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# A study in the design process and use of montage in the architecture of Zaha Hadid

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## Abstract

Studying Zaha Hadid's architecture raises questions about the method behind her dynamic architecture. Two views emerge when describing Hadid's design approach; one focuses on the generative method of the dynamic forms, and the other describes it as creating dynamic cinematic scenes. This paper aims to bridge the gap between the two perspectives by grounding the methods for setting the cinematic scene in the generative methods developed by Zaha Hadid. To achieve this goal, a comprehensive theoretical framework was developed, considering Hadid's innovative generative techniques and the cinematic montage technique as an editing technique for setting cinematic scenes, and guided by a general assumption that the montage technique is inherent in Hadid's generative methods. To verify this assumption, specific indicators were identified to reveal the use of montage and then applied to two case studies. Findings show Hadid reconstructed the architectural settings to create dynamic fields by introducing conflicts that dominated the field's centers of gravity, and that elements of rhythmic, tonal, and over-tonal montage techniques are embedded in her designs.

**Keywords:** Design process, Field, Dynamic form, Generative techniques, Montage, Experimental approach, Zaha Hadid

## 1. Introduction

Previous studies on Zaha Hadid's architecture explored the theoretical foundations of her dynamic designs and the strategies and techniques she employed to generate her distinctive forms. The study of AmatalRaof focused on the techniques Hadid used to create her forms. She recognized six techniques: Layering, abstraction and fragmentation, context and landscape, ground and gravity, light effects, seamlessness, and fluidity. The study found that contradiction is a key element in creating Hadid's unique forms [1]. However, it did not give a clear picture of the design process Hadid followed, or how she employed this contradiction. Youngjin Lee studied Hadid's design approach chronologically, comparing Hadid's early work with her later works to find consistency in the design approach despite the shift in the style from early geometrical forms to later parametric designs [2]. To explore the compatibility between the two languages, Lee used elements of Gestalt theory as analytical tools, which employed aspects of the design of dynamic images and the perception of spectators. The study found that concepts of form rotation and sequence were consistently employed in both her early and later works. She sought to create a differentiation in the perception of geometric forms from the viewer's perspective or through the integration of form and ground—that is, the integration of the components of the urban fabric and the building itself. The study found that the early works relied on only one of these concepts in each project, and she used both simultaneously in her later projects, linking the criteria of the urban environment with the morphology of



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architecture, the organization of the interior environment, and territories. The study focused on establishing consistency and connection among her projects within the evolutionary model of the design genealogy. However, this study did not provide a comprehensive view of her experimental design method, which activates the drawing environment and representations as a process for form generation.

Another specialised study by David Mertins falls within the framework of introducing Hadid's design process and the methodology followed. Mertins summarized Hadid's design approach as a combination of Malevich's Suprematist generative method and Ginzburg's constructivist design method. The essence of Ginzburg's method lies in beginning with abstract schemes that reflect the functional requirements of the building while remaining adaptable to structural and material constraints, later evolving into socially responsive spatial configurations. Hadid appropriated Suprematism as an experimental framework, employing generative techniques to explore organizational possibilities through lines that gradually developed into plans, sections, and isometrics. These lines and schemes captured the site's implied forces, rhythms, and directional flows, transforming functional requirements into spatial propositions [3]. Schumacher further dissected Hadid's experimental approach, framing her graphic space as a site of creative "play" rather than mere representation. He categorized her process into two phases: the playful proliferation of abstract entities resistant to immediate interpretation, and the selective refinement of these elements into architectural systems. Her generative method incorporated calligraphic fluidity, explosive fragmentation, and perspectival distortions, which were iteratively translated into tectonic forms through extensive drawing sequences [4]. Finally, the study of Betsky interpreted Hadid's design approach differently, viewing her as a cinematographer. Hadid accelerated perspectives, brought design elements into close focus, or presented their explosive disintegration in flashback-like sequences, revealing undiscovered movement potentials while constantly seeking new architectural expressions. Betsky compared her fragmented drawings for The Peak project in Hong Kong to scenes from Antonioni's film *Zabriskie Point* or Dali's *Exploding Rafealesque's Head* [5]. Besides, Betsky, in his book (1998), introduced her projects through her narrative voice, describing each scenario. For the Irish Prime Minister's house in Dublin, she prioritized crafting the site's narrative scene over conventional programmatic or contextual considerations [5]. While Betsky's writings addressed the cinematic scene-setting aspects of her work, they failed to explain the process.

The previous studies revealed two main approaches to defining Zaha Hadid's design methodology. The more prevalent studies focus on the technical aspects of her design process; however, few studies examined the design methods Hadid employed, which played a crucial role in developing an experimental approach—one that activated graphical space as the very medium of the design process. The other perspective for examining her methodology emphasized the creation of dynamic scenes and the description of scene-setting in her architecture as a product, rather than revealing the process behind their creation. This raises several questions:

- What is specific about Hadid's design method that results in designs like a cinematic scene?
- How have these cinematic-style scenes developed technically?

Returning to the realm of cinema, scene-setting relies on specific tools to structure and edit scenes' sequences. Montage is an editing technique for assembling, mixing, superimposing, and structuring images and shots [6]. Montaging the scene adds aesthetic impact by shaping rhythmic and tonal effects to trigger meaning in the spectator's mind; montage is the essence of cinematography, which technically adjusts composition and sequence, adds tonal effects of sound and light to narrate a story [6].

The definition of cinematic scene-setting and Betsky's description support an assumption that Hadid's design process inherently incorporated the assembly of montage techniques.

Research Methodology:

1. Develop a comprehensive theoretical framework examining Hadid's design methodology and generative techniques. This requires tracing her philosophical influences to establish conceptual origins.
2. Examine montage techniques to define the mechanisms and indicators of montage in Hadid's architecture.
3. Demonstrate a practical study to validate the research-specific hypotheses.

## 2. Zaha Hadid's design process

### 2.1. Philosophical background

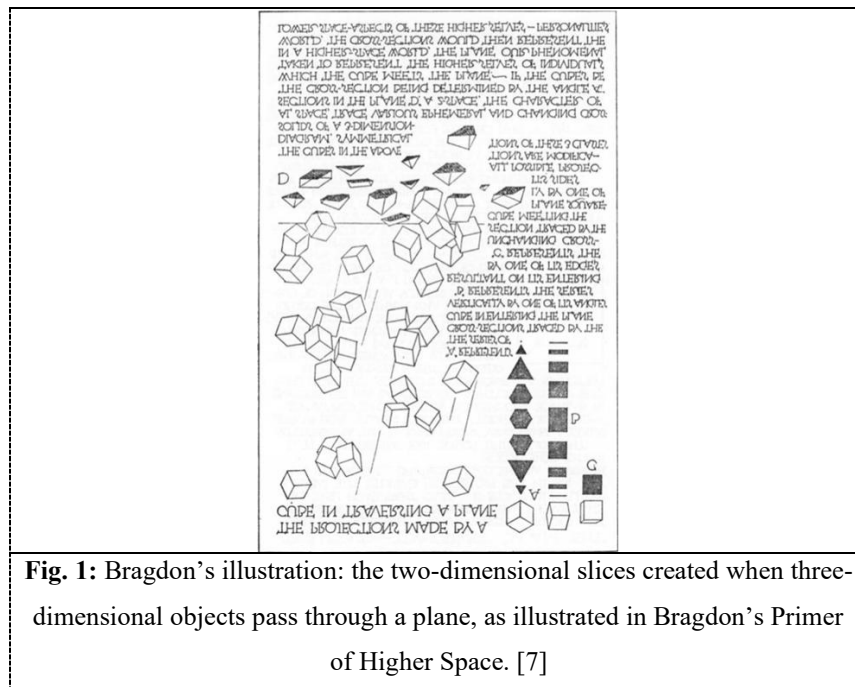
#### 2.1.1 Malevich's non-objectivity and suprematism

Kazimir Malevich is a Russian avant-garde artist well known for his abstract work of forms in motion using basic geometric shapes and primary colours, which formed the basis of Suprematist contemporary art in the last century. His suprematist paintings and forms represent concepts of infinity, motion, disorientation, lack of gravity, and non-objectivity—ideas profoundly influenced by Albert Einstein's theory of relativity, which redefined time and space as relative constructs dependent on the observer's frame of reference. He focused on how individuals perceive objective

events, highlighting the emotional response at the moment of observation- an experience that is singular and personal. Therefore, concepts of the momentary and the instant became central themes in the early stages of contemporary art movements [7].

