristics and land contours allows architectural forms to develop as integral components of the environmental system rather than as isolated objects (Ching, 2014). This approach is consistent with the principles of fluid architecture, which reject rigid boundaries between buildings and nature while encouraging the creation of continuous and contextually responsive spatial relationships (Negm & Abdel, 2021). Moreover, the principles of fluid mechanics as a scientific metaphor further enrich the interpretation of fluid architecture as a system that moves, flows, and adapts to its surroundings (Yendri, 2023).

One architectural work that exemplifies the synthesis of fluid architectural principles and topographical integration is The City of Culture of Galicia designed by Eisenman Architects. This cultural complex was conceived through a massing strategy that follows the natural contours of the site in Santiago de Compostela, thereby generating architectural forms that appear to emerge organically from the landscape. Although this project has frequently been examined from the perspectives of deconstructivism and formal experimentation, studies that specifically address the application of fluid architectural principles in relation to topographical integration remain relatively limited (Eisenman Architects, 2011).

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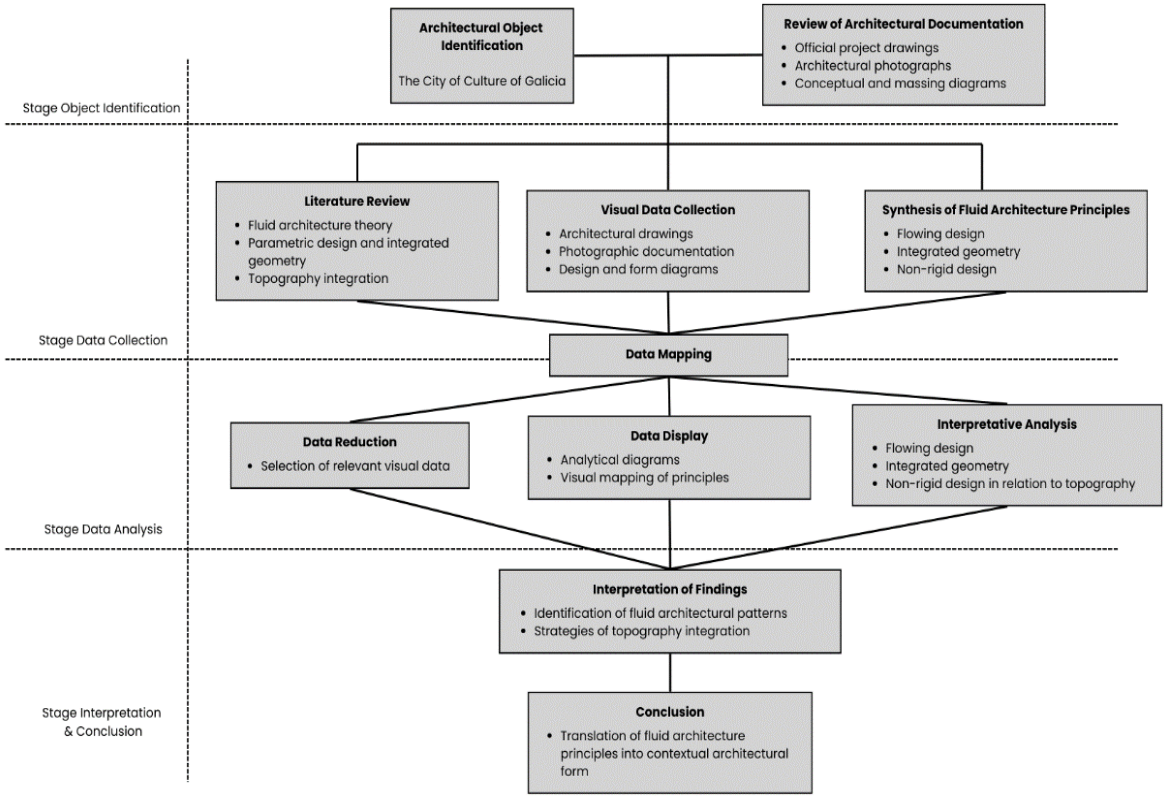
Based on this discussion, a research gap exists in understanding how the principles of fluid architecture are applied in a concrete and contextual manner within large-scale architectural projects situated on complex sites. Therefore, this study aims to identify and analyze the implementation of three primary principles of fluid architecture, namely flowing design, integrated geometry, and non-rigid design, as applied in The City of Culture of Galicia. Through a descriptive qualitative approach (Murdiyanto, 2020; Sugiyono, 2022), this research is expected to provide a more comprehensive understanding of how the abstract concept of fluidity is translated into architectural reality that is integrated with topography and environmental context.

