Connecting dancers and audience through interactive systems in an immersive dome environment

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Abstract

This thesis explores how interactive systems can enable audience participation within live interactive dance performances in the context of an immersive dome environment. Through a Research through Design approach, the project investigates how dancers, audience members, and interactive systems can co-create immersive experiences through movement, visuals, music, and audience interaction.

Developed in collaboration with Wisdome Malmö, the project combines body tracking, real-time visuals, and seat-based buttons that allow audience members to take part in the performance. Through iterative prototyping, embodied exploration, user tests, and a final live performance, the project generated situated knowledge regarding audience participation, embodied interaction, and interactive performances.

The findings highlight the importance of balancing immersion, visual complexity, and interaction clarity when designing participatory interactive performances. While increasing visual complexity enhanced immersion and playful exploration, excessive complexity also reduced participants' understanding of the interaction and compromised their sense of agency. The thesis further contributes with insights regarding the design of interactive dance specifically for immersive dome environments.

Ultimately, the project positions interactive dance as both a performative practice and a method for investigating embodied interaction, technological mediation, and interactive experiences for co-creation.

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1. INTRODUCTION

This chapter introduces the field of interactive dance and presents the context of this thesis project. It describes how interactive technologies have influenced performative practices and how audience participation can become part of interactive dance. The chapter also introduces Wisdome Malmö as the site of the project and stakeholder and presents the problem formulation, aim, and research questions.

The project is intended both for audiences and dancers engaging with interactive performances, and for designers interested in or working within the fields of interactive dance, embodied interaction, audience participation, mixed reality, and Human-Computer Interaction (HCI).

During the last decade, interactive technologies have influenced different art forms, such as painting, music, theatre and dance. The implementation of these technologies in art opens up new ways of expressing human creativity. Through the implementation of these new technologies, the artist co-creates with the computer, where the interaction looks similar to a dialogue between both, and the limits of what is considered the human body and what is considered the machine blur (Mullis, 2013, p. 118). Interactive dance can be defined as a type of dance where the movements of the dancers are detected by sensors that send data to a computer program. The computer interprets the results and creates an output that supports the artistic performance in real time. The output could be in the shape of music, visuals, lights or controlling physical elements. Interactive dancing has become a prominent area of research since it goes hand in hand with current trends in HCI that investigate how movement practices can inform and support interaction design (Birringer, 2004a, p. 171).

Within Interactive Dance there are recurrent elements that allow for the categorization of different types of work. One key differentiation lies in the technologies used to capture movement, such as wearable devices, camera-based tracking systems, or combinations of both. Another is based on how movement is translated into media technology, there are examples of controlling lights, projecting visuals and creating sounds (Mullis, 2013, p. 111), (Gonzalez et al., 2012, pp. 6–8). Since the development of the internet, this has also expanded to include telematic performances, where interaction occurs across distance (Birringer, 2004b, pp. 37–38; Kozel, 2007, p. 86). Types of interactive dance can also be differentiated depending on the context where they are performed. Performances can take place at theatres, galleries or in public spaces. Finally, distinctions can also depend in relation to participation and agency. Performances may involve solo dancers, groups, or couples, while in some cases, particularly those closer to interactive installations, the audience is invited to actively engage with the system, blurring the distinction between spectator and performer (Sha Xin Wei, 2006) (Birringer, 2004a, p.172).

This project is developed in collaboration with Wisdome, a dome space located within Teknikens och Sjöfartens hus (Malmö stad, n.d.). The dome is typically used for projecting films related to the museum's exhibitions, as well as for interactive games and occasional musical performances, although it has not previously been used for dance. The dome is equipped with high-resolution semi-spherical projection surface, LED lights integrated along its edge, a high-

quality sound system and seating equipped with five buttons per seat, which are commonly used for audience interaction when projecting games or films.

Figure 1. *Om Wisdome (Wisdome Sweden, n.d.)*

The project, will therefore, focus on the integration of those elements into an interactive dance performance. It looks at interactive dance from a performative perspective, where dancers perform in front of an audience and visuals will be projected in the dome based on their movements. These visuals will be accompanied by music and potentially light patterns. The motion tracking device is a Kinect camera, also provided by the museum. All the different elements involved are interconnected forming a sensitive environment that adapts and evolve as the performance develops.

