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REPRESENTATION OF THE SURFACE IN ARCHITECTURE: FROM THE WESTERN SOLUTIONS TO THE EASTERN CASE STUDIES OF SOLID DEVELOPMENT

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Abstract

Architecture is usually represented in two dimensions through codified representation methods, such as plan, elevation, and section. An elevation and its represented façade refer solely to the framed side of the building, preventing an overall understanding of it if decontextualized from the other elevations. To cope with this problem, various architects have developed methods of representation that would allow a total development of the architecture's exterior (or interior) surface to be depicted. The focus is on drawings that, with different assumptions and references, succeeded in the same intent: a total representation, developed in the plan, of all the interior or exterior façades of a given architecture. The Western examples resulting from Robin Evans' studies, which he called *Developed Surface*, introduce us to a kind of representation that would later be employed, with similar or lesser intentions, by numerous Japanese architects of the 1970s and 1980s. Each architect depicted architecture's interior or exterior surface for different reasons, but the starting reference was often a traditional Japanese paper model called *Okoshi-ezu*.
The paper aims to expand the knowledge of the *Developed Surface* drawings through the analysis of case studies of geometrical applications and by investigating the implications of a type of representation that allows for a novel perspective on the façades that make up architecture.

Keywords

Surface, Solid development, Façade, *Okoshi-ezu*, Continuity.

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1. INTRODUCTION

Architectural drawings cannot give an overall picture of a project, as they are tied to the architect's choice. Some aspects manifest themselves more clearly than others that are inevitably suppressed. Therefore, it is interesting to analyze how various movements, both Western and Eastern, wanted to represent as much information as possible in relation to the architectural surface in a single drawing, trying to generate a total image of it.

Examples of this tendency are some mid-eighteenth-century drawings developed in Europe, which began to adapt existing techniques of the orthogonal projections by Gaspard Monge. The objective was to achieve a new way of representing residential architecture, giving greater emphasis to the interior. Architect Robin Evans analyzes this particular drawing technique. He defines it as a "revealed interior surface", finding strong interactions between the visual and social spheres. In his essay *The Developed Surface: An Enquiry into the Brief Life and Death of an Eighteenth-Century Drawing Technique* [1] Evans identifies

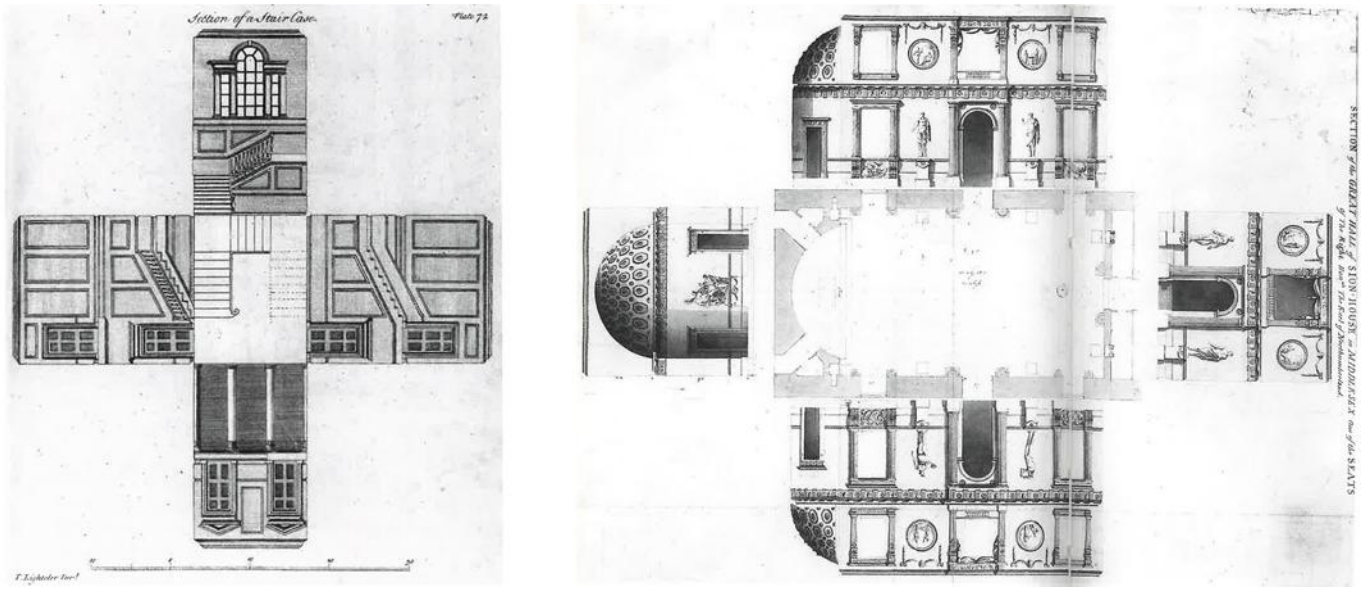

Fig. 1. *Graphic elaboration combining two images from [1]. Left: Thomas Lightoler, section of a stair hall from The Modern Builder's Assistant, 1757. Right: Robert Adam, section of the Great Hall at Syon House, 1761. Despite being more modern than Lightholer's, Adam's drawing employs a drawing grammar that is extremely Beaux-Arts: the elevations are not hinged to the plan. In Lightholer's drawing, the elevations are directly hinged to the plan, and we could almost build a tiny model out of it.*

several variants within this typology, citing some examples such as the case of Thomas Lightoler: in his drawing of the staircase hallway, published in "The Modern Builder's Assistant", it is possible to perceive the idea of four faces that seem to have been folded from their vertical position with the purpose of manifesting in a single image the inner surface of the architecture (Fig. 1, left). This technique emphasized the inner room as the sole object of the scene, with a heightened focus on the entire surface, clearly expressing each of the interior faces. Evans also refers to the Adam brothers, who produced many drawings in which the developed interior surface expressed their domestic architectural designs (Fig. 1, right).

Analysis of these examples shows that it is no accident that this technique was used to represent a specific type of architecture in the last decades of the 18th century. Indeed, the interior design of the developed surface was perfectly suited to these villas, characterized by a sequence of rooms that were intimately related to each other, seeking to differentiate themselves through tangible aspects such as decoration. This drawing technique made it possible to accentuate the differences by representing each room almost autonomously while at the same time blurring the connection between the interior and its surroundings.

In this sense, Evans understands drawing as a medium that interacts with what it represents, carrying and distributing information in a certain way that is not neutral. For this reason, this technique had little relevance in the Western world, as its rigidity did not allow it to represent how architecture evolved. Its limitations were to interrupt the continuity of space by making cuts between adjacent walls so that they remained flat.

