DANCER'S SPATIAL NEEDS THROUGH THE LENS OF BALLET MOVEMENT ANALYSIS: PERCEPTION OF SPACE IN THE CASE OF THE BALLET "GISELLE"

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Approval sheet of the Thesis

This is to certify that we have read this thesis entitled **"Dancer's spatial needs through the lens of ballet movement analysis: Perception of space in the case of the ballet "Giselle""** and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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ABSTRACT

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This thesis takes inspiration from the connection between architecture and the performing arts. It explores the relationship between body movement and architectural space through the analysis of the ballet "Giselle." By integrating elements of architecture, dance, design theory, and digital arts, the aim is to evaluate whether current spatial design standards sufficiently accommodate diverse movements, analyzing this by making additions to the already used methods in studying movement and spatial organization. The methodology involves an analysis of "Giselle" performances using motion capture technology and 3D modeling. This approach is compared with traditional movement notation systems like Laban Movement Analysis and Benesh Movement Notation. The integration of motion capture provides precise, real-time data, offering a deeper understanding of how different spatial environments impact dance movements. The findings reveal differences in movement dynamics between traditional theater settings and open, obstacle-free spaces. Interviews with dancers provide qualitative insights, reinforcing the quantitative data. The results underscore the importance of designing flexible and adaptable spaces that can accommodate a wide range of movements and activities. Overall, this research contributes to a deeper understanding of the interplay between architecture and the performing arts, offering new possibilities for innovative and responsive design solutions that enhance human movement and experience.

Keywords: *body movement, performing arts, space interaction, architecture and choreography, motion capture, 3D modeling*

ABSTRAKT

KUPTIMI I NEVOJAVE HAPËSINORE TË BALERINËVE PËRMES ANALIZËS SË LËVIZJEVE TË BALETIT: PERCEPTIMI I HAPËSIRËS NË RASTIN E BALETIT “GISELLE”

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Kjo tezë eshte frymëzuar nga lidhja midis arkitekturës dhe arteve skenike. Eksploron marrëdhënien midis lëvizjeve së trupit dhe hapësirës arkitekturore përmes analizës së baletit "Giselle." Duke integruar elemente të arkitekturës, baletit, dizajnit dhe arteve digjitale, qëllimi është të vlerësoje nëse standardet aktuale të dizajnit hapësinor përmbushin mjaftueshëm lëvizje te ndryshme. Kjo analize është kompletuar duke shtuar faktorë të ndryshëm në metodat tashmë të përdorura në studimin e lëvizjes dhe organizimit hapësinor. Metodologjia përfshin një analizë të performances së "Giselle" duke përdorur teknologjinë e kapjes së lëvizjes dhe modelimin 3D. Kjo qasje krahasohet me sistemet tradicionale të notacionit të lëvizjes si Analiza e Lëvizjes Laban dhe Notacioni Benesh. Integrimi i kapjes së lëvizjes siguron të dhëna precize dhe në kohë reale, duke ofruar një kuptim më të thellë të ndikimit të mjediseve të ndryshme hapësinore në lëvizjet e vallëzimit. Rezultatet tregojnë ndryshime në dinamikat e lëvizjes midis mjediseve tradicionale të teatrit dhe hapësirave të hapura, pa pengesa. Rezultatet theksojne rëndësinë e dizenjimit të hapësirave fleksibile dhe të adaptueshme që mund të akomodojnë një gamë të gjerë lëvizjesh dhe aktivitetesh. Në përgjithësi, kjo tezë kontribuon ne analizat e ndërveprimit midis arkitekturës dhe arteve skenike, duke ofruar mundësi të reja dizenjimi që përmirësojnë lëvizjen ne hapsirë dhe përvojën e individëve të ndryshëm.

Fjalët kyçe: *lëvizja e trupit, artet skenike, ndërveprimi në hapësirë, arkitektura dhe koreografia, analiza e levizjeve, modelimi 3D*

To the dreamer and doer within me,

Thank you for turning aspirations into accomplishments.

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INTRODUCTION

1.1 The impact of body movement in a built environment

The research explores the connection between body movements and architectural space examining how this integration can result in environments that're both visually appealing and functional. This thesis is concentrating more in the performing arts and it specifically studies the dancer's movements in the ballet Giselle. Since designers now-day work with set dimensions for different spaces, the movements of the dancers that will incorporate these spaces are not studied enough. Different dance numbers have different choreographies and different numbers of people on stage. Sometimes the stage is not big enough to incorporate these movements and the dancers and choreographers have to improvise by changing the choreography. As a result, this thesis it emphasizes the importance of adapting a design approach that takes into account human movement dynamics to create spaces that provide functionality and accessibility.

1.2 Merging Architecture and Performing Arts through the Study of Ballet Movements

The objective of this thesis is to explore the connection between movement and architecture, investigating how body movements can be studied and used throughout the design process to help create spaces that fulfill the needs of the people incorporating it. By analyzing the human movement and the relation to spatial organization this thesis also suggests new ways in analyzing movement in space, taking inspiration from the already existing methods. By understanding how the movements work, we will be able to design spaces specifically for what their function will be. Through analyzing the movements of the dancers in the Ballet "Giselle", this thesis aims to show how much of a part the body plays in shaping architectural spaces

and also assess whether existing spatial design standards adequately support diverse movements. This will be achieved by enhancing current methodologies used in the study of movement and spatial organization, aiming to provide architectural insights that can inform the creation of spaces that fulfill the needs of their users.

1.3 Methodology

The methodology used in this study is multidisciplinary and combines a variety of disciplines such as architecture, dance (specifically ballet), design theory and digital arts. This approach combines human movement, geometric analysis, and the interactivity of modern technology to redefine spatial experiences, with the aim of giving insights and understanding the engagement between the movement and spatial organization.

The process began with the literature review. This phase involved examining projects that explore the relationship between movement and architecture while analyzing their design approaches. Through this investigation we can identify important concepts and design choices. One important step in the literature review was analyzing dance visualization tools and motion capture techniques. After studying different techniques, the advantages and disadvantages of each one were analyzed and the input was used in improving the method used in this thesis, by adding new and improved methods in analyzing movement according to spatial organization.

The next step was starting with the analysis and using the inputs from other methods in the study. Firstly, I chose the ballet Giselle for the analysis. I filmed the dancers in the stage of the National Theater of Opera and Ballet. The next step of the study was finding two ballet dancers who were willing to be part of our project in order to separately film them in another site that is not the theater stage. I filmed them performing movements from different acts of the ballet Giselle in an open space, in the campus of “Epoka University”, without any isolated areas allowing the dancers to have enough room for any movement without any restrictions. Using a drone, the dance sequences were captured in top view and at the same time in front view.

Expanding on the use of the rotoscope technique this research incorporates motion capture technologies and 3D software's to understand how dance influences spatial dynamics. The first step of the analysis was taking each dance sequence filmed and import the pre-recorded data in Rokoko. Rokoko is a technology specialized in motion capture solutions. After uploading the videos, the software will process the data from the sensors and track the movements of the performer's body. It visualizes the skeletal structure and geometrical shapes representing the body. The next step was making the necessary adjustments to the data, such as cleaning up any noise or errors in the tracking data. After finishing with the adjustments, I exported the videos in 3ds Max format and also configured the necessary export settings, such as frame rate, scale, and included data types. After exporting the data, Rokoko will generate the file containing the tracked movements and geometrical shapes.

The next step was importing the videos in 3ds Max, making sure that animation and skeletal data are correctly mapped to the 3D model within 3ds Max. After that I assigned the imported motion capture data to the 3D character models in 3ds Max ensuring that the animation is correctly applied and the movements are accurately represented. After that 3ds Max tools were used to refine the animation and enhance the movements. The next was setting up the camera angles, lighting, and rendering settings within 3ds Max. The final step in 3ds Max was rendering the animation sequence to create the final video. After finishing with 3ds Max, I imported the videos in Photoshop after effects and used the app to add sound effects and background music. There were some unnecessary images in the background that were removed. Lastly the textures, colors and any sudden movements in the videos were fixed. After rendering the videos once again, the videos were ready to be exported and used.

The next step was the comparative analysis between the sequences filmed in the NTOB and the sequences created using the methods explained above. After getting the needed results an interview was conducted with the two dancers, which provided additional insights, supporting the findings of the study.

This approach not only advances the understanding of the relationship between movement and space but also offers new possibilities for the design and analysis of dynamic spatial experiences.

1.4 Scope of work

This thesis made a thorough examination of existing literature regarding body movement and architecture. Various articles and case studies were analyzed based on the principles that connect movement and architecture. Special attention and analysis were given to the connection between the movement in performing arts and how to incorporate this in architecture. The project involved filming and analyzing dancers' movements using rotoscope techniques, inspired by movement theorists like Laban and Benesh, to understand how their bodies navigate and use space. Comparative analysis were conducted by observing the ballet “Giselle” performances in the National Theater of Opera and Ballet and in an open space without obstacles. The aim is to evaluate whether current spatial design standards sufficiently accommodate diverse movements, doing this by making additions to the already used methods in studying movement and spatial organization, in order to give architectural insights that can help in the creation of spaces that fulfill the need of the people that will incorporate that space. The findings provide practical recommendations for architects on incorporating movement analysis into design processes.

1.5 Organization of the thesis

This thesis is divided in 7 chapters. The organization is done as follows: In Chapter 1, the problem statement, thesis objective, methodology and scope of works is presented. Chapter 2, includes the literature review regarding the materials needed to come to the conclusion about the relationship between architecture, dance, movement and geometry. Including case studies about the implementation of movement and dance in architecture design. Chapter 3, explains dance visualization and some methods used in analyzing movement. Chapter 4, consists of the analysis of the movement in the ballet Giselle in a comparative way between the movement at TOB and in an open space. In Chapter 5 is the discussion. Chapter 6 consists of the conclusions and recommendations for further research. In Chapter 7 are stated the references.

CHAPTER 2

LITERATURE REVIEW

Introduction

Dance, movement and architecture share a bond that goes beyond their surface differences. They come together by combining space, rhythm and the human experience. Dance and movement are able to express how the body interacts with space. This collaboration emphasizes the need of taking into account both the physical and experiential aspects of creating spaces where architecture also responds to human movement. This connection has been explored in studies and projects by visionaries like Rudolf Laban, who focused on dynamics in dance theory as well as architects like Zaha Hadid, whose designs capture the idea of motion. The intersections between dance, movement and architecture offers opportunities for innovation and improvement in the way we design spaces. It offers a perspective on the design of space in relation to our movements and how we move throughout that same space.

2.1 Architecture and Ballet

The connection, between dance and architecture is an exploration of space and movement where each discipline learns from and completes the other. Dance, with the way that the bodies move through space, provides a unique perspective in how to perceive and understand architectural shapes and spatial compositions. Similarly, architecture by creating different shape combinations helps and inspires the choreography of movement. This interplay puts upfront the significance of both fields in studying how space is created and occupied, and how movement interacts within that space (Foster, 2011).

Dance and architecture share a vocabulary in terms of form, line, balance and rhythm; however, the way that they are expressed through time and space is different. This

goes beyond fixed forms to embrace the nature of activity (Pallasmaa, 2012). The concept of " choreography" takes inspiration from the idea that the design process has to consider how bodies move through spaces to create shapes that form movement.

Collaborations between choreographers and architects reveal possibilities, for spaces that're not only functional but also aesthetically pleasing. These spaces encourage individuals to engage with their surroundings in different ways. For instance, when architect Frank Gehry collaborated with choreographer Benjamin Millepied, their collaboration resulted in performances that blended with the elements of the venue. This collaboration gave the audience an insight of dance and design come together. (Brandt, 2010).

Moreover, architects can benefit from employing spatial analysis techniques used in dance such, as methods used by Rudolf Laban. These techniques offer tools for understanding and designing spaces that take inspiration from movement. They underscore the significance of considering how the human body experiences architecture (Laban, 1971).

To understand the connection between architecture and ballet we must first examine in detail how elements like shape and proportion can be intertwined in both fields. Shape and form can be easily referred to as spatial expression and human motion, while architects use shapes and forms to design different spaces, ballet relies on the body to show the stories through movements within a given space (Leach, 2012). This mutual relationship has led to collaborations between architects and choreographers resulting in spaces and performances that challenge conventional perceptions. Knowing this relationship between movement and form, architects and choreographers explore how ballet can influence design while architecture can provide a support that enhances the narrative essence of ballet presentations.

2.1.1 Shape and form

The exploration of shape and form acts as a link between architecture and ballet showcasing a connection between spatial expression and human movement. In

both fields the arrangement of shapes and forms plays an important role in the design and aesthetic principles. Architects play with shape and form to create sustainable and visually attractive spaces while ballet through dancer's body and movement in space tells stories. (Leach, 2012).

The collaboration between architects and choreographers has resulted in performances and spaces that push the boundaries of our understanding of shape and form. For instance, the dynamic interplay between movement and the static environment in the works of choreographer George Balanchine and architect Santiago Calatrava exemplifies how ballet can serve as a source of inspiration for creating architectural forms. Similarly, architecture can provide a stage that complements and enhances the storytelling aspect of ballet performances (Picon, 2010).

Moreover, ballets principles of shape and form such as line, extension and silhouette find their place in design through the creation of guiding lines and contours that direct both the eye and movement within space. This shared vocabulary encourages an approach to design and performance while giving importance to the significance of dynamics and how our bodies interact with their surroundings (Krautheimer, 1986).

2.1.2 Symmetry and Proportion

In architecture symmetry and proportion guide the arrangement of space and form to create a sense of order. Similarly in ballet the alignment and proportion of movements and poses contributes to a harmony that enhances the impact of a performance.

The use of symmetry in architecture can be traced back to civilizations when it was used to show perfection, stability and beauty in structures. This concept is mirrored in ballet where choreography combines elements along with the alignment of the dancer's bodies, which are key components for capturing the audience's interest (Vitruvius, 1960). Proportion involves maintaining relationships between various parts within a structure or composition. This ensures that each element is appropriately balanced with respect to the whole. Vitruvius emphasized this aspect

by drawing parallels between human body proportions and those found in designed buildings.

The idea of seeking perfection through the proportions of a dancer's body and the spatial arrangement of movements and formations is ingrained in ballet (Foster, 2011). Similarly, architects like Le Corbusier have studied the concept of the "Modulor," which aims to bring an approach to modern architecture by using proportions based on the human scale (Le Corbusier, 1986). This system shows the principles found in ballet, where movement scope and scale are defined by the dimensions and capabilities of the body. These principles not only enhance the appeal of buildings and performances but also demonstrate a deeper understanding of human perception and beauty. It enables a dialogue between our built environment and human expression making us see and understand the space in a different way.

2.1.3 Rhythm and Flow

In ballet rhythm and flow are naturally ingrained in the choreography guiding dancers through time and space. Similarly in architecture rhythm can be found in the repetition of elements, patterns and the arrangement of spaces. Flow represents the movement of people within environments enabling a coherent and intuitive experience of the built structures (Zumthor, 2006).

Architectural rhythm is often achieved by repeating elements such as columns, windows or structural motifs. This creates a rhythm that guides the person's attention and movements within a space. (Ching, 1996). In ballet rhythm is not present in the music accompanying dancer's movements but, in their patterns and sequences. These movements reflect both the intentions of choreographers and the narratives during performances. The transitions, between movements in ballet are quite apparent and create a storyline that engages the viewers on an emotional level. (Foster, 2011).

When it comes to architecture the concept of flow is about designing spaces that allow for intuitive navigation encouraging natural movement that aligns with human behavior and needs. This can be observed in how rooms are laid out, how buildings are organized or even in the design of spaces. The goal is to create an

environment that feels connected and easy to navigate. Similarly in ballet flow directs the coordination of dancers in space and the transition between sequences. All these elements contribute to a performance that feels unified and harmonious.

The interplay between rhythm and flow emphasizes the significance of time, movement and sequence in creating experiences within both disciplines. Both architects and choreographers leverage these concepts to design spaces or performances that reflect the experience by highlighting the connection between surroundings and our bodies in motion (Frampton, 2007). Both disciplines heavily rely on rhythm and flow to establish a conversation, between form and function, space and movement. By delving into these interconnections, professionals in both disiplines have the ability to produce designs that strike a chord on a scale going beyond the limits of their fields.

2.1.4 Narrative and space

The relationship, between narrative, space, architecture and ballet is complex. These disciplines mutually shape each other experiences and meanings. In both architecture and ballet narrative plays a role in engaging, informing and inspiring the audience or inhabitants. In architecture narrative becomes a part of the design process as it influences the form, function and organization of spaces. Buildings and urban environments have the power to communicate stories of history, culture and community values while shaping identities and experiences. Renowned architectural theorist Christian Norberg Schulz emphasized the significance of "genius loci," or the spirit of a place. He suggested that architecture should reflect and enhance the narrative to its location (Norberg Schulz 1980).

Similarly, ballet employs narrative to guide choreography set design and music composition. Through dance movements and spatial arrangement on stage ballet performances, like Tchaikovskys "Swan Lake" or Prokofievs "Romeo & Juliet" narrate tales of love stories combined with conflicts resulting in journeys.

Space plays a role, in both architecture and ballet as it provides the backdrop for unfolding narratives. In architecture space is defined by structures, forms and the interplay of light and shadow. It guides movement and it draws attention to different

areas. Renowned architect Frank Lloyd Wright manipulated space to create effects in his buildings like the Guggenheim Museum in New York with its silhouette levels (Wright, 1943).

In ballet space controls both the stage and the story that dancer's tell. Choreographers such as George Balanchine revolutionized ballet by highlighting the dances elements. They used body geometry and spatial relationships between dancers to create narratives (Balanchine & Mason 1975).

The connection between architecture and ballet lies in their shared emphasis on using space as a means of storytelling. Both disciplines consider how individuals move through and experience space—be it dancers on a stage or people navigating through buildings or urban environments. This consideration of movement informs design choices and choreography amplifying narrative impact and emotional resonance.

The connection between narrative and space in both architecture and ballet is deeply intertwined, with each influencing and enhancing the other. Through manipulation of space and through the integration of narrative elements, architects and choreographers create designs that captivate, educate and emotionally resonate with their audiences. Exploring these interconnections provides insights into how we perceive and engage with our surroundings whether it be during a ballet performance or, within the built environment.

2.1.5 Spatial Awareness

Spatial awareness plays a significant role, in both architecture and ballet providing insights into how humans perceive and interact with the surrounding space. This skill refers to an individuals' capacity to be conscious of their position in space comprehend the relationship between objects in their environment and navigate arrangements. In architecture spatial awareness influences the design principles that determine how buildings and spaces are planned to meet different requirements. Similarly in ballet dancers rely on awareness to execute movements maintain formations and synchronize with the surrounding space and other dancers.

In architecture spatial awareness is essential for creating environments that're not practical but also psychologically comfortable. Architects utilize this skill to design spaces that're easy to navigate while meeting the needs of their occupants and promoting well-being. For instance, considerations such as room arrangement, flow between areas and integration of light and views all stem from spatial awareness. By understanding perception of space architects can develop fulfilling environments that enhance user's experience.

Important aspects, in architecture that necessitate spatial awareness include:

-Considering Human Comfort and Proportions: Designing spaces that are tailored to the needs and movement of individuals.

-Facilitating Easy Movement: organizing spaces to promote intuitive navigation.

-Establishing a Clear Structure: Establishing a sense of organization and importance by arranging spaces. (Ching, 1996)

Ballet requires dancers to possess a heightened sense of awareness being fully conscious of their body position, in relation to the performance area and other dancers. This awareness is important in order to maintain formations and executing choreography. Dancers undergo training to better understand the spaces that surround them, making them move with precision often in tightly synchronized groups.

Key elements of awareness in ballet are;

- Body Consciousness, which helps in understanding the positioning and movement of the body within the given space alongside other dancers.

-Spatial Arrangements, which is executing planned patterns and formations.

-Temporal Coordination in order to synchronize movements with music, dancers and changes in the surrounding space.

The connection between architecture and ballet lies in their attention on awareness, as a means to navigate and understand spaces. Both fields share an understanding of how space can be organized and perceived. Architects create the spaces while dancers bring those spaces to life by showing the potential that movement has within these architectural settings. This interaction shows the significance of

awareness as a link between the static and the dynamic. The connection between architecture and ballet serves, as a reminder of how space can shape behavior and change our overall experience.

2.2 Body Movement and Spatial reflection

The interplay between body movement, spatial reflection and their integration in ballet and architecture is a field of research that delves into how physical motion in space can influence and be influenced by the constructed environment. This connection is deeply rooted in our understanding of how humans perceive and interact with their surroundings as how these interactions are orchestrated and structured in both ballet and architectural design.

Body movement and spatial reflection studies the ways in which human bodies navigate through and engage with space, along with how these movements are perceived, mirrored and integrated across disciplines (Beisswanger, 2021). In ballet and architecture this interaction takes on the form of a dialogue between the dancer's body and the architectural space itself. It shapes the creation process, perception and overall experience within both art forms.

When dancers move across the stage, they in some kind of way by different movement and stage positions shape the audience's perception of the space. Although architecture and ballet are different, both art forms capture motion and harmony. Interactive elements in both fields highlight the importance of understanding spatial dynamics and human connections. By exploring these similarities, we gain insights into how human activities influence our perception of space and movement. This deepens our appreciation for both architecture and ballet, while also revealing the relationship between humans and their environments. Below, we'll delve into these elements further and explain how they connect to both disciplines.

Spatial Design: Ballet heavily relies on choreography—a sequence of movements within space—while architecture organizes space through design principles. Both disciplines establish patterns and flows within their realms resulting in a shared language of movement and form. Choreographers as architects work with

elements such as balance, symmetry, rhythm—albeit utilizing different mediums. This common vocabulary lays the groundwork, for exploring their interconnectedness (Soltani et al. 2019).

Perception and Experience: In ballet the movement of dancers, in relation to the stage, set design, impacts how the audience perceives space and reacts emotionally. Similarly, the way people navigate through spaces and interact with it influences their cognitive experience of those spaces. Architects like Steven Holl have emphasized the significance of phenomenology which's the study of experiences in space. This aligns well with the experiences created by ballet performances (Derya, 2004).

Dynamic vs. Static: While ballet is characterized by motion as dancers gracefully move across the stage architecture is often seen as static. However there exists a concept known as " music" that suggests architecture, much like ballet captures movement and rhythm in a form. Architectural designs by Frank Gehry exemplify this idea with their fluidity and dynamism challenging notions of structures while drawing parallels to the graceful movements of dance (Derya, 2004).

Interactive Spaces: Both ballet and architecture benefit from the understanding of spaces. In ballet performances interaction occurs between dancers themselves between performers and audience members as, within the performance environment itself. Similarly in architecture it involves how occupants interact with each other within layouts of spaces (Soltani et al. 2019).

The architecture of theater buildings, like the Palais Garnier in Paris demonstrates how various elements can enhance the ballet viewing experience by focusing on sightlines, acoustics and overall ambiance. Using the body as a reference point is crucial in both ballet and architecture (Plm, 2017). Ballet utilizes the dimensions and abilities of the body to determine movement possibilities while architecture considers human scale to establish proportions. This shared underscores the connection between these two disciplines as they both prioritize the human body in their design and performance.

In conclusion exploring the relationship between body movement, spatial reflection and their integration within ballet and architecture uncovers an interplay of discipline, creativity and human experience. By examining these parallels and interactions between these fields we gain an understanding of how space, movement and perception re-influenced by human activity. This interdisciplinary approach not enriches our appreciation for ballet and architecture. Also provides insights into the broader relationship, between humans and their surroundings.

2.2.1. Architectural Response to Dynamic Activities: Creating Flexible Spaces for Various Movements

Projects that interpret architecture through choreography have become increasingly popular. They not only offer a perspective on how movement is influenced within architectural contexts, but also raise important questions about authority, accessibility and the politics of space. This concept of mimicking ballet transitions in design brings attention to the underlying principles of organization in choreography. Architects and choreographers who have pushed the boundaries of thinking, such as the efficiency studies of the Frankfurt Kitchen and Le Corbusier's architectural promenade demonstrate how spaces can influence movement and vice versa (Beisswanger, 2021).

When we explore dances interpretation of space, we discover a connection between the physical form of architecture and the nature of movement. This becomes particularly significant when considering how ballet transitions can be replicated within spaces. Ballet, with its fluidity, precision and expressive movements provides architects with a vocabulary to create spaces that enhance user's experiences. The choreographic principles found in ballet—such, as sequencing, timing and flow—can inform design to produce spaces that encourage movement patterns evoke emotional responses and take people on a narrative journey through their physical surroundings (Beisswanger, 2021).

By regarding architecture as a type of choreography, architects can build spaces that accommodate different, extreme movements but also actively mold it mirroring the way ballet choreographers create sequences that navigate and articulate space

through dance (Beisswanger, 2021). This approach encourages an examination of how design is influenced by the human body in motion.

2.2.2. Spatial Flow and Choreography: Mimicking Ballet Transitions in Architectural Space

The examination of spatiality in architecture as discussed by figures like Prof. Douglas Vieira de Aguiar and echoed through the works of architects and theorists such as Schmarsow, Hildebrand, Frankl, Le Corbusier, Tadao Ando, Helio Oiticica Bernard Tschumi and Greg Lynn offers insights into the dynamic interplay between space, body and movement. This body of work provides a foundation for comprehending Spatial Flow and Choreography in architecture.

The idea of incorporating ballet techniques into design is rooted in the research and practices of experts, in both fields. Rudolf Labans analysis of movement and space provides a framework for understanding how architectural design can engage with the body and its surroundings (Laban, 1971). Architecture scholars like Juhani Pallasmaa emphasize the significance of sensory and embodied experiences advocating for spaces that actively involve the senses. When it comes to design, ballets principles can offer insights. Concepts like flow, balance and tension in ballet can be translated into strategies for creating interconnected spaces that promote natural movement flows. Similarly, the dynamic balance and tension seen in ballet poses can inspire forms and structures that have a sense of harmony and potential, for movement (Beisswanger, 2021).

The concept of spatiality places emphasis on the experience and observers movement, within space—a notion closely aligned with ballet choreography principles. Ballet relies on movements and precise transitions where dancers navigate and articulate space through their bodies. Similarly, architects like Schmarsow and Ando believe that considering the movement of the body is crucial in experiencing and understanding space. They suggest that architecture can be orchestrated, like a ballet to guide and enhance the user's experience (Beisswanger, 2021).