In contrast to other types of interactive dance, this project is not involving wearable devices or working with telematic performances across distances. Instead, it focuses on the unique potential of the dome as an immersive environment and on the role of the audience as active participants. While the audience does not perform through bodily engagement, they still contribute in shaping the experience through the dome's built-in buttons having an influence in the development of the performance.

1.1 Problem formulation

Interactive dance is presented in this research project as a performance practice that has the potential to enhance the expressive capacities of the dancers by incorporating interactive technology. Previous research in interactive dance has primarily focused on the relationship between dancers and the interactive environment. However, less attention has been given to how interactive technologies can enable meaningful audience participation, allowing spectators not only to observe but also to engage, communicate, and contribute to the performance (Birringer, 2004a, p. 36).

This project investigates how interactive technology can invite dancers to explore new forms of playful interaction, both between dance partners and with their own bodies, while also incorporating audience participation into the performance and transforming the space into a shared environment for co-creation.

The challenge lies in designing these interactions in a way that fosters engagement without overwhelming participants or disrupting the dancers' embodied experience. This research project therefore explores how specific design features influence the balance between technological mediation, audience participation, and the embodied engagement of the dancers.

1.2 Aim

The aim of this project is to explore how the design of an interactive system can enable audience participation in live interactive dance performances in ways that foster engagement and shared experiences within the context of an immersive dome environment.

1.3 Research questions

1. What design features of the interactive system influence the balance between audience participation, dancers' embodied engagement, and technological mediation in immersive dance performances?

2. How do input mechanisms, such as seat-based buttons, shape the audience participation, engagement and influence within the performance?

1.4 Wisdome Malmö

The project is developed in collaboration with Wisdome Malmö as stakeholder. The dome environment is part of the Malmö Museums (Malmö Stad, n.d.) and has previously incorporated audience participation in films and games through buttons integrated on the seats. This project takes advantage of that existing feature of the space by using the seat-based buttons as a mechanism for audience participation within the performance.

Figure 2. *Malmö Stad / Malmö Museum / Wisdome Malmö (Malmö Stad, n.d.)*

2. BACKGROUND AND THEORY

This chapter presents the theoretical and conceptual foundations that support the thesis project. It introduces the development of interactive dance, its relationship to mixed reality and immersive performance, and the role of embodied interaction within Human-Computer Interaction (HCI). The chapter also situates the project within Research through Design and discusses how performance, choreography, and the body can function as sites of knowledge production.

2.1 Interactive dance

This section introduces the field of interactive dance and traces its development through historical and contemporary examples. It discusses how interactive dance differs from both conventional dance and interactive art installations, highlighting concepts such as embodiment or technological mediation. Lastly, the section presents key design principles for interactive dance that informed the development of experiments.

2.1.1 The development of interactive dance throughout the years

The origins of the field lie in the 19th century studies of motion and the early 20th century with the development of film, electronic music, digital art and telecommunications. These new developments introduced in performances new elements such as cameras, screens, synthesizers and digital software. Dance soon started to incorporate lights, video-projections, sensors, and real-time motion tracking. To present the development of interactive dance, the following examples illustrate some of the technical and artistic changes that have shaped the field throughout the years:

- Chronophotography. In the late 19th century Muybridge and Marey documented and analysed body motion through photography sequences (Birringer, 2004a, p. 165).
- In the 1940s the artist Maya Deren in *Study in Choreography for Camera*, fully realized her vision of freeing the human body from the confines of theatrical and actual space by experimentating with the screen as active site for choreography. She treated the camera as a participant able to manipulate time and space (Birringer, 2004a, p. 165).
- Art history conceives the beginning of interactive dance in the 1960s with Fluxus, an international, interdisciplinary community of artists, composers, and designer, who experimented with media and technology. It was the rise of cybernetic art and closed-circle video installations (Birringer, 2004a, p. 166). From this period, Variations V (1965) is one of the earliest examples of interactive dance. This installation used a theremin to detect the dancers' movement and produce sound (Svenss, 2020, p. 6).
- Virtual Reality, *Dancing with the Virtual Dervish* 1994 Yacov Sharir and Diane Gromola created an early example of an immersive performance environment. A dancer wear a head-mounted display and data gloves to navigate a 3D computer-generated torso built from X-ray and MRI data (Birringer, 2004a, p. 166).