To manifest these ideas, Malevich challenged pictorial conventions, developing an abstract language to suppress the representation of the exterior perceived world and the use of subjectivity as an analytical tool to interpret it [7]. His suprematist method abandoned perspectival depth, flattening the picture plane into a field of two-dimensional geometric forms.

Claude Bragdon's illustration, see Figure 1, suggested that Malevich's irregular shapes derived from oblique cross-sections of cubes. The resultant slices yield polygonal forms when viewed from unconventional angles, that is, looking at them from beneath; the irregular two-dimensional shapes represent the three-dimensional polygons [8]. Malevich developed his system to create the illusion of movement through static geometric forms. By employing a carefully constructed language of colour, layered shapes oriented in multiple directions, and strategic placement against white backgrounds to evoke infinite space, he achieved dynamic compositions from fixed elements [8]. Hadid's approach to form-making reflected Malevich's non-objectivity in three key aspects: presentation and drawing, representation and analogy, and functionality and open work.



### 2.1.2. Dynamic exploding scenarios and generative techniques

Technically, Malevich's Suprematism liberated Hadid from the constraints of perspective-based drawing, allowing her to later adopt drawing as a primary design method. Her drawings give the impression of multiple perspectives within a single image, opening the picture plane to employ the space beyond it while showing objects in recessive space. Foster described her drawings as extending in all directions, creating complex, ambiguous images that presented architectural projects in unconventional ways [9].

As Hadid explained in her interview with Achim Borchardt-Hume, her drawings served not only as presentations but as a process of design. This approach began early in her career when conventional orthographical projections (isometrics and axonometries) proved inadequate for conveying her architectural vision in her graduation project. Seeking more expressive graphical methods, she developed progressive drawing techniques that evolved through distinct stages. These methods

employed explosion, layering, and fragmentation; initially to represent dynamic spatial concepts, and ultimately to generate them, marking significant shifts in her design thinking [10].

In her early stage, she developed dynamic exploding scenarios to present buildings' horizontal plans and vertical slices as elements arriving and occupying sites. During a Tate Gallery interview discussing her graduation project—a hotel and facilities invading Malevich's tectonic Alfa—she likened it to a "shipwreck" arriving on the Thames. She showed the tectonic rotation several times before settling on the bridge, employing a unique drawing approach where buildings 'arrive' as: Site-deposited slices, segmented exploded objects, or layered composite drawings [10]. For the Irish Prime Minister's Residence, she exploded the drawing template, combining site plans, floor plans, and enlarged sections in multiple scales and orientations within a single drawing [5]. These presentation techniques ultimately evolved into a design method, exemplified in projects such as The Peak, where the club structure appeared 'exploded.' Hadid transformed graphic space from a representational medium into a generative tool for developing building tectonics. Her painterly techniques, such as dissolving objects, dark/light gradations, stippling, colour washes, and modulation, were reinterpreted as architectural principles, informing both the conceptual and physical realization of structures in their settings [4].

Unlike Malevich, Hadid employed representation and analogies as architectural potentials. Her work did not literally depict the physical world or natural scenes; instead, it translated Malevich's non-objectivity and abstraction through her own architectural lens. She utilized analogy and representation to develop scenarios and present her abstracted architecture within urban contexts. Unlike literal representations, her drawings suggested potentials and motivations for emerging objects [3]. Fontana described them as precursors to "lines", where sensations were "drawn" gradually using traces, shadowed tones, and projections, calling them "objects to become", using Plato's term [11]. Schumacher regarded her analogical approach as an innovative, imaginative technique, noting her particular interest in landscapes and foodstuffs as rich sources of inspiration [4].

### 2.1.3 Functionality and open work

Interpreting the physical world depending on the artist's feelings and the non-objectivity was essential in defining the relationship between form and use. Mertins remarked that Malevich believed that forms do not have a corresponding absolute utility; rather, forms suggest a plastic sensation, to which the abstracted form gives a feeling: lying on, sitting on, and eating on; it is the objectless world of sensation. He worked on the effects of sensation and psychology; the embodiment of the feeling and sensation in the artwork results in ambiguous art that is open to multiple interpretations or, as Umberto Eco calls it, 'the open work'. Zaha Hadid was influenced by these ideas and designed her furniture pieces with multiple uses: one could lean on it, climb on it, slide on it, crawl through it, and even eat on it [3]. This approach evolved into her concept of the open multi-use plan, where architecture and furnishings provided spatial possibilities for users to interpret freely. Examples, including the Maxi Museum in Rome, exemplify this philosophy, with its continuous, adaptable plan inviting diverse engagements.

### 2.1.4. Seamlessness and field

Malevich developed his system with defined rules, referring to his dynamic forms as "satellites" or machines in motion. He achieved a sense of movement from static geometric elements through disciplined, utilitarian principles. By employing non-static formal manipulation, he created compositions that conveyed motion. His forms suggested a state of motion, evoking an aircraft in flight propelled not by engines or wings, but by the inherent forces of form and natural processes. This motion arose from the form's seamlessness and internal cohesion—an invisible, magnetic-like force binding its elements [11].

Hadid explored these ideas and expressed them architecturally through techniques where the form was interconnected parts, held together by an invisible "magnetic field." This concept of a dynamic field was inspired by Malevich's concept of dynamic form and the seamless integration of parts into a unified whole. Guided by this vision, Hadid developed generative design methods that reflect these principles. Schumacher explained that Hadid created implied points of origin inside or

outside ‘the field’ to ensure continuity in form through clear organizing rules. These rules coordinate the direction of elements at the level of the whole, while allowing varied directions and complexity at the level of individual parts [12]. Hadid was also influenced by field theory in urban design. The concept of the field became the medium through which Hadid developed her Suprematist “satellites”, which resembled the magnetic field in physics. The field, according to architect and theorist Stan Allen, is like a spatial model or formal arrangement that unifies several parts and yet keeps the identity of each part [13]. Christopher Alexander discussed this concept in his book “Notes on the Synthesis of Form.” Alexander views the physical simulation of the magnetic field as a good fit between form and context: “Form is the pattern that is set up by iron filings when they are placed in a magnetic field” [14].

From another perspective, Rowe and Slutzky emphasized the significance of the field concept through Gestalt psychology’s figure-ground theory and the concept of psychological field; the elements were perceived as either figure or ground. They compared traditional and modern urban fabrics: in the traditional cities, relationships between objects take precedence over the objects themselves. Voids could be read as separate figures, while solids form a continuous background, forming a two-dimensional figure-ground pattern of buildings and open spaces. In contrast, modern urban fabric treats the building as the figure, with the surrounding space as background [14].