2. RESEARCH METHODS

This study adopts a qualitative method with a descriptive approach, as it allows for an in-depth and interpretative exploration of architectural design phenomena, emphasizing the understanding of meaning and context beyond purely statistical measurement.



Picture 1 Research Method Diagram
Source: Author, 2025

Data collection was conducted through a literature review of fluid architecture theories and visual observation of the architectural documentation of the case study object. The collected data consisted of architectural drawings, photographs, and conceptual diagrams of the building.

Data analysis techniques followed the interactive model proposed by (Miles et al., 2014), which consists of data reduction, data display, and conclusion drawing. Visual data from The City of Culture of Galicia were analyzed based on indicators of fluid architecture principles synthesized from the theories proposed by Nath (2015), (Barge, 2021), and (Negm & Abdel, 2021). These indicators include flowing design, integrated geometry, and non-rigid design.

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3. FINDINGS AND DISCUSSION

3.1 Case Study Description: The City of Culture of Galicia

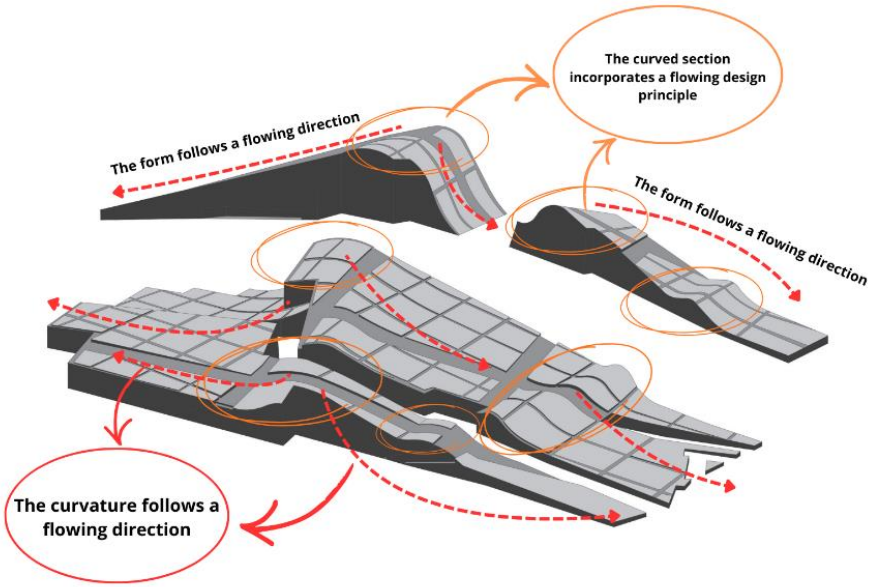
The City of Culture of Galicia (Cidade da Cultura de Galicia) is a cultural complex located on Monte Gaiás, in Santiago de Compostela, Spain. Designed by Eisenman Architects and completed in 2011, the project encompasses a total built area of approximately 82,800 square meters on a site covering 135 hectares. The complex consists of six primary building volumes, namely the Galicia Museum, the International Art Center, the Library, the Galicia Archive, the Music Theater, and the Cultural Innovation Center. These volumes are interconnected through a network of pedestrian pathways and open plazas that structure the overall spatial organization of the site.