- *BIPED* (1999) Choreographed by Merce Cunningham, captures motion to generate virtual dancers created from the data of past performances and projected as re-animations onto the stage alongside real dancers (Mullis, 2013, p. 112)
- *Flying Birdman* (2002). This multi-site performance linked dancers across the U.S. and Brazil via the Internet. It created a "relational architecture of flows," where performers in different physical locations interacted within a virtual screen (Birringer, 2004a, pp. 172–173).
- GLOW (2006). In this case, the camera and motion tracker are connected above the dancer and the dancer dances on a digital screen that projects patterns, lines, grids, geometrical shapes lights and shadows based on the movement of the dancer. How the dancers interact with the technology varies along the performance. In some instances, it seems that it is the dancer shaping the visuals but in other moments the dancer reacts to the visuals, making the dancer act as if he/she was enclosed by the grid, representing a conflict between both entities. In this example, bidirectionality becomes obvious as both entities shift from active to passive roles (Mullis, 2013, p. 113).
- *Heavy Recursion* (2011). In this production, an overhead camera and theatre microphones captured sounds and movements. The choreography was influenced by circuit boards and coding and had visualizations of the silhouettes of the dancers (Gonzalez et al., 2012, p. 401)
- In *Dancing with Drones* (2019), the dancer's movements were shaped by the drones, which were equipped with speakers. By exploring the interaction from a first-person perspective, the performer developed a sense of intercorporeality, where choreography was inseparable from the engagement with the drones (Eriksson et al., 2019; Svenss, 2020, p. 7)

These examples illustrate how technology has transitioned from a passive instrument to an active agent that co-creates with the dancer. According to Johannes Birringer, the focus is no longer solely on choreography but on generating a sensory, intelligent space that responds to the dancer's movements (Birringer, 2004a, p. 172).

There are two examples that were not included in the previous list, as they require special attention. It is perceived that they represent two different ends of the spectrum of interactive dance, and this project can be conceived as a combination of both approaches.

- *Ghost Catching* (1999). In this performance the spectator could only see the image of the projection of the dancer but not the dancer himself. The dancer's body was transformed into 3D patterns of different colours that appeared and disappeared leaving traces of the artist's performance. It gave the illusion of the machine trying to capture the essence of the dancer or his/her soul (Kaiser Paul & Eshkar Shelley, 1999). This performance brought up the concept of performing identity and embodied writing in the digital space. By transforming the body into movement data, the artist can express identity through visual abstractions that are unrelated to colour skin, race or gender. The interactive environment becomes a medium through which the identity of the dancer is reconfigured, enabling a form of expression that is not constrained by social categorization or norms (De & Valverde, 2002, p. 85). This work has been widely referenced in discussions on digital embodiment and the perception of the body in interactive dance (Birringer, 2004a, p. 166).

- T-Garden (2001). “T-Garden is a responsive environment where visitors can put on sound, dance with images and play with media together in a tangible way, constructing musical and visual worlds 'on the fly'.” (Sha Xin Wei, 2006).This project focuses on blurring the lines between the performer and the public, since everyone is participating in shaping the experience. Through playful interaction and exploration, the visitors establish social connections and find new form of communication through the technological medium. With an ecological theme, this example invites visitors to reflect on mutating systems such as memory, alchemy and recognition.

T-Garden shares similarities with the participatory approach explored in this thesis. However, it is argued that this example, although presented within Interactive Dance in multiple papers, its lays more over the category of an interactive dance installation. To cite Luke Hespanhol, Martin Tomitsch in *Designing for Collective Participation with Media Installations in Public Spaces* (Hespanhol & Tomitsch, 2012, p. 2) where the authors present ubiquitous interaction as a type of interaction in interactive art installations, T-Garden presents all the characteristics of this type of art installations. The project claims to “Dissolve the lines between performer and spectator”, however, from this thesis project perspective, this occurs because there are no designated performers. Instead, all visitors act as participants with equal agency (Birringer, 2004a, p. 24).