Ruby clarified that Hadid’s main concerns regarding modern urban fabric centred on a building’s ground level and the straight lines of modern city planning. In most cases, the ground level of a modern building remains empty and lacks programmatic definition—a practice widely recognized as one of modern urbanism’s major shortcomings. Le Corbusier significantly termed this approach “liberation from the ground,” as one of the Modern Movement’s principles [15].

The second issue involved the rigid straight lines of modern urban planning, where gridiron organization dominated the scene. Le Corbusier’s urban planning admired the Romans’ grid system while rejecting the Medieval period’s organic model. Hadid’s urban model engaged with the idea of a figure-ground concept, treating the building as a figure. However, her buildings functioned as fields composed of interconnected parts, adapting to the city’s field [16], which placed a field (a building) within a larger field (a city). Hadid undertook her ambitious project to complete what she viewed as the “unfinished work” of the Modern Movement, asserting that “modernity was an unfinished project that deserved to be pursued” [3].

## **2.2. Zaha Hadid’s design methods**

To reconcile interior and exterior spaces and resolve the Modern Movement’s ground-level deficiencies, Hadid employed techniques of hybridity and combination. This approach reflected the Futuristic Art concept— particularly Umberto Boccioni’s 1912 call for figures that invite the environment to be part of the “plastic” figures by opening their structure [9]. Hadid realized this vision by dramatically opening structures, integrating mobile urban elements (streets, ramps, infrastructure) into buildings. These elements not only shaped her fields but also functioned structurally [10]. Projects, such as the Contemporary Art Centre in Cincinnati, used the urban carpet concept, and Cardiff Opera House used the idea of a bubble to connect the ground level with the first, exemplifying her seamless continuity between street and ground levels.

As a starting point to this process, Mertins mentioned that she used the inherent rhythms and flows of the site to create her forms’ dynamic rhythms [3], while Foster remarked that her schemes seem to emerge from site-specific tensions [9]. She transposed this tension by bringing external elements into the building and, at times, flipping the horizontal ground level into a vertical surface. According to Schumacher, this merging of site and structure, along with the integration of site materials, represented a process of hybridity and recombination that led to unpredictable outcomes, requiring realignment, recontextualization, and reinterpretation [4].

Through these methods, Hadid activated her concept of the dynamic field, applying Malevich’s ideas of form’s economy and seamless unity to guide the design process.

### **2.2.1 Generative techniques and setting the scene**

Hadid's field is permeable; composed of distinct yet interconnected parts, as if bound by a magnetic force. To achieve this, she developed four radical techniques of form generation: Explosion, Distortion, Calligraphy, and Landscape.

In this context, Patrik Schumacher explained that an explosion implied a varied, fragmented, permeable field capable of expansion by returning to an original implied point. This field, though scattered and multidirectional, remained ordered rather than random, with a heterogeneous arrangement of elements radiating from a central epicentre [12].

The second technique, distortion, involves reinterpreting perspective drawings to create irregular, distorted forms using multiple centres and distorted projection lines. Hadid used these curved lines to intensify the field, allowing diverse elements to be organized within a distorted yet coherent geometry. The field's cohesion was maintained by a dominant force, like a magnet, that directed and integrated various elements in one set or pattern.

The calligraphy technique focuses on continuity of lines and varied areas of compression and relief curvature formed by foci and focal centres. This heterogeneity solves the functional program, where rounded places satisfy functional needs. The rapid, dynamic movement of calligraphy curves differs from the curves drawn using French curve tools. By exploiting these qualities in building geometries, Hadid gained the freedom to organize her drawing field.

Finally, the Landscape technique involved the gradual transition and flow of spaces rather than sectoring them. Here, spatial and territorial boundaries are redefined—from outline layouts to altered internal topography and texture—treating the field as a medium modified by different forces, resulting in overlapped territories with blurred, smoothed transitional boundaries. To bolster this idea, Hadid used painterly techniques, including dissolving, colour modification, stippling, and water wash [4].

Mertins considered these generative tools as moves that allowed her to expand the formal repertoire, moving beyond Malevich's limited forms [3]. Although this expansion introduces spatial organizational challenges, such as morphological-functional articulations, it provides new problem-solving techniques, especially for complex programs or irregular sites. For instance, trapezoidal shapes effectively addressed unusual plot shapes [4].

### 2.2.2 Create the field: Hadid's design process

This section outlines key theories on Hadid's design method: Schumacher's two-phase model (drawing/proliferation followed by selection/interpretation) and Mertin's blend of Ginzburg's constructivism with Malevich's Suprematism.

This study complements the framework by addressing the site's role, incorporating Foster's proposition that Hadid's schemes emerge from site-specific tensions. Consequently, we define Hadid's design process as comprising three stages: Site scanning and tension activation, Drawing the content and proliferation, and Drawing interpretation, [Tab. 1].

**Table 1:** Theoretical framework of Zaha Hadid's design process

Create a dynamic field						
Stage of site Scanning and tension activation	Stage of drawings and Proliferation (rebuild the setting)				Stage of drawings interpretation	
	Create the setting contents	Create the center(s) of gravity(ies)	Use Analogy and Narrative scenario	Use generative techniques		
					Reading the set of drawing from a formal point of view	Reading the set of drawing from a functional point of view

Vocabularies of the design process framework will be explained in the following paragraph:

Stage 1: Site Scanning and Tension Activation, which includes:

- Study the forces of the site, rhythms, and directional flows
- Identify and amplify a core conflict to establish architectural tension.

Stage 2: Drawings (the content) and Proliferations, which include:

- First, reconstruct the site setting by merging environments through contextual materials and hybridization, forming the field's compositional elements. This process-maintained continuity with the site while incorporating moving urban infrastructure—what Hadid termed "tick-tick elements", referring to small, mobile elements like ramps, bridges, and passages. The contextual elements were abstracted and reduced to essential gestures, devoid of details to avoid immediate recognition. This process of defamiliarizing employed minimal detailing to prevent volumes from immediately denoting rooms [4]. As Betsky notes, these abstract gestures can function as a unified gesture or as a collage of distinct, cut-out gestures [5].
- Establish centre(s) of gravity: Utilize forcing element vectors where lines, surfaces, shapes, and planes are launched or met. Schumacher identifies these as "points of origin" [12].
- Employ analogy and develop scenario: Hadid preferred using an inexhaustible realm of landscape formation analogies to describe the process of form formation, including carving canyons, dunes, and sliding geological layers. She equally incorporated unconventional food analogies, including chewing gum, sandwiches, and spaghetti [4].
- Use generative techniques to create the seamless dynamic field: Explosion, Distortion, Calligraphy, and Landscape.

Stage 3: Drawing Interpretation: Schumacher described this stage as a gradual interpretive process, where graphic configurations gradually transform into spatial features. The resulting spaces extend in multiple directions, with different functions establishing distinct focal points. The users orient themselves not through traditional urban design elements like axes or edges, but through new ontologies of distributed densities, directional bias, scalar grains, and gradient vectors [4].

This selection and interpretation of drawings included:

- Reading the set of drawings from a formal perspective: The elements are read abstractly, detached from traditional ontological terms, and then distributed spatial territories of compression and acceleration. Hadid repurposed concepts of enclosure, boundaries, screens, and openings to free the inhabitants from familiar terminology, enabling them to encounter the abstract compositions and navigate spaces independently [16].
- Functional reading of resultant spaces: Spatial programming involves designing events along a defined movement path, then carefully extending the ground-level events/ actions throughout the building program. Ruby described it as "a choreography of events along a specific path of movement" [15].