Conceptually, the complex adopts a distinctive approach of organic deconstructivism. The massing configuration is generated through a digital superimposition process between the medieval street map of the historic city of Santiago de Compostela and the natural topography of Monte Gaiás. This process results in architectural forms that resemble a costra pétrea, or stone crust, evoking the imagery of an archaeological site fragmented by natural incisions. Consequently, the design establishes a fluid spatial and formal relationship between human-made architecture and the surrounding natural landscape.

3.2 Analysis of the Flowing Design Principle

The principle of flowing design in this building is not merely interpreted as the application of curved lines, but rather as a topological response to the site context. Based on visual analysis, the roofscape is designed in a wave-like configuration that mimics the natural topography of Galicia, reaching variable heights of up to 30 meters.

The building mass does not stand as an autonomous object separated from the ground. Instead, it is conceived as emerging directly from the contours of the hill itself. The analysis indicates that the curved lines of the roof and façades generate a seamless visual continuity across the six building volumes. This continuity creates an illusion of continuous movement, in which the boundary between the natural landscape and the architectural structure becomes increasingly blurred. Within the framework of fluid architecture, this approach reinforces the notion that the building forms an integral part of the landscape's energy flow, rather than functioning as a static object placed upon it within The City of Culture of Galicia.



Picture 2 Analysis of Flowing Design in the Roof Form That Follows the Topographic Contours (Source: Author, 2025)

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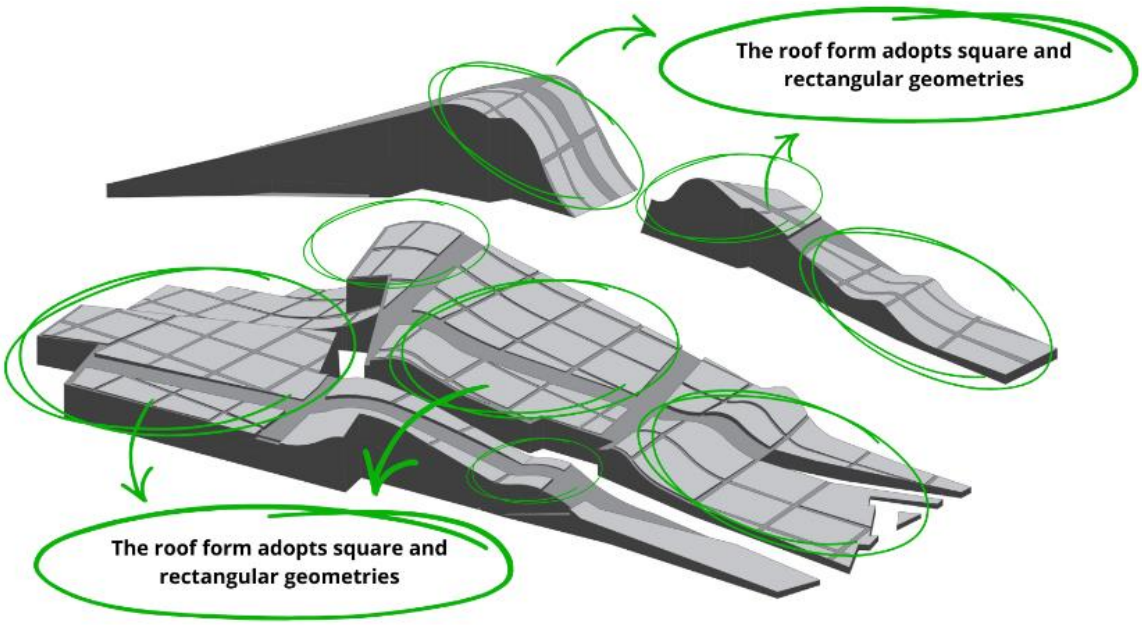
As illustrated in Picture 2, the continuous curved lines, indicated by red dashed lines, form a building composition that appears to flow seamlessly from the ground. The building masses and roof profiles are characterized by continuous geometries without contrasting or abrupt formal transitions. This continuity generates the impression that the architecture functions as an integrated, constructed landscape element rather than as an external object placed upon the site. Within the context of The City of Culture of Galicia, such an approach reinforces the notion of architectural form as an extension of the terrain itself.