However, a similar type of representation called *okoshi-ezu* had been previously developed in Japan, different from the Western case in the fact that it manifested itself in a paper model. This method is said to have originated in the Edo Period, mainly for the construction of a house for the tea ceremony (*Chashitsu* 茶室). The Japanese nobility found in the tea ceremony masters a way of conceiving architecture beyond modularity. At the height of the Edo period, the so-called *Sukiya* style came forward, a way of conceiving space and architecture strongly indebted to the tea room, marked by rustic simplicity and honesty of materials. Buildings ascribable to the *Sukiya* style are thus composed of particularly controlled spaces to take the user on a real journey of awakening the senses through specific heights, materials, and lighting.

It was necessary to develop a type of representation that would better enable the design of the details needed by this kind of architecture. Thus *okoshi-ezu*, or *tate-ezu*,

were born [2]. These are drawings that today we would call *paper models*, where parts carefully glued onto the plan, once folded, went to shape an accurate three-dimensional model of the building. Details and annotations useful for construction were then drawn on these folding walls, as well as the arrangement of stones in the plan and whatever else needed to appear within the finished design. In addition, creating an enclosed space also allowed for an understanding of the entry of light and the general appearance of the finished object [3, 4].

However, such a design control tool still leaves some doubt about its actual use. Andrew Barrie says there is still no certainty that *okoshi-ezu* was only used in the preliminary stages of the project [5]. There is also the possibility that such drawings were made only upon completion, almost for the owners' amusement. In fact, several *okoshi-ezu* depict famous buildings, suitable for recording them in detail. Although a Western counterpart can be identified in the paper model of the late 1700s (such as the playful *Images d'Épinal*), the *okoshi-ezu* embodies in so many ways the Japanese way of conceiving space, making it inextricably linked to the land of the Rising Sun.

2. AIMS OF THE RESEARCH AND METHODS

This research aims to broaden the topic of architectural representations that employ the *Developed Surface* solution. This technique is a niche in the field of architectural drawing, addressed in a very comprehensive way by Robin Evans, especially relating to a specific historical period. Recently, Anna Katrine Hougaard [6] has taken Evans' theories as a starting point by extending them through application experiments that see surface development as a generative tool.

Within the scope of this research, there is room for practical application, but the primary goal is to pick up the threads of Evans' discourse in the hope of adding case studies to the theories already enunciated. Specifically, the references considered in this paper have a particular location: Japan. While Evans dwelt on purely Western suggestions, we have seen that, in Japan, there is a different starting point. The *okoshi-ezu* can lead us to different representations and results ascribable to the theme recounted by Evans.

The research thus starts from Western references and then moves to Eastern case studies in order to investigate their similarities and contrasts. The ultimate goal is to define the strengths and weaknesses of an unconventional type of representation.

It is useful to specify that, within this research, the term *surface* is never used to describe the material connotations that a façade might have. The concept of *surface* is seen from a *Kandiskian* perspective, or rather within the framework of descriptive geometry, thus a geometric form without thickness having only two dimensions. Either way, it is a surface that is allowed to move in three-dimensional space through rotational hinge movements, with the possibility of developing an eventual architectural solid.

3. CASE STUDIES

As the introduction shows, the *okoshi-ezu* is a type of representation in which flat development is only one of its two conformations. The main goal was to obtain a three-dimensional paper model. The production of *okoshi-ezu* was limited to the Edo period only, reaching modern times as a curious object of the tradition. Although we speak of a niche of tradition-related objects, they have returned to center stage among postwar Japanese architects. Intending to preserve and popularize traditions in response to an increasing Westernization of the country, some architects have recovered this type of representation by actualizing it.

Among the first to devote attention to *okoshi-ezu*, and thus to a representation involving a flat development of the façade, we have Sutemi Horiguchi. Horiguchi can be regarded as one of the first modern architects. He was one of the founders of the group of Japanese secessionists known as *Bunri Ha Kenchiku Kai*, and over the years, he took up the forms of Western architecture in an extremely modern way [7]. He was also an architectural historian and designed much in the *Sukiya* style. His interest in this particular style led him, in the latter part of his career, to produce a 12-volume series known as the *Tea Ceremony Illustrated Collection* (茶室おこし絵図集), published from 1963 to 1967 by Bokusui Shobo (Fig. 2). Stored inside hardback boxes were *okoshi-ezu* repro-