The concept of the promenade as advocated by Le Corbusier aligns with the transitions seen in ballet. In ballet dancers move purposefully through specific spaces. It mirrors how ballet choreographs movements to tell a story. Oiticica's work emphasizes how participants move through installations while Bernard Tschumi explores the disconnection between space and event. Both highlight the potential for architectural spaces to be designed with fluidity and dynamism to ballet performances. Tschumi suggests that actions define space much as spaces define actions, like how ballet movements and transitions are influenced by the performances spatial context (Charitonidou, M. 2020). Greg Lynn advocates, for forms based on motion, which supports the idea of incorporating ballet like transitions in architectural design. His suggestion that architecture should embrace an practical approach, to movement offers a foundation for designing spaces that are not just visually captivating but also inherently designed to facilitate seamless movement and interaction much like a ballet (Khachatryan, 2023)

By incorporating the principles of flow and choreography into design we encourage a more nuanced consideration of how people navigate and experience space. Taking inspiration from ballet transitions architects can create environments that foster a sense of continuity, rhythm and flow. This approach enhances the experience by orchestrating the movement of users enriching both the functional aspects of architectural design. Moreover, it deepens the connection between structures and human activities emphasizing architectures role as a backdrop, for live choreography.

2.2.3 Body Movement of the ballerinas and their spatial needs

Providing specific space dimensions for each movement is important to designing an optimal environment for ballet dancers. Below there are analyzed the dimensions and spatial requirements for key ballet movements:

For the Arabesque position, the dancer extends one leg behind while the other supports their weight, with arms usually extended. This movement requires significant horizontal and vertical space to accommodate the extended limbs. At least 2 meters (6.5 feet) in width and 2.5 meters (8 feet) in height are necessary (Brown, 2018). To ensure safety and freedom of movement, a minimum of 1.5 meters (5 feet)

of unobstructed space should be maintained around the dancer.

The Pirouette involves a complete turn of the body on one foot, with the supporting leg either straight or bent, and the other leg in a position such as passé. This movement requires ample horizontal space, with at least a 2-meter (6.5 feet) diameter for the turning area, ensuring no interference (Johnson, 2019). To facilitate smooth turning while preventing slips, the floor must have the appropriate friction. Additionally, a clearance of at least 1.5 meters (5 feet) around the turning area is essential.

A Jeté is a leap from one foot to the other, with one leg extended forward and the other backward in the air. This movement demands considerable vertical space and a clear path. At least 4 meters (13 feet) in length for the leap and 3 meters (10 feet) in height are necessary (Johnson, 2019). The landing area must be cushioned to absorb impact and reduce the risk of injury. A minimum of 2 meters (6.5 feet) of unobstructed space around the leap path should be ensured.

The Grand Plié involves a deep bend of the knees where the dancer lowers their body towards the ground while keeping their back straight and feet turned out. This movement needs enough horizontal space for the dancer to bend without hitting nearby objects. At least 1.5 meters (5 feet) in width is recommended, and a minimum of 1 meter (3.3 feet) of unobstructed space around the dancer is necessary (Brown, 2018). The floor should provide adequate cushioning to support the knees.

Pas de Deux Lifts are movements involving one dancer lifting another, commonly seen in partnered dances. This requires significant vertical and horizontal space to execute safely. At least 3 meters (10 feet) in width and 4 meters (13 feet) in height are recommended (Brown, 2018). The ceiling height must be sufficient, and the floor should offer stability and support. Additionally, a minimum of 2 meters (6.5 feet) of unobstructed space around the lifting area is essential.

In general, designing spaces for ballet dancers involves ensuring clearance and obstacle-free areas. Ballet dancers need unobstructed areas to perform movements involving extensions, jumps, and spins. Any obstructions can lead to injuries and limit the expression of the dance. Spaces should have minimal furniture, with mirrors on walls to create the illusion of a larger space and aid in alignment (Taylor, 2022).

The flooring in ballet studios must be specifically designed for dance, with the right amount of give (spring) to reduce the impact on dancers' joints. Sprung floors

are ideal for ballet, providing the necessary support for jumps and turns while minimizing injury risks. For small groups (5-10 dancers), a minimum area of 10 meters by 10 meters (33 feet by 33 feet) is recommended (Brown, 2018).

Ceiling height is another critical factor, especially for movements involving lifts and jumps. Studio and stage designs should incorporate high ceilings, typically no less than 3.5 meters (12 feet), but preferably 4 meters (13 feet) to accommodate these movements (Davis, 2020). The surface friction of the floor should be optimal to enable smooth turns while preventing slips. Harlequin or marley floors are commonly used in ballet studios, providing a consistent and safe surface for various movements (Brown, 2018).

Good acoustics are necessary for dancers to hear music cues clearly, which is critical for timing and coordination. The space should have sound-absorbing materials to prevent echoes and enhance the clarity of music and instructions (Lee, 2021). Proper heating, ventilation, and air conditioning (HVAC) systems should be installed to maintain an optimal temperature range of 20-24°C (68-75°F) and provide fresh air circulation, ensuring a comfortable environment for dancers (Green, 2022).

These dimensions and considerations help create a space that meets the physical and performance needs of ballet dancers, allowing them to practice and perform safely and effectively.

2.3 Stage Design

Stage design, also referred to as scenography plays a role, in the performing arts. The connection between stage design, architecture and ballet is profound. By combining principles of space, form and movement it tells a story and it also contributes to the aesthetic of a production. (Dance Theatre Between the Body-Space and Atmosphere in Architecture: Pina Bausch).

The relationship between architecture and stage design lies in their shared principles of manipulating and understanding space. Both disciplines focus on how spaces can shape experiences. Renowned architects and stage designers demonstrate an understanding of how physical structures can influence perception and behavior.

For instance, just like architectural spaces can make one feel welcome or confined, stage design through using techniques such as perspective, scale and

proportion changes and shapes viewers experience. Notable architects like Frank Gehry and Zaha Hadid are known for creating spaces that possess movement and fluidity—qualities that're also crucial in settings, like ballet performances. Furthermore, the use of materials, lighting and shadows plays a role, in both fields allowing designers and architects to shape a space (Serkan et al, 2021).

The design of the stage should fulfill to the requirements that ballet has. Additionally, it should support the narrative and thematic elements of the performance. Through different aspects such as lighting techniques and projections the stage can transform to put together different acts. Choreographer George Balanchine often collaborated closely with stage designers to ensure that his ballets visual elements were in alignment with his choreography (Leach, 2008). This harmony between movement and visual design holds significance in ballet as storytelling primarily relies on dance than spoken or sung words.

The history of ballet showcases iconic stage designs that have become inseparable, from their performances. For example, when Salvador Dalí collaborated with the Ballet Russe de Monte Carlo, on the ballet "Bacchanale " they brought a touch to stage design that had an impact on how ballet was perceived in the 20th century. These collaborations highlight the influence that integrating architecture and stage design principles has had on ballet (Kersten,2008).

In conclusion the interplay between stage design, architecture and ballet emphasizes the significance of visual elements in enriching both dance experiences. By incorporating principles stage designers create environments that complement and enhance the depth of performances. The collaboration among these disciplines continually pushes boundaries in performance arts resulting in captivating experiences, for audiences.

2.3.3 The need for floor space

"*Children and the man of primitive ages see the world through a bodily perspective, that is through physical experience. They see the amazing unity of all existence. Man of later times loses this view through his reflective delusions, and also because of his increasing tactile incapacity. He establishes stability in his mind as a contrasting partner to mobility. In this way he becomes unrelated to his surroundings which are,*

in the widest sense, the universe, and thus he loses his personality, which needs transgression from the I into the You so that he may be part of the harmonious order in the great and universal flux. However, there have always been and still are people who are obliged to practise and observe movement more closely. Friedrich Nietzsche "The Will to Power," 1883-1888.

Dancers are like ‘children and the man of primitive ages”. They perceive space physically. Dancers move through space, feel the space, relate to the space, and become one with the space. Architects on the other hand perceive space conceptually, like the ‘man of later times’(Kersten,2008)

The physical relationship of the dancers with the space places many demands on dance spaces. One of the most important requirements for dancing is floor space. Without a specific floor space, dancing is simply not possible. Depending on the floor area, the range of work and its execution are both dependent on each other. Large groups of dancers clearly need more space than small groups. However, some dance techniques require more space than others. The size of the floor depends on the choreography and the desired atmosphere in the theater.

Different dance techniques require different stages. Most classical ballet performances require deep stages, resulting in a more or less square stage. The depth of the stage emphasizes the perspectives of groups of ballet dancers. Most modern dancers prefer wider stages, resulting in a rectangular floor plan with longer diagonals (Kersten,2008). Modern dancers use the diagonals, because these are the longest straight lines to move over on the stage. Dancers need a larger wing space in comparison to actors, musicians or opera singers. They also need sufficient wing space to make their entrances and exits, often at great speed or carrying another dancer. Dancers waiting to go on stage also need space to do exercises to keep their muscles warm (Kersten,2008)

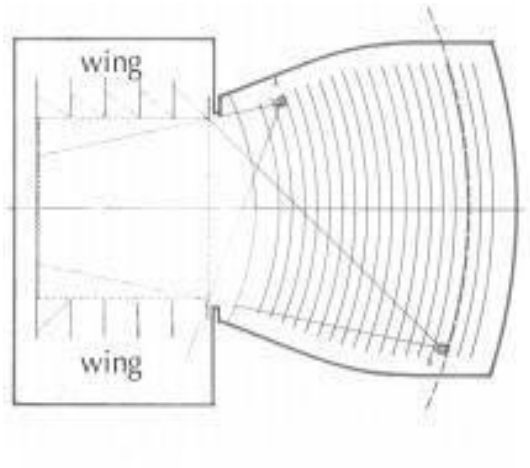

Figure 1. Picture showing the wing spaces in a stage design *(source: Kersten,2008)*

The architecture of the theatre space is based on social conceptions. The performance is all about the experience of the audience and the dancers. The quality of the experience depends to a great extent on the space. The performance is not only a representation of the dance: it is a representation of the dance in the space (Kersten, 2008). According to Brandstetter (2015), the spatial arrangement and architectural design of performance spaces significantly influence the dynamics of dance and the interaction between performers and the audience. Through examining a workshop on movement and space conducted by Explorelab group of the Faculty of Architecture in Delft, it resulted that the participants were aware of their position in space because they could imagine the geometry of the space.

We use space for orientation and directing movements. By using fixed planes, lines or points and the geometry of space, we are able to determine our position and direction intuitively. Dancers are trained to move in space, they are fully aware of the instruments they use to orient themselves in, they can project the dance into different spaces by imagining the "front" of the space (Kersten, 2008). Hanna (2008) explains that dancers develop a heightened sense of spatial awareness and proprioception, enabling them to navigate and perform in various spatial configurations effectively. In the workshop that was conducted it resulted that the geometry of a space is very important for orientation. When we are spinning around, or moving fast, or moving backwards, we cannot see the whole space, but we are still able to know where we are in the space. That happens because we use a mental picture of the geometry of the space in order to determine our position.

According to Tschacher and Haken (2007), mental imagery of spatial geometry helps individuals maintain orientation and direction even when visual information is limited. We remember the starting point and the direction of our movements. Our mind combines this information with a representation of the geometry of space to create our place in space. Because of this, it is easier for us to imagine rooms with clear geometry. Therefore, rectangular and cubic spaces are more useful in dance than spaces with odd shapes. Rectangular spaces are most common in dance. But not every theatre has an end stage format, in which the audience is seated at one side of the stage. In thrust stages theatres the audience is seated at three sides and in in-the-round stage theatres even at four sides of the stage. In these kinds of theatres dancers cannot discern a clear front and might have difficulties orientating themselves, because the sides look the same (Kersten,2008).

2.3.4 The persistence of the rectangular floor plan

The basis for the rectangular floor plan for dance was laid in the French courts of the 16th century. Since, most western theatre dances have been made for rectangular stages with a clear 'front' and entrances at the sides of the stage (Kersten,2008). Most studios as well have the same rectangular form as the stage. In the study conducted by Kersten, it was examined that we like to be in a recognizable geometrical space when we are moving because of the idea that a perceptible geometry helps in orientation. Rectangular spaces are discernable geometrical spaces. The four walls of rectangular spaces function as planes to focus on. (Kersten,2008)

In Laban's theories rectangular stages are preferable because the kinespheric cubes can easily be projected on these stages (Figure 1.26). Laban associated the human body with a cube. He explained that the body has a clear 'front' and 'back' and 'left' and 'right' and that the most basic geometrical figure that corresponds to these orientations is a cube (Kersten,2008). But it is culturally determined that we associate a cube to a human body. The tendency to make abstract models could be determined by our western scientific culture.

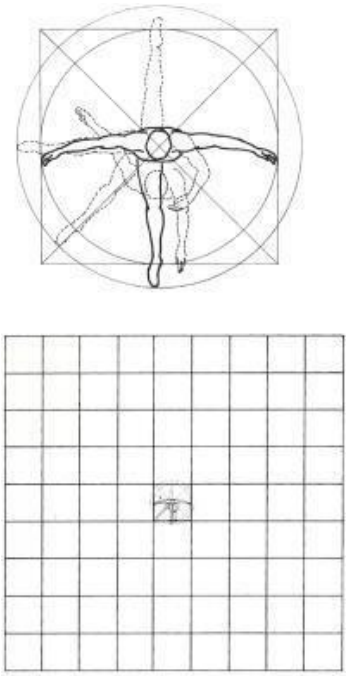

Figure 2. Laban's kinespheric cube (source: Kersten,2008)

2.3.5 The National Theater of Opera, Ballet and Popular Ensemble in Tirana

"I regard the theatre as the greatest of all art forms, the most immediate way in which a human being can share with another, the sense of what it is to be a human being." – Oscar Wilde, n.d

The history of TKOB begins in 1950, the year in which the Albanian Philharmonic was created, which included the state choir, symphony orchestra, lyric singers, ballet troupe, conductors, director and a small administrative-technical group. The year 1953 is known as the beginning of the history of the National Theater of Opera and Ballet when it was founded as the National Theater of State Opera. Since then, this institution has been the center of performances of opera and ballet art in Albania. In 1959, the National State Opera Theater merged with the Ballet Ensemble and the National Opera and Ballet Theater was created, thus giving it a wider artistic dimension and a more complete approach to promoting the art of ballet in the country (Rreth Nesh – Teatri I Operas & Baletit, 2018.)

The state philharmonic developed its activity in the building where the National Theater is today and later in 1953 it was transferred to the building where the University of Arts is today. The first opera and ballet performances were held in this building. In 1957, the National Ensemble of Folk Songs and Dances was created, which became part of TKOB (Rreth Nesh – Teatri I Operas & Baletit, 2018.)

The first ever performance of the TKOB troupe is the opera "Rusalka" by the Russian composer A.S. Dargomizhsky, which was performed on November 27, 1953. Whether the first performance of the TKOB troupe's ballet, "Kujdesi i kote" by Hertel, was performed in 1957. (Rreth Nesh – Teatri I Operas & Baletit, 2018.)

Renovation

The renovation project at the National Theatre of Opera and Ballet (NTOBFE) in Tirana aimed to improve the aesthetics and functionality of the historical building. The project involved transforming the auditorium and rehearsal facilities, accommodating 250 artists, including the National Symphony Orchestra, choir, ballet troupe, soloists' lyric troupe, and popular ensemble. The renovation aimed to create a modern theatrical experience in Albania, balancing the old and new through architectural elements that convey their transition in time. The design, by Kahle Acoustic & TTAS, reached the best international acoustic standards and technologies. The only intervention was the stage tower, a metallic structure above the stage that houses the theater's technological machines. The balconies of the auditorium were also designed to expand the theater's capacity. The renovation project aimed to educate social life and raise awareness about collective cultural memory (EUMiesAward, n.d).

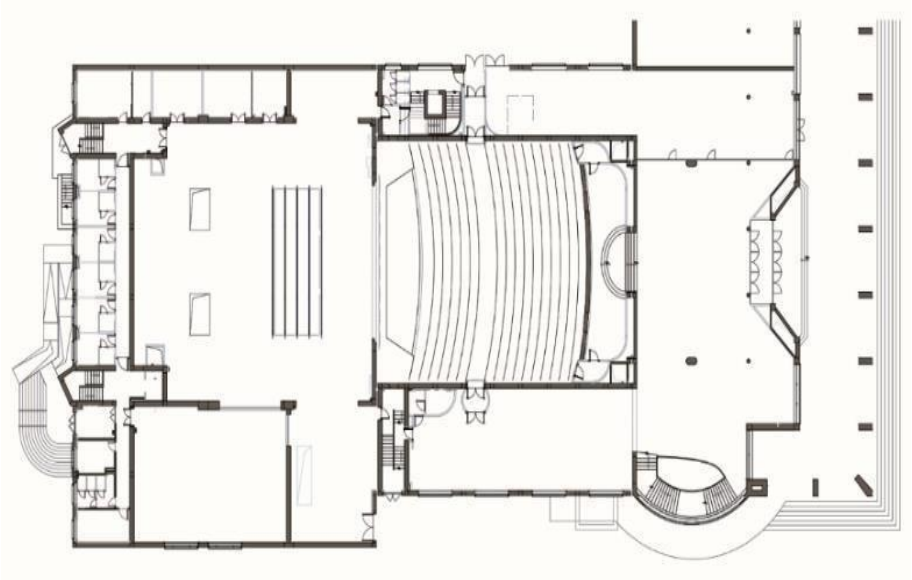

Figure 3. Ground floor of the NTOBFE (source: EUMiesAward, n.d)

2.4 Case studies

2.4.1 Tesseracts of Time

“Writing about music is like dancing about architecture” – Martin Mull

"Tesseracts of Time" is a dance performance by architect Steven Holl and choreographer Jessica Lang, aiming to explore the relationship between performance and environment through four phases linked to the passing of four seasons. The dance sections correspond to the four types of architecture: under the ground, in the ground, on the ground, and over the ground (STEVEN HOLL ARCHITECTS · Tesseracts of Time: A Dance for Architecture, n.d.)

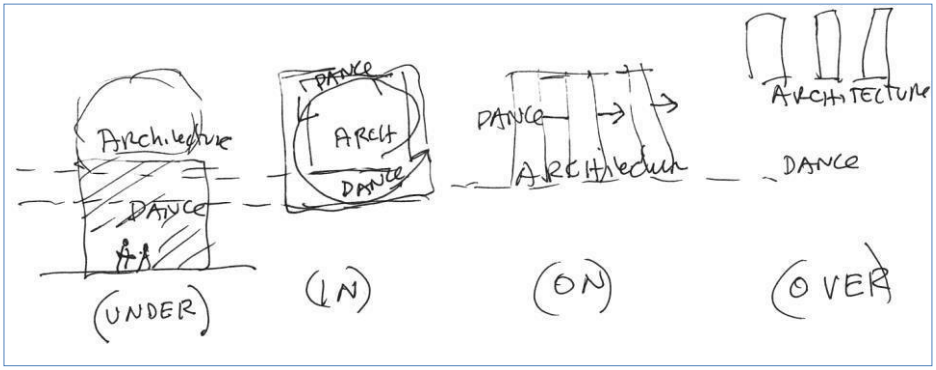

Figure 4. Sketches of the four sections of the dance (source:archdaily.com)

The first act, 'UNDER', opens with a soft passage of sunlight over the architecture's interior spaces, followed by a linear dance driven by David Lang's percussive music, resulting in a vibrating, black shadow on stage. (STEVEN HOLL ARCHITECTS · Tesseracts of Time: A Dance for Architecture, n.d.)

Figure 5. Scene from the first act (source:archdaily.com)

The second portion, 'IN', uses enlarged displays to transform the projected architecture into an atmosphere. The dance movement defies gravity while exploring geometry via emotional expression. Despite the perspectival depth generated by scaling figures, the movements remain two-dimensional, with dancers standing still while stretching appendages and bowing to match the architecture's shapes. (STEVEN HOLL ARCHITECTS · Tesseracts of Time: A Dance for Architecture, n.d.)

Figure 6. Scene from the second act (source:archdaily.com)

The third section, 'ON,' showcases three 12-foot-tall 'Tesseract Fragments' on stage, transforming into a four-dimensional cube in geometry. Dancers create the fourth dimension by moving on top of the fabric structures, obscuring, bending, and

distorting their forms. The choreography is playful, allowing the objects to serve as slides, shelters, or terrain, enhancing the performance's exploration of spaces.

Figure 7. Scene from the third act (source:archdaily.com)

The fourth phase, 'OVER', gives color to the environment and the dancer's attire, transforming the items into background components. The music settles into a mesmerizing hum, and the dancers move fluidly and airily, evoking joyful devotion. The items become backdrop components, hanging above the stage like a setting sun.

The ending of Seasons returns to the darkness of 'UNDER' at the beginning, with no beginning or ending.

Figure 8. Scene from the fourth act (source:archdaily.com)

Shape and Form. The use of shape and form helps in capturing the multidimensionality connected with tesseracts, which are four-dimensional geometric

figures. The architectural design made by Steven Holl, within the performance employ abstract shapes aiming to give the example of traversing through various dimensions of time and space. These forms serve as an interactive element with dancers moving in and around them simulating a physical journey through different layers or states of existence.

Figure 9. Sketches explaining the shapes used in the performance(source:divisare.com)

Symmetry and Proportion. Symmetry and proportion are usually used to establish a sense of balance and harmony. However, because of the fact that this project accepts multidimensionality as its focus, asymmetries or disproportions are presented to test viewers' perceptions of space and time. These elements engage the audience by dragging them into the performance's narrative flow while also prompting them to consider the complexities in the perceptionion of time and place.

Figure 10. Elements on stage showing asymmetry (source:divisare.com)

Rhythm and Flow. The importance of rhythm and flow derives from the ability to fill the gap between design elements and dance components. Jessica Langs choreography coresponds to the forms and spaces created by Holl. The dancer's movements mirror the shapes that are constantly changing throughout the performance, creating this way a synchronisation between dance and design. It gives the idea of time passing and of movement within the space.

Narrative and Space. The interplay of space, architecture and dance in expresses a narrative that explains the dimensions of time by moving throughout the 4 different seasons. Holls architectural spaces are active elements of the story shaped by the choreography. The dancer's movements within these spaces conveys emotions, while the changing environments adds depth and context to the narrative. This suggests that our perception of time and space is both personal and universal.

Spatial Awareness and Stage Design. Spatial awareness and stage design have an impact in the audience's experiences. Holls stage design challenges the idea of perspective by using techniques that create depth and dimension. This approach improves the performers and the audience's spatial awareness as they move through these environments. The design decisions regarding space, and the interaction between dancers and architectural elements are important in expressing the theme of different performances.

Figure 11. Picture showing the stage design(source:divisare.com)

2.4.2 Embodied Spaces: On the Edge of Movement

Architecture has often overlooked the relationship between body movement and space, ignoring the potential for body movements to shape and be shaped by spatial configurations. Marianna Chrapana and Virginia Giagkou's project explores this relationship by analyzing the constituent elements of body movement and the generation of space according to them. Four case studies were selected: climber, tightrope walker, diver, and aerialist. The experimental process involved chronophotographies, animation programs, and the introduction of different spatial elements to study the configuration of space according to the movement. This research contributes to the understanding of the relationship between body movement and space in architecture. (Embodied Spaces: On the Edge of Movement, n.d.).

Shape and Form. This project explores the relationship, between body movements and architectural. Through the analysis of chronophotography and the transformation of movements into three snapshots they establishe a connection between the body and architectural forms. This approach enables the creation of spaces that are shaped by trajectories and forces resulting in organic forms that capture the complexity of human movement.

Symmetry and Proportion. In contrast to approaches that prioritize symmetry and proportion for aesthetic reasons Chrapanas work proposes a reconsideration of these concepts from a movement perspective. By acknowledging the motions and varying proportions inherent in human movement dynamics she challenges architectural symmetries and proportions. This encourages designs that can adapt to patterns, unpredictable, shaped by human activity.

Rhythm and Flow. The interaction, between movement and space is also influenced by rhythm and flow. This research focuses on climbers tightrope walkers, divers, aerialists revealing how architecture can accommodate and enhance natural rhythms and flows associated with bodily motion. By creating spaces that align with these rhythms architects have the ability to design environments that promote different transitions and mvements. This results in an atmosphere that reflects the bodys kinetic energy.

Spatial Awareness and Stage Design. Chrapanas perspective in stage design underscores the significance of understanding how our bodies move within a context. This work suggests that architectural spaces can be seen as stages where everyday life unfolds. By considering how individuals move and interact within these stages architects can create spaces that enhance visibility, accessibility and overall occupant experience. This ensures that for every movement, the needed room is given room to be noticed and appreciated.

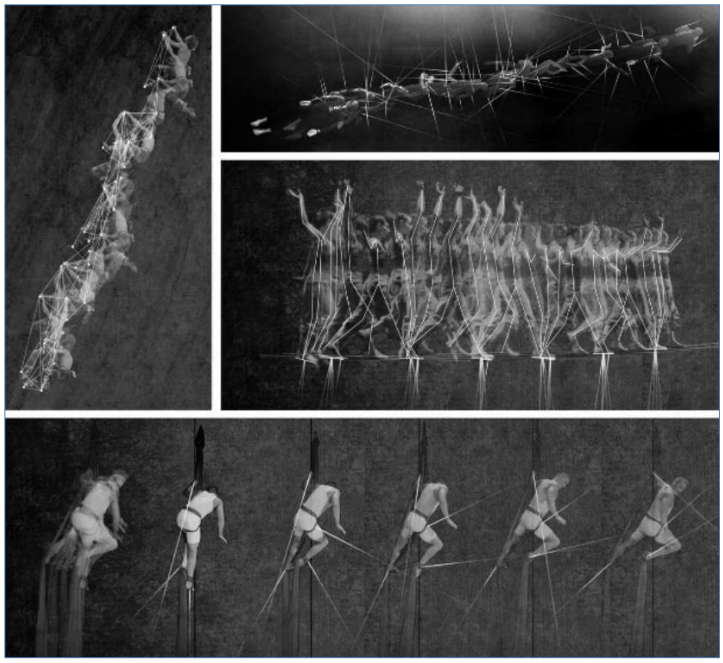

Figure 12. Experimental process. The first step of the analysis.(source:futurearchitecture.com)

The figures below show the analysis of the selected movements through chronophotographies. Frame analysis and identification of the structural and constituent elements of each movement. 1. Climber: the body anchors. 2. Tight-rope walker: the forces of the moving body applied to the rope. 3. Diver: the forces applied to the body due to the water pressure. 4. Aerialist: the forces applied to the silks during movement (Embodied Spaces: On the Edge of Movement, n.d.).