3.3 Analysis of the Integrated Geometry Principle

One of the key characteristics of fluid architecture lies in the harmonious integration of multiple geometric forms. This building does not rely solely on free-form shapes, but instead combines distorted Cartesian geometries as part of its formal composition.

Based on the analysis of floor plans and massing configurations, the design reveals the use of square, rectangular, and trapezoidal geometries that have undergone deformation in response to the curvature of the site. This geometric integration allows rigid, orthogonal forms to be transformed into fluid spatial configurations while maintaining structural coherence and formal continuity within The City of Culture of Galicia.



Picture 3 Integrated Geometry Analysis Showing the Combination of Square and Trapezoidal Geometries in The Roof Pattern and Floor Plan
(Source: Author, 2025)

As shown in Picture 3, square and trapezoidal geometric elements, indicated by green and blue circles, are applied within the roof pattern and spatial layout. These geometries are integrated with the curvilinear lines of the building mass, thereby forming a unified and coherent formal system. Eisenman employs a superimposition technique in which the street grid of the historic city is effectively imprinted onto the undulating topography of the hill. As a result, the originally rigid grid geometry becomes distorted and curved in accordance with the terrain, generating a contemporary yet harmonious architectural expression.

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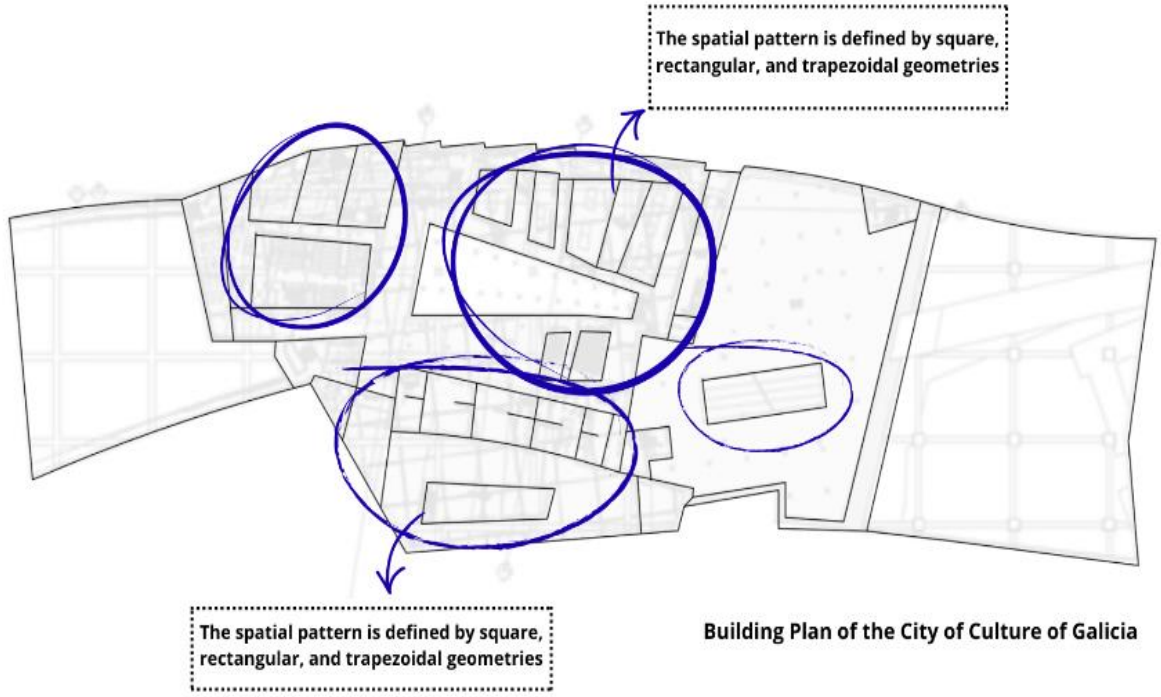
In contrast to other fluid architectural works that predominantly adopt purely biomorphic forms, The City of Culture of Galicia exhibits a distinctive character through the integration of distorted Cartesian geometries. An analysis of the floor plans and roof configurations reveals the consistent use of basic geometric forms, including squares, rectangles, and trapezoids, which are deformed to follow the curvature of the site. Through the superimposition process, these geometric elements do not function independently, but rather interact to form an integrated structural and spatial system.