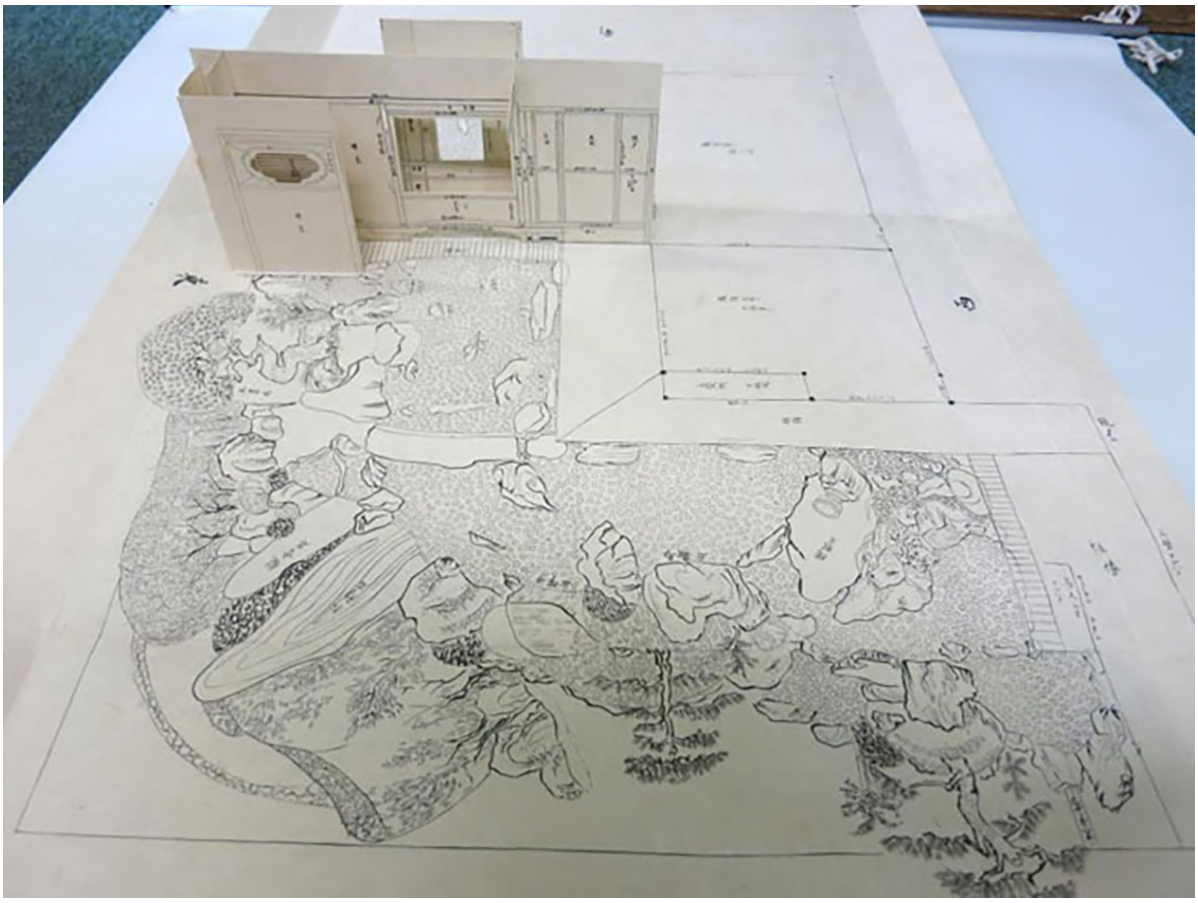

Fig. 2. *One of the okoshi-ezu by Sutemi Horiguchi developed and built. Source: retrieved from https://www.bunsei.co.jp/old-book/ctg-08/japanese-tea-room/. Accessed on January 20, 2023 [8].*

ductions of famous Japanese tea rooms (the *Chashitsu* mentioned above). Through a representation of the past, Horiguchi brought attention back to the perfect spatial control of tea rooms.

After him, Arata Isozaki also gave space to *okoshi-ezu* within an exhibition that made him mainly well-known internationally: *MA - Space-time in Japan*, first mounted at the Festival D'Automne in Paris in 1978 [7]. Within the exhibition, Isozaki sought to clarify to Western visitors how Japanese *space-time* induces active participation in the viewer. Among the elements of traditional architecture, such as the *himorogi* (a holy place for the summoning of the Shintoist Kami) or the *kaiyu-shiki* (the strolling through the garden, named *teien*), he introduced the *okoshi-ezu* as well. He dedicates an entire drawing to it, which employs a six-part division (to recall a *byōbu*, the folding wind wall) characteristics of the other works in the exhibition. He framed the paper model in its plan conformation, thus open with all the inner sides flipped flat (Fig. 3).

Within the text, Isozaki explains how the three-dimensionality of the "Tea House" emerges from the combination of flat elements placed in relation to each other and not from a Western-style volumetric spatial conception. He also uses a dashed line, Monge-derived, to represent the connection of the different parts. The rhythmic division of the vertical lines often gives space to those leading to the explanatory texts.

The two architects used *okoshi-ezu* as a means of popularizing Japanese tradition in order to preserve it. The case studies presented in this paper recover instead the solutions of surface development from a modern perspective to represent new projects. Each of the three case studies starts from the aforementioned references and then approaches the representation of the surface in a different way.

The first case study sees the focus placed on the exterior surface of the architecture. The façade is the focus of Minoru Takeyama, known in the West primarily for being one of the forefathers of Japanese post-modern-

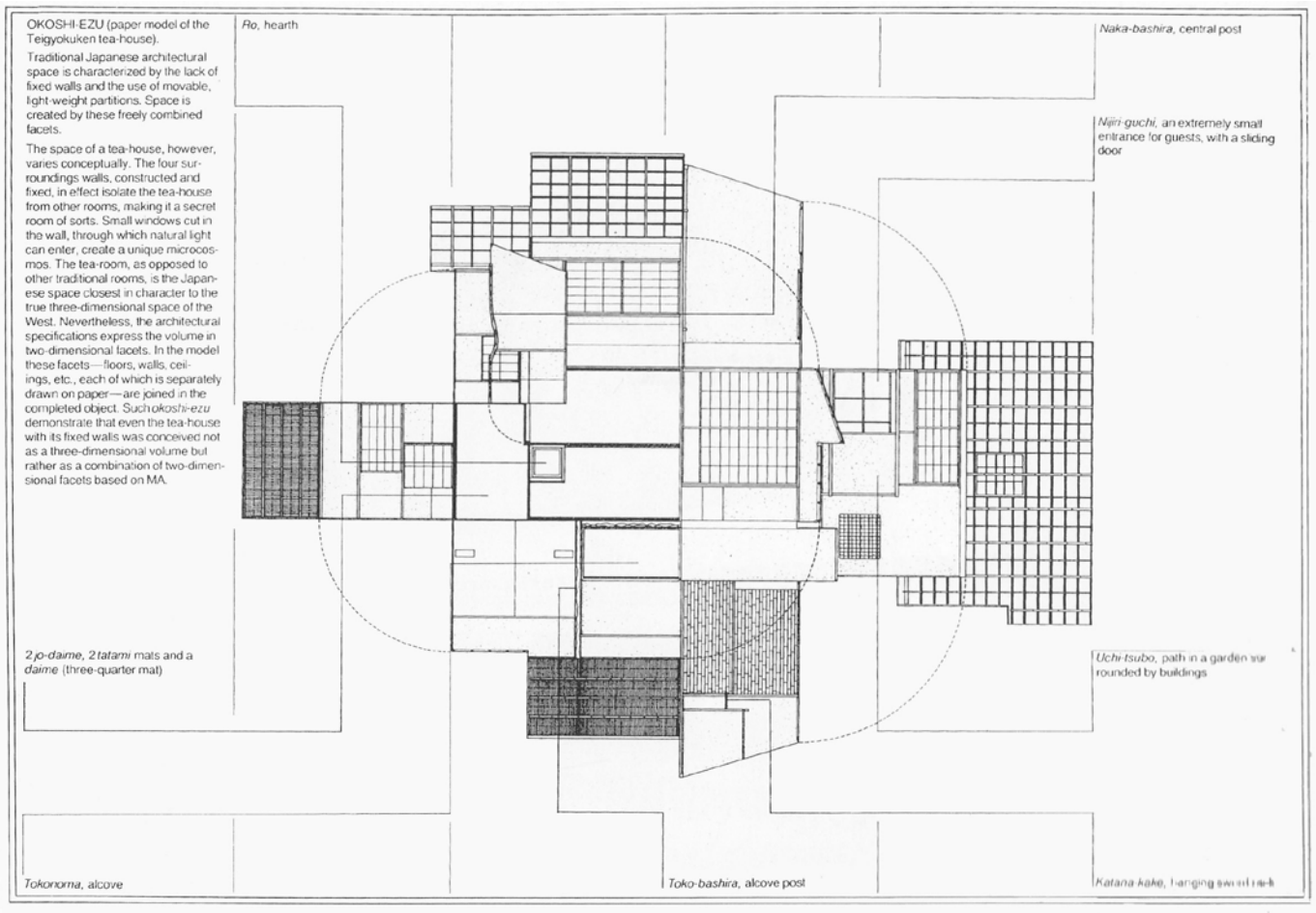

Fig. 3. *Arata Isozaki, Okoshi-Ezu of the Teigyokuken Tea House from the Exhibition MA - Space-time in Japan, 1978. Source: [7].*