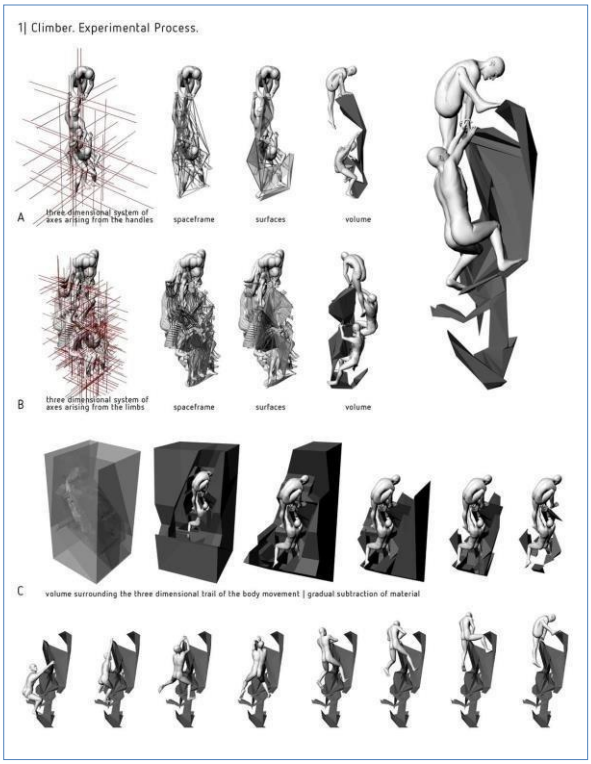

Figure 13. Case study no.1: the climber (source:futurearchitecture.com)

The thesis explores Case Study No. 1 which experiments with the body movement of the climbers. This section of their research focuses on unnderstanding how the movements involved in climbing can influence space. Their methodology consists of a series of steps aimed at capturing and translating climbing movements into design;

1. **Generating a Three-Dimensional Tracing of Movements:** This step involves an analysis of climbing movements using techniques such, as chronophotography, which captures sequential movements over time. By translating these movements into three models they effectively create spatial representations that depict the climber's path and actions. (Embodied Spaces: On the Edge of Movement,n.d.)
2. **Identifying and Documenting Body Anchorpoints**: The aspect of climbinglies in the points where the climbers body interacts with the climbing surface. These anchor points, where hands and feet make contact with the surface are recorded. Thisprocess helps in understanding the interactions between the body and its environment,

for defining spatial requirements and design considerations when developing architectural space. **Generation of space:** After analyzing movements and anchor points the next stage involves conceptualizing and designing spaces that accommodate and support these movements.

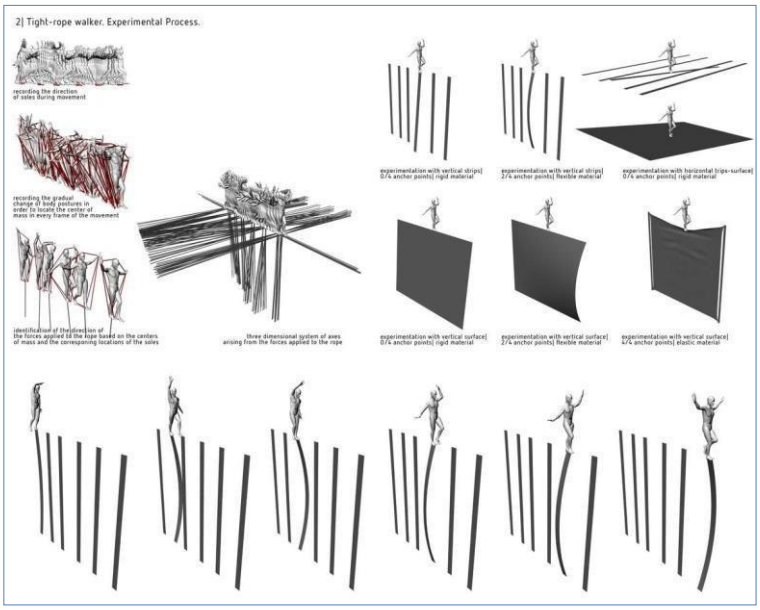

Figure 14. Case study no.2: the tight-rope walker (source:futurearchitecture.com)

In Case Study No. 2 the main focus is the tight rope walker. The objective of this study is to translate the balance and precise movements of a tight rope walker into design. In order to achieve this there are taken some steps.

1. Creating a Three-Dimensional Representation of the Movement: Initially, the movements of the tight rope walker were analyzed. This involves understanding the trajectory, balance and coordination required for tight rope walking. The resulting 3D representation visually depicts the balance and linear path associated with this.

2. Analyzing Forces Applied to the Rope Based on Foot Placement and Center of Mass: A significant aspect of this case study involves examining how the body of a tight rope walker interacts with the rope. The focus was on understanding how forces are applied through foot soles and how weight distribution affects their center of mass. This analysis helps in understanding the physics underlying the

equilibrium and motion on the rope, which's essential for designing environments that can accommodate or imitate the conditions of tightrope walking.

3. Creating Space: With the data from the motion analysis and force identification at hand the other step consists in designing a space that embodies the requirements and dynamics of tightrope walking.

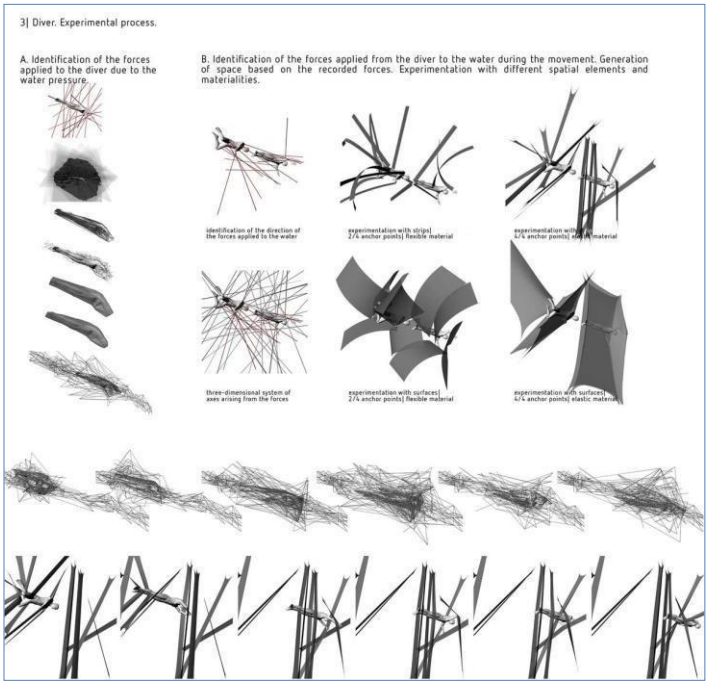

Figure 15. Case study no.3: the diver (source:futurearchitecture.com)

Case Study No. 3, in "Embodied Spaces; On the Edge of Movement" by Marianna Chrapana and Virginia Giagkou explores the world of diving. In this section of their thesis the authors delve into how the dynamic interaction between a diver's body and water can inspire concepts and spatial design.

1. Generating a Three-Dimensional Representation of Diving Movements: The first step is to capture the movements of divers. This process aims to visualize their trajectory from the leap into the air through their descent all the way to their entry into the water. By understanding and analyzing these movements researchers can start envisioning spaces that embody the elegance and fluidity found in diving.

2. Understanding Forces Exerted on the Body Due to Water Pressure: When diving, the body faces forces caused by water pressure. This aspect of the study focuses on comprehending how these forces impact a diver's movement and posture as they enter into the water. Such analysis helps in designing spaces that can replicate or accommodate this.

3. Understanding Forces Exerted from a Moving Body onto Water: When a diver jumps into the water, they also create ripples, waves and turbulence. This interaction between the diver and the water is studied to gain insights, into how movement can shape and influence the surrounding environment. This understanding helps in designing spaces that can dynamically respond to activity.

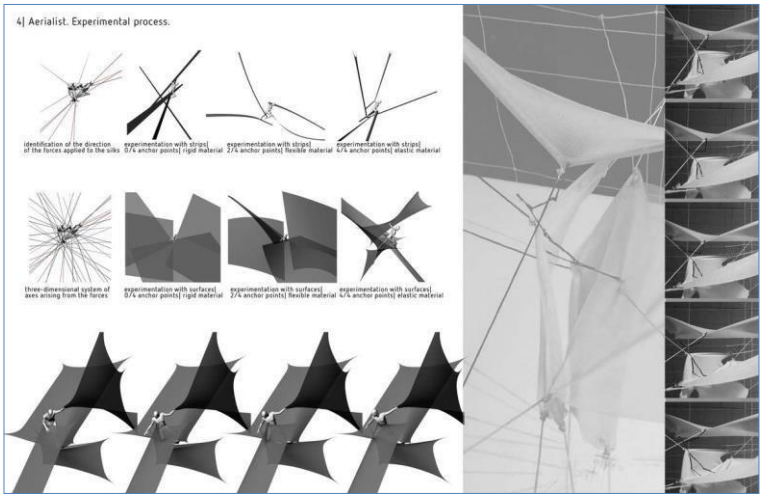

Figure 16. Case study no.4: the aerialist (source:futurearchitecture.com)

In the research Case Study No. 4 4xplains the exploration of an aerialists movements and their potential impact on design. Marianna Chrapana and Virginia Giagkou lead this case study employing an approach to translating the gravity defying actions performed on aerial silks into concepts for spatial design.

1. Creating a Three-Dimensional Representation of Movement: The process starts by capturing the aerialists movements. This involves recording the movements as well as various poses adopted by the aerialist. The aim is to analyze and understand the paths, twists, turns and wraps that define performances providing a blueprint for exploring spatial possibilities.

2. Understanding Forces Applied to the Silks During Movement: It revolves around understanding the forces applied by the aerialist onto the silks. These forces include tension, compression and torsion which dynamically change as the aerialist moves.

3. Creating Engaging Spaces: Once we understand how aerialists move and the forces involved the next step is to design spaces that capture the fluidity, verticality and complexity of arts. This means developing structures that allow flexibility in the movements.

2.2.2 Oskar Schlemmer's ballet of geometry. The Stick Dance

Oskar Schlemmers famous ballet, known as the "Stick Dance" or Stäbetanz was created during the 1920s, at the Bauhaus. The performance focuses on the interplay between the body and geometric shapes. What makes it more remarkable is the use of sticks attached to the dancer's bodies. These sticks are used to minimally restrict their movements and to visually extend their actions into the surrounding space offering a better understanding on how our connect with space. Schlemmer envisioned these poles as lines that connect forms with the space, this way transforming dancers into moving sculptures inspired by constructivist principles (The Guardian, 2022).

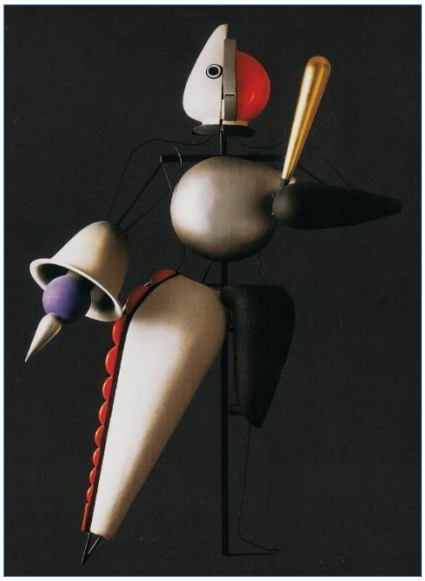

Figure 17. Model from The Triadic Ballet, black sequence, 1920-22 (source:theguardian.com)

The "Stick Dance" represents one facet of Schlemmers artistic exploration at the Bauhaus. During this period, he made researches about movements. Schlemmers work on the stage the "Stick Dance," focused heavily on the connections, between the body, gestures and the historical aspects of space and time. His aim was to bring abstraction by activating constructivist forms through time. (Stäbetanz, 2018)

Alongside performances like the "Hoop Dance " Schlemmer classified these works as "material dances." These performances explored the possibilities offered by materials, such as wooden sticks attached to dancer's bodies. This exploration aimed to push the boundaries of mechanics and movement in order to find new ways to shape and design space. (100 Years of Bauhaus, n.d.)

Figure 18. Stilt dancer, 1927 (source:theguardian.com)

Schlemmers "Stick Dance" stands as a testament to his groundbreaking approach to performance art. He strived to merge visual and performing arts into an expression. His work is key in comprehending how art, architecture and performance intersected during that time period reflecting the ethos of Bauhaus and its influence, on aesthetics.

Shape and Form: In the piece titled "Stick Dance ", as mentioned, Schlemmer employs costumes equipped with poles to extend the dancers limbs giving rise to a transformation of the body into a dynamic sculpture. Through these extensions the dancer's shapes and forms undergo modification resulting in an interplay between their

bodies and the geometric lines and angles of the poles. This leads to a blending of geometric elements that go beyond conventional notions of dance. (Fabrizi, 2018)

Symmetry and Proportion: The use of sticks within the dance introduces an exploration of symmetry and proportion. While symmetry exist within the body, the addition of poles amplifies it. This way also challenging our perception of balance and harmony.

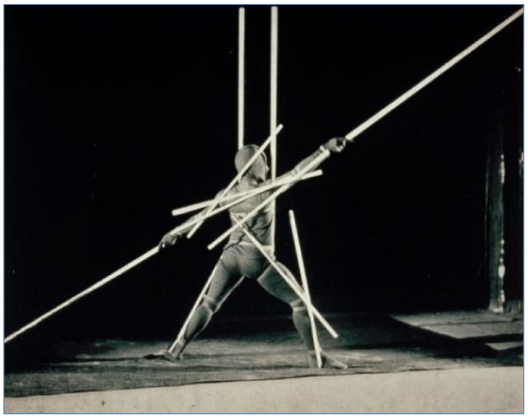

Figure 19. Stick dance, 1928 (source:theguardian.com)

Rhythm and Flow: In "Stick Dance," rhythm and flow are not solely dictated by the dancer's movements, but are influenced by their interaction with the sticks. The contrast created because of this gives the idea of a captivating rhythmic pattern. This interaction focuses on the way dancers move in terms of time and space. The rhythm is not observed but felt as the dancers navigate through different positions and shapes.

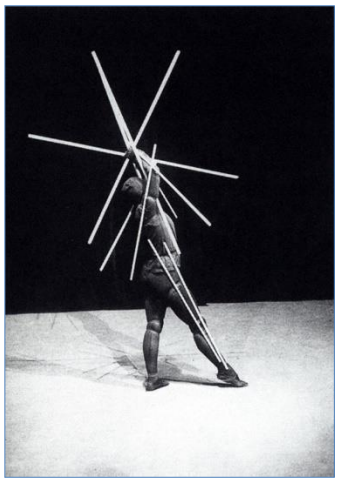

Figure 20. Stick dance, 1928 (source:theguardian.com)

Narrative and Space: "Stick Dance" doesn't follow a storyline; instead, it creates a narrative by exploring how movement interacts with space. The choreography of the dance and the design of the costumes tell a story, about how the human body relates to spaces. Each movement and gesture symbolizes a conversation between the form and the geometric elements surrounding it. This narrative is abstract in nature emphasizing exploration of form and movement within boundaries. (Fabrizi, 2018)

Awareness of Space and Stage Design: Schlemmers background, in sculpture and painting greatly influences how space is perceived on stage in "Stick Dance." The stage becomes an extension of the dancers themselves where the geometric shapes of their costumes interact with the abstract performance area. The design highlights depth, scale and dimensions of the stage creating a layout that challenges both dancers and audience members. By using poles and carefully choreographing their movements dancers demonstrate their awareness of their surroundings while navigating through the stage with intent. (Fabrizi, 2018)

Figure 21. Example of the stick dance (source:theguardian.com)

2.2.3 Discussions

The case studies mentioned above study the interplay, between motion, spatial elements and design offering viewpoints in areas like architecture, dance and visual arts. Through an analysis of these case studies we can get insights into the study of

motion, space and design. These studies underscore the importance of awareness and stage layout, in developing the audience engagement and performance quality.

Each case study explores elements in its way. "Tesseracts of Time" combines architecture and dance to “move through” time and space. "Embodied Spaces" focuses on translating movements into configurations while "Stick Dance" transforms the human form into geometric structures that change our perception of space.

Abstract shapes and figures are used in "Tesseracts of Time" to find multidimensionality challenging notions of symmetry and balance. "Embodied Spaces" from a movement perspective also highlights the structures that emerge from human movements. By incorporating sticks the dancer’s forms in "Stick Dance" are expanded, altering symmetry and proportion while underscoring the link between the body and geometric elements.

Whether its the interplay of dance and design in "Tesseracts of Time " the different rhythms associated with movements in "Embodied Spaces " or the rhythmic patterns in "Stick Dance," rhythm and fluidity contribute to the exploration of movement within a space. Additionally spatial awareness and stage design are elements across all case studies. From challenging perspectives in "Tesseracts of Time" to examining how bodies move within a setting in "Embodied Spaces " or viewing the stage as an extension of performers in "Stick Dance," awareness and stage design enhance the quality of performances.

In essence a comparative analysis of these case studies showcases approaches to investigating the relationship, between movement, space and design. These studies underscore the significance of collaboration, creative experimentation and narrative expression.

CHAPTER 3

MOVEMENT VISUALIZATION TOOLS

3. Dance visualization

Dance consists of two qualities, Its form and its temporality. These qualities can be visualized in different ways. Form can be visualized by using traditional ways such as painting, photography etc. Whether temporality has different approaches. Temporality refers to the movement of dancers through time, and specifically within relationship to the music, tempo, meter, or rhythm (Mackrell, 2024).

In the following chapter there are explained various techniques to record and visualize dance, as well as the advantages and disadvantages of each one. This helps us further on in the development of our analysis and technologies.

3.1 Movement Notation

Notation is an important tool for communicating ideas in many fields, including dance. It functions as a link between architectural, musical, visual, and verbal realizations. The main techniques for notating dance are Benesh notation and Labanotation, both of which are developed from classical ballet and cater to highly organized and adaptable motions (Harris 2002). Labanotation, developed by Rudolf Von Laban, is flexible enough to adapt to the experimental character of new dances. Both methods analyze human body movement based on space, time, and motive.

The difficulty in movement notation is dealing with the massive quantity of data needed to capture motions of each individual body component in three dimensions of space and time. Using symbols might be a solution, but it would need a huge number of symbols, resulting in complicated notation. A notational system should be simple and legible, but completeness and correctness must be weighed against simplicity and legibility. A movement notation must include essential elements such as the body's location, direction, limb position, head, torso, and pelvic features, movement quality or dynamics, and prop manipulation. (Singh 1982).

3.1.1 Laban Movement Analysis

Laban Movement Analysis is a system for observing, describing, prescribing, performing, and interpreting human movement. It uses a three-line stave that is read from the bottom to the top of the page to record movements, with symbols placed on the same line representing simultaneous movements (Stathopoulou 2011). Basic symbols describe direction, turns, level, and duration, while ancillary symbols indicate the path, stage arrangements, and dynamics of movement. The symbols are organized at the left and right side of the centerline, representing the left and right limbs and spine. This system is both theoretical and experiential.

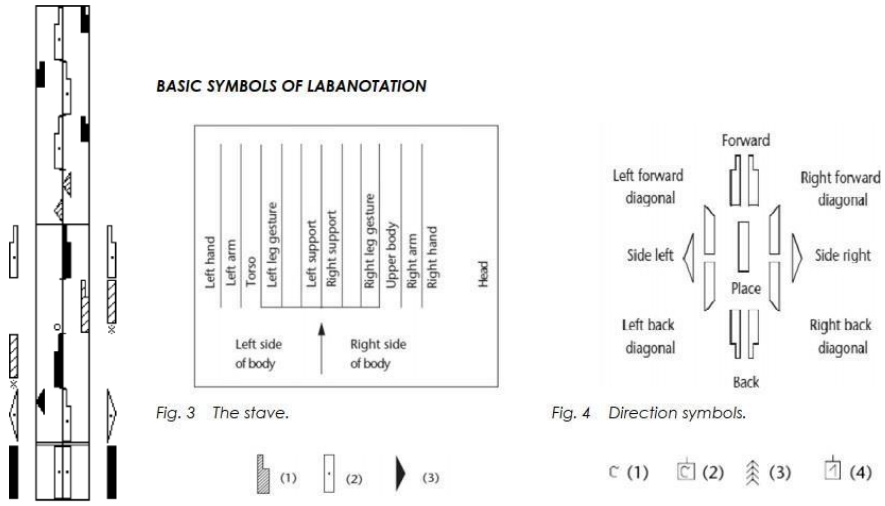

Figure 22. Basic symbols of labanotation (source: Laban, 1966).

Laban's kinesphere, a virtual icosahedron, represents the many body positions in a dancer's body. This kinesphere has a steady, vertical axis around the center and 27 designated spots. The axis tilts and rotates as the body moves, causing the kinesphere to move as well (Laban, 1966)

Movement may be broken down into aspects like the number of dancers, body components, space occupied, time parameters, dynamics, and other spatial qualities. The temporal element influences the pace and length of movement, whereas movement dynamics reflect the outcome of energy expenditure across time. Laban established a set of movement attributes known as efforts, which incorporate space, time, and energy. Other spatial characteristics include changes in direction, level, size,

transitions, distance or rotation, and sorts of movement pathways (Hutchinson 1970). The Kinesphere is crucial aspect of dance performance.

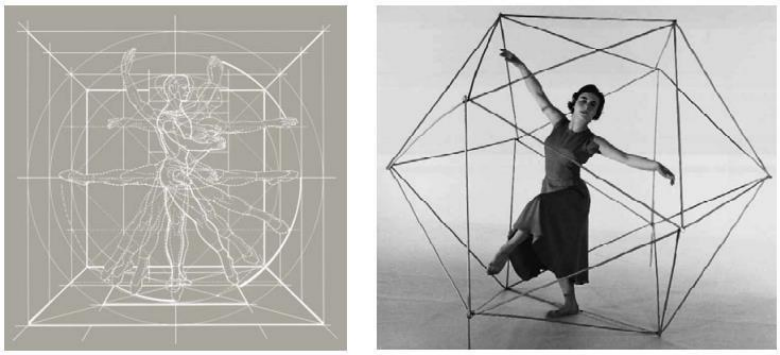

Figure 23. Kinesphere: The area where the body is moving within and the Icosahedron. (source: Laban, 1966).

Labanotation depicts movement in an explicit manner. As a result, it may be used in a wide range of fields and applications. It is most commonly used in dance to preserve choreography for future reference (Hutchinson 1970). However, it may be utilized for research purposes in any discipline that requires comparing diverse motions, including productivity study, medical research, sociological and anthropological research, robotics, and many others (Rickett 1996).

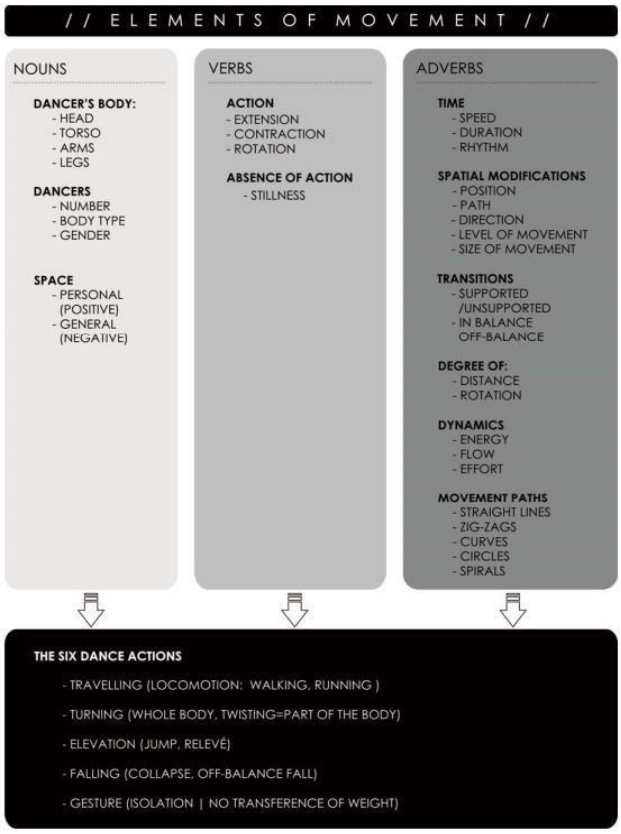

Figure 24. Elements of movement according to Rickett (1996) and Hutchinson(1970). *(source:* Stathopoulou 2011).

3.1.2 Benesh Movement Notation

Benesh notation is a technique for documenting motions from behind the performer, highlighting basic body postures by marking the projection of the four body extremities and bends into the coronal plane (Singh 1982). This projection is not a real whole-body projection, but rather the projection of body segments in relation to the body midline onto the correct positions between the stave lines. The five-line music stave divides the human body into head, shoulders, waist, knees, and feet. Leger lines cover all possible body positions, representing the maximum reach of hands and feet during jumps. The stave is divided into square frames, making the notation visually appealing and reducing the need for many symbols (Benesh & Benesh, 1956).

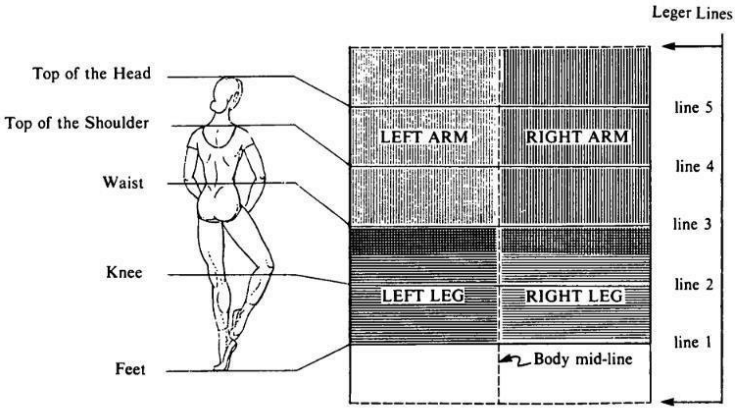

Figure 25. The Benesh Stave *(source:* Benesh & Benesh, 1956)

For three-dimensional information, standard limb indicators are used, but it is not required to specify how far in front or behind the extremities are. The indications for all limbs are the same and do not distinguish the limb to which they relate. When a limb sign leaves its domain, it is softly crossed out with a diagonal stroke known as a crossover (Stathopoulou 2011).

The basic signs:

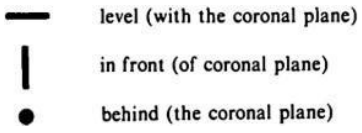

Figure 26. The basic signs of Benesh notation (*source:* Stathopoulou 2011)

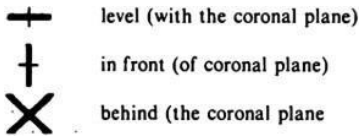

Figure 27. The basic signs for bends in knees and elbows (*source:* Stathopoulou 2011)

Crossovers are classified into two types: lateral crossovers, in which an extremity or bend goes to the opposite side of the body, and vertical crossovers, in which a foot or

bent knee moves above the waist line and a hand or bent elbow moves below it (Stathopoulou 2011). The two crossover signs are:

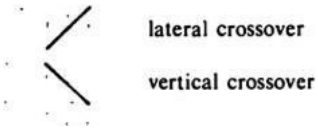

Figure 28. The two crossover signs (*source:* Stathopoulou 2011)

The head is represented by a straight line drawn between the fourth and fifth stave lines, with one end fixed to the intersection of the fourth stave line and the body mid-line, and the other constantly touching the fifth. The angle between this head line and the body's mid-line determines whether the head tilts to the right or left. A shorter straight line perpendicular to the head line denotes the chin position, and its length indicates the degree of rotation in the head. The junction of the head and chin lines defines the amount of backward or forward bend of the head (Singh 1982).