The next section will focus on scene-setting technique (montage) in the filmmaking industry and its application in architecture, analysing it to determine where it might fit within Hadid's design process framework.

### **3. Montage definition and architecture**

Scene-setting in the cinema realm relies on a specific technique, montage, which is originally a cinematic editing technique theorized by the Soviet director Sergei Eisenstein (1898-1948). Eisenstein argued that meaning emerges from the conflict between opposing elements. He believed that the conflict adds aesthetic impact to the assemblage of shots. In filmmaking, the montage technique serves as the primary means of assembling, collecting, and superimposing images to develop new scenes. The dynamic process of juxtaposing unrelated details and arranging images triggered meaning in the spectator's mind [6].

While montage involves theme, meaning, narrative, and structured assemblage, it also relies on conflict to generate continuity and movement.

Structuring the assemblage and montaging scenes has been applied in architecture. Vidler clarified that architecture embodies the principle of montage. The perception of a moving spectator in an apparently disordered composition receiving varied scenes coincides with the spatial perception of a steady position since the spatial perception system is in motion, even when the person is standing still, taking a glance around the space by moving the head [18]. Le Corbusier applied this principle in the design of his Villas of the Twenties. Beatriz considered Le Corbusier's house to be a machine

for seeing rather than a machine for living [19]. The successive frames and scenes while walking around resemble those of the cinema camera's eye. Other architects, such as Bernard Tchoumi and Rem-Koolhaas, also employed the principles of montage outside the scope of this paper.

### 3.1 Montage types

Jeffrey Todd identified the key elements of film montage as frames of scenes and moves. He categorized montage techniques into Metric, Rhythmic, Tonal, Over-tonal, and Intellectual Montage, each serving to structure and organize the arrangement of the film's frames and add aesthetic impact by controlling the graphical and visual effects [17].

Metric montage controls individual frame length based on a formula, while rhythmic montage creates tension based on film content. For instance, in Eisenstein's 1925 film "*Battleship Potemkin*", the steady rhythm of soldiers marching and firing at the crowd contrasts with the chaotic escape and dispersal of the crowd. This conflict derived continuity and progression to the next scenes. Tonal montage uses graphic effects and emotional sound to create visuals, while over-tonal montage blends multiple techniques. Intellectual montage involves the viewer's mental activity to synthesize a meaning [17].

Categorizing the montage into four types represents the level at which the montage technique is applied. Collectively, montage involves conflict established through contrary scenarios, opposite rhythms, opposite graphic effects, texture, and light tonality.

### 3.2 Montage techniques, generative methods, and Hadid's design process

In this section, we discuss where to place the cinematic montage in the design process [tab.1] by analysing the relationship between montage techniques and Hadid's generative methods.

Comparing cinematic montage and Hadid's design process reveals a montage-like approach. Montage involves assembling opposing images with conflict to maintain continuity and movement in the structural sequence of frames, triggering a meaning read and interpreted by the inspector. Similarly, Hadid provided conflict by releasing forces and implied rhythms within a site, while her generative methods combined diverse elements to develop a field of drawings and lines. This process created a seamless setting, resembling a cinematic setting, through the proliferation of drawing lines. Interpreting the lines and configurations into forms and usable spaces represented the final stage in the process, implied an intellectual imaginary role for the architect during the design process, and for the user after use.

A close analysis of these generative techniques revealed that a field's diversity and continuity result from explosion's fragmentation, distortion's iteration and multiple viewpoints, calligraphy's changing centrifugal forces, landscape's multiple apparent textures of landscape morphology, and topographies. Seamlessness emerges when diverse elements are oriented towards their centre(s) of gravity—points from which all lines and forces radiate, such as the explosion's epicentre, the distortion's vanishing viewpoint(s), and the centre of calligraphic curvatures' centrifugal forces. The landscape technique remains unique as it merges topographical morphological textures through painterly techniques, using ideas of overlapping, blending, and boundary dissolution to create a unified field. Table 2 [Tab. 2] illustrates the assumptions for placing each montage technique under Hadid's generative technique. We assume a rhythmic montage, tonic, and over-tonic montage underlined by distortion, explosion, calligraphy, and the landscape-generative technique. Intellectual montage is related to cognitive operations and ideation for interpreting the drawings or spaces in use. We assume the designer during the design process, or the spectator's ideation after using the space, as possible persons involved in the intellectual montage. Therefore, intellectual montage is underlined by the stage of interpretation of the drawings in [tab.2], or it is performed by the user after the building operation.

The close theoretical analysis contributes to the formulation of a specific research problem, which focuses on two points: the site's role in providing the conflict that is crucial to establishing montage elements. The second point involves

exploring the relationship between Hadid's generative methods and various montage techniques. We assume that the montage rhythmic, tonic, and over-tonic techniques are embedded in Hadid's generative methods.

To explore the presence of montage techniques in Hadid's design methods and to validate the assumptions, a practical study will be conducted. The next section will focus on:

- Identification of the indicators of Hadid's generative methods.
- Identification of the mechanisms and indicators of montage techniques, and their possible values.

**Table 2:** Assumptions for placing the montage technique aligned with Hadid's generative technique

		Create a dynamic field					
Stage of site Scanning and tension activation	Stage of drawings and Proliferation (rebuild the setting)				Stage of drawings interpretation		
		Create the setting contents	Create the center(s) of gravity(ies)	Use Analogy and Narrative scenario	Use generative techniques		
				Distortion	Explosion	Calligraphy	Landscape
Invite tension				Create dynamic rhythms: rhythmic montage Create tonal montage elements		Intellectual montage (by the designer)	Intellectual montage (by the designer)

### 3.4 Indicators of generative methods and montage techniques:

From the description of the theoretical framework of the design process, we extract the indicators and possible values [Tab. 3], this table summarizes the characteristics of Hadid's generative methods used to create diversity and continuity.

This was deduced from the previous definition of field theory, where every field has a center toward which all its components are directed or launched. Zaha Hadid creates this field centre through her strategy of introducing conflict and stress inherent in the directions of the dynamic forces at the site, using the intersection point/s of these opposite forces as the centre/s of the field developed for her project.

Accordingly, the technique employed in Hadid's projects can be identified through certain indicators. The explosion technique is characterized by both fragmentation and the centre of explosion, while the distortion technique is marked by iterative drawings using multiple vanishing points and distorted geometries. Calligraphy is recognized through continuous lines and compressed or relieved curves, suggesting motion. Finally, the landscape technique is characterized by painterly techniques: colour modulation, light-dark gradients, dissolving objects, and water wash [4].

**Table 3:** Characteristics of Hadid's generative methods to create diversity and continuity

Technique	Mechanisms to indicate the technique	Description of the variables
Explosion	Fragmentated irregular shapes and elements directed toward explosion centre	1. Trapezoidal irregular shapes, 2. elemental bits and pieces, 3. Planar irregular shapes.
Distortion	Shifted drawings directed towards more than one vanishing point	1. Shifted shapes and iteration of perspectival drawings 2. Curvy projection lines of perspective drawing
Calligraphy	Visual continuity of curvy lines with acceleration or deceleration	1. free curvy lines spins around a centre. 2. Relief/compressed curvy lines 3. Combination of reversed types of curved

Landscape	Graphical painterly elements in Hadid's sketching Open plan layouts	lines: concave and converse 1. graphical textures, graphical stippling, water wash, colours modulation. 2. Continuous open interiors, boundaries' dissolution, overlapped territories and spaces, building - context continuity, figure-ground merged boundaries.
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Depending on the previous definition of montage elements, conflict applied at various levels representing montage types, the following mechanisms were deduced to indicate the existence of various montage techniques [tab. 4]:

- Rhythmic montage: create tension through opposing rhythms of movement.
- Tonal montage: use contrasting sensory effects (tactile, light tonal, audio), including material effects and textures, light/dark contrasts, and sound tonalities.
- Over-tonal montage: combines rhythmic and tonal montage.
- Intellectual montage: Features viewer-derived meaning and spatial flexibility (multi-use spaces; open plans could be interpreted for different uses). However, we excluded this variable from the practical study; the indicators should gauge the user's experience, the user's interpretation of space functional meaning and usage, or the designer's interpretation of the created field of lines and drawings.