In contrast, this thesis project maintains a distinction between the roles of performers and audience members, providing each with distinct forms of expression within a shared environment. It positions itself between these two approaches: on the one hand, it incorporates the expressive abstraction of the performers’ bodies, as seen in *Ghostcatching*; on the other, it aims to engage the audience through a participatory design approach similar to *T-Garden*.

2.1.2 Interactive Dance in comparison to conventional dance and interactive art installations

Interactive dance differs from conventional dance in that it incorporates responsive technologies that extend the dancer’s expressive possibilities. It introduces a dynamic relationship between the dancers and the environment, where the environment actively participates in shaping the performance. However, this shift raises important questions regarding how agency and attention are distributed between dancer and system and what is conceived as the focal point. Authors like Susan Kozel and Wilson-Bokowiec agree in that “technology should not be understood as an external tool, but as an extension of the body itself.” (Kozel, 2007). Therefore, finding a balance between what the media technology represents, and the body engagement of the dancers is an important factor in interactive dance. This so-called mediation is further developed in 2.1.3 Design principles for interactive dance.

Another aspect that is often mentioned when comparing interactive dance with conventional dance is the notion of technique and whether it is possible to talk about technique. In Interactive dance the body and the internet, Berringer points out that the ‘body’, referring to this hybrid between the data visualization and the dancer, has not conscious control over the techniques,

“perhaps it has no technique” (Birringer, 2004b, p.167). According to Hedemyr techniques have always been the fundamental ‘methods’ of dance, Spatz defines techniques as “the knowledge that links one practice to another” and its most important aspect is that it is repeatable (Hedemyr, 2023, p. 79) (Spatz, 2017, p. 7). In Interactive dance, techniques now involve “movement-with-camera” and “movement-with-sensors”, being completely depending to the sensitive environment. Interactive dance then challenges the idea of technique as something stable and repeatable. According to Berringer these “virtual techniques” requires dancer to have some understanding of the task of writing code and “mapping” movement to media to be able to develop a choreography. Lately, some critique the notion of the “hybrid body”, humans intertwined with the technology, arguing that technology disconnect the body from many of its functions, replacing with virtual images instead of expanding (Birringer, 2004b, p.171).

Designing for interactive dance involves then multiple disciplines, including programming, lighting design, interaction design, and choreography, as well as an understanding of how bodily movement is translated into digital data. As Berto Gonzalez points out in his paper *Dance-inspired technology, technology-inspired dance* (Gonzalez et al., 2012, p. 398), every discipline needs to be involved in the creative process.

“Harmony emerges as experts from one domain learn enough about the other domain to make contributions with recognizable value in that other domain.” “During this process, our dance colleagues became significantly more technical savvy, while we gained a significant understanding of the intricacies of dance, choreography and performance.” (Gonzalez et al., 2012, p. 398)

The distinction between interactive dance and interactive art installations can at times be difficult to define. In this thesis interactive dance is understood as form of performative interaction, in which performers engage with interactive systems in front of an audience (Hespanhol & Tomitsch, 2012). Following the Johannes Birringer’s perspective, “interactive real-time computing in installation art shift the ‘process’ to the physical involvement of the observer or user, and thus alters all conventional distinctions between ‘artwork’ and ‘observer’, which is not the case in interactive performances staged for an audience.” (Birringer, 2004b, p. 172). The author Berto Gonzalez, Erin Cherry and Celine Latulipe in *Dance Inspired Technology, Technology Inspired Dance* (Gonzalez et al., 2012) also presents the similarities and differences between Interactive Dance and Interactive Art Installations and agrees with Birringer in that the difference lies in the audience becoming the performers. Berto Gonzalez, however contributes with valuable insights from the discussion by explaining how Interactive Art Installations and immersive media has influenced his work in shaping five design principles for interactive dance. In the creation of those, he draws from the work of Snibbe, who recommends that immersive media should be visceral (how media is first experienced physically and emotionally before it is experienced symbolically or rationally), responsive, continuously variable, socially scalable, socially familiar and socially balanced (Snibbe & Raffle, 2009; Gonzalez et al., 2012).