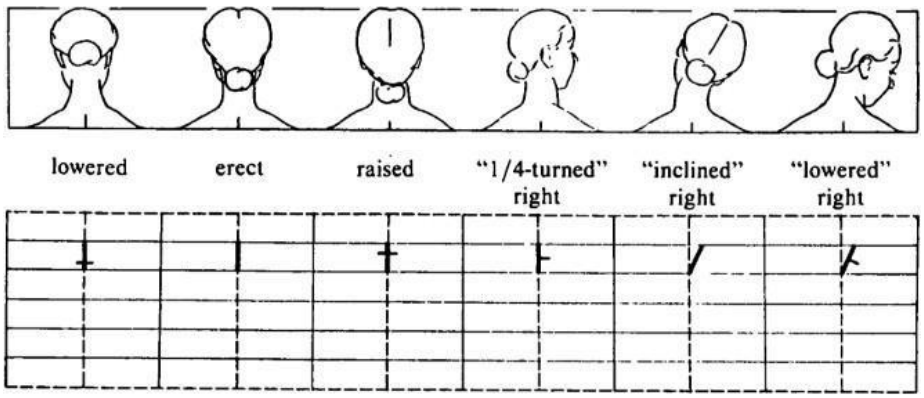

Figure 29. The junction of the head and chin (*source:* Benesh & Benesh, 1956)

The third stave line portrays the waist, and all bends and twists from the waist upward are recorded between the third and fourth stave lines. The basic indications employed and their modification are the same as those used on the skull. Hip (pelvic) motions are represented identically on the second and third stave lines.

Benesh notation employs movement lines to represent continuous smooth motions. A movement line represents the course of movement in space from the beginning

position to the final position, summarizing an unlimited number of intermediate places. It is affixed to a sign at its end location but not at its start, providing guidance for the movement. If the moving limb moves in a forward or backward curve from its starting position, the movement lines are qualified using the qualification signs (Benesh & Benesh, 1956).

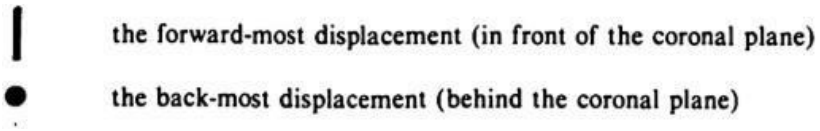

Figure 30. The qualification signs (*source:* Stathopoulou 2011)

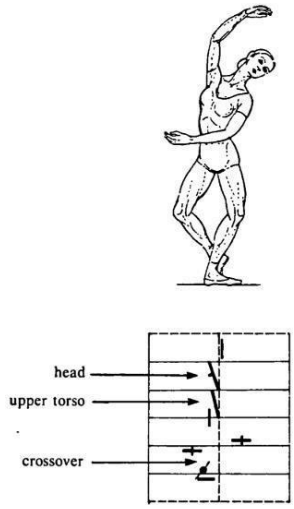

Figure 31. The main body signs (*source:* Stathopoulou 2011)

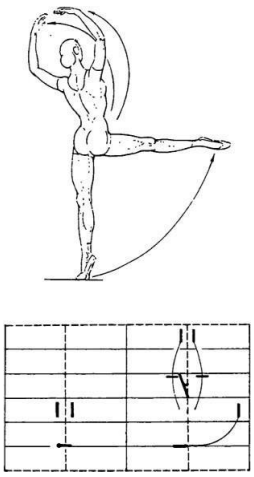

Figure 32. Movement lines (*source:* Stathopoulou 2011)

The movement way in Benesh dance is a specific type of movement when the body leaves the ground. The movement line extends across multiple frames, starting under the take-off position and ending at the landing position. It is drawn between the first stave line and the leger line underneath it. The recorded movement line corresponds to the real movement path along the first stave line.

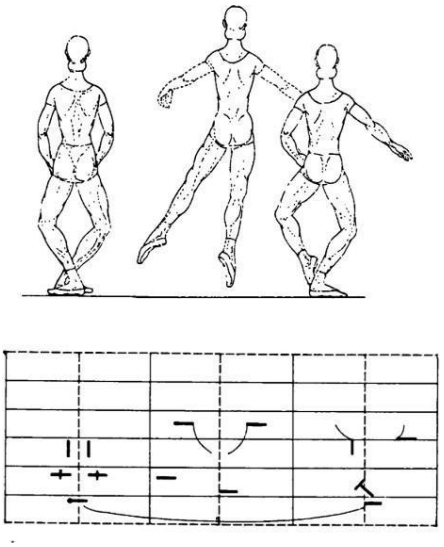

Figure 33. Recording of the jumps (*source:* Stathopoulou 2011)

Benesh notation uses eight basic direction signs to indicate the performer's orientation relative to the observer.

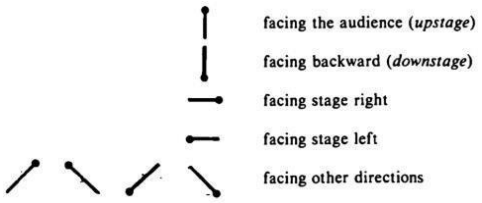

Figure 34. The direction signs (*source:* Stathopoulou 2011)

To connect movement to rhythms and words, the stave is split into bars of beats. The number in the upper left corner of the stave is the musical time signature, which indicates the number of beats per bar. Movement rhythm indicators occur above the stave, signifying full or fractional beats. The fundamental rhythm signals are:

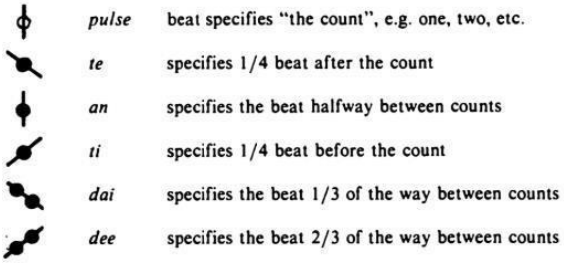

Figure 35. The fundamental rhythm signals (*source:* Stathopoulou 2011)

Appendix B shows a sample Benesh score. This basic notation system can be extended to capture movements of eye, hand, and fingers, which are crucial in dance styles like Bharat-Natyam.

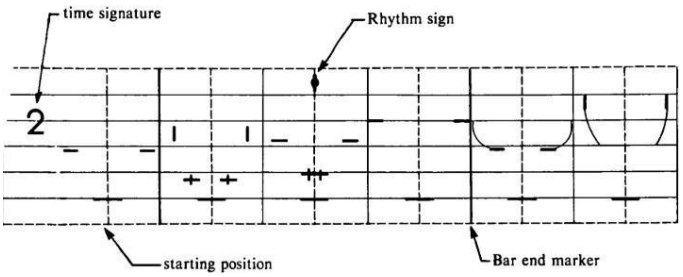

Figure 36: Time signature and bars (*source:* Benesh & Benesh, 1956)

The table below shows general comparative information about the Laban and Benesh methods of analyzing movement.

Table 1: General information about Laban and Benesh methods of analyzing movement. (*source:* courtesy of the owner)

		Similarities
LMN	BMN	
was developed in the early 20th century by Rudolf Laban	was developed in the mid-20th century by Rudolf and Joan Benesh	have the purpose of documenting and analyzing human movement
uses geometric shapes and lines to represent movement	uses a combination of symbols, lines and dots	use symbols and diagrams to represent movement
focuses on the qualitative aspects of movements such as effort, space and shape	focuses on the quantitative aspects of movement, focusing on spatial relationship and timing	are used to facilitate communication and analysis within the dance community
has a broader application beyond dance and is used in different fields such as movement therapy, anthropology and theater	is primarily used within the Benesh institute and associated dance programs, with a more limited application outside these contexts.	Are used to preserve different choreographies

3.2 William Forsythe's 'Dance Geometry'

William Forsythe, a choreographer from Germany, has gained a lot attention for his intricate interpretation of dance and choreography. His work is influenced by digital technology and algorithmic processes, with his improvisation techniques and collaborations with architects and digital artists for the visualisation of dance in 'Synchronous Objects'. Forsythe's technique focuses on isolation and decentering, disregarding symmetry, rectilinearity, and basic sensomotoric and somatic logics (Stathopoulou 2011). The muscles and joints of his dancers engage in disfigured mimics, gestural deformation, and dislocating bending of joints and extremities. As Boenisch points out in his article about William Forsythe and the *'equations of bodies'*: *'Any symmetry and rectilinearity are ignored, as were even the most* ***basic***

***sensomotoric and somatic logics and hierarchies**. The muscles and joints of these moving bodies indulged in what appeared as an uncontrolled **flow** of disfigured mimics, gestural **deformation**, a **dislocating** bending of the joints and the **extremities** in physiognomically impossible manners'* (Boenisch 2007). Forsythe's aesthetic principles differ from classical ballet values, as the dancers come from a background with classical ballet. Instead, the dancers engage in unstable, complicated movements that focus on the process rather than the result. Forsythe's choreography shares similarities with Frank Gehry's architecture, using 'tilted' and 'distorted' forms, making his work 'post-modern' and 'deconstructivist'.

Forsythe's approach to computational technology is beneficial for both choreographers and architects. Forsythe's method encourages new ways of composing dance movement, extending beyond traditional dance styles. For architects, it offers a creative way to explore space by learning from the body's potential within the framework of design and computational technology (Stathopoulou 2011). This exchange is promising, as choreographers can use algorithmic processes as a generator for their dances, and architects can generate forms from dance. This exchange is particularly promising in both fields.

3.2.1 Exploring 'Improvisation Technologies'

After working with ballet dancers Forsythe understood that they are taught to interpret chorographical movement by matching lines and forms in space. He broke down dance movement into points, lines, planes, and volumes and began producing choreographies with techniques such as rotation, extrusion, inscription, folding, and unfolding (Stathopoulou 2011). He highlighted that there are unlimited movement combinations, which are limited only by the actual structure of the human body. Forsythe's choreographies are not predetermined but rather based on improvisation techniques, with dancers given 'U-lines' to develop movement phrases. These phrases might include brief sentences, mathematical concepts, verbs and adjectives, computational procedures, and even absurd phrases. Forsythe's choreographies are not mandated, but rather provide a unique and efficient means for ballet dancers to convey their grasp of chorographical movement (Spier 1998).

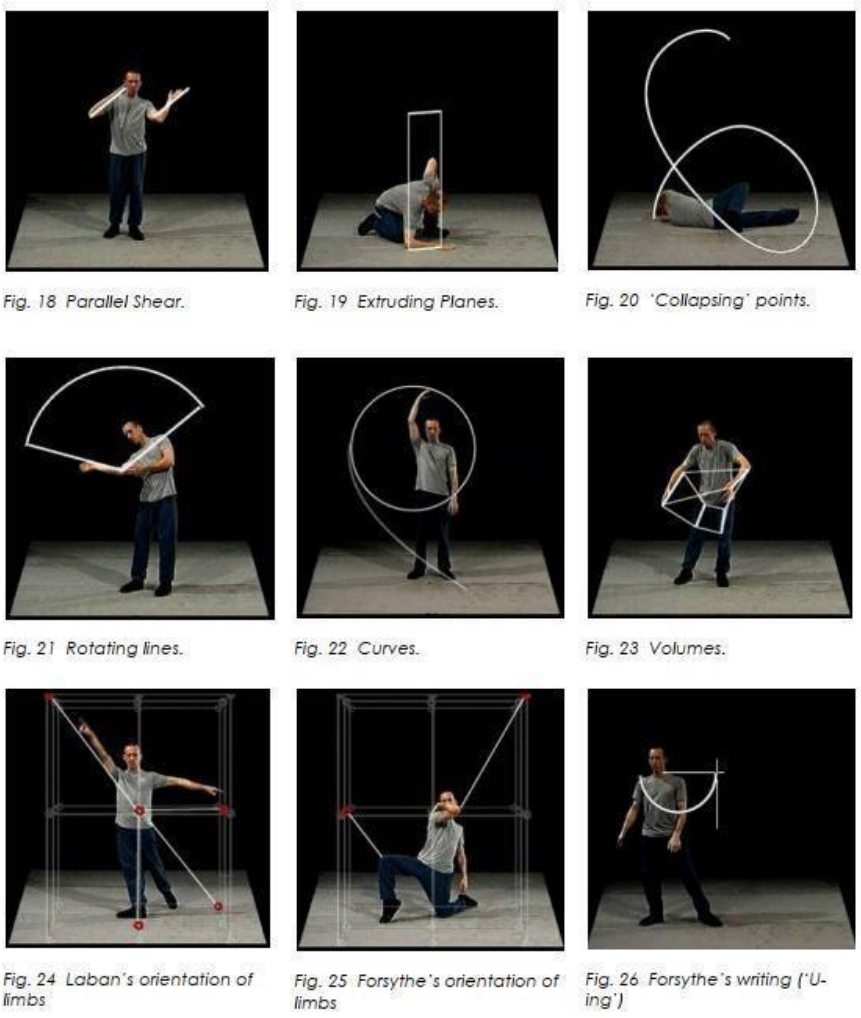

Figure 37. Movement improvisation (*source:* Stathopoulou 2011)

Forsythe developed 'Improvisation Technologies', a training tool for dance, to teach principles and ideas in Frankfurt Ballet dancers. The tool uses computational technologies to visualize geometric structures hidden behind dancing movements. The CD-ROM, divided into 60 video chapters, shows essential principles of Forsythe's improvisation techniques. Dancers are trained to imagine trails in space, either implanted by current movements or the one left behind, and learn to manipulate and transform this imaginary geometry, emphasizing the space created by the moving body rather than the body itself (Stathopoulou 2011).

3.2.2 ‘‘Synchronous Objects – Visualizing Choreographic Complexity’

William Forsythe and Ohio State University's Advanced Computing Center for the Arts and Design (ACAD) worked together on an interactive project called 'Synchronous Objects for One Flat Thing, Reproduced' to investigate the complex structures of Forsythe's choreographic thought in his work. Over thirty academics from several areas teamed with dancers to showcase their findings using 3D animation, annotation, and interactive visuals. The choreography was performed by seventeen dancers on a grid of twenty tables, and the data gathered was separated into spatial and attribute categories. The researchers divided the data into three categories for OFTr interpretation: movement material, cueing, and alignments. Movement material contains the sets of choreographic sequences, cues alter the flow of the dance, and alignments allude to Forsythe's understanding of movement (Stathopoulou 2011).

A multidisciplinary group of researchers created 'Synchronous Objects', which contains twenty visualization approaches and tools. These tools convey cues, alignment in 2D and 3D space, video-related tools, 2D interactive graphics, and 3D representation methods. They show how to quantify and represent complicated dance-spatial data in tangible or abstract ways utilizing transformations, derivations, and interactive tools. These technologies have established a graphical vocabulary for dance that can be read and understood in an interdisciplinary context, and they have served as a source of inspiration and innovation.

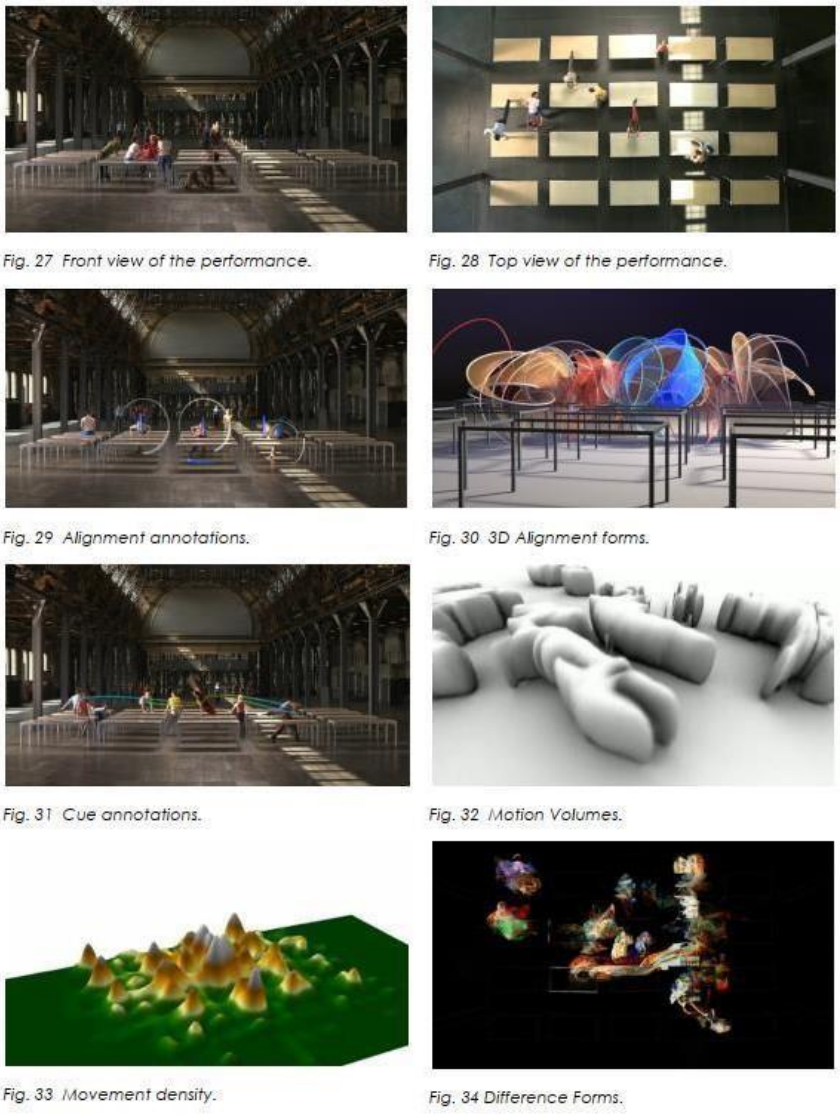

Figure 38: Various visualization techniques used in "Synchronous objects" (*source:* Stathopoulou 2011)

3.3 Motion capture

3.3.1 'Chronophotography – origin of the motion capture

Motion Capture's origins can be traced back to the 19th-century experiments of Jules-Etienne Marey, who invented the 'chronophotograph' in 1870 to record multiple frames of movement on a single plate. In 1882, he created a 'photographic gun' using a glass plate instead of bullets, resulting in a plate with twelve different images around the edge, showing different frames of a subject's movement. Jules-Etienne Marey gave to

wear to the people that he filmed black suits with metal strips or white lines to study movement, disengaging from body characteristics and overlapping images. This technique allowed him to record limb movements of people walking or running past the camera. A similar suit is used today for recording Motion Capture Data. Marey's inventions and techniques laid the foundations for motion pictures and motion capture, allowing for the photographic capture of movement over time. (Stathopoulou 2011).

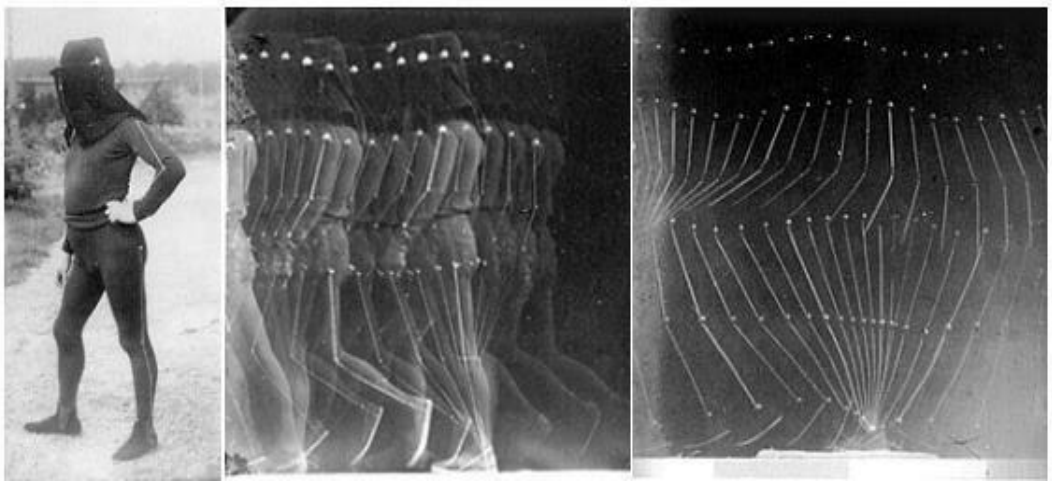

Figure 39: Motion capture suit and photos showing the body and the markers (*source:* Stathopoulou 2011)

3.3.2 What is Motion Capture?

Motion Capture systems record movement from a person to translate it onto a digital model. There are three methods: mechanical, magnetic, and optical (Ebenreuter 2005). Mechanical and magnetic capture uses an exoskeleton suit with metallic parts to locate limb positions and joint angles. Optical motion capture is the most common, using spherical targets placed on the performer's body.

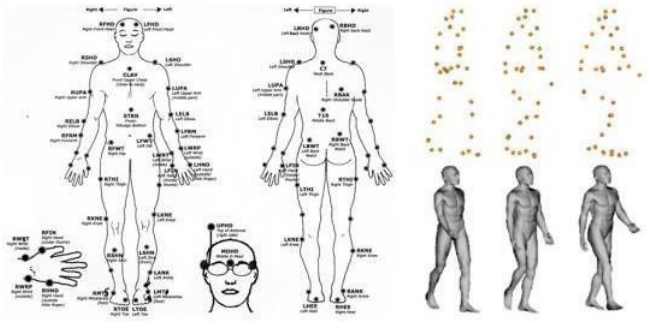

Figure 40: The markers positioned on different parts of the body (*source:* Stathopoulou 2011)

Optical motion capture is the process of capturing marker locations with many cameras and triangulating them to generate 3D coordinates, which allows for comprehensive recording of complicated movements. However, as Ebenreuter remarked in 2005, the raw data requires substantial processing before it can be utilized as an animation.

Figure 41: A dancer wearing a suit used in optical Motion Capture Systems (*source:* Stathopoulou 2011)

3.3.3 Applications of Motion Capture

Motion Capture data technology is widely used in the film industry for creating realistic animations, extracting complex movements that are difficult to analyze and reproduce with inverse kinematics. It's also used for real-time performances in

interactive media and studying human movement in medical and sport science (Brown et al. 2005).

MoCap has been used for a variety of applications, including dance pieces such as the OpenEnded Group's 'Ghostcatching' and in the design sector. 'Ghostcatching' is a digital art project that transforms choreographer Bill T. Jones' dance phrases into animated handdrawings. FRONT, a Swedish design firm, has devised a method for transforming freehand furniture ideas into real products using MoCap and Rapid Prototyping (Brown et al. 2005). This entails capturing pen strokes and producing 3D digital data, which are subsequently molded into plastic furniture.

Figure 42: Step by step of MoCap from body movements to the final drawn body (*source:* Stathopoulou 2011)

Motion Capture Systems offer significant potential for studying movement, as noted by Michael Girard, a digital artist and software designer for animation characters, as they can be isolated and examined without human body characteristics.

3.4 Analysis of the movement visualization tools.

In this section, the methods explained above that are used for the visualization of movements will be analyzed. Since the analysis that we have to make for the ballet Giselle are inspired by the analyzes of Laban, Benesh, etc., it is necessary to study in a comparative way these methods. In the tables shown below are presented some of the main aspects of the methods that were explained. By using the information in these

tables and the information discussed above, the aim is to identify essential aspects for further examination and refinement in our analysis of "Giselle."

As also mentioned, one of the main problems in any movement notation is that of coping with the enormous amount of information needed to record movements of each individual body part in three dimensions of space and in time and using only symbols as part of the analysis would require a large number of symbols which wouldn't be that easy understood and this is not our intention. This is one of the points that I took into consideration when deciding about the methods that I further on use.

When explaining labanotation there are some potential areas for improvement. For example, it analyses the movement in isolation without taking into consideration the interaction that is needed with other dancers or objects. This is one of the points that we aim to fix since our analysis consists of the relation of movement with the spatial design. Labanotation is also traditionally represented using symbols on a score sheet, which may be limited in accessibility and usability for non-experts. Developing interactive visualization tools or software applications could improve this. As also seen in **Figure**, Labanotation uses geometric shapes and lines which is useful in our analysis since it gives a better definition of the body and the space that it needs for specific movements.

Table 2: Laban Movement Notation analysis (*source:* courtesy of the owner)

		Laban Movement Notation
Origin		- Created by Rudolf Laban in the 1920s. - Developed to record all forms of human movement, not limited to dance.
Purpose		- Comprehensive system for documenting, analyzing, and teaching movement. - Used in dance, physical therapy, ergonomics, and more
Structure		Vertical Staff: - Movement is recorded from bottom (start) to top (end). - Columns: Represent different parts of the body.
Symbols		-Geometric shapes and lines indicating direction, level, and quality of movement. - Effort and space aspects are also covered.
Key Components in depth	Symbols	Geometric Shapes: Indicate direction (forward, backward, sideways, etc.). - Lines: Show levels (high, middle, low) and pathways. - Effort and Space: Symbols for effort (dynamics) and spatial factors.
	Stave	- Vertical with different columns for different body parts. - Helps in visualizing movement as a continuous flow.
	Movement	- Comprehensive system including effort (how), space (where), time (when), and flow (continuity). - Can notate any type of human movement.

Benesh movement notation is similar to Labanotation. Similarly, if we add motion capture systems and digital software, we could streamline the process of BMN analysis and transcription which can improve the analysis. Benesh notation makes use of movement lines to record continuous movements. A movement line traces the path of movement in space from the starting position to the final position and summarizes an infinite number of intermediate positions. This means that adding tracing lines to the movements that we analyze may be helpful in better understanding the space that this movements occupy. Benesh links movements to rhythm since his main purpose is to preserve choreographies. We do not do that in our analysis. We simply analyze the movements in space without taking into consideration rhythm or force of the movements, since our aim isn't to preserve a choreography.

Table 3: Benesh Movement Notation analysis (*source:* courtesy of the owner)

		Benesh Movement Notation
Origin		- Developed in the 1950s by Rudolf and Joan Benesh. - Initially designed to record ballet movements but has since been adapted for other dance forms.
Purpose		- Recording and analyzing dance movements, particularly in ballet. - Used to communicate choreography, preserve performances, and teach dance
Structure		- Five-Line Stave: Similar to music notation. - Top Line: Represents the head. - Second Line: Represents the shoulders. - Middle Line: Represents the waist. - Fourth Line: Represents the knees. - Bottom Line: Represents the feet.
Symbols		- Use lines, shapes, and dots to represent body positions and movements relative to the stave lines.
Key Components in depth	Symbols	Lines and Shapes: Represent various body parts and their movements. - Dots and Other Marks: Indicate specific positions or actions. - Modifiers: Adjust the meaning of basic symbols to convey more detail.
	Stave	- Horizontal with five lines representing different body parts. - Similar to a musical stave but adapted for movement.
	Movement	- Detailed notation for timing, dynamics, and spatial orientation. - Can represent complex sequences of dance moves.