ism. Takeyama's path passes through Waseda University, Harvard, Jean Lluis Sert, and Arne Jacobsen. In '64, he founded Minoru Takeyama Architectural Research Institute, and as early as '68 came the first major project that would bring him immediate success [10]. We are talking about the buildings *Ichiban-kan* and *Niban-kan*, which arose within a short distance of each other in Kabuki-cho, the entertainment area of Shinjuku, Tokyo. The two buildings, also known as *BOS* and *BOS-2,* stood towering among the existing buildings in the area, which were still small at the time. In fact, until 1963, it was forbidden in Japan to construct buildings higher than 31 meters in height; only with the introduction of the *Yousekiritsu* (floor area ratio), which allowed greater height based on the area in which the building stood, was the construction of skyscrapers and large-scale buildings allowed. From that moment on, skyscrapers began to crowd the Japanese capital, starting with the 1964 Olympics. However, the *Ichi* (one) and *Ni* (two) scale was not the most prominent feature. What immediately made them iconic buildings was the curious volumetry that shaped them, and especially the cladding applied to them. Geometric motifs and colors covered the faces of solids that looked like the fruit of a child's wooden constructions. Pure extruded volumes, without any kind of functional reference, housed motifs on their faces that could be traced back to Victor Vasarely's Op-art. Inside were playrooms and clubs for adults.

Charles Jencks put the *Niban-kan* on the cover of his famous 1977 book *Post-Modern Architecture*, published almost ten years after the two buildings were completed. The *Ichi* and *Ni* had already foreshadowed the schizophrenia and incoherence of Tokyo while representing some characteristics of *Po-Mo* through their pure forms. What is interesting, however, is how Takeyama represented these buildings. Of course, photographs abound, but some drawings exemplify what *Ichi* and *Ni* (especially) represent. To understand why it is necessary to

talk briefly about the architect's theories during those years. While much of Takeyama's career is based on opposition to the ideas of the Metabolist group, it is undeniable that the latter irretrievably influenced many of the architects who witnessed their establishment, at least with respect to the association between architecture and biological processes. Takeyama, who speaks of architecture as a *unicellular organism* in one of his texts, is no exception. His goal is to break away from the concept of metabolism-driven growth in favor of independent and autonomous architectures. To do so, however, he relies on a comparison related to biology, in which he states: «[…] a single cell is encapsulated in a membrane with functions as a sort of a communication link between the inside life and the external stimuli. To me, the membrane was more meaningful than the inside core. […] the surface came to be independent in its expressive role and even lost its primary function as a mediating element» [10].

Therefore, Takeyama is not concerned with the internal function of the building; his is a *façade architecture*. He focuses on the membrane that relates the building to its context, allowing it to influence and live independently. Hence, it is no accident that he comes to produce drawings that are nothing more than the flat development of the different façades of the *Niban-kan* (Fig. 4). One might immediately think of *okoshi-ezu*, but probably the most apt comparison (as Takeyama's later career will show) is with *origami*. So, a playful valence, where the different façades can be folded in a way that reconstructs the membrane of the building.

A membrane that Takeyama imagines from the beginning as a mutable object, ready to change to relate to the frenetic Kabuki-cho. To make it so, he relies on Kiyoshi Awazu, a very famous graphic designer who was responsible for the book *Metabolism 1960* and later *Kisho Kurokawa Selected Works* [11]. Awazu then designs brightly colored façades, the same ones he used in his posters in those years. At first, the building is repainted every five years, hosting different membranes occasionally.

In these representations, Takeyama treats the façade as a separate element, a real membrane that develops flat, ready to change. The flat development in this situation is merely turned outward as a covering: a dress that conceals an interior protected from prying eyes.

The second case worth analyzing is that of an architect who could be called the most colorful fruit that Tokyo's chaos produced in the 1980s: Kunihiko Hayakawa. His buildings synthesized urban disorder, assimilated it, and reproduced it in scenarios composed of two-dimensional elements assembled. Tokyo's labyrinthine, overstimulating, and paradoxical qualities became the engine of spaces where pastel colors muted

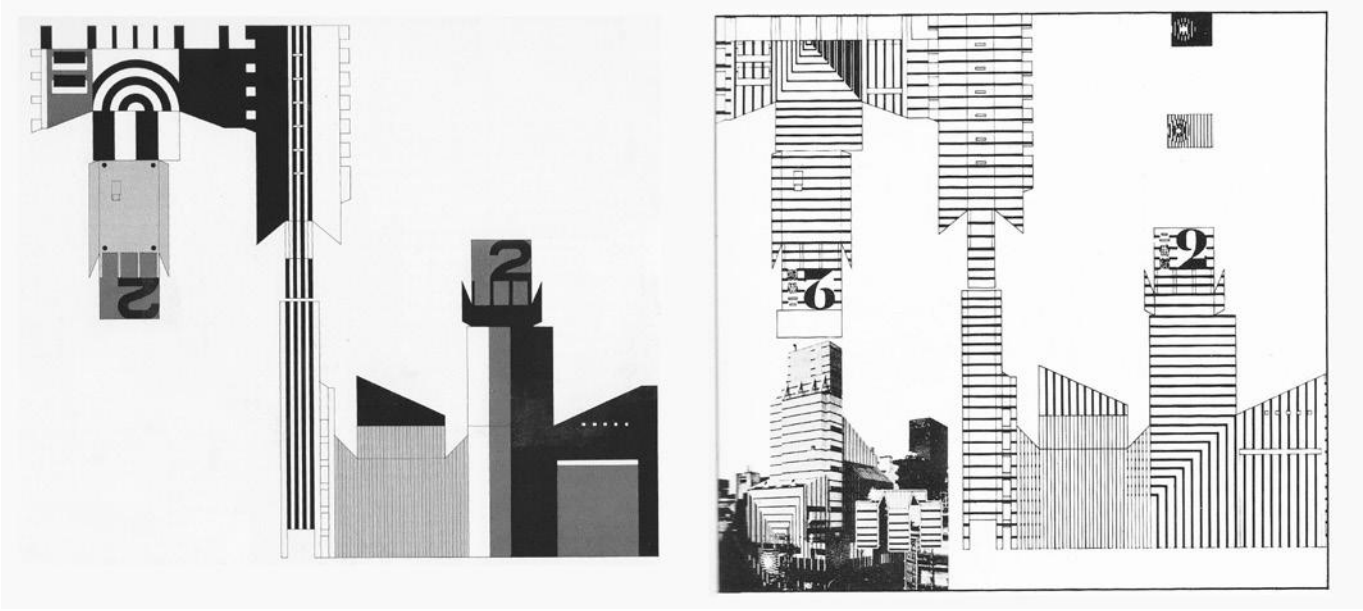

Fig. 4. *Graphic elaboration combining two versions of the* Niban-kan*'s surface. Left: Minoru Takeyama,* Niban-kan*, 1968. Source: [9]. Right: Minoru Takeyama,* Niban-kan *Repainted, 1976. Source: [10].*

external visual noise. We are not talking about architectural masterpieces, quite the opposite, but solutions that fully represent that particular moment in Japanese architecture.