**Note:** Metric montage was excluded from the practical study as it constituted a highly technical tool dependent on specialized cinematic montage formulas.

**Table 4:** Indicators of various Montage types

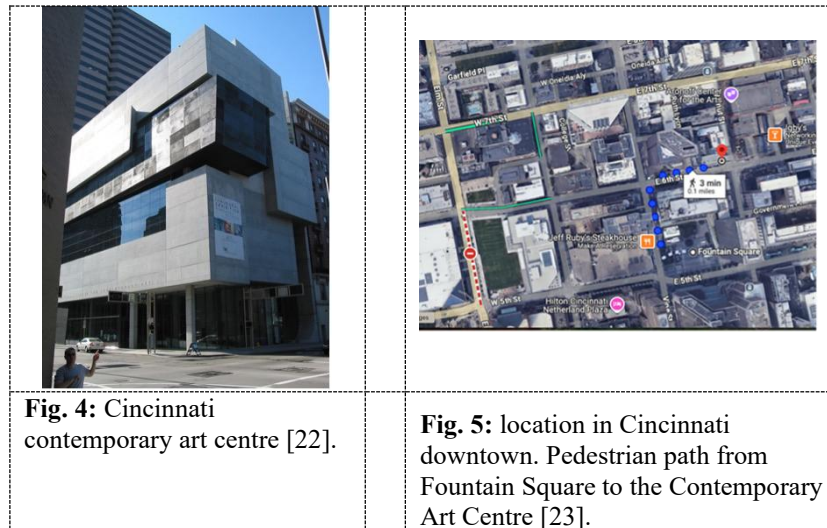
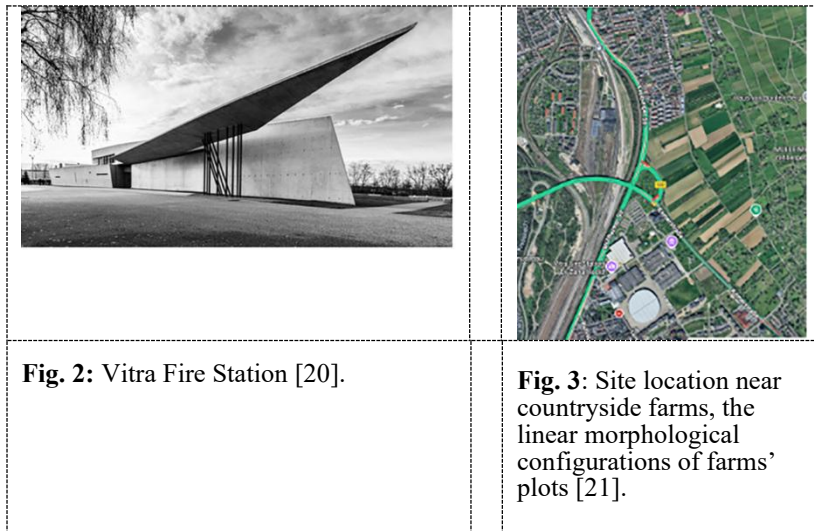
Montage type	Indicators	Variables possible values
Rhythmic Montage	Two opposite rhythms of movement	1.Random-Regular 2.Horizontal- Vertical 3. Stright-Rotation
Tonal Montage	Opposite textures or patterns of textures	Mixture of opposites: 1.Regular patterns- Random 2.Linear, straight- Radial 3.Smooth-Harsh
	Opposite Lighting and colour effects	1.Dark- Light effect 2.Heavy- Light effect 3.Black- White
Over Tonal: Use of more than on type of montage	Combination of rhythmic and tonal montage	

#### 4. Examine the Vocabularies of the Design Method and Montage techniques in Hadid's Design Process-Practical Study

This practical study depended on the critics' quotes and descriptions from journals, books, and websites to explore the site's role in creating the dynamic field and to support the thesis that montage tools are integral to its creation (both stage 1 and 2). Additionally, to help illustrate and clarify the qualitative measuring procedure, sketches were created for each montage variable by the researcher using original drawings.

To investigate the site’s role and identify the montage tools in Hadid’s design process, this framework analyzed two representative projects: Vitra Fire Station (Weil am Rhein, Germany, 1993, see [Tab. 5] and [Tab. 6] and Contemporary Art Center (Cincinnati, Ohio, 2003), see [Tab. 7] and [Tab. 8].

The case studies were deliberately selected from Hadid's early work featuring manually produced drawings to demonstrate that montage techniques fundamentally inform her generative methods, independent of computer-aided design. Both projects occupy distinct urban contexts: As indicated in Figures 2 and 3, Vitra Fire Station occupies a peripheral factory campus location in Weil am Rhein, and the Contemporary Art Center is situated in downtown Cincinnati, Ohio-USA, see Figures 4 and 5.



## 5. Results and discussion

In general, the indicators of montage elements were clearly evident in both case studies. The conflict and diversity in movement rhythms, along with the tonal effects of contrasting textures, design elements, surface materials, and lighting conditions, actively shaped the entire scenes of buildings’ exteriors and interiors. Additionally, the two case studies revealed the site's dominant role in creating the field.

**Table 5:** Case Study 1: Explore the site's role in developing the dynamic field

Vocabularies of the design process	Quotes, texts, and Descriptions
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Scanning the forces of the site and tension activation.	<p><i>“Dr Fehlbaum describes the fire station as Vitra’s first urban building, meaning that it does not sit on an American-style city block like their previous buildings, but has to turn the corner as the main road on the site curves round sharply at this point.” [24]</i></p> <p><i>“It was the road, and the factory sheds surrounding the site, that would inform the rationale of Hadid’s proposal” [25]</i></p> <p><b>Researcher’s Comment:</b></p> <p><b>Tension between the bend in the road and the main direction of the urban landscape context</b></p>
Create the setting contents.	<p><i>“The building was envisaged as a linear landscape zone, almost as if it were the artificial extension of the linear patterns of adjacent agricultural fields and vineyards.” [26]</i></p> <p><i>“As a synthesis of the design of individual buildings and town planning, it brings the urban fabric right into the building.” [27]</i></p> <p><i>“Zaha Hadid has seized this conflict of angles with both hands. She has made many sketches of the geometry of the surrounding infrastructure and developed this as a basis for the design.” [24]</i></p> <p><b>Researcher’s Comment:</b></p> <p><b>Street Linear elements and geometric shapes of surrounding buildings, and linear pattern of agricultural field, Figure 3.</b></p>
Create the center/s of gravity/ies	<p><i>“The design’s primary feature is a series of layered screening walls, between which spaces are punctured and break according to the station’s functions.” [5].</i></p> <p><i>“The main Puncture is the movement of the fire engines, perpendicular to the line of the walls and the landscape as a whole.” [5]</i></p> <p><i>“In the backyard, volumes run into each other in a very dynamic way. They meet at one point, but they then exploit in different directions.” [28]</i></p> <p><b>Researcher’s Comment:</b></p> <p><b>The Gravity centre is where the perpendicular movement hits the main direction of the parallel walls and screens, this represents the centre of the Frozen explosion, Figures 7 and 11.</b></p>
Use Analogy & Narrative scenario	<p><i>“...The whole building is frozen motion, suspending the tension of alertness, ready to explode into action at any moment.” [5]</i></p> <p><i>“Anyone who approaches the wing-type building from the rear of the factory site has an experience similar to the opening scene of Hitchcock’s Vertigo, where the main character, played by James Stewart, is frozen in free fall by a camera zooming in and out. The building both opens and shrinks back.” [27]</i></p> <p><b>Researcher’s Comment:</b></p> <p>Frozen moment for the explosion scenario, Figure 11.</p>
Use generative techniques	<p><i>“This design utilizes isometric and perspectival distortion as design moves that help fitting the project into a contextual trajectory and deliver observer-dependent visual effects that animate the spatial experience.” [11]</i></p> <p><b>Researcher’s Comment:</b></p> <p><b>Distortion technique using multiple vanishing points to draw the different directions of the exploded walls, Figure 10, and [Tab.3]</b></p>