When studying William Forsythe, it is noticeable the type of dance that he studies. The movements of classical ballet are replaced by unstable, complicated movements, which no longer focus on the result, but on the process of it. Even though this study focuses on the ballet movements, step by step method can be used for every type of movement. One important detail that Forsythe suggests is an interesting and creative way to explore space, by learning from the body's potential, within the frame of design and computational technology. In his project "Improvisation Technologies", there is a The CD-ROM featuring 60 video chapters of lecture demonstrations by Forsythe, showcasing the geometrical structure behind dancing movement. The problem is that

there are only this video chapter so the information is limited. If there were visualization techniques and representation methods, such as 3D modeling, motion graphics, and virtual reality, it could enhance the analysis of Forsythe's spatial choreography.

Table 4: William Forsythe (*source:* courtesy of the owner)

		William Forsythe
Origin		
Purpose		- Redefine dance and choreography using new media and technologies. - Create resources for dancers, choreographers, and audiences to explore and understand dance in new ways.
Structure		-Dance Geometry: Uses geometrical principles to explore spatial relationships in dance. -Improvisation Technologies: Multimedia tool that teaches improvisation through visual and verbal instructions. -Synchronous Objects: Collaborative project translating dance into data to reveal choreographic structures.
Symbols		-Geometric Forms: Circles, lines, planes representing spatial pathways. -Digital Notations: Visualizations and annotations in multimedia applications. -Movement Symbols: Abstract representations of movement patterns and choreographic principles.
Key Components in depth	**Symbols**	-Dance Geometry Symbols: Geometric shapes and lines indicating dancers' pathways and spatial relationships. -Improvisation Technologies Symbols: Icons and visual markers representing specific improvisational prompts. -Synchronous Objects Symbols: Data visualizations illustrating movement sequences and interrelations.
	Stave	-Dance Geometry: Conceptual staves as lines or planes in space guiding movement. -Improvisation Technologies: Virtual staves providing a framework for improvisation exercises. -Synchronous Objects: Digital staves mapping out choreography's temporal and spatial dimensions.
	Movement	-Physical Movements: Emphasis on the physical articulation of geometric principles. -Improvisational Movements: Exploration within a structured digital environment. -Choreographic Movements: Analyzed and visualized through data to understand underlying structures.

The last to be analyzed is motion capture, which is one of the most important tools in this study. By adding lines into the videos or sequences that are analyzed with motion capture, we get more detailed analysis about the movement and the space that each movement needs without needing symbols to capture and study the movements. This way we combine some of the most important elements of each method and come up with a new way/method of analyzing movement. Further on into the research is better explained how these methods actually come up together.

Table 5: Chronophotography and motion capture analysis (*source:* courtesy of the owner)

		Chronophotography	Motion Capture
Origin		- Jules-Etienne Marey Late 19th century	- Late 20th century
Purpose		- Study and capture motion	- Digitally capture movement for analysis and animation
Structure		- Sequential photographs	- Markers and sensors tracked by cameras or software
Symbols		- Individual frames, overlapping images	- Markers, digital points
Key Components in depth	**Symbols**	- Single frames	- Reflective markers or sensors
	Stave	- Film strip or photographic plate	- Digital 3D space or software interface
	Movement	- Continuous motion broken down into static frames	- Real-time recording of motion translated into digital form

CHAPTER 4

RESULTS AND ANALYSIS

4.1 Giselle" Movement Comparison and Results: Theater vs. Open Space

After editing the videos in the software explained and getting the needed results, the videos taken in NTOB (National Theater of Opera and Ballet) with the videos taken in an open space and the analyses made in front and top view were combined. By making this comparison and capturing different movements from segments of the videos, it makes it possible to define the space that these movements need and also if the space occupied is the same in the theater and in the open space.

First analyzed are two solo segments one from the boy and one from the girl. Analyzing solo segments allows for a clear and focused examination of individual movement patterns without the complexity of interactions between multiple dancers. These segments are analyzed through lines that trace the body movements and give a better definition of the shapes created through the movements and also the spaces occupied. The traced lines offer a definition of the shapes formed by the body movements. This helps in understanding how different movements create distinct spatial forms. Analyzing the spaces occupied by the movements helps in understanding the dancer's spatial awareness and the effective use of space in performance. It also provides insights into how different movements fill the performance area and interact with the spatial boundaries.

The collages below with the shots captured from the videos are listed as followed: In each shot the top image is the video filmed in the NTOB, showcasing a dancer performing a specific move, middle Image is the same move performed in an open space, analyzed through tracing movement from a front view. And the Bottom Image, is the same move performed in an open space, analyzed through tracing movement from a top view. This exact listing is followed in each analyzes.

4.2 Analysis of the dancer's solo sequences

First solo dance sequence

I started the analysis with the movement sequences of the boy dancer. As seen in figure 43, When starting the movements, the dancer at the NTOB begins their motion from a position that is further away from the left corner of the stage compared to the dancer in the open space. This indicates a larger initial displacement or a more extended starting position and in figure 44, which shows the movement exactly after the start, we notice that both dancers are in alignment with one another in the same space.

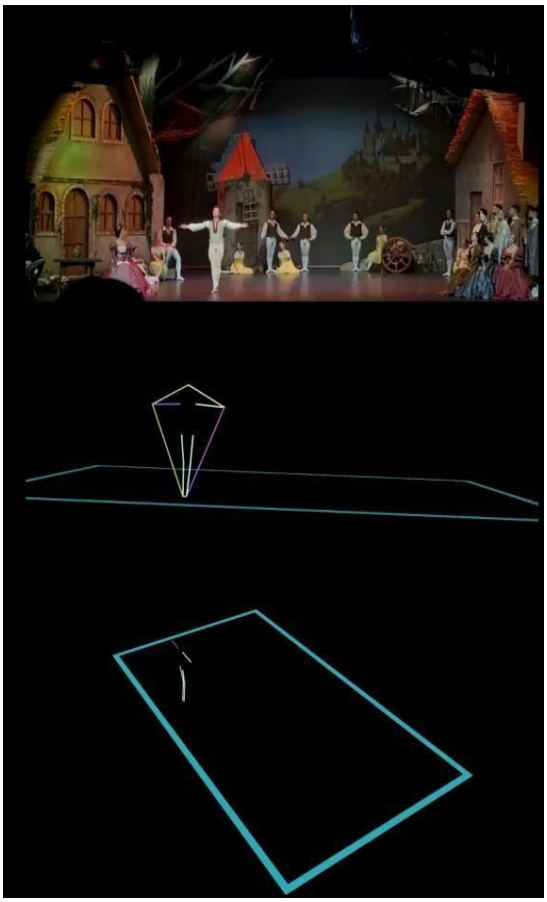

Figure 43. Comparative analysis between the ballet dancer in two different stages stages (*source:* courtesy of the owner)

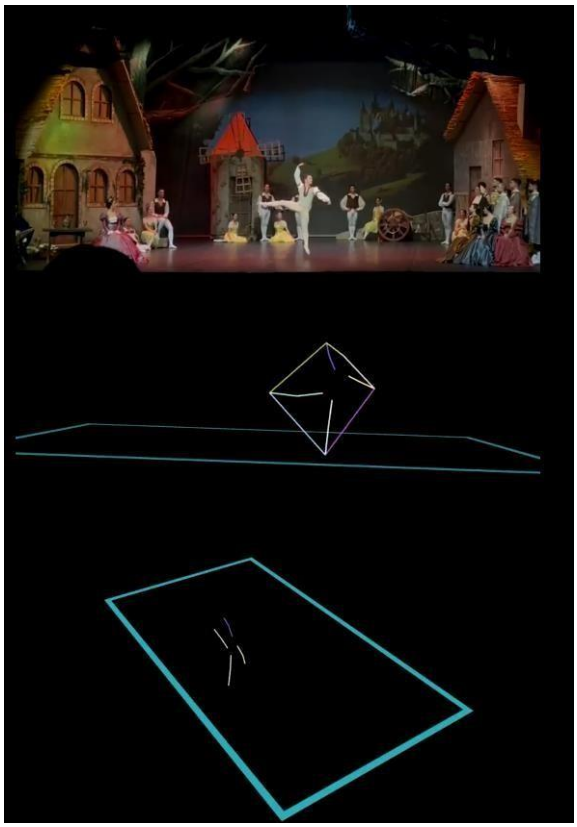

Figure 44. Comparative analysis between the ballet dancer in two different stages stages (*source:* courtesy of the owner)

Continuing with the analysis of the other segments of this sequence, in figure 45 the bottom image clearly shows the dancer being further than the dancer in the theater. This means again that even though figure 44 shows the dancers being in the same position, one movement still makes the difference. These images implicate the same fact as mentioned above that the theater space limits the dancer's ability to fully extend their movements, leading to a more controlled and confined performance.

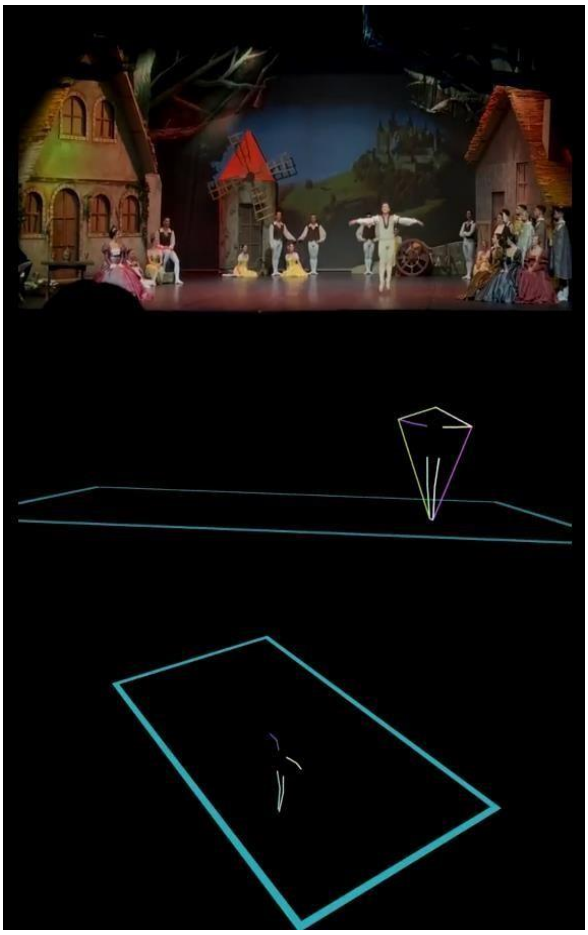

Figure 45. Comparative analysis between the ballet dancer in two different stages stages (*source:* courtesy of the owner)

Figures 47 and 48 show the last movements of this dance sequence. In figure 47 we notice that the dancer in the bottom image is more behind with movement than the dancer in the theater (top image). From the movement in figure 46 to figure 47 the dancer has continued with the same force patch. Whether in figure 48, which is also the last movement of this sequence, the dancer's movements finish almost in alignment. The dancer in the open space was further behind the one in the theater and in this sequence they are again in the same frame.

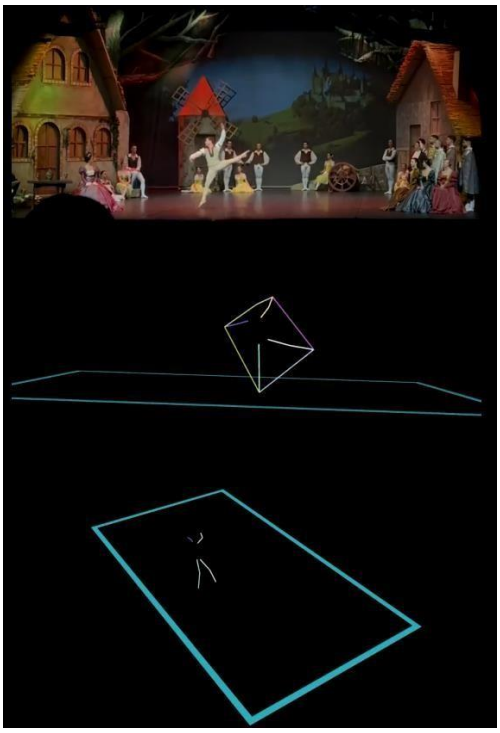

Figure 46. Comparative analysis between the ballet dancer in two different stages (*source:* courtesy of the owner)

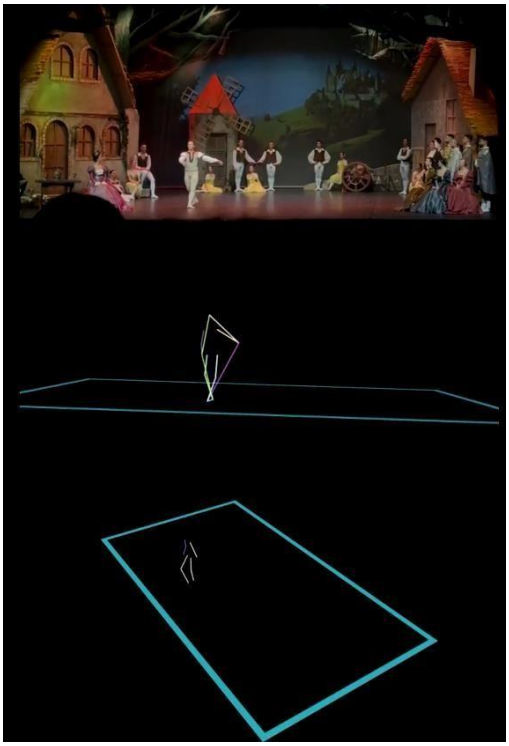

Figure 47. Comparative analysis between the ballet dancer in two different stages stages (*source:* courtesy of the owner)

When analyzing the movements, the application works as rotoscope. It captures every movement in each moment and it forms different shapes. As seen in figure 49 these are some of the first shapes that are formed because of the movements of the dancers. Here we can clearly see the impact that shape has in dance and the correlation to architecture. Each movement, shape, has its own needed space and this way we can better find and study the space that this movements need. The initial shapes formed by the dancers' movements illustrate the dynamic interaction between the dancers' bodies and the space. The variation in shapes shows how each movement requires specific spatial dimensions, highlighting the relationship between movement and space.

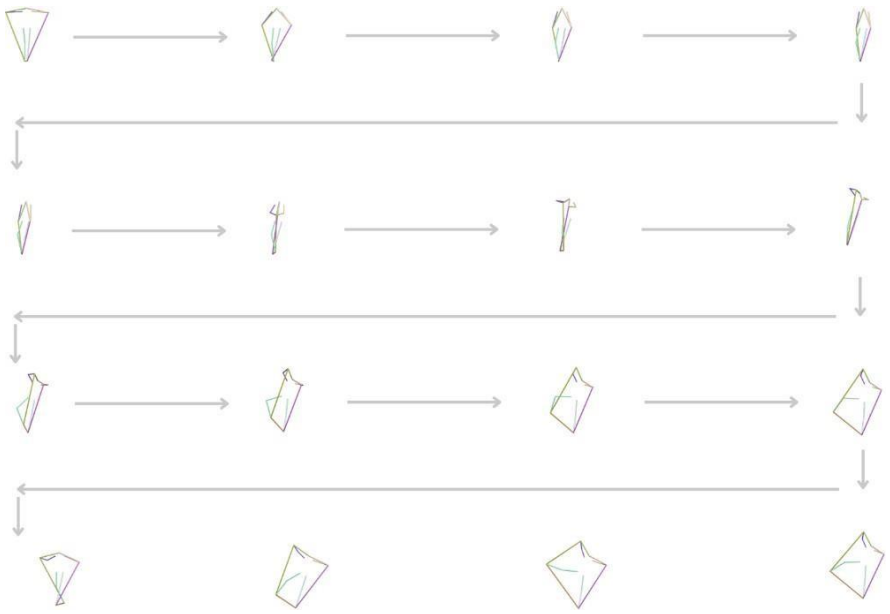

Figure 48. The various shapes exported from Rokoko (*source:* courtesy of the owner)

Another important analysis that can be conducted through this method is that each shape formed through various movements can be analyzed by also adding the parameters of the space where you want those movements performed. As seen in figure 50, there are several shots of the movements within a determined space in front and top view. This way the choreographers or scenographers can exactly see and study the space that each movement realistically needs. By capturing the movements within a defined space, we can analyze how the dancers interact with their environment. The

front and top views provide a better understanding of the spatial requirements for each movement. This analysis helps in optimizing the choreography to fit the space available, ensuring that the dancers can perform comfortably and effectively.

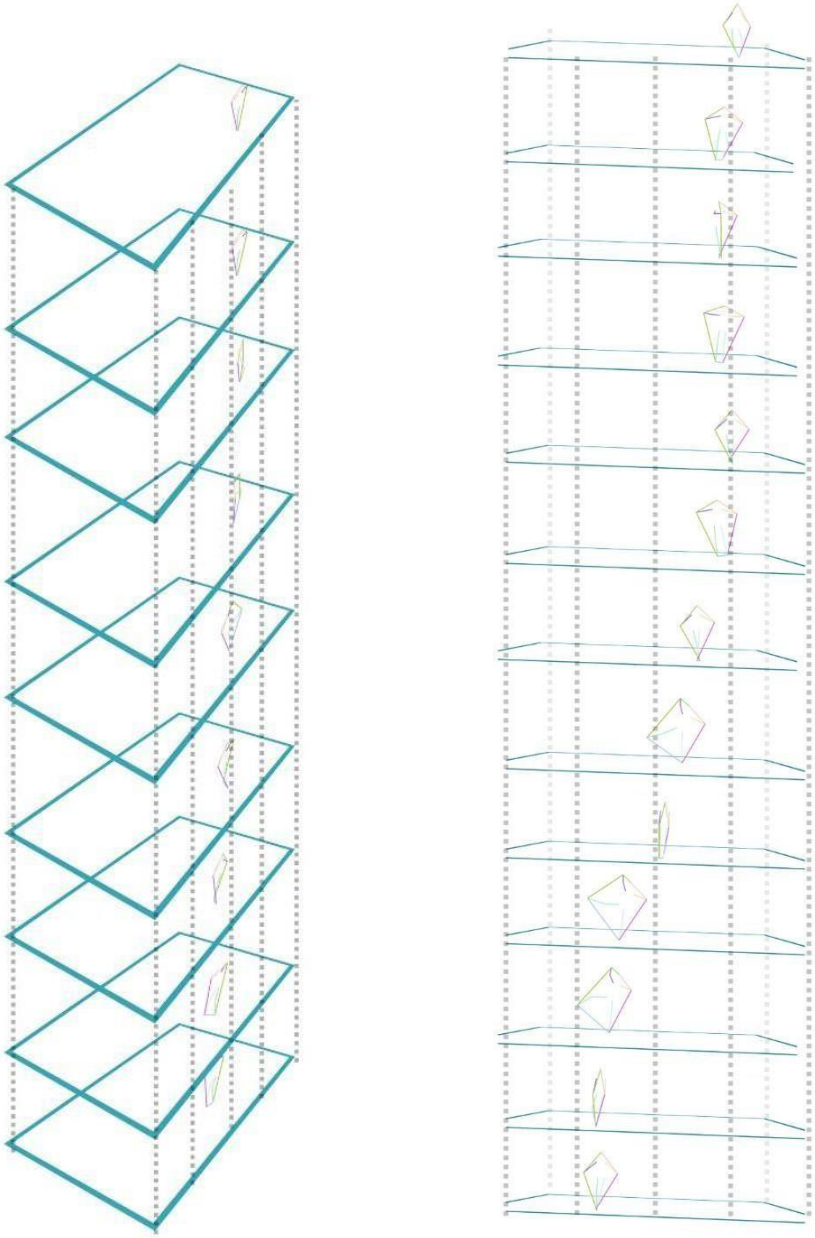

Figure 49. Exported frames of the geometrical shapes tracing the dancers' body in top and front view (*source:* courtesy of the owner)

An important issue when designing is thinking the space that a sequence of movements might need. Figure 52 and 53 show in front and top view the space that the sequence we filmed and analyzed until now needs. By overlapping the movements with one another we create a pattern and flow of each sequence, by getting this way the space that this specific dancer needs. By knowing the space that is occupied is easier to decide the movement of background dancers and also stage objects. This way we organize and arrange the spatial configurations by taking the consideration how the space will be used. The resulting pattern provides insights into the flow and rhythm of the dance. This information is important for planning the placement of other dancers and stage elements, ensuring an efficient use of space.

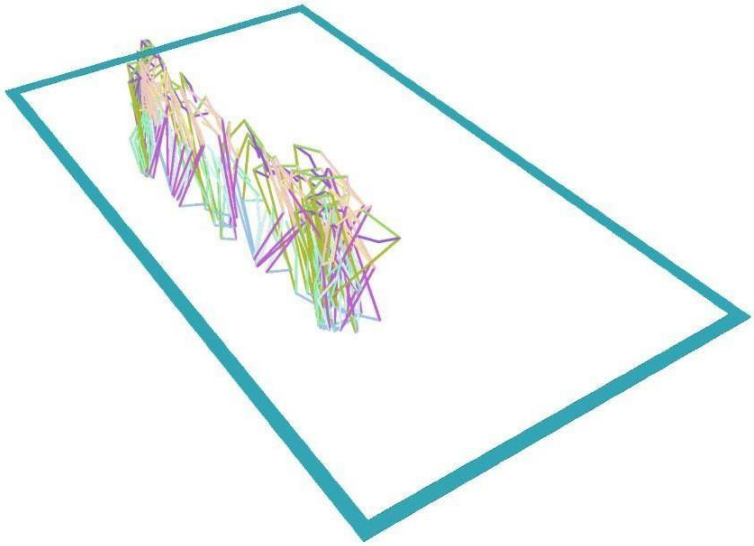

Figure 50. Overlapped movements shapes of the dancers and the space it occupies in top view (*source:* courtesy of the owner)

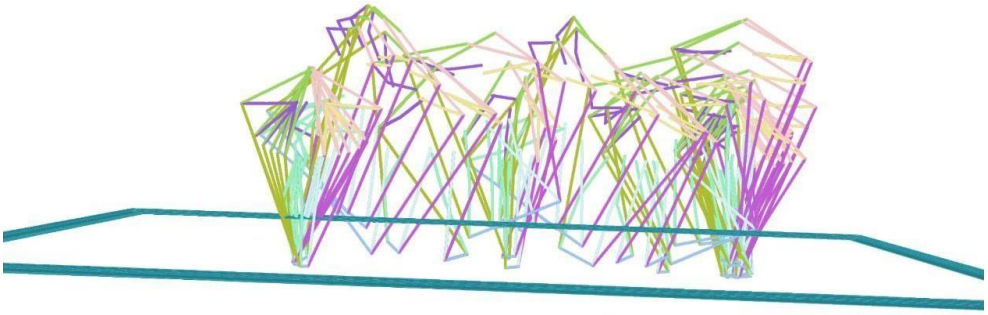

Figure 51. Overlapped movement shapes of the dancers and the space it occupies in front view (*source:* courtesy of the owner

By the analysis conducted, we come to the conclusion that understanding the space needed for each movement allows choreographers to plan choreographies that maximize the use of available space, enhancing the overall performance. By knowing the spatial requirements, choreographers can better coordinate the movements of multiple dancers, avoiding collisions and ensuring better transitions.

Stage designers can use this analysis to arrange stage elements in a way that complements the dancers' movements, creating functional performance space. Ensuring that dancers have adequate space to perform their movements also reduces the risk of accidents and injuries.

Dancers can also perform more confidently and expressively when they are not constrained by space limitations, leading to a more impactful performance. A well-planned stage layout that allows dancers to fully utilize their movements can also create a more engaging and visually appealing experience for the audience.

SECOND SOLO DANCE SEQUENCE

In order to analyze the movements better and to see if other sequences have the same problems as the one studied above, I decided to make the same movement and space analysis to another soloist dancer, this time a girl.

The difference between this sequence and the one studied above is that this has more jumps and the space occupied is denser than in the first one, since it makes roundabouts throughout the stage. As we can observe in Figure 54, the dancer in the middle and bottom starts the movement out of the stage configuration that I have put. The reason that I did not change the square of the stage and put it exactly where the dancer starts the movement, is because through the analysis we will see that no matter where I put the square the dancer will still go out of the lines because of the density of the movement and the space that each jump and spin needs. This is the main difference in Figure 54 and this is the main point for the analysis of this sequence.

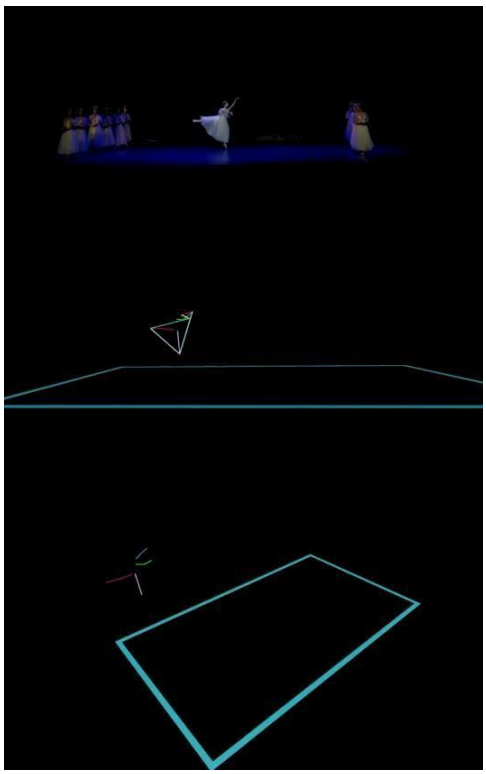

Figure 52. Comparative analysis between the ballet dancer in two different stages (*source:* courtesy of the owner)

In figure 55 and 56 we notice that the top image of the dancer in the theater is almost the same, meaning that even though there have been movement and jumps, the line of the movement there stays the same which means that the dancers are not fully extending their jumps but do "fake ones" to not occupy a lot of space. As seen in the middle and bottom image, the extent of the jumps occupies much space because the dancer is in the limit of the lines, and in some steps, it even goes out of the lines again.

These movements occupy the whole space within the lines and even go out at some sequences. This means that the space these movements need is bigger than the ones they do in the theaters.