2.1.3 Design principles for interactive dance

Berto Gonzalez, Erin Carrol and Celine Latulipe (Gonzalez et al., 2012)when developing the design principles for interactive dance emphasizes that first and foremost, the main focus is on creating dance, and as a performance art, it is important not to forget that thoughtful consideration must be given to all parts of the performance: “the choreography, the visualizations, the interactivity, and the integration of technology and choreography” (Gonzalez et al., 2012, p. 399).

Following, what they call as practice-based research, these are the five design principles they present for interactive dance:

Connected kinetics

Connected kinetics means that the performance should be able to communicate to the audience that it is the dancers who are controlling the visualizations and that the environment is responding to their actions. These principles make interactive dance so interesting, since it means that slight changes between performances given by dancer’s improvisation for instance will provide the audience with a unique experience (Gonzalez et al., 2012).

Augmented expression

The sensitive medium should enrich the capacity of expression of the dancers even providing them with a completely new set of tools. This expansion is not only determined by the intended use that the technology was designed for but also by how the dancers experiment with it and the end use that they give it. Therefore, the interactive environment should encourage this sense of discovery and exploration.

In relation to this, a key component of interactive dance that often appears in academic works is the bi-directionality aspect. It means that the relationship between the system and the dancer is not unidirectional but reciprocal and highlight the ability of the dancer to push the limits of the technology through embodied interaction. Authors such Johannes Berringer and Susan Kozel describe bi-directionality as merging with the technology and losing the boundaries of what defines the individual and what defines the data representation (Birringer, 2004a; Kozel, 2007).

This perspective can be further understood through the concept of relational architecture that defines the interactive environment as sensory, intelligent, sometimes unpredictable and even as an active dance partner. As it was mentioned previously when presenting T-Garden, the environment was perceived as a stable ecological system that evolves with the performer (Sha Xin Wei, 2006).

These concepts are recognizable also in the work Very Nervous System by David Rokeby (Rokeby, 1990), where video cameras, image processors, and sensors are used to track body movements in a physical space and translate these into real-time sound, creating what he calls a “nervous environment”. To quote one of his lines

“The language of encounter is initially unclear but evolves as one explores and experiences. The feedback is not simply 'negative' or 'positive', inhibitory or reinforcing; the loop is subject to constant transformation as the elements, human and computer, change in response to each

other. The two interpenetrate until the notion of control is lost and the relationship becomes encounter and involvement." (Rokeby, 1990).

Aesthetic harmony

The principle of aesthetic harmony emphasizes the importance of a coherent relationship between the dancer and the interactive medium, where both elements complement each other to form an integrated aesthetic experience. Berto Gonzalez, Erin Carrol and Celine Latulipe in (Gonzalez et al., 2012) share that initially their intention was to create an equal balance between dancer and environment, but after developing multiple dance performances as case studies, they concluded that it doesn't necessarily needs to be an equal balance but a more nuanced and sophisticated relationship that depends on the performance. The goal should be then the creation of an overall coherent aesthetic experience, where depending on the moment either the dancer or the technology may take the lead.

This principle can be connected to what Birringer calls as 'technological mediation', which describes how interactive systems shape and extend the dancer's expressive capabilities. For Eric Mullis (Mullis, 2013, p. 112) mediation is necessary to experience bidirectionality. "The mediation enacted by interactive technologies is positive in that it extends the dancer's sphere of intentionality and blurs the line between body and technology" (Mullis, 2013, p. 119). According to Eric Mullis, when the interaction is fast and efficient, it allows the audience to view the dancer and the environment as "causally intertwined" (Mullis, 2013, p. 112).

Interactive Build

Interactive build consists of matching the intensity of the visualizations and interactions with the progress of the performance. For instance, if there is a recurrent element in the choreography that builds up until reaching a conclusion, the visualizations should follow a similar progression and conclusion. This principle emphasizes on the context and that the sensitive environment should adapt to it over time (Gonzalez et al., 2012).

Integrated process

This principle refers to the integration of the individuals responsible for the technology into the choreographic creative process, in order to better understand and support the union of dance and media. It once again emphasizes the interdisciplinary nature of interactive dance and the importance of developing a shared understanding across disciplines (Gonzalez et al., 2012).