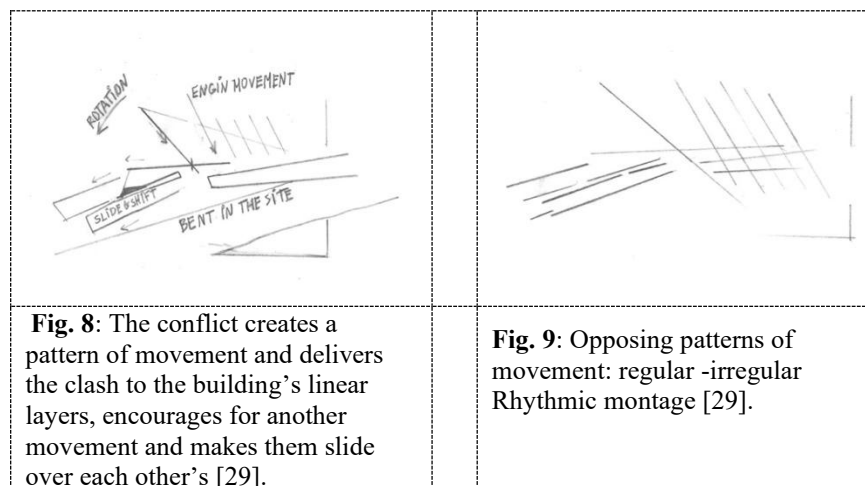
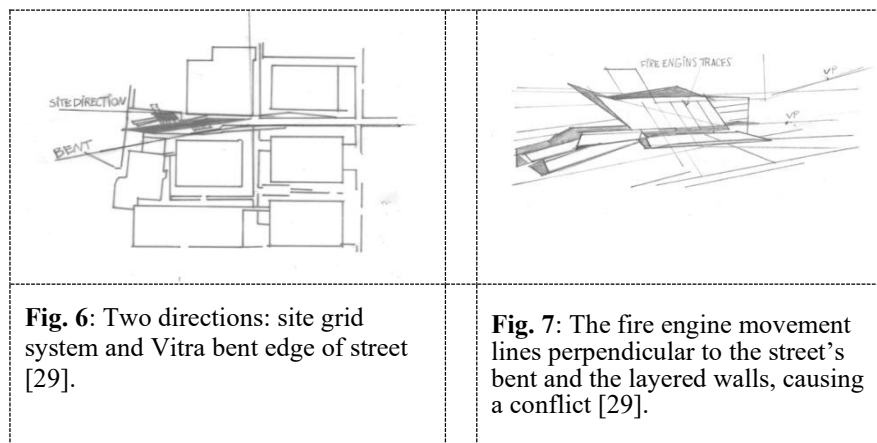
**Table 6:** Case study 1- Investigate Montage tools in the design process

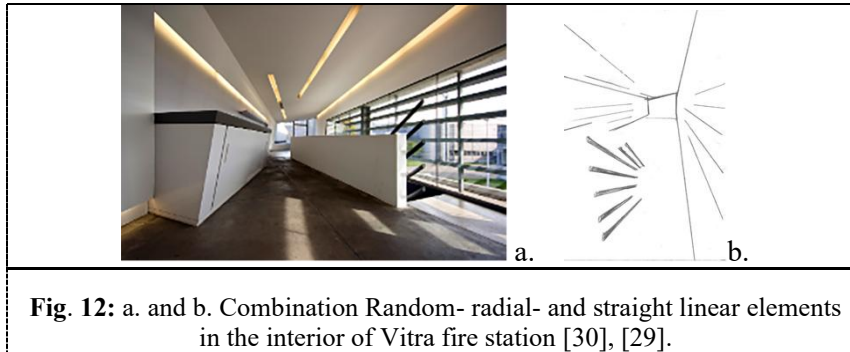
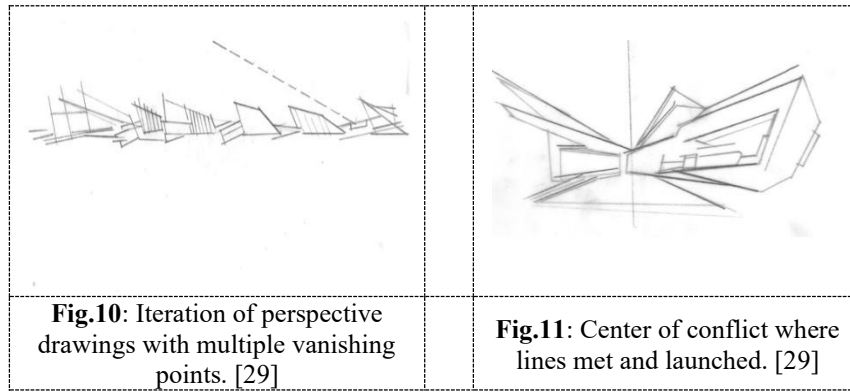
Description Number	Critique Quotes related to Montage elements and Scenes’ descriptions
1	<p><i>“Lines inscribed in the pavement reflect the movement of the building’s intended occupants: tracks curve out of the garage meant to house fire engines, while other paths hint at the choreographed exercises of the firemen. Even the walls of the building seem poised to slide past each other; in the case of the garage, two large panels actually do.” [25]</i></p> <p><b>Researcher’s Comments</b></p> <p><b>Rhythmic Montage elements: Tension brought from the street bent, Figure 6, caused two types of opposite movements, fire engines perpendicular on the main direction of the walls and site landscape. This clash encourages and generates attempts to the next movement; it delivers the clash to the building’s linear layers and makes them slide over each other’s and punctures the linear layers to provide openings.</b></p> <p><b>Rhythmic Montage: Regular/Random, see [Tab. 4] and Figures 8 and 9.</b></p>
2	<p><i>“The building both opens and shrinks back. Like the point of a needle, a thirty-metre-long cantilever roof projects over the vehicle room; it then changes into the binding framework of the first floor and recreation and work rooms extend radially.” [27]</i></p> <p><i>“... Each of the shifted surfaces unites, rising and curved, convex and falling, a whole bundle of directions.” [27]</i></p> <p><b>Researcher’s Comment</b></p> <p><b>Rhythmic montage elements: a change in movement direction due to the shifted surfaces in all directions.</b></p> <p><b>Rhythmic Montage: Regular/Random, see [Tab. 4] and Figure 9.</b></p>
3	<p><i>“Each element of the interior adds to the feeling of movement in the building as neighboring elements contain lines that run parallel, and the perception to depth is tampered by adding slanted planes onto sides of the wall, making each room seem even larger. Also each element featured is kept simple in terms of detail, elements are comprise just as volumetric prisms.” [28]</i></p> <p><b>Researcher’s Comment</b></p> <p><b>Tonal Montage elements are available (opposite textures): the linear lighting fixtures and the slim linear elements run in every direction were superimposed on neutral trapezoidal linear volumes with minimal details, Figure (12).</b></p> <p><b>Rhythmic Montage regular/ Random, see [Tab.4]</b></p> <p><b>Researcher’s Comment</b></p> <p><b>Over tonal montage: combined Rhythmic and Tonal Montage.</b></p>