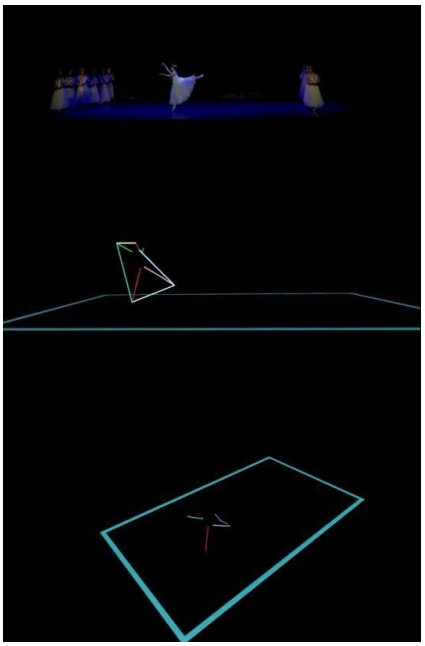

Figure 53. Comparative analysis between the ballet dancer in two different stages (*source:* courtesy of the owner)

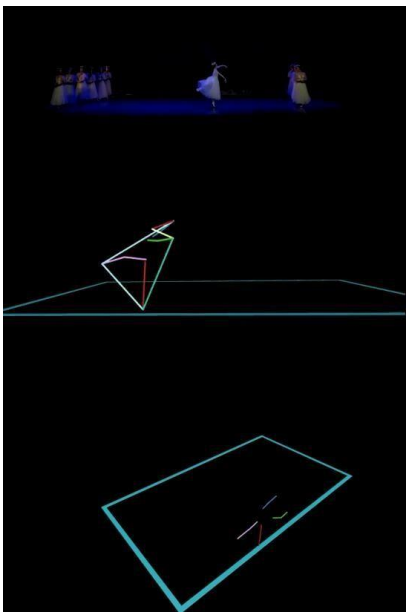

Figure 56. Comparative analysis between the ballet dancer in two different stages (*source:* courtesy of the owner)

Figures 57 and 58 further illustrate this point, showing that the dancer once again moves outside the lines to complete the movements. This reinforces the observation that the space in the theater is not sufficient for the full range of movements the dancer performs.

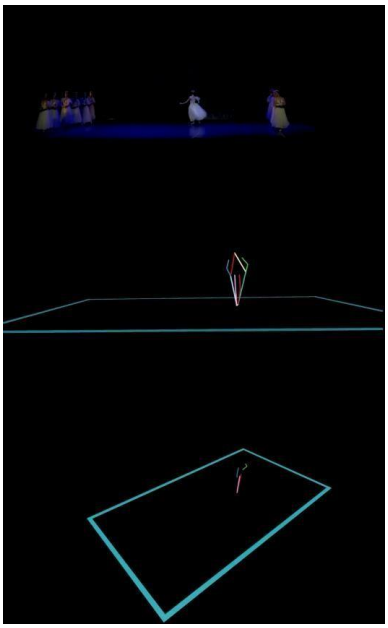

Figure 55. Comparative analysis between the ballet dancer in two different stages (*source:* courtesy of the owner)

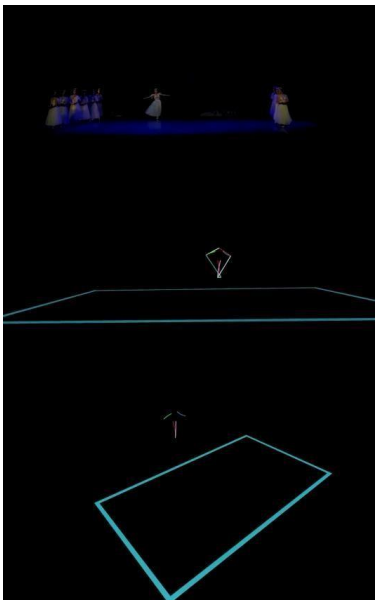

Figure 56. Comparative analysis between the ballet dancer in two different stages (*source:* courtesy of the owner)

The figures 59-62 show the relationship between shape form and ballet by adapting and making configurations according to given spaces. The analysis below shows the space that is occupied by each movement sequence. In these figures, the shapes formed by the movements of the dancers highlight the correlation between the physical space and the spatial requirements of the dance. The various configurations illustrate how different sequences of movements occupy space, emphasizing the importance of adequate spatial planning in choreography and stage design.

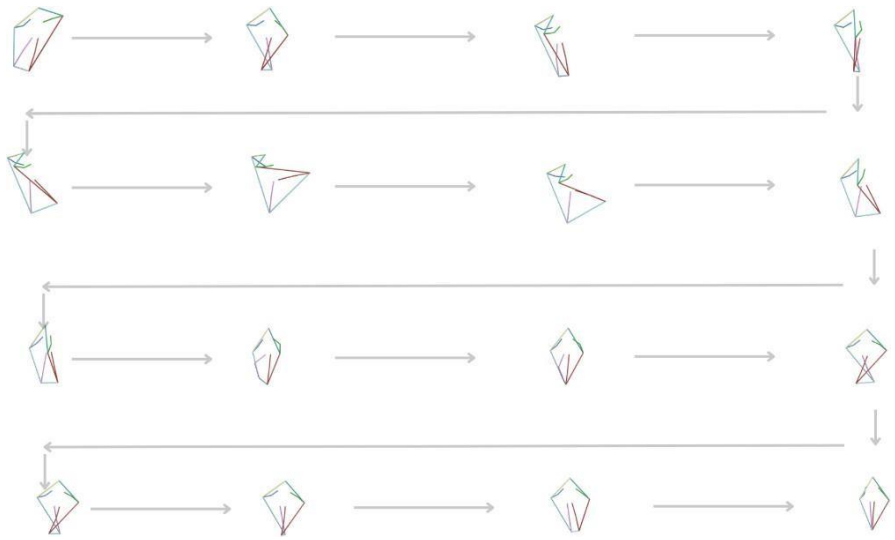

Figure 57. The various shapes exported from Rokoko (*source:* courtesy of the owner)

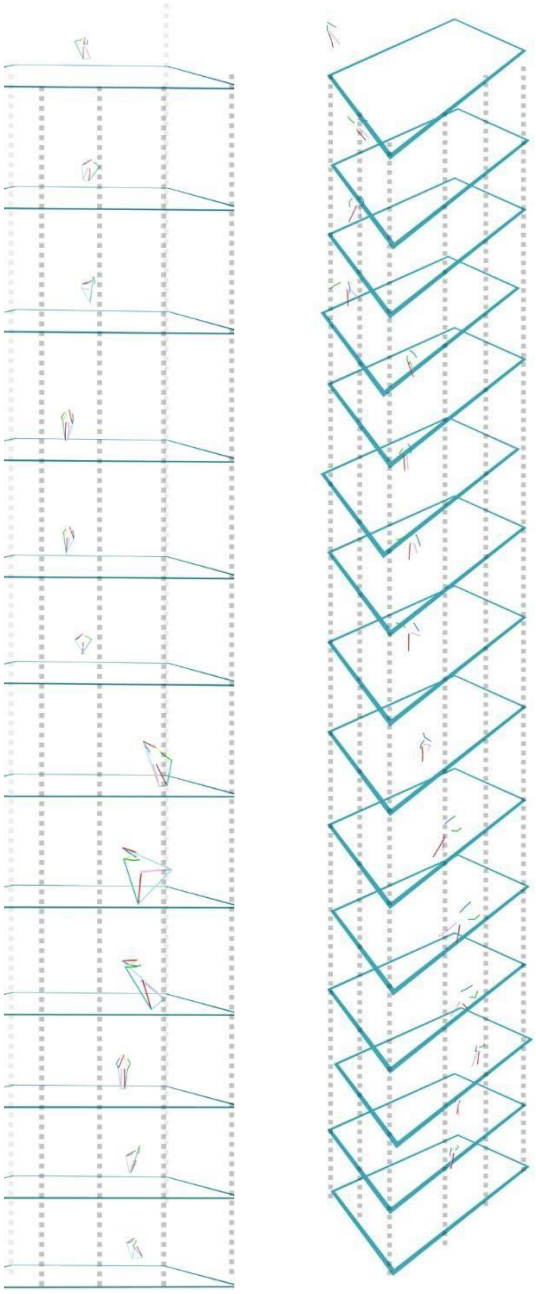

Figure 58. Exported frames of the geometrical shapes tracing the dancers' body in front and top view (*source:* courtesy of the owner)

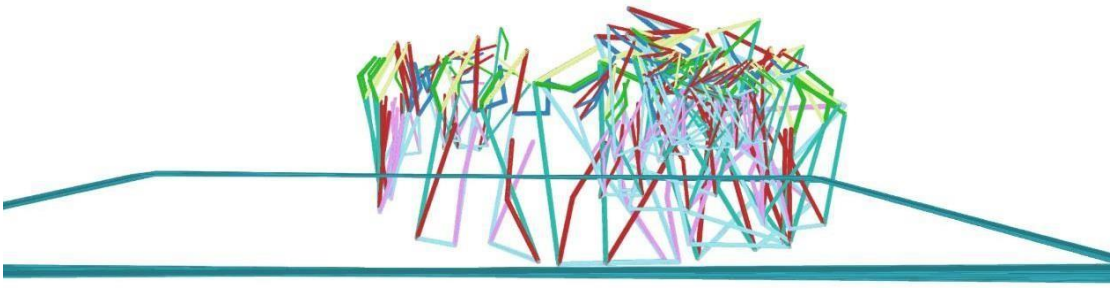

Figure 59. Overlapped movements shapes of the dancers and the space it occupies in front view (*source:* courtesy of the owner)

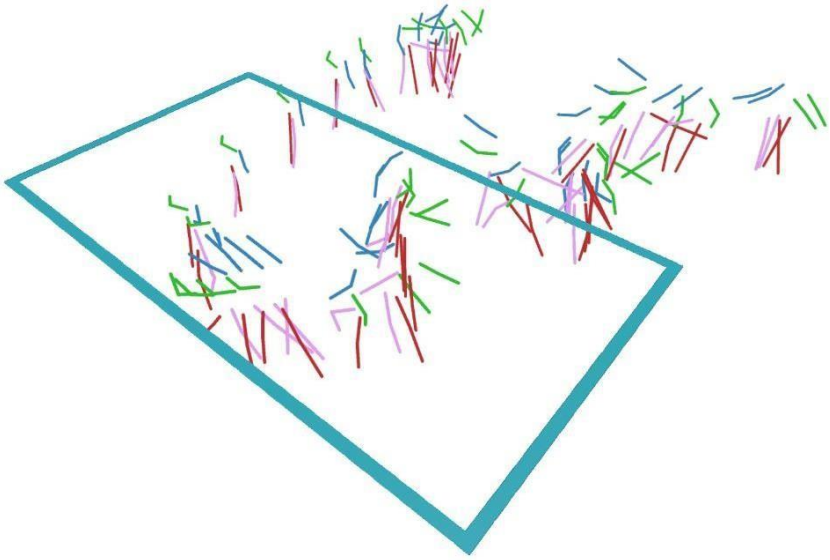

Figure 60. Overlapped movements shapes of the dancers and the space it occupies in top view (*source:* courtesy of the owner)

This analysis of the female soloist's movements reveals similar spatial challenges as identified in the previous sequence with the male dancer. The comparison between the

theater environment and the open space highlights an issue: the constrained space in the theater limits the dancers' ability to fully extend their movements. The dancer frequently moves outside the defined boundaries in the open space, indicating that the actual space required for these movements is significantly larger than what the theater stage can accommodate.

Figures 54 through 58 consistently show that the dancer's movements, especially jumps and spins, are much more expansive in the open space compared to the restricted, more controlled movements performed in the theater. This confirms that in a less constrained environment, dancers naturally utilize more space to fully express their movements. This reinforces the conclusion from the first section: dancers are constrained by the limited space in the theater.

The findings from this sequence further support the practical applications highlighted previously. Choreographers need to consider the actual spatial requirements of movements to optimize performance routines. Stage designers must ensure that the performance space is adequate for the full range of movements to prevent accidents and enhance the visual appeal of the performance. Additionally, a well-designed stage layout can significantly improve the overall quality of the performance.

The other analysis' conducted are of two sequences that follow the movements of a couple of dancers. Through this comparative analysis the aim is once again to compare the movement in space in NTOB with the movements filmed in an open space and seeing the similarities and differences between the space that these dance sequences, movements need.

4.3 Analysis of the dancer's couple dance sequence

First couple dance sequence

Analyzing the movement in Figure 63, it can be seen that horizontally the dancers are almost in the same space. Even when moving through figure 64 the horizontal movements are still in alignment with one another.

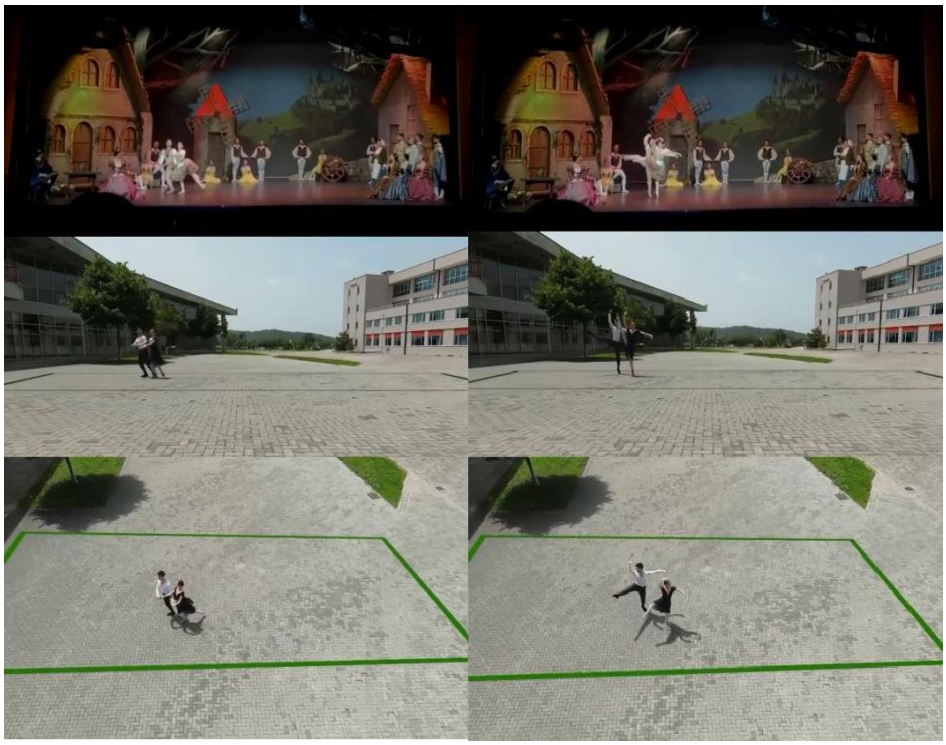

Figure 61. Comparative analysis between the couple of ballet dancers in two different stages (*source:* courtesy of the owner)

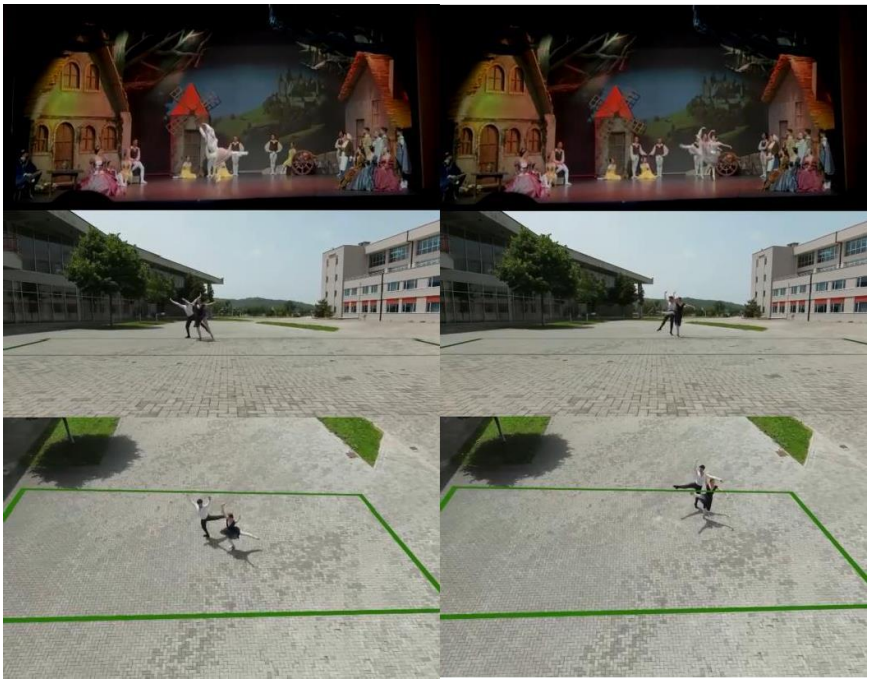

Figure 62. Comparative analysis between the couple of ballet dancers in two different stages (*source:* courtesy of the owner)

Looking thoroughly through figures 65 to 66, what can be noticed is that the movement horizontally is still in alignment in both stages. The difference is that vertically the dancers are positioned in the end line of the stage and even pass the line configuration.

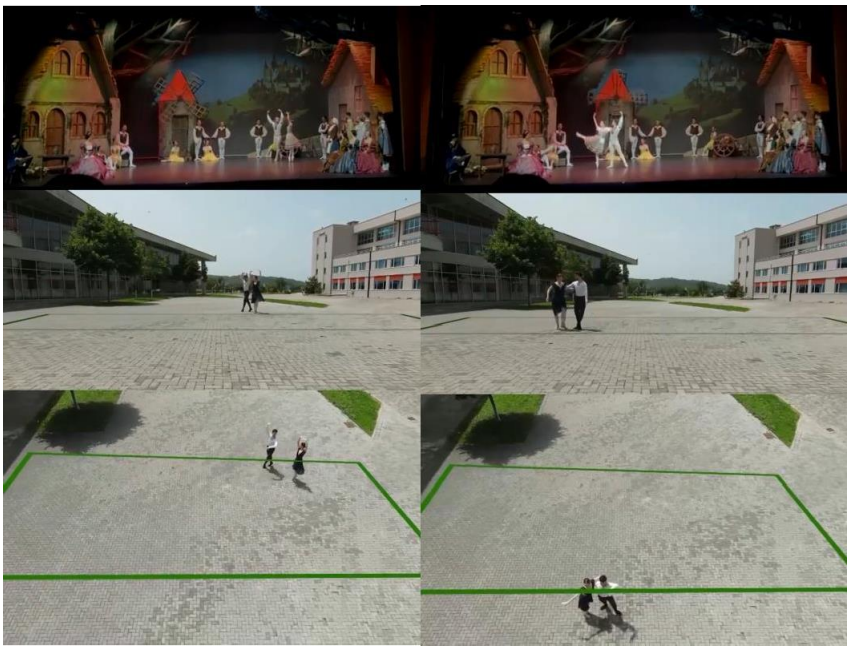

Figure 63. Comparative analysis between the couple of ballet dancers in two different stages (*source:* courtesy of the owner)

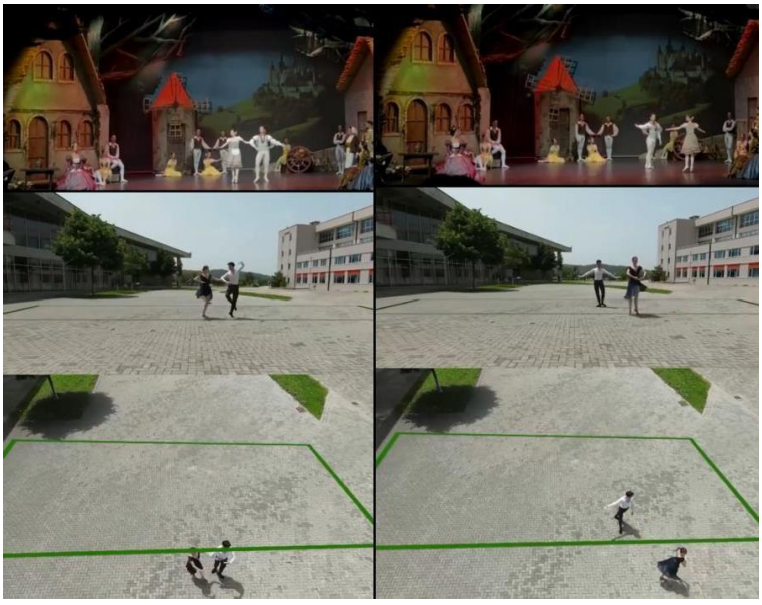

Figure 64. Comparative analysis between the couple of ballet dancers in two different stages (*source:* courtesy of the owner)

SECOND COUPLE DANCE SEQUENCE

The second sequence, which is shorter than the other sequences filmed, is almost the same as the first one analyzed. As it can be noticed in figure 67 and 68 the dancers are in alignment with the movements in the NTOB and in the open space.

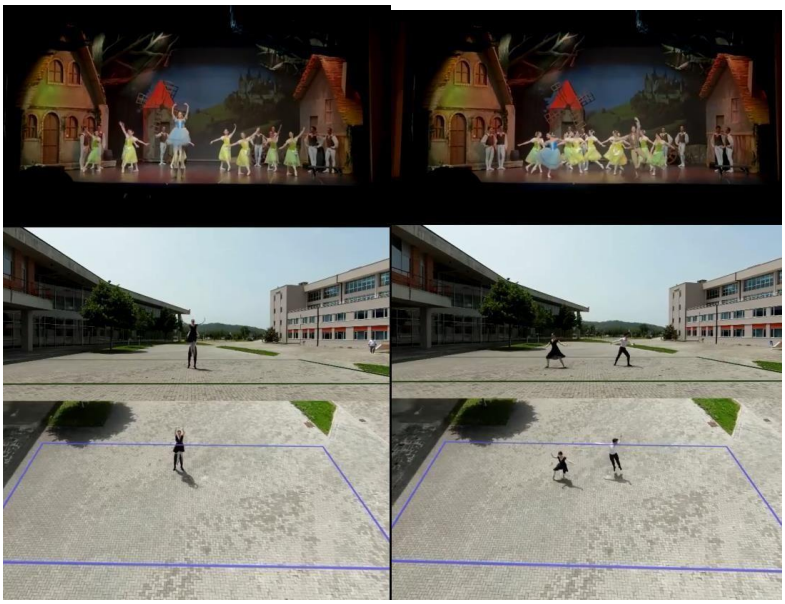

Figure 65. Comparative analysis between the couple of ballet dancers in two different stages (*source:* courtesy of the owner)

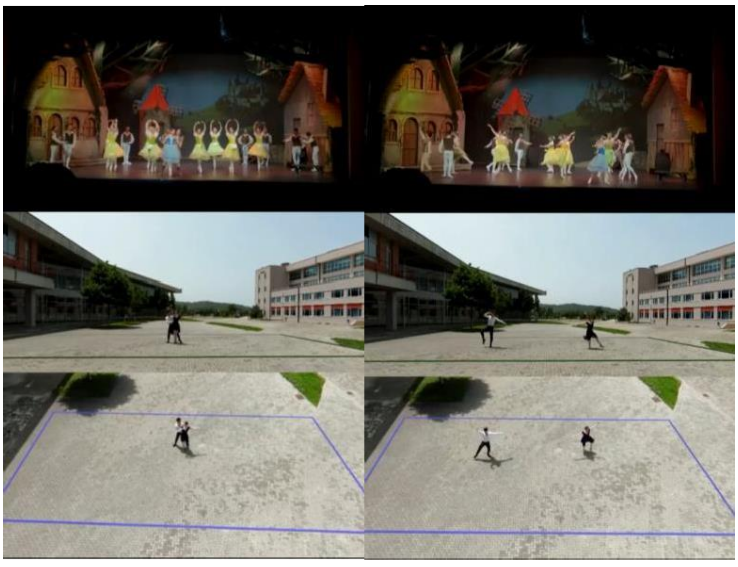

Figure 64. Comparative analysis between the couple of ballet dancers in two different stages (*source:* courtesy of the owner)

In the end of the dance sequence, it can be seen that the dancers in the opera stage have moved more horizontally than the dancers in the open space, which is the first time happening in this analysis. Since there are other dancers in the opera stage this causes the interaction of the protagonists, making them need a different space for movement.

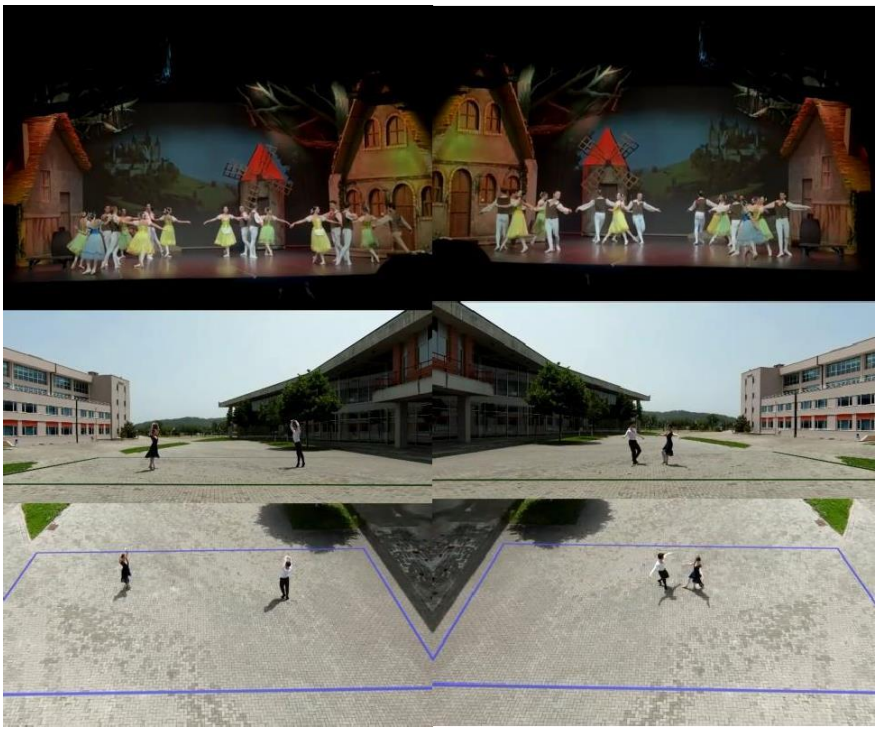

Figure 67. Comparative analysis between the couple of ballet dancers in two different stages (*source:* courtesy of the owner)

4.4 Interview results

The interviews with ballet dancers Armando Meci and Sabina Maklekaj revealed several key findings that provide practical insights into the relationship between spatial design and dance performance. These findings highlight the dancers' experiences and perspectives on performing in different spaces, emphasizing the importance of spatial awareness, flexibility in design, and the integration of dancers' feedback in architectural planning. In order to better explain the results coming from the interviews, further on are explained the findings separated in different sections.