Already in his early projects, Hayakawa focused on drawing, or at least on compositions that are representative of his architecture. In projects such as "House in Minami-Aoyama" (1981) and "House at a Bus Stop" (1982), he already employed a mix of special axonometry and tilts to create figures that reference architecture while not being fully legible.

The experimental drawings of the early projects can be considered in retrospect almost as a preamble to the representations he would produce in 1985 with his most famous project: "Atrium". It is a reinterpretation of the concept of a multi-unit complex, in which Hayakawa imagines twelve apartments of varying sizes connected by a large open-air interior courtyard. Hayakawa considers this atrium to be an *interior landscape*. Once inside, it is possible to find garden elements such as a gate, steps, a fountain with a small pool, a sculpture, and even a rotunda. Another characteristic is the checkerboard paving, which is slightly rotated from the direction of the lot. Hayakawa describes the project as a non-natural, artificial space: «The atrium does not have any elements that simulate nature, thus making it as much of an artificial scene as possible. […] Only the atrium space is colored, out of a desire to introduce a festive and theatrical atmosphere within the housing complex» [12].

It is interesting to see that Hayakawa, starting from this project, began to produce drawings published as *Elevational Development* (Fig. 5). These are drawings where the interior elevations were flipped flat, with hinges placed naturally at the connection with the atrium. These kinds of drawings allowed Hayakawa to show the scenic quality of the internal façades all at the same time. «The landscape produced [in Atrium] is two-dimensional, man-made, and gives the feeling of being alien to everyday life» [13].

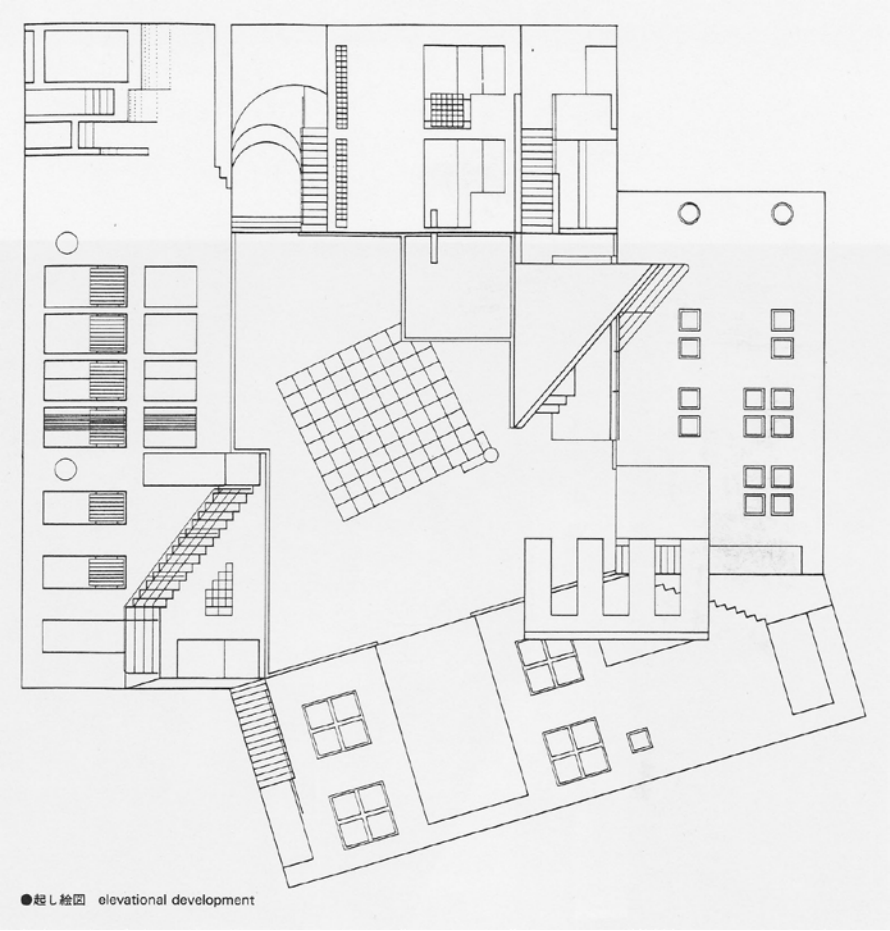

Fig. 5. *Kunihiko Hayakawa, Atrium, 1985. Source: [12].*

When Hayakawa mentions two-dimensionality, we cannot help but think of *okoshi-ezu*. Thus, he does not introduce a novelty in the Japanese representational landscape but applies it intelligently to his architecture. His drawings perfectly express the bi-dimensional quality of his façades. What is more, Hayakawa does something counterintuitive: instead of totally flattening the elevation once it has been flipped, he decides to leave parts still joined to the plan, using a special axonometry (Y and Z axes coincide) depending on the direction in which the elevation is flipped. In doing so, he then adds different dimensions to the represented space, creating an ambiguity that can only be resolved if the drawing is observed in portions. It also adds the sectioned portions to the overturning, representing multiple meanings.

The labyrinthine conformation of Tokyo led Hayakawa to design a project in 1989 called "Labyrinth", which is the epitome of his influences and theories on architecture. It is again a housing complex with an inner courtyard, where many staircases and ramps connect different units. It is his most spatially complex project, reminiscent of the distributional complexity of the famous Habitat 67, a residential project by Hayakawa's former employer, Moshe Safdie.

The semi-regularly shaped courtyard allows for precise tilting. However, it again introduces a three-dimensional component, with the flights of stairs often depicted in special axonometry (Fig. 6). The development of the elevations in this project also sees the introduction of color, which is extremely flat and homogeneous, further enhancing the two-dimensional effect of the elaborate design. The elevations become theatrical wings dropped to the ground with a thud. The architecture becomes readable only by trying to connect the different pieces of the labyrinth. Each one has different openings, but the color allows for a common depth between the different tilts, making the space of what Hayakawa calls the *valley* layered by levels.