2.2 Mixed reality and immersive performance

This section presents mixed reality as a framework for understanding interactive dance performances that combine physical and digital environments. Drawing particularly from Marika Hedemyr's work, it discusses immersive performance, site-specificity, and the relationship between bodies, space, and technology. The section also present Wisdome Malmö as a mixed reality environment and highlights the particularities of the space.

Interactive dance can be considered a form of mixed reality. Marika Hedemyr defines mixed reality as "experiences and technologies that combine physical reality with a layer of digital information and media". She argues by quoting Rouse et.al., that mixed reality refers to the creation of a hybrid situation in which the physical and the digital coexist and interact (Hedemyr, 2023, p. 113; Rouse et al., 2015).

In the context of interactive dance, this aligns with the conception of the stage a *sensitive environment* (Birringer, 2004a, p. 172) that, like a living organism, reacts to the movement of the dancers and the audience engagement, in this case.

Mixed reality is a broad concept that doesn't refer to a specific technology but rather extends through various practices. Marika Hedemyr identifies different categorizations depending on how it is used in artistic practices, including: public art using augmented reality on mobile devices, geo-located storytelling experiences, immersive theatre and performance, installation works that integrate physical architecture with digital augmentation, and choreographic practices that explore distributed or telematic performances.

As in Hedemyr's work, this project approaches mixed reality as a place-specific and immersive practice and falls under the category of immersive theatre and performances (Hedemyr, 2023).

2.2.1 The site-specificity of Wisdome

A strong integration to the site is a defining feature of mixed reality. According to Marika Hedemyr, site-specific performances can be defined as performances designed for and perform within a particular location. In this project, two key aspects of Wisdome Malmö positions the performance within this category rather than as a conventional interactive performance:

- The stage is an immersive dome, which offers a distinctive setting. There are relatively few examples of interactive dance performances that uses this type of environment. One of the closest examples is MSG Sphere, located in Las Vegas, which often host big concerts and immersive performances.
- The seats include five buttons that allow the audience members to interact with the dome and actively participate in shaping the experience.

Marika Hedemyr relates site-specific performances also to the political and societal context in where the performance takes place, as presented in 2.3.1 Parallels between design and performance practices. Parallels between design and performance practices. In her words, “a site is never empty. Instead, it is treated as a complex social and geographical landscape that we inhabit” (Hedemyr, 2023). While this project acknowledges the cultural and societal context of the site, its focus is on the particular affordances, both digital and physical, that the place provides.

This relationship between place, interaction, and technology reinforces the mixed reality nature of the performance.

2.3 Research Through Design

This section introduces Research through Design (RtD) as the methodological foundation of the project. It discusses the relationship between artistic practice, design, and knowledge production. The section also explores parallels between design and performance practices and presents interactive dance as a discipline situated between them than can generate knowledge.

Until the 1970’s there was a clear separation between science, design and art. Both design and art often carried connotations that categorize them as subjective or even irrational pursuits, or a waste of skills and time (Frayling, 1993). However, the increasing complexity of technology has led to the formation of multidisciplinary teams where the creative methods that come from Design and Art are perceived as very valuable for fostering innovation and testing complex concepts. In this context, “Doing Design” is increasingly recognized as an important part when “Doing Research”, forming the basis of the methodology that today is known as Research through Design (Stappers, 2007).

Donald Schön, one of the foundational thinkers behind Research through design, pointed out the similarities between artists and researchers. He coined the term “professional artistry” referring to how mastery in any professional career can only be obtained through learning how to navigate situations of uncertainty, uniqueness and value conflict. According to Schön, knowledge is obtained through extensive practice, challenging the traditional model “Technical Rationality” (Schön, 1987). In his work, he proposes the implementation of design and artistic methods into research. In *Educating the Reflective Practitioner,* he takes the learning process of students in architecture and uses it as an example of what he calls the “reflective practicum”, a setting where students learn by doing, reflecting and iterating. They do so under the supervision of a teacher that is referred as a “mentor”, as it is commonly viewed in artistic disciplines. This creative process mirrors scientific methodologies, as both involve problem framing, implementation, evaluation and experimentation. He argues that practice-based fields like design, architecture or arts, produce legitimate forms of knowledge and that not all knowledge can be measured or acquired through just theory. Christopher Frayling further established these connections in conceiving the artist as a researcher. Referring to the way they deeply investigate certain areas to develop their work and follow step-by-step methodological processes. He provides the example

of famous artists like George Stubbs, who investigated the animal anatomy and created extensive portfolios of drawings that later on served scientists, challenging the stereotypes that goes along with the image of the artist as anti-rational and impetuous (Frayling, 1993).