Key Findings from the Interviews

Experience in Open Spaces vs. Traditional Venues

Armando noted that performing in an open space offered greater freedom and dynamic movement compared to traditional venues. However, this setting also posed challenges such as potential disorientation and the need to adapt to varying ground surfaces. Similarly, Sabina found that the open environment provided a sense of boundlessness, allowing for more expansive and expressive movements. Nonetheless, she highlighted the difficulty in maintaining precise spatial orientation without the usual stage boundaries and markers, requiring the dancers to rely more on their spatial awareness and coordination.

Sufficiency of Stage Space in Theaters

Armando expressed that theaters can feel restrictive for complex choreographies, especially with large groups of ballerinas. He suggested that more depth and width on stage would help to execute elaborate choreographies without compromising performance quality. Sabina also explained that traditional stages sometimes limit the full potential of choreography for large groups, making it need a lot of planning to avoid collisions. A theater designed with a more flexible and bigger stage area would enhance the ability to perform complex pieces.

Managing Space with Large Groups

Effective management of space with large groups requires a lot of rehearsals, spatial markers, and clear communication, according to Armando. He suggested flexible and modular staging options to improve theater spaces. Sabina stressed the importance of rehearsals, visual cues, peripheral vision, and timing. She emphasized the need for clear sightlines and flexible space configurations to ensure that all dancers can move harmoniously and avoid collisions.

Maintaining Spatial Awareness

In confined stage areas, Armando explained that dancers rely on stage markers and spatial cues to maintain spatial awareness. In open spaces, visual and auditory cues from the environment and fellow dancers are essential. Sabina described using

different strategies for confined and open spaces. She relies on peripheral vision and environmental cues to maintain spatial awareness.

Adapting to Spatial Constraints

Armando mentioned that modifying movements, such as shortening leaps and adjusting formations, help in improvising dance sequences in limited space. Sabina also discussed making adjustments, including tighter formations, shorter leaps, and modified lifts, to fit within spatial constraints. These modifications ensure that the choreography remains effective even in restricted spaces.

Favorable Architectural Elements for Ballet

Armando identified several architectural elements that are conducive to ballet performances, including spacious stages, clear sightlines, and flexible lighting options. He suggested incorporating movable stage elements and ensuring spacious wings to enhance performance quality. Sabina added that spacious stages, high ceilings, and clearly defined boundaries significantly improve the quality of ballet performances. She also suggested that workshops with dancers could provide valuable feedback on stage dimensions, surface materials, and other design elements.

These insights from the interviews provide recommendations for improving the design of performance spaces, ensuring they meet the specific needs of ballet dancers. They reinforce the theoretical findings of the thesis, offering this way an understanding of how spatial design influences dance performance.

CHAPTER 5

DISCUSSIONS

5.1 Discussion about methods used in the literature review and in this thesis' analysis

The methodology used in this thesis integrates advanced motion capture technology and 3D modeling. This section delves into a detailed comparison of the methodologies analyzed in the chapters above, highlighting the improvements and contributions of the approach used in the analysis conducted on this thesis.

Table 6 shows the main concepts of Laban and Benesh movement notation. Highlighted in blue are some of the concepts used in the method conducted. In order to create a method to analyze the video sequences and to get the result, some key aspects had to be taken from previous methodologies. Further on are explained the similarities and differences about these methods.

Table 6: Laban and Benesh Movement Notation and thesis methodology comparison (*source:* courtesy of the owner)

Concept	Laban and Benesh Movement Notation	Thesis Methodology
Similarities with Laban		
Comprehensive system	**Comprehensive system** for documenting, analyzing, and interpreting movement	Integrates similar **comprehensive system**
Representation	Uses **geometric shapes** and **lines** to represent movements	Uses **3D modeling** to represent movements
Focus	Focus on **effort** and **spatial aspects**	Focus on **spatial aspects**
Spatial awareness	**Kinesphere concept** informs **spatial awareness**	Informs **spatial awareness** in **motion capture analysis**
Differences with Laban		
Precision	Lacks precision of **real-time motion capture**	Offers precise **real-time motion capture**
Notation	**Abstract notation**	Detailed, easy-to-understand **3D visualizations**
Analysis	**Static analysis**	Allows **dynamic analysis** in various **spatial configurations**

LBN Similarities

Like Laban Movement Analysis, our methodology aims to provide a comprehensive system for documenting, analyzing, and interpreting human movement. Both methods use geometric shapes and lines to represent movements. Laban's kinesphere and our 3D modeling both emphasize the spatial dimensions of movement. Laban's focus on the effort and spatial aspects of movement (Laban, 1966), is mirrored in our analysis, where we examine how different spatial environments impact the quality and dynamics of movements. Open, obstacle-free spaces enable more natural and unrestricted movements, allowing dancers to utilize their full range of motion and enhancing movement fluidity and expression. Conversely, traditional stage designs with fixed dimensions often limit the dancers' ability to execute certain movements, necessitating modifications to choreography and reducing performance quality. Dancers have to adapt their movements in confined spaces, which impacts expressiveness and dynamism. Therefore, architectural designs for performance spaces should prioritize flexibility and adaptability, incorporating movable and reconfigurable elements to create environments that support dynamic and expressive ballet performances.

The concept of the kinesphere informed the understanding of spatial awareness and how dancers navigate their environment, leading to the integration of this awareness into the motion capture analysis. (Bradley, 2009)

LBN Differences

Laban's method provides a detailed symbolic representation of movements but lacks the precision of real-time motion capture. Our methodology offers a higher degree of accuracy in capturing the nuances of movements. Laban's notation, while comprehensive, is abstract and may be challenging to interpret without training (Bradley, 2009). In contrast, the 3D modeling provides detailed visualizations that are easier to understand and analyze. Labanotation is primarily suited for documenting and analyzing pre-determined movements. Whether, the method used in this thesis allows for the dynamic analysis of movements in various spatial configurations, offering flexibility in exploring different scenarios as it can be seen in figure 68.

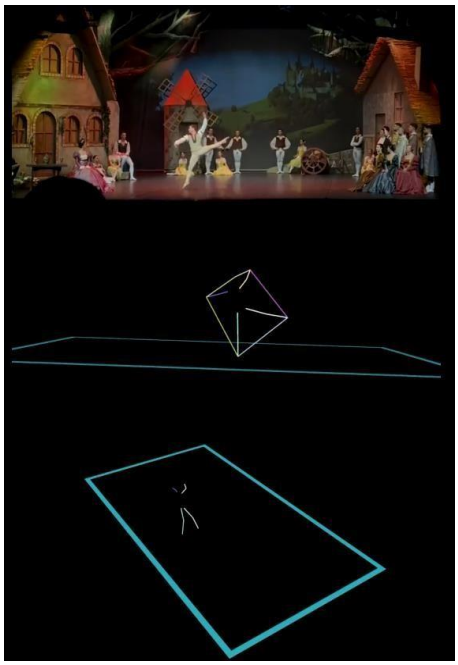

Figure 68. The method of analyzing movement in the thesis (*source:* courtesy of the owner)

BN similarities

Both Benesh Movement Notation and our methodology aim to provide a detailed account of body positions and movements. Benesh notation's primary focus on ballet movements aligns with the thesis, which centers on analyzing the ballet "Giselle." The structured approach of Benesh notation, using a five-line stave, is akin to our use of digital tools to create structured, detailed visualizations. This can be better seen in figure 69.

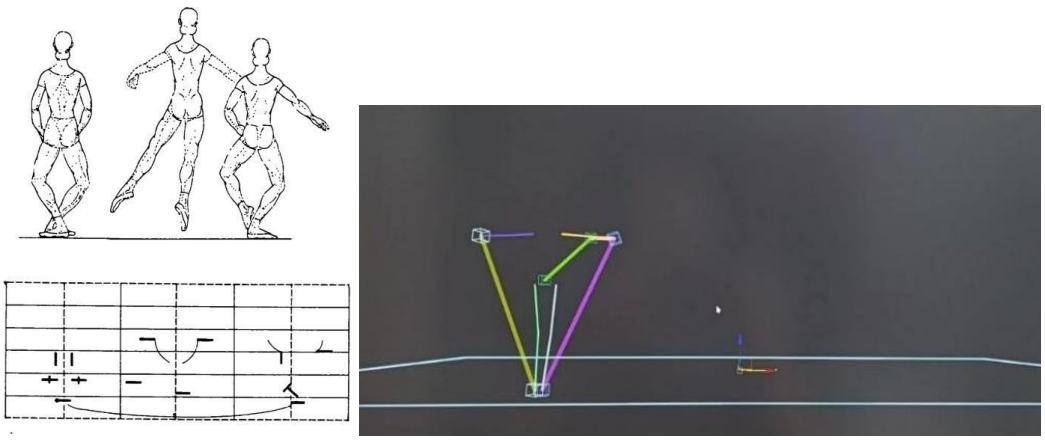

Figure 69. Comparison between BN and the thesis methodology (*source:* courtesy of the owner)

BN Differences

The Benesh notation provides a detailed account of body positions and movements but can be time-consuming to create and interpret (Hutchinson Guest, 2005). Whether motion capture technology captures detailed movement data in real-time, significantly improving efficiency and accuracy. Benesh notation is two-dimensional, whereas the 3D modeling offers a three-dimensional perspective, providing a better understanding of how movements interact with space. Unlike Benesh notation, which documents movements post-performance, our method allows for real-time analysis and feedback, enabling immediate adjustments and insights.

Table 7: Laban and Benesh Movement Notation analysis (*source:* courtesy of the owner)

		Laban Movement Notation	Benesh Movement Notation
Origin		- Created by Rudolf Laban in the 1920s. - Developed to record all forms of human movement, not limited to dance.	- Developed in the 1950s by Rudolf and Joan Benesh. - Initially designed to record ballet movements but has since been adapted for other dance forms
Purpose		- Comprehensive system for documenting, analyzing, and teaching movement. - Used in dance, physical therapy, ergonomics, and more	- Recording and analyzing dance movements, particularly in ballet. - Used to communicate choreography, preserve performances, and teach dance
Structure		Vertical Staff: - Movement is recorded from bottom (start) to top (end). - Columns: Represent different parts of the body.	- Five-Line Stave: Similar to music notation. - Top Line: Represents the head. - Second Line: Represents the shoulders. - Middle Line: Represents the waist. - Fourth Line: Represents the knees. - Bottom Line: Represents the feet.
Symbols		-Geometric shapes and lines indicating direction, level, and quality of movement. - Effort and space aspects are also covered.	- Use lines, shapes, and dots to represent body positions and movements
Key Components in depth	Symbols	Geometric Shapes: Indicate direction (forward, backward, sideways, etc.). - Lines: Show levels (high, middle, low) and pathways. - Effort and Space: Symbols for effort (dynamics) and spatial factors.	Lines and Shapes: Represent various body parts and their movements. - Dots and Other Marks: Indicate specific positions or actions. - Modifiers: Adjust the meaning of basic symbols to convey more detail.
	Stave	- Vertical with different columns for different body parts. - Helps in visualizing movement as a continuous flow.	- Horizontal with five lines representing different body parts. - Similar to a musical stave but adapted for movement.
	Movement	- Comprehensive system including effort (how), space (where), time (when), and flow (continuity). - Can notate any type of human movement.	- Detailed notation for timing, dynamics, and spatial orientation. - Can represent complex sequences of dance moves.

William Forsythe's Methods Similarities

Table 7 shows the main concepts that are further on analyzed regarding Forsythe's methods.

Both Forsythe's methods and our approach integrate technology to analyze and visualize dance movements. Forsythe's use of geometric principles to explore spatial relationships in dance (Forsythe, 2009), is a key similarity, as our method also uses geometric modeling to understand movement dynamics. Forsythe's Dance Geometry, which uses geometric shapes to represent pathways and spatial relationships, inspired the use of 3D modeling in this thesis to visualize the spatial dynamics of movements. (Forsythe, 2009). Forsythe's exploration within structured environments inspired the experimental approach conducted in filming the dancers in a space with no boundaries.

William Forsythe's Methods Differences

Forsythe's methods rely on the use of digital tools and multimedia for exploring dance. The methodology used in the analysis is built on this by incorporating motion capture technology, offering precise and detailed movement data. Both Forsythe's Dance Geometry and our approach use geometric principles to understand movement. Our method enhances this by providing real-time, three-dimensional visualizations that offer deeper insights into spatial dynamics. Forsythe's Synchronous Objects project translates dance into data visualizations (Forsythe, 2009). Our approach similarly uses digital tools but focuses on integrating this data with architectural design, providing a practical application for improving spatial configurations.

Table 8. William Forsythe's analysis and thesis methodology comparison (*source:* courtesy of the owner)

Concept	William Forsythe's Methods	Thesis Methodology
Similarities		
Integration of technology	**Integration of technology** for analyzing and visualizing **dance movements**	**Integration of technology** for analyzing and visualizing **dance movements**
Geometric principles	Use of **geometric principles** to explore **spatial relationships** in dance	Use of **geometric principles** to explore **spatial relationships** in dance
Dance Geometry	Forsythe's **Dance Geometry** inspired the use of **3D modeling** to visualize spatial dynamics	Use of **3D modeling** to visualize spatial dynamics
Differences		
Digital tools and multimedia	Uses **digital tools** and **multimedia**	Incorporates **motion capture** for precise data
Visualization	**Real-time**, three-dimensional visualizations provide deeper insights into spatial dynamics	
Synchronous Objects	Forsythe's **Synchronous Objects** project translates dance into **data**	Integrates this data with **architectural design** for practical applications

Unique Contributions of the Methodology used in this thesis

The use of motion capture and 3D modeling provides detailed and accurate visualizations of movements, capturing nuances that traditional methods might miss. This precision allows for a more thorough analysis of how movements interact with different spatial environments. The ability to capture and analyze movement data in real-time offers significant advantages. It allows for immediate feedback and adjustments. By combining quantitative data from motion capture with qualitative insights from dancer interviews, it provides a better understanding of how spatial environments impact ballet movements. This approach allows for the dynamic analysis of movements in various spatial configurations, offering flexibility in exploring different scenarios. This is an important aspect for designing spaces that can accommodate a wide range of movements and activities.

Unlike traditional methods that primarily focus on documenting and analyzing movements, methodology emphasizes the practical application of these insights in architectural design. By integrating movement analysis with spatial design, it creates different solutions for creating environments that can be fully functional. This methodology not only addresses the limitations of traditional methods but also offers new possibilities for analyzing movements in spatial organization.

Table 9. Unique contributions of this thesis' methodology (*source:* courtesy of the owner)

Unique Contributions of the Thesis Methodology	Description
Detailed Visualizations	Motion capture and 3D modeling provide precise, nuanced visualizations of movements
Real-time Analysis	Offers immediate feedback and adjustments, capturing movement data in real time
Combination of Data	Integrates quantitative data from motion capture with qualitative insights from dancer interviews
Dynamic Analysis	Allows exploration of various spatial configurations, essential for designing flexible spaces
Practical Application	Focuses on applying movement analysis to architectural design, creating functional environments
New Possibilities	Addresses limitations of traditional methods and offers innovative solutions for analyzing movements in spatial organization

5.2 Deeper understanding of the methodology used in this thesis

When working with the editing of the videos there were some problems that came up along the way. The first problem came with the filming. Even though the dance sequences were filmed with a drone, there was a lot of shaking in the footages. This is why before starting with the editing I had to balance the images in order to export the data. After fixing the shaking and exporting the data, in order to get the best results camera tracking was used, so I put the camera movements according to the footage focusing in more than three points. The more viewpoints there are, the better the video will be.

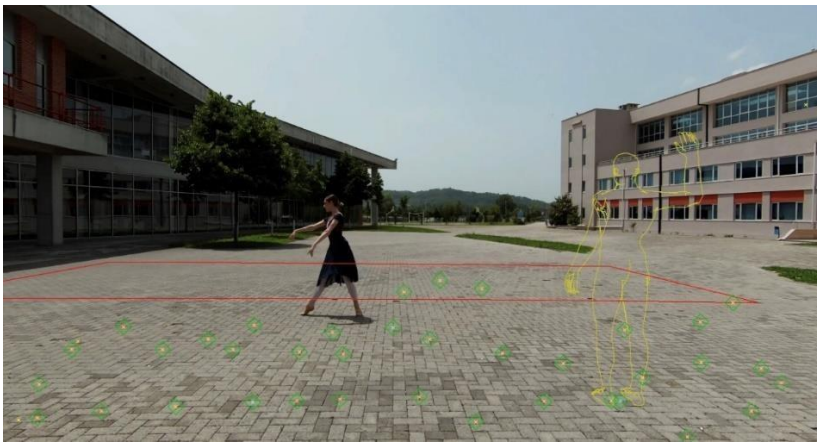

Figure 70. Image captured in 3ds Max capturing and fixing the sudden movements in the footage (*source:* courtesy of the owner)

When analyzing the movements of the solo dancers, there were different ways used until coming to the end result which was more effective for the study. Firstly, as it can be seen in figure 71, the lines of movement exported from the top and front view added in the same background as the dancers. This did not help the analysis since there was no way in knowing where in the space was the movement happening.

Figure 71. First try in combining the geometrical lines with the body of the dancers (*source:* courtesy of the owner)

The second method used was the one showed in figure 72, 73. After exporting the lines exported from the movements, it was tried to connect it with the body of the dancers. When trying to overlap it with one another and creating one image, the lines could not align with the body of the dancer resulting on the lines being much further in the space than the actual body. This why this method was also excluded since it did not show accurately the connection between the movement and the space.

Figure 72. Second method in combining the geometrical lines with the body of the dancers (*source:* courtesy of the owner)

Figure 73. Second method in combining the geometrical lines with the body of the dancers (*source:* courtesy of the owner)

The last method, shown in figures 74 and 75, was the one used in the analysis I chapter 4, where the background was removed and there were only the exported lines moving in the space. This proved efficient because the lines were moving exactly where the dancers were, capturing this way the exact spatial movements.

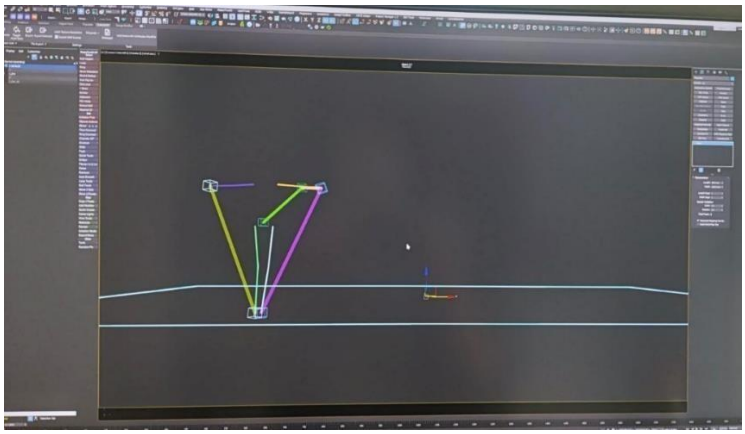

Figure 74. The final method in capturing the lines and movements of the dancer's body in front view (*source:* courtesy of the owner)

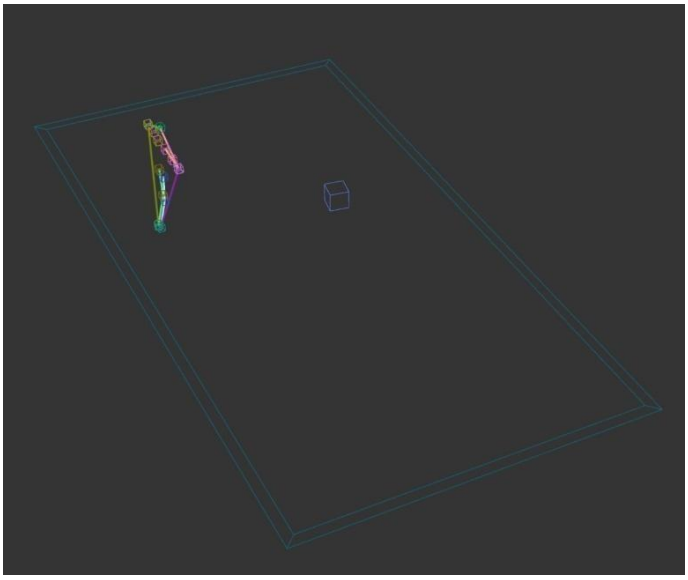

Figure 75. The final method in capturing the lines and movements of the dancer's body in top view (*source:* courtesy of the owner)

In the analyses in chapter 4, the movements of the solo dancers were studied by using the motion capture techniques and technologies, whether the video sequences where the dancers were in pairs is only studies by adding the stage lines. This happened because of a restriction with the footages. When wanting to analyze motion capture in is suggested that the people being studied wear motion capture suits. When trying to make and export the tracking of the movements there was overlapping of the lines and

the camera could not capture all the movements correctly, making it difficult to separate the movements of both dancers.

5.3 Integrative Methodology: Comparison of the Interview results with the Analysis' results

The interviews with the ballet dancers provided important qualitative data that added important input also to the quantitative and visual analysis conducted in Chapter 4. These interviews offered insights into the dancers' experiences and perceptions of performing in different spatial environments, providing an understanding of how architectural design impacts movement dynamics and overall performance quality. This section discusses the key findings from the interviews and their relation to the analysis in Chapter 4, highlighting the implications for architectural design and the integration of body movement in space.

The interviews with the dancers revealed several recurring themes and observations. Dancers reported a greater sense of freedom and fluidity when performing in open, obstacle-free spaces compared to traditional theater settings. They highlighted how the lack of physical constraints in open spaces allowed for more expansive movements. This brought the thought that traditional stage designs, particularly those with fixed dimensions and limited depth, often imposed restrictions on their movements. Expansive leaps, long traveling steps, and wide arm movements are constrained by the limited space, reducing the dancers' ability to fully express the choreography. Choreographers must adapt their original vision to fit within the stage's physical limits. This often involves shortening the length of movements, reducing the height of jumps, or compacting group formations to avoid collisions and ensure all dancers fit within the stage boundaries. These constraints sometimes required them to modify or adapt their choreography, which could affect the overall quality of the performance. They may also feel constrained by the physical limits of the stage, leading to less innovative choreography. To cope with spatial restrictions, choreographers might resort to using similar patterns and formations repeatedly, which can make performances less diverse.

The dancers also mentioned the importance of spatial awareness in navigating the performance space. The qualitative data from the interviews complements and

reinforces the quantitative and visual analysis conducted in Chapter 4. Here's how the interview findings align with the results of the spatial analysis:

Spatial Freedom and Movement Fluidity

The analysis in Chapter 4 demonstrated that open, obstacle-free spaces allowed for more natural and unrestricted movements, as evidenced by the greater range of motion and fluidity observed in the motion capture data. This finding aligns with the dancers' reports of increased spatial freedom and movement fluidity in open spaces. The visualizations showed that dancers could utilize the full extent of their kinesphere, leading to more dynamic and expressive performances.

Impact of Stage Design on Performance Quality

Chapter 4's comparative analysis revealed that fixed stage dimensions often limited the dancers' ability to execute certain movements. The need to adapt choreography due to spatial constraints was visually evident in the motion capture data, where movements appeared more constrained and less fluid on traditional stages. The dancers' feedback about the restrictive nature of traditional stages directly corroborates these observations, highlighting the need for more flexible and adaptable stage designs.

Through the analysis there were some cases where the dancer in the open space needed more space that it was provided in the theater to finish that exact movement. This means that when making a jump in a defined space with other dancers and surroundings, the dancers have to restrain their body from moving as much as it needs. Whether when in an open space the same jump occupies a larger space and the dancers leave the body to its full potential. This means that the dancers in the theater restricts their movements to fit the available space, while in the open space, the movements are more expansive. In the open space, the dancer utilizes the full potential of their body movements, indicating that the physical constraints of the theater impact the overall dynamics of the performance.

The integration of interview findings with the spatial analysis in Chapter 4 has several important implications for architectural design. Firstly, architectural designs should

prioritize flexibility and adaptability to accommodate a wide range of movements and activities. Movable and reconfigurable elements can help create spaces that can be adjusted to meet the specific needs of different performances. Design elements that enhance spatial awareness, such as clear sightlines, appropriate lighting, and unobstructed pathways, can improve performers' ability to navigate and interact with the space. Consideration of dancers' perspectives during the design process can lead to environments that better support dynamic activities. While traditional stage designs have their place, there is a need to balance these with different approaches that address the limitations identified in the analysis.

Table 10. Analysis of the key elements of the interview (*source:* courtesy of the owner)

Aspect	Interview Findings	Analysis	Implications for Architectural Design
Spatial Freedom and Movement Fluidity	Greater freedom and fluidity in open spaces	Open spaces enable more natural, unrestricted movements	Designs should prioritize flexibility and adaptability
	Open spaces allow expansive movements	Greater range of motion and fluidity observed in motion capture	Movable and reconfigurable elements for adaptable spaces
Impact of Stage Design on Performance Quality	Traditional stages impose restrictions	Fixed stage dimensions limit movements	Enhance spatial awareness with clear sightlines, appropriate lighting, and unobstructed pathways
	Choreographers adapt movements due to spatial constraints	Need to adapt choreography evident in motion capture data	Consider dancers' perspectives during the design process
	Traditional stages are restrictive, as confirmed by dancers	Traditional stages limit overall performance dynamics	Balance traditional stage designs with flexible approaches
Practical Examples from the Analysis	Dancers in open spaces utilize full body movements	Dancers needed more space for expansive movements	Support dynamic activities with designs that allow unrestricted movement
	Theater settings require movement restrictions	Theater settings limit overall performance dynamics	Adaptable spaces improve performance quality

CHAPTER 6

CONCLUSIONS

6. Conclusions

This thesis explores the relationship between dance movements and spatial requirements, highlighting the impact of space constraints on the performance quality of ballet dancers The integration of dance and architecture offers a new field of exploration that can lead to new design solutions. By studying the movements of dancers and understanding their spatial requirements, architects can create spaces that fulfill functional needs of the occupants. This study's observations have solely focused on the dancer's movements in space, without taking into account materials, height, light, or sound.

It focused on dance visualization methodologies, comparing traditional movement notation systems like Laban and Benesh with modern motion capture technologies. The analysis highlighted the strengths and limitations of each method, emphasizing the innovative approach used in this thesis, which integrates motion capture with 3D modeling to provide a detailed and dynamic analysis of dance movements. This method provides precise and accurate data capture, enables real-time analysis, and enhances visualization through 3D modeling. The detailed visualizations help in a better understanding of spatial dynamics and the interactions between the dancer's body and the surrounding space. Moreover, the flexibility and adaptability of this approach allow for dynamic analysis in various spatial configurations, making it applicable to diverse performance settings. The integration of quantitative data from motion capture with qualitative insights from dancer interviews offer important understandings of how spatial environments impact dance performance. However, this method also has its limitations. The use of specialized equipment and the need for technical expertise can be costly and challenging, potentially limiting accessibility. The complexity of data processing and the need for advanced skills in interpreting 3D models pose additional challenges. Either way it helps the designers understand the space with the people incorporating it.