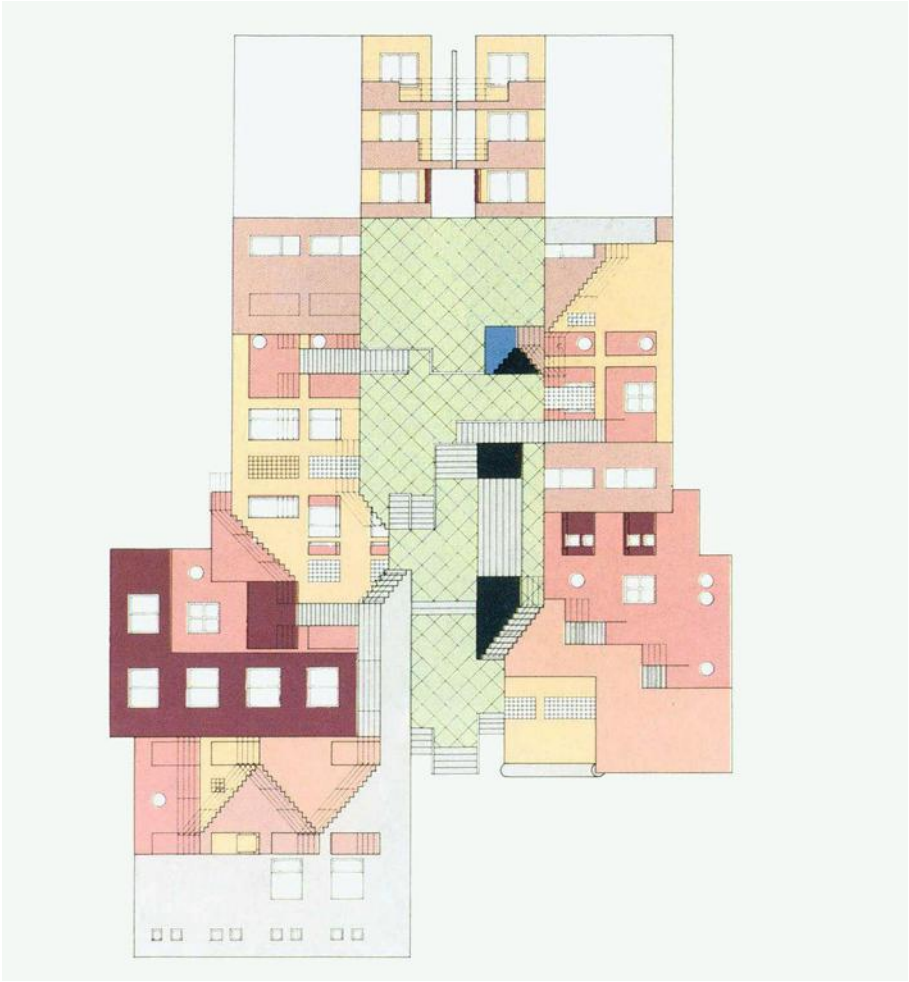

Fig. 6. *Kunihiko Hayakawa, "Labyrinth", 1989. Source: [14].*

Kunihiko Hayakawa enjoys a limited reputation (and consequently a limited bibliography), but with a few clear steadfast points he has succeeded in synthesizing the convolution of Tokyo into architectures as complex as the Japanese city. His drawings reflect this willingness to work in fragments to control an inordinate amount of external input. His approach to representation fits perfectly within the complex and richly changing period of mid-1980s Japan. The interior façades he depicts in development remind us of the 19th-century ones recounted by Evans, of which Hayakawa was probably unaware. The reference here again is presumably the *okoshi-ezu*, but in its most intimate and controlled sense, relating to the proper design of the tea room.

The third case study presented is also about a little-known architect in the West, Takefumi Aida. Among the *anti-metabolism* group ArchiteXt members, Aida had a varied and sometimes contradictory theoretical and design path, but it did not prevent him from creating some of the most interesting architecture of 1970s and 1980s Japan.

Around the 1970s, his idea was that modern architecture resulted from a series of continuous imitations of something done before, crowding the cities. Therefore, he decides to try to avoid any pitfalls related to the axioms of modern architecture. The fruit of his theories is one of his most famous projects, the "House like a Die", also called the "Dice House", from 1974. It is a detached house, which, as the name implies, looks like a die: in fact, in addition to being cubic, it also presents the different dots (i.e., square windows) that characterize the faces of a die in the elevations. So, are we talking about a mere divertissement similar to American novelty architecture, or is it an architecture with a valid theory behind it? In the case of Aida, the answer is both.

On the one hand, the building is undoubtedly a comic object, born in the climate of great compositional freedom that reigned at that time in Japan. Wacky, or at least curious, single-family houses were the order of the day. On the other hand, the Dice House becomes the manifesto and foundation of later Aida architecture. On the theoretical level, the house exemplifies his motto "Form follows *Fiction*" rather than the modernist *Function*, a phrase that connects us back to the theme of the play and pantomime to avoid any connection to already built architecture. In short, it is a way of hiding any functional aspect of the house behind a surface: «By giving special importance to the external form of architecture, I intend to seek the independence of the building. In *Nō* theater masks, emotions are not expressed externally. The goal is to conceal the emotions. The hidden expressions, I understand them as an expression of silence. The Dice House is presented in an ironic way, wearing a mask that is a die. The die is a big face, facing the exterior space. It is a mask of architecture» [10].

Aida mentions silence, a feature he hopes to achieve by hiding the true expression of his architecture behind a mask. This paper is not focused on the completeness of the theories in relation to the built artifact; indeed, what interests us is how Aida decided to represent his "Dice House" in relation to the aforementioned theo-