Furthermore, the building façades, which employ locally sourced Galician granite, are articulated in accordance with these curved geometries. This treatment produces a surface texture that appears smooth and continuous while simultaneously retaining a clear sense of geometric definition. Consequently, the project demonstrates how rigid geometric systems can be transformed into fluid architectural expressions through contextual adaptation and topographical integration.



Picture 4 Integrated Building Geometry of the City of Culture of Galicia
(Source: Author, 2025)

3.4 Analysis of Non-Rigid Design in Fluid Architecture

The principle of non-rigid design emphasizes flexibility, organic form, and the avoidance of sharp angles or static, box-like configurations. This principle is clearly manifested in the roof and façade elements of The City of Culture of Galicia. Rather than employing flat and vertically rigid surfaces, the building façades are articulated through inclined and curvilinear planes that follow the continuous flow of the roof geometry.

This design approach reinforces spatial fluidity and visual continuity, allowing the architectural envelope to respond dynamically to both the massing strategy and the underlying topography. As a result, the building envelope functions not as a rigid boundary,

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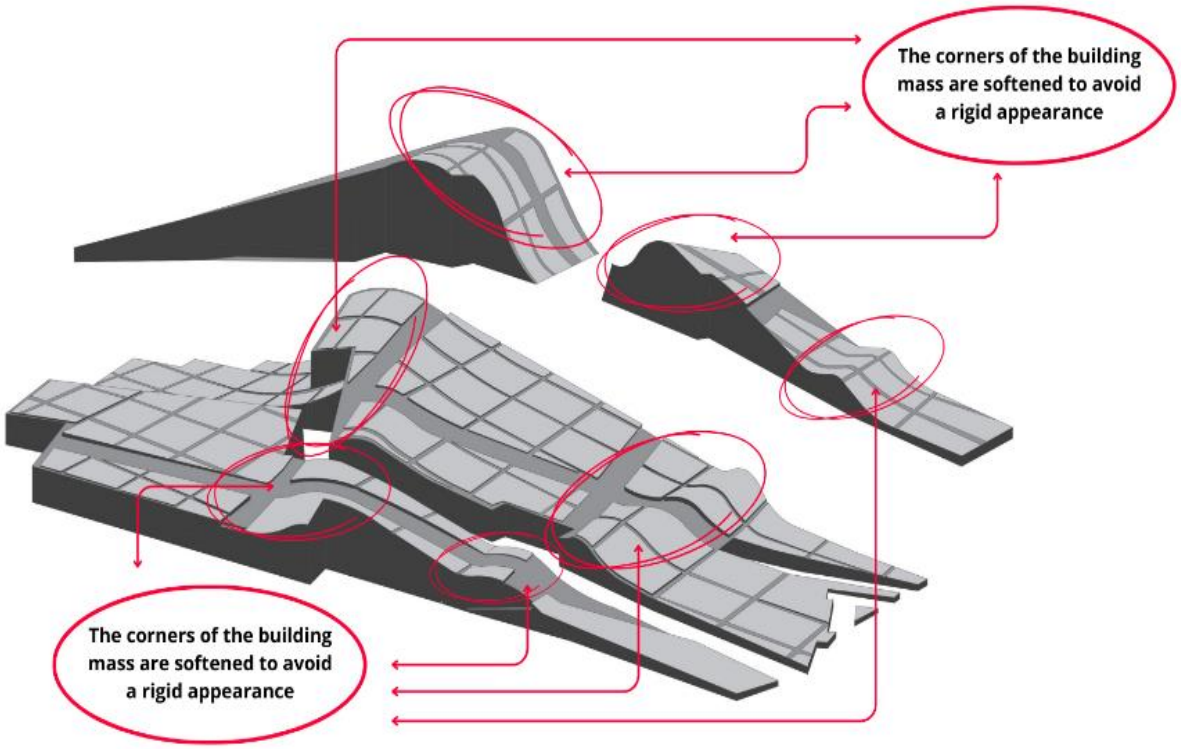
but as an adaptive surface that mediates between interior space and the surrounding landscape.