Assuming the site's dominant role in creating the field, the two case studies revealed that the site enabled the conceptual design by providing the essential conflict that initiates the design process. This conflict was then translated into the building and utilized as the field's centre of gravity. Both projects' compositional elements were derived from the site of the project. For the Vitra fire station, revert to [Tab. 5], the design incorporated the geometry of adjacent sheds and the morphological shapes of nearby farms, as shown in Figure 3. In contrast, the Contemporary Art Centre utilized urban elements like sidewalks and the city grid, maintaining them in simple, neutral, and abstract shapes, as shown in [ Tab.7] and Figure 13.

For the assumption of inherited montage elements in Hadid's generative techniques, the results of the montage elements are as follows:

The presence of montage elements was identifiable in both cases. The Vitra Fire Station particularly demonstrated a direct correlation between the distortion generative technique, shifted shapes due to iteration of perspectival drawings [Tab. 5], and the rhythmic montage [Tab.6]. The conflict of opposite directions established a scenario of action-reaction, which encouraged the next move. The distortion technique's multiple vanishing points orchestrated the orientation of tilted and shifted geometries, producing the building's dynamic rhythmic scenes as shown in Figures 8 and 9. In addition, using multiple vanishing points and the iteration of perspectival drawing creates a proliferation of lines; see Figure 10. They developed a set of drawings and created the three-dimensional volumes from which Hadid selected her preferred ones. The tonal montage was achieved through scattered, slim, leaner lighting slots on abstract trapezoidal volumes, adding another compositional layer to the interior scene, see Figure 12. This created a tonal montage superimposed upon the rhythmic foundation, collectively resulting in an over-tonal montage.





Contemporary Art Center

For the Contemporary Art Centre, Hadid’s sketches revealed calligraphic techniques, see Figures 15 and 16, achieving field seamlessness through continuous “Urban Carpet” lines and rotated gallery lines around central points. The final design translated these curvatures into geometric upper-level volumes using a jigsaw puzzle analogy [Tab.7].

The Contemporary Art Centre similarly revealed a correspondence between calligraphic techniques and rhythmic montage, horizontal/ vertical, and zigzag/ rotation, see Figures 13 and 14, and [Tab. 8]. The calligraphy technique effectively developed varied rhythmic scenes through shifting flow patterns, transitioning from horizontal to vertical movements, then spinning around a central point. Tonal montage effects were equally evident through contrasting spatial elements, heavy-light, and solid-void, as shown in Figures 17 and 18, in both interior and exterior spaces. Moreover, the landscape generative techniques in Hadid’s sketch connected the ground with the upper vertical levels through a series of graphical textures: stippling and spiralling lines, as shown in Figure 16. This technique presented space continuity and overlapping despite the variety of exhibition levels and contents. The continuity was represented and transformed into volumetric communication elements: zigzag-like stairs flying on a wrapped smooth carpet wall, connecting the floors vertically and impressing the effects of opposite visual graphical tones.

The combination of tonal and rhythmic montage elevated the compositional strategy to an over-tonal level, particularly when viewing through the carpet voids from upper galleries to lower levels.

These important findings showed the coordination and strong tie between Hadid’s generative methods and montaging scenes.

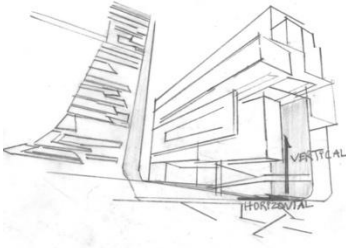
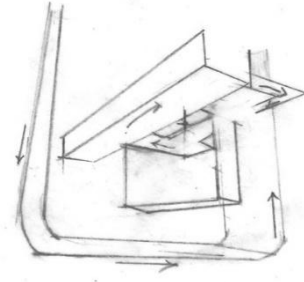
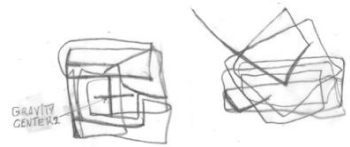

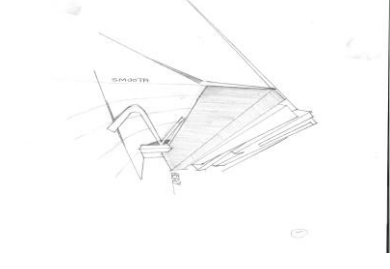
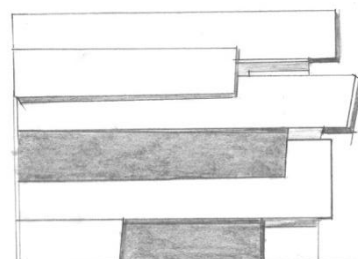
**Table 7:** Case Study 2- Explore the site's role in developing the dynamic field

Vocabularies of the design process	Quotes, texts, and Descriptions
Scanning the forces of the site and tension activation	<p>-“It lay along a pedestrian route running from the nearby Fountain Square to the Aronoff Center for the Arts across the street, ensuring a constant flow of people.” [31]</p> <p>-“...Despite its central location, the CAC was virtually invisible from the street.” [31]</p>
<p><b>Researcher’s Comment:</b>  <b>The Fountain Square, Rosenthal Museum, and Aronoff Centre museums face a conflict between pedestrian flow routes and city grid planning, with no direct connection, see Figure 5.</b></p>	