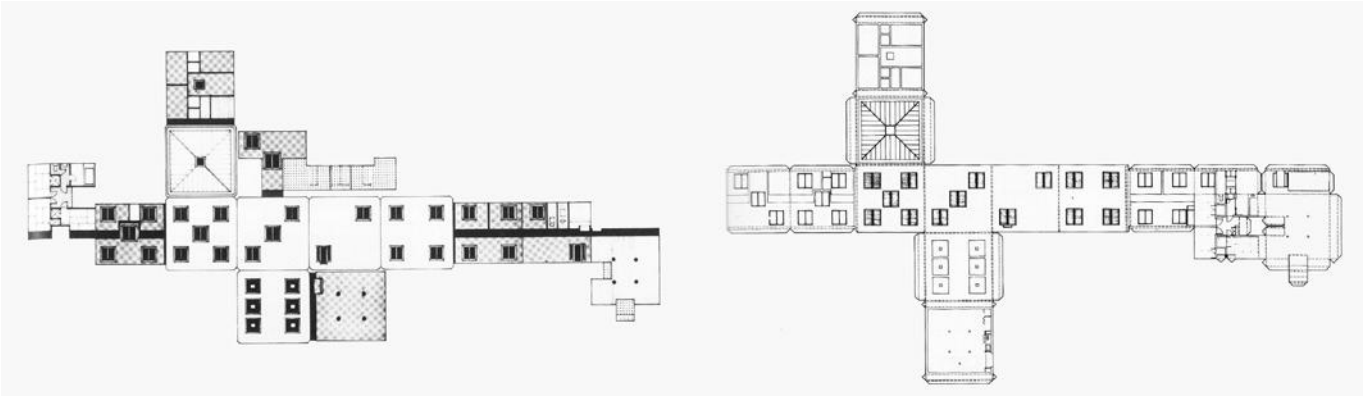

Fig. 7. *Graphic elaboration combining two different versions of Aida's "House like a Die". Left: Takefumi Aida, "House like a Die", 1974. Source: [16]. Right: Takefumi Aida, "House like a Die" (Okoshie Drawing), 1978. Source: [10].*

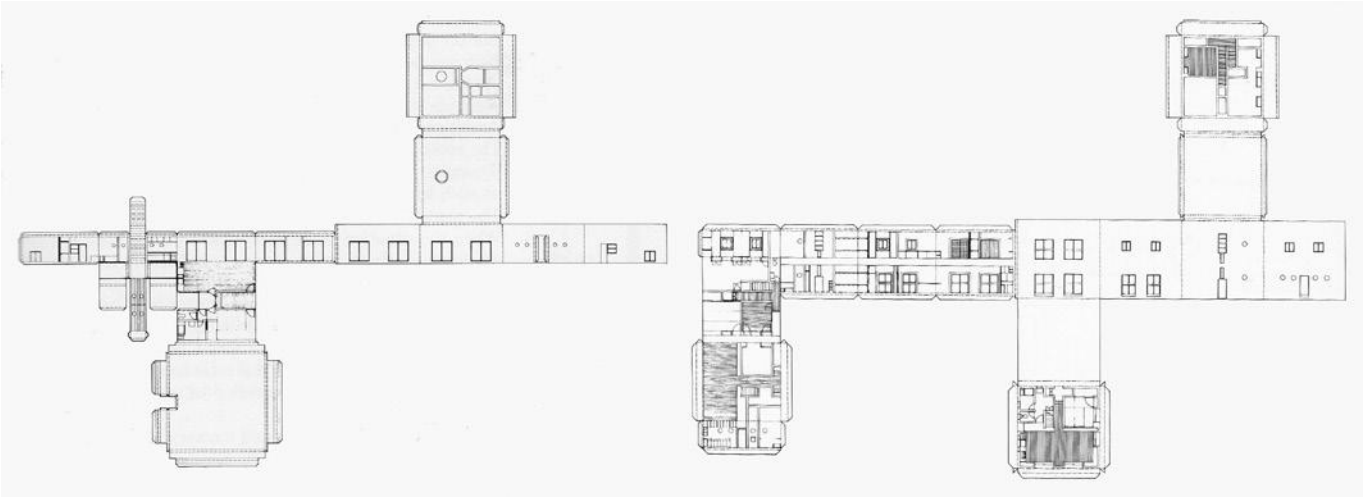

Fig. 8. *Graphic elaboration combining two drawings by Takefumi Aida. Left: Takefumi Aida, Annihilation House (Okoshie Drawing), 1978. Right: Takefumi Aida, Nirvana House (Okoshie Drawing), 1978. Both houses are from 1972, but the drawings presented were published in this version only in 1978 inside Frampton's A New Wave of Japanese Architecture [10].*

ries. The solution he adopts, in retrospect, seems the only possible one: an *okoshi-ezu*. His architecture made of masks is developed in the plane (Fig. 7, left). A traditional method of representation is employed to tell something new. The faces of the die are all visible at the same time: like a dress spread out on a table, the "Dice House" opens before the viewer in all its parts. Even the face with the number six is visible since it is not in contact with the ground thanks to six *pilotis*. The *okoshi-ezu*, in the Edo period, served to control the different interior finishes better, but Aida operated a reversal of meaning. His drawing aimed not to control the artifact's design but rather a part of its performance, a mask of architecture that can be assembled like a children's game.

It is precisely the concept of an assemblable game that introduces a design that is the direct evolution of the one just analyzed. In fact, the latter could be considered a prototype of a series of more curated drawings presented as part of the "A New Wave of Japanese Architecture" tour organized by the IAUS and Kenneth Frampton in 1978. For the occasion, Aida produced no less than three drawings in the *okoshi-ezu* style, depicting his (up to that time) most famous architecture. The drawing of the "Dice House" (Fig. 7, right) immediately allows us to make a comparison with its magazine precursor of four years earlier. The differences are many: the first one employed screentones for some backgrounds, paying no particular attention to the stage of eventual assembly; the second one, on the contrary, is clearly a more polished design, perfect for display and, at the same time, taking the question of assembly seriously, depicting the folding lines as well as the small fins that, once folded and glued, allow for perfect construction. The playful component becomes very clear here, and the other two projects represented in this style, "Annihilation House" and "Nirvana House", also share with "House Like a Die" the concept of an architectural mask (Fig. 8). Indeed, it is from them that this concept starts, having been built a year before the "House Like a Die". Their meaningless elevations tied to pure geometric forms are the masks that Aida makes his architecture wear, not to make them talkative but rather silent.

Aida's drawings turn out to be a summation of the iterations expressed by Takeyama and Hayakawa, developing the totality of architecture in plan: interior and exterior coexist and can be observed simultaneously.