Picture 5 Application of Non-Linear Forms in The Roof and Building Mass to Avoid Rigidity
(Source: Author, 2025)

The analysis presented in Figure 5 indicates that the corners of the building masses are articulated through curved treatments, as highlighted by the red circles, thereby avoiding rigid right-angle intersections. The undulating roof that extends along the edges of the building masses generates a dynamic impression and conveys a sense of movement across the overall composition.

Nevertheless, it is important to note that at the level of interior spatial layout, the building retains several orthogonal angles as a consequence of the historical map superimposition concept. However, from a volumetric and exterior perspective, the architecture consistently expresses a fluid character. This condition demonstrates how non-rigid design principles can coexist with underlying geometric constraints while still achieving a coherent fluid architectural expression within The City of Culture of Galicia.

3.5 Summary of Fluid Architecture Principle Implementation

Based on the preceding analysis, the implementation of fluid architecture principles in the case study can be summarized in the following table.

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Table 1. Matrix of Fluid Architecture Principal Implementation in The City of Culture of Galicia

Implementation on Building Elements	Architectural Findings
An undulating roof manipulated to follow the topographical contours of Monte Gaiás Hill.	The building does not function as a detached object, but rather as a constructed landscape or landform architecture that integrates with its natural surroundings.
Superimposition of the historic street grid of Santiago, composed of square and trapezoidal geometries, which is distorted to follow the terrain surface.	This process generates a harmonious hybrid form that reconciles rigid historical geometry with the organic curvature of the topography.
The use of continuous and inclined roof and façade surfaces that avoid static, box-like forms.	This approach creates a dynamic sense of movement on the exterior, even though traces of orthogonal angles remain within the interior spatial layout.

Source: Author's Analysis, 2025

4. CONCLUSION

This study concludes that The City of Culture of Galicia represents a comprehensive application of fluid architecture principles through a contextual topographical and deconstructivist approach. The project does not merely exhibit free-form expression, but rather integrates architectural design holistically with site conditions, landscape, and the underlying geometric system.

The research findings indicate that the principle of flowing design is manifested through massing composition and undulating roof forms that follow the natural contours of Monte Gaiás Hill, thereby enabling the building to function as a landform architecture that is visually and conceptually integrated with the surrounding landscape. The principle of integrated geometry is implemented through a superimposition technique that combines basic geometric forms, including squares, rectangles, and trapezoids, with topographical curvature, resulting in hybrid configurations that reconcile geometric rigor with fluid spatial continuity. Meanwhile, the principle of non-rigid design is expressed through the articulation of non-linear roof and façade elements that avoid sharp angles, thereby generating a dynamic, continuous, and adaptive architectural expression.

This study affirms that fluid architecture should not be interpreted solely as a biomorphic or free-form approach, but can instead emerge from a conceptual dialogue between historical geometry, topographical conditions, and digital design technologies. Such an approach expands the potential of contemporary architectural design by fostering solutions that are not only visually expressive, but also deeply contextual and site-responsive.

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Based on these findings, this research recommends that fluid architecture principles be applied in a more critical and contextual manner in the design of large-scale architectural projects, particularly on sites characterized by complex topographical conditions. Furthermore, future research is encouraged to explore the relationship between the application of fluid architecture and the quality of interior spatial experience, as well as the functional performance of buildings, in order to enrich the understanding of the practical implications of this concept within architectural practice.

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