Table 11. Analysis and overview of the methodologies studied and used in this thesis (*source:* courtesy of the owner)

Aspect	Laban Movement Notation	Benesh Movement Notation	William Forsythe	Methodology Used in This Thesis	Overview
Origin	Created by Rudolf Laban in the 1920s.	Developed in the 1950s by Rudolf and Joan Benesh.	Developed in the late 20th century by William Forsythe.	Developed in the 21st century through the integration of motion capture technology and 3D modeling.	Integrates advanced motion capture and 3D modeling, providing a detailed, dynamic, and accurate analysis of dance movement, enhancing the understanding of spatial dynamics and
Purpose	Comprehensive system for documenting, analyzing, and teaching movement.	Recording and analyzing dance movements, particularly in ballet.	Redefine dance and choreography using new media and technologies. Create resources for dancers, choreographers, and audiences to explore and understand dance in new ways.	Provide a detailed, dynamic, and accurate analysis of dance movements. Integrate digital tools to enhance understanding of spatial dynamics in dance performances.	Combines real-time data and 3D visualizations for a comprehensive view of spatial interactions, allowing for dynamic analysis and architectural design applications.

Structure	Vertical Staff. Movement is recorded from bottom (start) to top (end). Columns: Represent different parts of the body.	Five-Line Stave: Similar to music notation. Top Line: Represents the head. Second Line: Represents the shoulders. Middle Line: Represents the waist. Fourth Line: Represents the knees. Bottom Line: Represents the feet.	Dance Geometry: Uses geometric principles to explore spatial relationships in dance. Improvisation Technologies: Multimedia tool that teaches improvisation through visual and verbal instructions. Synchronous Objects: Collaborative project translating dance into data to reveal choreographic structures.	Motion capture technology captures real-time movement data. 3D modeling visualizes the captured movements in a three-dimensional space, offering a comprehensive view of spatial interactions.	Advanced digital tools provide detailed motion paths and geometric shapes to illustrate spatial relationships and dynamics in real-time.
Symbols	Geometric shapes and lines indicating direction, level, and quality of movement.	Use lines, shapes, and dots to represent body positions and movements.	Geometric Forms: Circles, lines, planes representing spatial pathways. Digital Notations: Visualizations and annotations in multimedia applications. Movement Symbols: Abstract representations of movement patterns and choreographic	Digital points and lines represent body positions and movement paths. Geometric shapes and models illustrate spatial relationships and dynamics.	Utilizes precise digital points and geometric shapes to provide a clear and accurate representation of movement dynamics and spatial interactions.

Key Components in Depth	- Geometric Shapes: Indicate direction (forward, backward, sideways, etc.). - Lines: Show levels (high, middle, low) and pathways. - Effort and Space: Symbols for effort (dynamics) and spatial factors.	- Lines and Shapes: Represent various body parts and their movements. - Dots and Other Marks: Indicate specific positions or actions. - Modifiers: Adjust the meaning of basic symbols to convey more detail.	- Dance Geometry Symbols: Geometric shapes and lines indicating dancers' pathways and spatial relationships. - Improvisation Technologies Symbols: Icons and visual markers representing specific improvisational prompts. - Synchronous Objects Symbols: Data visualizations illustrating movement sequences and interrelations.	- Motion Capture: Real-time data capture of movement with high precision. - 3D Modeling: Detailed visualization of movements in three dimensions. - Integrations: Combines quantitative data from motion capture with qualitative insights from dancer interviews.	Enables real-time analysis of movement dynamics with high precision, offering a more detailed and accurate understanding of spatial and choreographic elements.
Stave	Vertical with different columns for different body parts.	Horizontal with five lines representing different body parts.	N/A	N/A	N/A

Movement	Comprehensive system including effort (how), space (where), time (when), and flow (continuity). Can notate any type of human movement.	Detailed notation for timing, dynamics, and spatial orientation. Can represent complex sequences of dance moves.	- Physical Movements: Emphasis on the physical articulation of geometric principles. - Improvisational Movements: Exploration within a structured digital environment. - Choreographic Movements: Analyzed and visualized through data to understand underlying structures.	Real-time capture and 3D modeling of movement dynamics.	Enables real-time analysis of movement dynamics with high precision, offering a more detailed and accurate understanding of spatial and choreographic elements.

Incorporating the principles of dance into architectural design can lead to the creation of spaces that are more dynamic and responsive to human movement. This approach promotes a deeper understanding of how space can influence behavior and interaction. The design of stages and performance areas can be optimized to provide sufficient space for dancers, reducing constraints and allowing for more natural and expansive movements. This enhances both the safety and quality of performances. The use of motion capture and digital visualization technologies in the analysis of dance movements also provides important insights that can inform architectural design. These tools help in avoiding and filling the gap that is between theoretical concepts and practical applications.

Considering human movement in the design process emphasizes the importance of human-centered design. Spaces that are designed with the user's movements and activities in mind are more likely to be comfortable, accessible, and enjoyable. This approach aligns with the broader trend towards creating more livable and sustainable built environments.

Through analysis using motion capture technology, we captured and studied different dance and movement sequences both in a theater setting and an open space. The findings consistently demonstrate that the constrained space of a theater stage significantly limits the dancers' ability to fully extend and express their movements. In the open space, dancers naturally utilize a broader range of motion, resulting in more dynamic and expansive performances. This pattern was observed across different sequences and dancers, reinforcing the conclusion that a less restricted environment is essential for optimal dance performance.

The figures analyzed, from the initial shapes formed by the dancers' movements to the detailed configurations of space occupation, reveal the important role that space plays in the execution of ballet. The comparative analysis of movements in the theater and open space underscores the need for choreographers and stage designers to consider the actual spatial requirements of dance routines. By understanding these requirements, they can optimize the choreography, stage layout, and overall performance quality.

Furthermore, the practical applications derived from this study underscore the importance of space in both choreography planning and stage design. Choreographers can better coordinate the movements of multiple dancers, avoiding collisions and ensuring smooth transitions. Stage designers can create functional performance spaces that complement the dancers' movements.

Ultimately, this thesis highlights the necessity for enough space in dance environments to allow dancers to perform confidently and expressively. A well-designed stage layout that accommodates the full range of movements can lead to more engaging and visually appealing performances, benefiting both the dancers and the audience.

In conclusion, this thesis has demonstrated the potential for a deeper integration of dance and architecture, highlighting the benefits of considering human movement in the design process. Future research could further explore this relationship, potentially leading to the development of new design methodologies that incorporate the dynamic and expressive nature of dance into the built environment.

6.1 Key Contributions and Implications

This thesis makes some suggestions that might help in the fields of architecture and spatial movement. Firstly, the integration of motion capture technology and 3D modeling, which provided a detailed and dynamic analysis of how different spatial environments impact dance movements. This approach offered deeper insights into the relationship between movement and space, informing the design of more responsive and adaptable environments. The combination of traditional movement notation systems with modern motion capture techniques represents another method approach. This approach enhances the precision and clarity of movement analysis.

The thesis introduced and used several key terms to improve the analysis and understanding of dance movements within architectural spaces. Motion Capture (MoCap), refers to the technology used to record the precise movements of dancers, capturing detailed data that traditional methods might miss. 3D Modeling, which involves creating a three-dimensional representation of the captured movements, providing a comprehensive view of spatial interactions. The term Kinesphere, from Laban Movement Analysis was used to describe the personal space within which a dancer moves, emphasizing the spatial dimensions of movement. Geometric Pathways that represent the trajectories of movements in space, crucial for visualizing and analyzing dance dynamics. Spatial Awareness, highlighting the dancers' conscious understanding of the space around them, which is essential for performing in various environments. Dynamic Analysis refers to the real-time evaluation of movements, allowing for immediate feedback and adjustments. Temporal and Spatial Dimensions are terms used to describe the aspects of movement related to timing and the use of space, respectively. Symbolic Notation from traditional systems like Laban and Benesh involves using symbols to represent different movement elements. Integrative Methodology, which is a term used to describe the combination of quantitative data from motion capture with qualitative insights from dancer interviews. Performance Quality, that explains the overall effectiveness and expressiveness of the dance, influenced by spatial design and movement freedom. These terms contributed to a more precise and nuanced analysis of how different spatial environments impact dance movements.

The findings of this thesis highlight several important aspects and implications. Firstly, the analysis showed that open, obstacle-free spaces allowed for more expansive and expressive movements compared to traditional theater settings. Dancers reported a greater sense of freedom and fluidity, which was corroborated by the motion capture data. In traditional stages, fixed dimensions and limited depth-imposed restrictions on dancers, requiring them to modify or adapt their choreography. This sometimes compromised the performance quality, as noted in both qualitative interviews and quantitative data.

The combination of traditional movement notation systems (like Laban and Benesh) with modern motion capture techniques provided a new tool for movement analysis. This approach increased the precision and clarity of the data, allowing for clearer insights into movement dynamics. The integration of 3D modeling enabled a more detailed visualization of movements, making it easier to understand and analyze the spatial interactions of dancers.

The findings offer recommendations for architects on how to incorporate movement analysis into the design process. By considering the spatial needs and preferences of dancers, architects can create more functional performance spaces. Recommendations include creating flexible and adaptable stages, using modular design elements, and ensuring sufficient space for dynamic movements and transitions. The thesis highlights the potential for cross-disciplinary collaboration between architecture and dance. By drawing on concepts and methodologies from both fields, the study opens up new possibilities for innovation and creative exploration.

6.1 Limitations

As also mentioned before in the thesis, there were some limitations with the 3D modelling. Firstly, since the dancers weren't wearing motion capture suits it made it impossible to track more than one dancer at a time. For other people wanting to try this method of analyzing movement in space it is recommended to have the needed equipment. While the thesis offers practical recommendations for architectural design, the actual implementation of these insights in real-world projects was not tested. The transition from theoretical and experimental findings to practical application remains

an area for future exploration. Creating accurate and detailed 3D models is time-consuming and requires specialized skills and software. The complexity of modeling different spatial configurations and movements can be a limiting factor.

6.2 Future recommendations

Implementing parametric data in the design and analysis process can create dynamic models that adjust in real-time based on specific parameters related to movement dynamics. This approach allows for continuous customization and adaptability of spatial designs to meet performance needs. Using parametric tools to provide real-time feedback during the design process can facilitate collaboration between architects, choreographers, and dancers. Applying the insights and methodologies developed in this thesis to real-world architectural projects will validate the findings and demonstrate their practical utilites.

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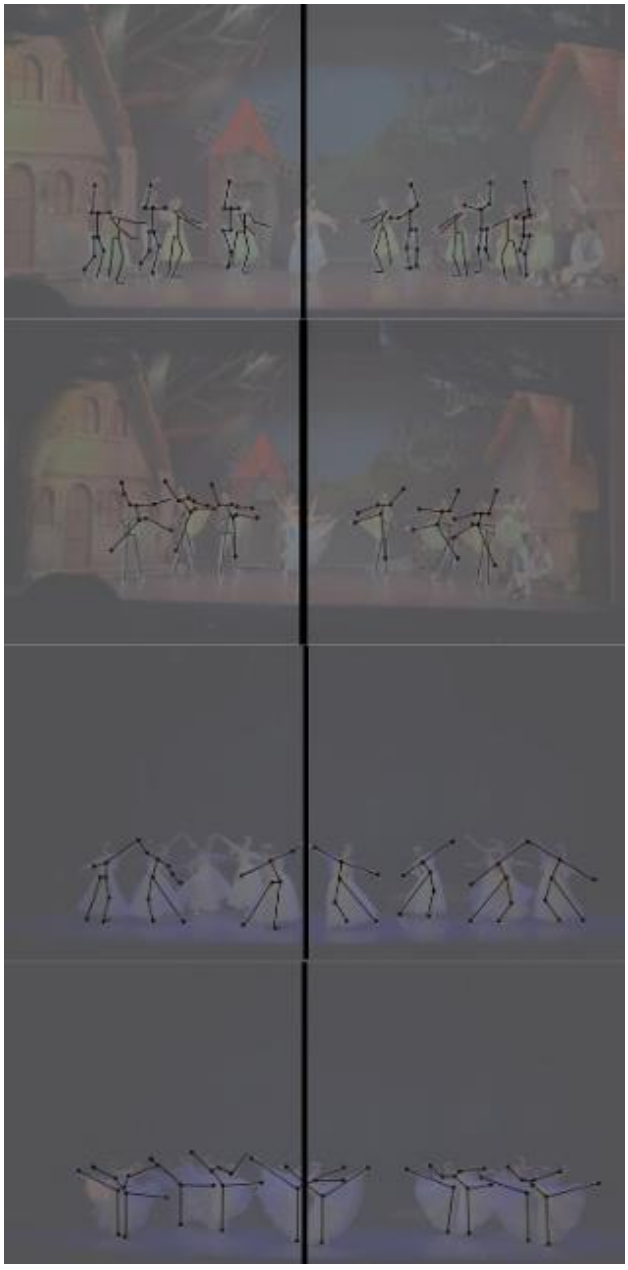
APPENDIX

Appendix 1. Analysis of shape and form in the ballet Giselle

Appendix 2. Analysis of movement and flow in the ballet Giselle

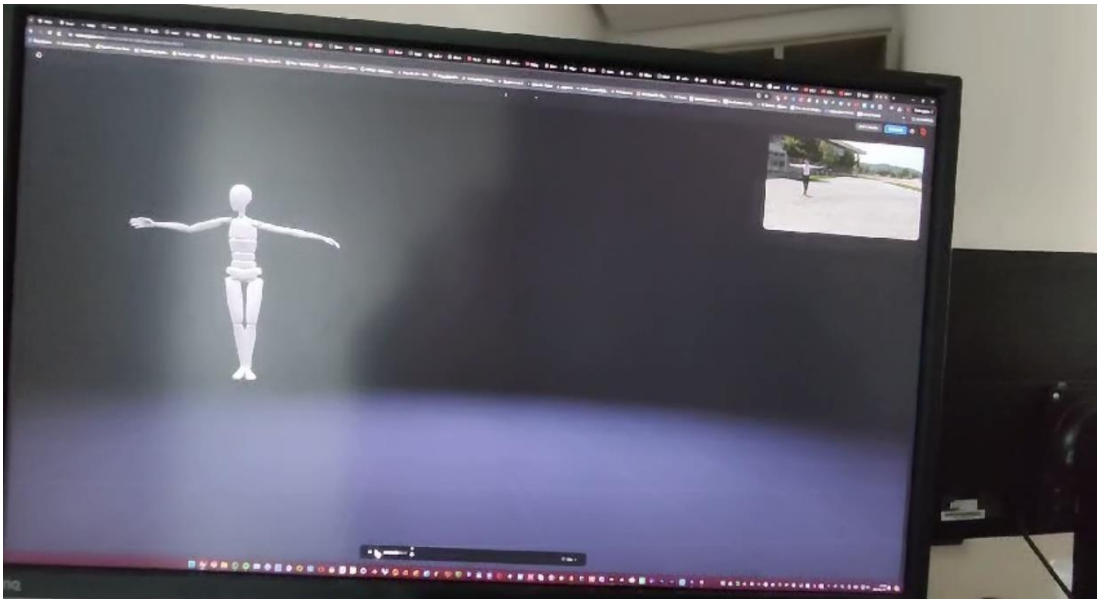
Appendix 3. Analysis of movement and flow in the ballet Giselle

Appendix 4. Analysis of symmetry and proportion in the ballet Giselle



Appendix 5. Filming the footages of the dancers in the Epoka University's campus

Appendix 6. The animated body exported from Rokoko



Appendix 7. Transcript of the Interview with the ballet dancer Armando Meci

Interview with the ballet dancer Armando Meci

Orkida: How did you feel performing in an open space differently to other venues you've danced in? What were some challenges or advantages of dancing in this particular space?

Armando:Performing in an open space felt liberating compared to traditional venues. The absence of walls and a ceiling allowed for a greater sense of freedom and expression. The advantages included a broader range of movement and the ability to explore more dynamic choreography. The disadvantages included the potential for disorientation without familiar stage markers and the need to adapt quickly to varying ground surfaces and external conditions.

Orkida: Do you think the stage space in the theater is sufficient to accommodate complex choreographies with a large group of ballerinas?

Armando:While the stage space in theaters is often designed to accommodate ballet performances, it can sometimes feel restrictive for complex choreographies, especially with large groups of ballerinas. The wings and backstage areas need to be spacious enough to allow for quick transitions and movements. More depth and width on stage would help in executing elaborate choreographies without compromising the performance quality.

Orkida: How do you manage the use of space when performing with a large group of ballerinas to ensure everything runs smoothly? What are some spatial qualities that you would improve in the theater?

Armando:Managing space with a large group requires meticulous rehearsal and precise coordination. We rely on spatial markers and cues to ensure everyone knows their position relative to others. Communication and timing are crucial. To improve theater spaces, I would suggest incorporating more flexible and modular staging options, enhanced lighting to define spatial zones clearly, and larger wing spaces for smoother entrances and exits.

Orkida: How do you maintain spatial awareness when performing in a confined stage area compared to an open space without defined boundaries?

Armando:In a confined stage area, maintaining spatial awareness involves using the stage's physical markers, such as the proscenium, wings, and backdrop, as reference points. In an open space, I rely more on visual and auditory cues from fellow dancers and the surrounding environment. Regular rehearsals in the performance space help to internalize the layout and spatial relationships.

Orkida: How did you adapt your performance when there were spatial constraints in the National Theater of Opera and Ballet?

Armando:Adapting to spatial constraints involved modifying movements to fit the available space without compromising the choreography's integrity. For example, expansive leaps might be shortened, or formations adjusted to avoid collisions. There have been quite a few times that we have had to make this kind of differences in order to occupy less space than a movement needs. Spatial awareness and careful planning during rehearsals were essential to ensure smooth execution.

Orkida: Can you provide examples of how you modified your movements to fit the space during the performance?

Armando:During a performance in a smaller venue, we adjusted our group formations to be tighter and more compact. For instance, in a grand jeté sequence, we shortened our leaps slightly to avoid the edge of the stage. In partnering work, we modified the spacing of our lifts to ensure safety and avoid obstructions.

Orkida: What role does spatial awareness play in ensuring synchronized movements with your fellow dancers, especially in varying spaces?

Armando:Spatial awareness it ensures that movements are harmonious and coordinated. We use peripheral vision and spatial cues to align ourselves with the

group. In varying spaces, we rely on constant communication and rehearsal to adapt our positions and movements to the specific environment.

Orkida: Based on your experience, what architectural elements or space designs do you find most favorable to performing ballet?

Armando:Architectural elements that are conducive to ballet performances include spacious stages with adequate depth and width, smooth and sprung floors, clear sightlines for both dancers and audiences, and flexible lighting options to enhance spatial definition. Adequate wing space and high ceilings also contribute to better performances.

Orkida: In what ways do you think architects and designers can better accommodate the needs of ballet dancers in performance spaces

Armando:Architects and designers can better accommodate ballet dancers by consulting with dancers and choreographers during the design process. This ensures that the specific needs and nuances of ballet performances are thoroughly understood and integrated into the design. After a difficult performance because of the space that we had to dance in this has actually been a topic of conversation with the other dancers and there were some ideas that we had

For example, incorporating movable and adjustable stage elements it helps in creating different stage configurations, for different choreographies and performance styles. Another important aspect for us is Ensuring that the wings are spacious allows for smooth transitions on and off stage which provides us with enough room to prepare for the entrances.

Appendix 8. Transcript of the Interview with the ballet dancer Sabina Maklekaj

Interview with the ballet dancer Sabina Maklekaj

Orkida: How did you feel performing in an open space differently to other venues you've danced in? What were some challenges or advantages of dancing in this particular space?

Sabina: Performing in an open space was a unique experience, quite different from traditional indoor venues. The open environment provided a sense of boundlessness, allowing for more expansive and expressive movements. This freedom was liberating as it felt like we were breaking free from the usual constraints of a stage. The advantages include also the ability to fully utilize space. However, this setting also presented some challenges. Without the usual stage boundaries and markers, it is difficult to maintain precise spatial orientation, requiring us to rely more on our spatial awareness and coordination with each other.

Orkida: Do you think the stage space in the theater is sufficient to accommodate complex choreographies with a large group of ballerinas?

Sabina: The stage space in theaters is generally well-suited for many performances, but when it comes to complex choreographies involving large groups of ballerinas, it can sometimes feel a bit restrictive. The dimensions of most traditional stages require a lot of planning and coordination to ensure that all movements are executed smoothly and without crowding. In larger productions, especially those with a lot of dynamic movements, the available stage space can limit the full potential of the choreography. Dancers must be very aware of their positioning and movements to avoid collisions and to maintain the visual impact of the performance. In my opinion, a theater designed with a more flexible and bigger stage area would enhance the ability to perform complex pieces.

Orkida: How do you manage the use of space when performing with a large group of ballerinas to ensure everything runs smoothly? What are some spatial qualities that you would improve in the theater?

Sabina: Managing space with a large group of ballerinas requires a lot of rehearsals, and clear communication. During rehearsals, we establish spatial awareness and coordination by repeatedly practicing formations and movements. We use visual cues, such as markings on the floor, and predefined landmarks to maintain precise positioning and spacing. In addition to visual cues, we rely heavily on peripheral vision and physical awareness of our fellow dancers to ensure that everyone moves in harmony. Timing and musical cues also play a crucial role in synchronizing our movements, helping us stay in sync even in complex sequences.

Orkida: How do you maintain spatial awareness when performing in a confined stage area compared to an open space without defined boundaries?

Sabina: Maintaining spatial awareness in different performance environments requires different strategies and techniques. In a confined stage area, we utilize the physical boundaries and markers of the stage, such as the edges of the proscenium, wing spaces, and specific set pieces, to orient ourselves. These markers help in maintaining consistent positioning and alignment during performances. We make slight modifications to our choreography to fit the space. This might involve shortening the travel distance of steps, adjusting the height of jumps, or tightening group formations to avoid collisions and make the best use of the available area. We also rely heavily on peripheral vision and spatial awareness of our fellow dancers to maintain synchrony and avoid crowding. Close coordination and communication during rehearsals help in achieving seamless group movements.

In an open space, we depend on visual cues from the environment and auditory cues from the music and fellow dancers to navigate the space. This includes using natural landmarks, sounds, and other environmental features to maintain orientation.

Orkida: How did you adapt your performance when there were spatial constraints in the National Theater of Opera and Ballet?

Sabina: We had to adjust our performance to fit the spatial constraints of the National Theater of Opera and Ballet by altering our movements to accommodate the limited

space while preserving the core of the choreography. This included shortening the distance and height of jumps, as well as reorganizing formations to prevent collisions. Careful planning and extensive rehearsals were important to ensure that everything was executed smoothly within the restricted area.

Orkida: Can you provide examples of how you modified your movements to fit the space during the performance?

Sabina: I will go in some details about this question since I had to improvise quite a few times. In a performance with limited stage space, we made several adjustments to ensure that our choreography remained effective. I will tell you some specific examples of what we actually do in these cases.

We brought our group formations closer together to make better use of the available space. This involved reducing the distance between dancers, which required precise coordination to avoid collisions and maintain the visual impact of the formations. We also utilized diagonal lines more frequently in our formations to maximize the use of the stage's width and depth. This helped create the illusion of a larger space and added dynamic visual elements to the performance.

Another thing that we often do is modify large movements. For expansive leaps like grand jetés, we reduced the leap distance slightly to ensure that dancers remained within the stage boundaries. This required careful adjustment of our take-off and landing points to maintain the grace and height of the jumps without overshooting the stage. We shorten the traveling distance of steps like chassés and piqués, ensuring that movements are contained within the limited space.

During partnering sequences, we had to make sure that lifts and turns were executed within a confined area. For example, in overhead lifts, we adjusted the height and duration to avoid hitting any overhead structures or lighting. We also practiced tighter, more controlled turns to prevent over-rotating and encroaching on nearby dancers' space.

We modified the timing and direction of our entrances and exits to accommodate the smaller wing space. This often meant staggering our movements and using different pathways to ensure smooth transitions.

In particularly tight areas, we simplified certain movements to ensure they could be executed safely. For instance, instead of performing a full pirouette, we might opt for a demi-pointe turn. We added more directional changes within our movements to keep the choreography interesting and dynamic. This involved quick pivots and shifts that allowed us to navigate the limited space more effectively.

Orkida: What role does spatial awareness play in ensuring synchronized movements with your fellow dancers, especially in different spaces?

Sabina: Spatial awareness is important in achieving precise synchronization with fellow dancers, ensuring that our movements are coordinated and harmonious. We rely heavily on our peripheral vision to keep track of each other's positions and movements without directly looking at our fellow dancers. This allows us to maintain alignment and timing, ensuring that our movements are in sync. Spatial awareness helps us maintain our positions within formations, ensuring that lines, circles, or other patterns are executed perfectly. This is especially important in group dances where visual symmetry and precision are key to the overall impact.

Synchronizing movements requires us to be acutely aware of the timing of our steps, jumps, and gestures in relation to the music and each other. Spatial awareness allows us to anticipate and match the timing of our fellow dancers, creating a unified performance.

In confined stage areas, spatial awareness helps us avoid collisions and make efficient use of the available space. We adjust our movements to fit within the constraints while maintaining the choreography's integrity. Spatial awareness enables us to make real-time adjustments during the performance. If a fellow dancer is slightly off-position, we can subtly shift our own position to maintain overall alignment and synchronization. Being spatially aware allows us to be flexible and adaptive,

responding to unexpected changes or variations in the performance space. This adaptability is crucial for maintaining the flow and continuity of the performance.

Orkida: Based on your experience, what architectural elements or space designs do you find most favorable to performing ballet?

Sabina: From my experience, several architectural elements and space designs significantly enhance the quality of ballet performances. A spacious stage with sufficient depth and width allows us to perform expansive movements and complex formations without feeling constrained. This is important for both solo performances and large group choreographies. Clearly defined stage boundaries also help us maintain spatial orientation and execute their movements with precision. High ceilings are also important for accommodating lifts, jumps, and other vertical movements. They allow us to perform at our full height. High ceilings are also beneficial for rigging lights, curtains, and other stage equipment without interfering with the performance space.

Orkida: In what ways do you think architects and designers can better accommodate the needs of ballet dancers in performance spaces?

Sabina: Architects can actually improve performance spaces for ballet dancers by incorporating our specific needs and preferences into the design process. For example, involving dancers and choreographers early in the design process ensures that the practical insights and preferences are considered. Our input on spatial requirements, movement patterns, and performance dynamics can help create a space that is both functional and inspiring. Another thing that I personally have thought of is hosting workshops and simulations with dancers because it can provide valuable feedback on stage dimensions, surface materials, and other design elements.