4. GEOMETRICAL APPLICATIONS

It was possible to reconstruct on a 3D modeler the plane development of the "Dice House" in order to understand how it works spatially. Such operation was particularly easy, partly by virtue of the building's windows, arranged as mentioned above like the numbers on a

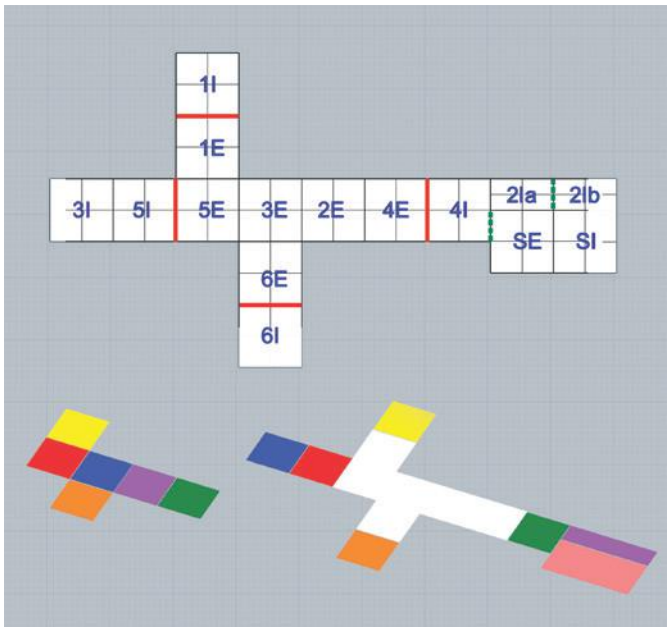

Fig. 9. *Analysis of the flat development of the "Dice House": correspondence relations between external and internal faces together with connection hinges (red lines) and cut lines (green dashed lines). Source: graphic elaboration by Alekos Diacodimitri.*

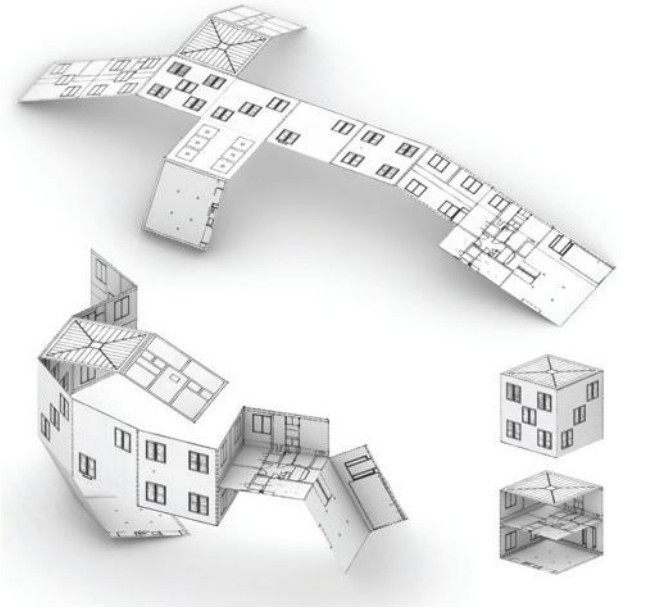

Fig. 10. *Render of the "Dice House" model with folding steps and middle floor construction. Source: graphic elaboration by Alekos Diacodimitri.*

playing dice, making the recognition of homologous interior and exterior faces immediate. Indeed, the most interesting aspect of such an operation is precisely the relationship created between the exterior and interior of the architecture. Each wall and floor of the building is shown simultaneously in its two visible faces, imagining the architecture as two solids contained within each other. Once developed on the plane (Fig. 9), the building is configured as a normally unfolded main cube (the outer one, i.e., the dice), around which the corresponding inner façades have been juxtaposed; these façades are connected to the main cube by four outer/inner connection hinges (in red in the image), around which faces 1I, 4I, 5I and 6I must make a 180-degree rotation. Face 3I rejoins its counterpart by following face 5I to which it is connected and making a 90-degree rotation in the opposite direction, while face 2I is affected by a particular step worthy of interest (Fig. 10): in order to allow the representation of the inner slab of the second floor (whose extrados and intrados are represented by faces SE and SI), face 2I has been decomposed into two sections (2Ia and 2Ib) that are rejoined by automatically recomposing the face once the rotation of both faces of the inner slab is completed. Two cuts (in dashed green in the image) are required to make this process.

The peculiarity of this representation is undoubtedly its ability to show, as mentioned above, all the faces of the solid simultaneously, relating the interior and exterior of the building without losing its spatial continuity and without creating unclear image overlays. In a single drawing, two-floor plans, the roof plan, three hypographs (ceiling plan), four elevations, and four sections are shown simultaneously, allowing the image user to reconstruct the spatial conformation of the building with a few simple mental steps.

5. CONCLUSIONS

Within this research, it was chosen to experiment with 3D modeling software, specifically *Rhinoceros*. The software employs NURBS, mathematical functions that allow different geometric entities to be visually represented. Its flexibility and rigor make it the most suitable software for handling operations on surfaces. The choice of using a 3D modeler, in this case, becomes an added value compared to the representation and reconstruction of the *okoshi-ezu* on paper. As geometric qualities are investigated and studied from a historical and theoretical standpoint, the modeler makes it possible to undo any irregularities and imperfections in the paper,

as well as its thickness. This latter feature also involves the eventual imprecisions caused by the folding of the paper, resulting in a hinge never working in a precise geometrical way.

The case studies recounted and the experimentation allowed us to expand the theme of architectural representation through the developed surface: this is a niche in architectural drawing that seems to surface only in response to specific expressive needs combined with a strong cultural identity. It is a type of drawing that asserts itself in alternating stages, often forgotten or simply overlooked by architects or academics.

The reason it does not seem to regain luster today is easily identifiable by two interconnected factors. The first is related to the tools used for representation. Software allowing the control of an architectural artifact in its three dimensions bypass the need to develop a solid in plan. If we want to see all the elevations simultaneously, it is possible to split the screen to frame them all. At the same time, projects are often conceived through solids, moving in a 3D environment that does not need to be flattened to be controlled. Thus, the flat development of a solid was born with assumptions of design control that simply no longer exist today.

The second factor is the direction that the forms of architecture have taken today, partly and mainly because of software that allows them to be controlled. Flowing, curved, or non-regular forms go poorly with a tilting-in plan that sees the regularity of simple solids as a cornerstone.

Despite the factors that hinder this type of representation, we can see an equal number of reasons that make it unique and still extremely useful and communicative today. These representations irretrievably take us back to analog drawing, the proper use of two-dimensional representation methods, and the rigor derived from the proper use of proportion and scale. These factors are inextricably linked with a conception of handcrafted architecture, often synonymous with greater care and reasoning, which sees the development of the surfaces as a way of verifying façade design. The characterization and balance relationships and the symmetries and asymmetries of an envelope are immediately highlighted. The grammatical continuity (or discontinuity) of a façade is verified in an omniscient drawing that becomes an excellent design control tool.

Such reasoning clashes with the direction that contemporary architecture seems to have taken. However, the representation of the surface of architecture can today be a tool of renewed inspiration for an approach to the façade and the total design of an artifact, holding within it a unifying gaze.

Authors contribution

While the authors shared the research in its entirety, they contributed to the text as follows: M.B.T. for chapter 1; A.D. for chapters 2 and 4; F.R. for chapter 3; E.C. for chapter 5.

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