Create the content of the setting	<p><i>"Read as an exploded axonometric study, the drawing presents each level of the building in a sequence that emphasizes its diversity with respect to one another. A series of lines, varying in thickness, some dotted, some spiralling, connects the levels, see Figure 16. These represent the features intrinsic to the building and its site—the interior circulation system, street traffic, views, and solar and geological forcefields."</i> [32]</p> <p><i>"Hadid's vision of connecting the building to the urban core is seen in the glass façade of the lobby and the Urban Carpet—the continuation of the concrete sidewalk, gallery floor, and curve up the north wall of the building."</i> [31]</p> <p><i>"An 'urban Carpet' was conceived to create a simultaneously horizontal and vertical composition—as if the city's grid had been curved upward."</i> [5]</p> <p><b>Researcher's Comment:</b></p> <p><b>City grid, street sidewalks, and street infrastructure are used. See Figures 13 and 14</b></p>
Create the centre(s) of gravity(ies)	<p><i>"... 'Unfolded Site Study' literally presents the flow of the urban carpet, which, as realized, begins at the sidewalk in front of the building and curves upward at the back of the building—the horizontal floor rising to become the vertical wall."</i> [32].</p> <p><i>"In the drawing, the fragmented lines that break up the building's interior present an abstract view of the Center's stair ramps, dividing the gallery spaces into odd geometries."</i> [32]</p> <p><i>"...The entire building is thus in contact with the carpet, and through this connection, the entire building is an extension of the city."</i> [32]</p> <p><i>"...The gallery spaces were driven by another idea: The Jigsaw, ...the variegated intersections between the volumes and the voids between them could be viewed as a three-dimensional puzzle."</i> [31]</p> <p><b>Researcher's comment:</b></p> <p><b>Two gravity centres:</b></p> <p><b>The volume where the extended horizontal outdoor pedestrian way and the lobby vertical rear wall meet, see Figures 13, 14 and 15</b></p> <p><b>The ramp and vertical wall formed the center of gravity, connecting everything.</b></p> <p><b>2. Jigsaw puzzle center: the geometric volumes of the gallery rotate and intersect around a central stair void. Figure 15</b></p>
Use Analogy & Narrative scenario	<p><i>"...While the 'Urban Carpet' concept informed the design of the ground level, the gallery spaces were driven by another idea: the 'Jigsaw Puzzle.'" [31]</i></p> <p><b>Researcher's comment:</b></p> <p><b>Two analogies: Urban Carpet and Jigsaw Puzzle</b></p>
Use generative techniques	<p>See Hadid's free hand sketches of the Jigsaw puzzle published on the website of Zaha Hadid Architects. Com. [34]</p> <p><b>Researcher's comments:</b></p> <p><b>Hadid used calligraphy to create upper galleries with geometric rectangular forms around a central communication core She transformed calligraphic curved lines into geometric forms using sidewalks and streets' rectilinear shapes, Figures 13, 14, 15, and 16</b></p> <p><b>Figure 16 illustrates the continuity of spaces in vertical direction where the spaces overlapped and boundaries dissolved; she is establishing for vertical open superimposed volumes using graphical painterly language. Accordingly, the Landscape technique is available.</b></p> <p><b>Landscape technique, see [Tab. 3].</b></p>

**Table 8:** Case study 2- Investigate Montage tools in the design process

Description Number	Critique Quotes related to Montage elements and Scenes' descriptions
1	<p><i>"The second aspect is that of anti-gravity- recalling Magritte's suspended rock. This is the tension that is created between gallery spaces that appear to be carved from a single block and their lightness as they hover over the lobby."</i> [5]</p> <p><b>Researcher's Comment:</b></p> <p><b>Tonal Montage elements: Heavy/Light, Figure 17, and Figure 14</b></p>
2	<p><i>"Facade studies for the CAC emphasise the geometrical and sculptural quality of the Center's exterior. Projecting out from the grid of the city block, the two one-of-a-kind facades mirror Hadid's concept of the CAC as a cluster of irregular volumes"</i> [32]</p> <p><b>Researcher's comment:</b></p> <p><b>The interwoven voids and solids are reflected clearly in the façade.</b></p> <p><b>Tonal Montage: Solid/void effect, Figure 18.</b></p>
3	<p><i>"An 'urban Carpet' was conceived to create a simultaneously horizontal and vertical composition..." [5]</i></p> <p><i>"..The ramp-like stairs at the back of the building zigzag against the Urban Carpet wall, guiding visitors and allowing multiple views into the Jenga-like galleries and out onto the cityscape."</i> [33], see Figure 17.</p> <p><b>Researcher's comment:</b></p> <p><b>Rhythmic Montage: Horizontal/Vertical Figure 13</b></p> <p><b>Rhythmic Montage: vertical stairs' zigzag movement/ upper floorings' rotation around a centre Figure 14</b></p> <p><b>Tonal Montage: Two visual patterns, visual zigzag pattern and visual smooth moving background, Figure 17</b></p>

	
<p><b>Fig. 13:</b> Hadid's "Urban carpet" sketches showing horizontal vertical direction, street elements brought inside the building [35].</p>	<p><b>Fig. 14:</b> Continuation of horizontal urban carpet to upper flooring, then rotation, upper galleries appear like heavy rock floating in the lobby [35].</p>
	
<p><b>Fig. 15:</b> sketches of the jigsaw analogy using calligraphy technique [35].</p>	<p><b>Fig. 16:</b> Hadid's sketches showing continuity of spaces in vertical direction where the spaces overlapped and boundaries dissolved [32].</p>
	
<p><b>Fig. 17:</b> Two tonal effects: heavy galleries floating over the lobby impressing heavy – light tensional effect, and zigzag stairs against smooth carpet wall. [35]</p>	<p><b>Fig. 18:</b> Solid- void design in the façade of the contemporary art centre. [35]</p>

### Design process findings

dealing with the process stages, in both cases, while the site played a crucial role in establishing the architectural narrative of conflict potentials, the generative techniques created the field, and functional requirements and programmatic demands contributed to narrative development; the primary voice told the story of inhabitants engaging with the spaces.

While the generative technique created and controlled the field's seamlessness through specific tools, both the generative technique and analogies guided the creation of the building's final form. In Vitra Fire Station, compressed lines converge at a binding point (where the fire engines perpendicularly meet the wall), then radiate outward, using a "frozen explosion" analogy to narrate the spatial scenario. Similarly, in the Cincinnati Contemporary Art Museum, while calligraphy and landscape generative techniques guided and created the field's elements horizontally and vertically, the jigsaw analogy shaped the exhibition's spatial elements.

Similarly, the calligraphy generative method in the contemporary art centre created continuity and differentiation in the movement from outside to inside, from horizontal to vertical, and from straight to rotation. This change in the pattern of movement is read as a rhythmic montage. The conflict between the horizontal flow of movement and the vertical rare wall planned for a new scene of stairs hovering inside a flowing vertical volume. And the rotated exhibition floors in the upper levels came third.

Finally, it is of note that the differentiation in viewer perception is created through the building's integration with the urban fabric elements and the integration of form-ground in both cases, findings unlike those of Youngjin Lee's study [2].

## 6. Conclusion

Hadid never mentioned using montage as a procedure for her design process; however, in both cases, this paper captured the presence of montage elements of all main types: rhythmic, tonal, and over-tonal. The main finding of this research was that montage elements are incorporated into generative methods due to the similarities between Hadid's generative methods and montage techniques. The correspondence between rhythmic montage, distortion, and calligraphy generative techniques is due to the change in direction of movement created by the generative methods. The conflict's effect as an action has been demonstrated by multiple reactions that follow; for Hadid, conflict is a strong force that scatters the layers, perforates the walls, or turns the floor vertically upward, then spins. For the rhythmic montage, the conflict between opposing directions develops in the next scene.

The tonal montage, underlined by and corresponding with the landscape generative method, is responsible for creating a visual transformational sensory impression. This paper found that the conflict in tones is responsible for feelings and emotional effects that trigger meaning rather than providing potential for the next move or scene; it is irresponsible for the continuity of the next scene. Rather, it adds emotional value to the scene itself.

The other aspects of correspondence are found among the montage types. There was a corresponding tonal montage and rhythmic montage in both cases. The seamless integration of form, site, and movement is achieved through the correspondence of tonal and rhythmic montage, which confirms the effectiveness of Hadid's methods in raising the architectural visual and spatial experience to an over-tonal multi-sensory level.

Analogy shaped the ideas indirectly and supported the continuity of scenes in her projects. Hadid used analogies to describe a thing in process to be or an action taking place, to guide the explosion, distortion, calligraphy lines, and directions.

To continue the sequence of scenes, Hadid employed scenarios of action and reaction and narrated stories for her abstracted characters.

Finally, the established theoretical framework and findings provide a foundation for investigating additional montage types, particularly intellectual montage, which focuses on user interactions and interpretation. Hadid fundamentally believed her spatial designs should liberate users' imagination rather than impose conventional spatial paradigms.

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