These similarities and connection have started a movement toward a convergence between artistic and scientific ways of knowing. A debate still remains regarding artistic research, on whether it counts as research or not and whether its outcomes can be considered as scientific knowledge. From the lenses of design, on the other hand, and taking into consideration the value of prototypes as carriers of knowledge (Stappers, 2007), RtD has become a well-established framework in the field.

Research on Interactive Dance lies precisely at this intersection of science, technology, art, and design. The field requires a "mutual disciplinary understanding" because both dance and computing are independently complex. To cite Berto Gonzalez on this merging of knowledge “our dance colleagues became significantly more technical savy, while we gained a significant understanding of the intricacies of dance, choreography and performance.” (Gonzalez et al., 2012).

Following an RtD approach, this project focuses on practice and experimentation, utilizing the body as an "experiential interface" to create prototypes and reflect findings back into the academic field (Hedemyr, 2023).

2.3.1 Parallels between design and performance practices

Analogues between the methods used in Art, Design and Science have been discussed by multiple authors. Marika Hedemyr focuses on the intersection between the fields of choreography and interaction design, reflecting on how a "technique" in the performing arts is similar to a "method" in design. Drawing on Spatz, she notes that "technique is the general term used to discuss how practice comes into play in an embodied way" (Spatz, 2017) and is defined primarily by its repeatability. The author observes that traditionally design methods where primarily rational and lineal, whereas today design methods are highly influenced by artistic and participatory ways of working (Hedemyr, 2023, p. 79).

The paper *Dramaturgical Analysis A Relational Approach* draws the same connections by outlining a methodology for “dramaturgical analysis” that shares similarities to how designers approach research. Its Triadic framework, presenting the three main planes of dramaturgy can be connected to design elements. For instance, the first plane composition, refers to all the strategies and structure for arranging space and time that a performance must follow and it draws the connection to architecture as it involves “the deliberate deployment of structure in order to provoke or enable live events”. The second plane, the spectator, focuses on how the work address them and organize their sensations and meaning-making processes, directly connecting to what designers refer as the user. The third plane is the context, presenting the importance of how the work is related to the outside world in a particular sociocultural moment. Something that is also considered an important pilar in design when considering how the market is going to receive a product (Nibbelink & Merx, 2021).

These analogues highlight the common ground between choreography, performance and design, characterized by a shared focus on composition, embodiment, spectatorship and context. It is within this common ground that this project positions its practice-based exploration of interactive dance, approaching the development of artefacts as spatial, relational and experiential configurations through which knowledge can emerge.

2.3.2 Performance as a way of making knowledge

Technology, according to the scholar Barbara Kirschenblatt-Gimblett, has always been part of the history of performance. There have been multiple metaphors to describe the stage: mechanism, clock-work, construction, system, apparatus, and even computer (Salter, 2010, p. 11). To quote Peter Sellars in his book *Entangled*, "the performing arts are really an unstable mixture amalgamating light, space, sound, image, bodies, architecture, materials, machines, code, and a perceiving public into a unique spatiotemporal event." (Salter, 2010, p. 11). He argues that there are unique characteristics of performances that distinguish them from other forms of knowledge making:

- An interest in enaction or doing.
- A preference for real-time dynamic processes over static objects or representations.
- An engagement with the present moment.
- Embodiment and materiality.
- Immanent experience.
- The effect of both human and non-human presence.
- Processes of transmutation and reconstruction (Salter, 2010, p.16).

These aspects positions performance not only as a medium for artistic expression, but as a mode of inquiry through which knowledge can emerge and be reflected upon.

Following this perspective, this thesis approaches interactive dance through a combination of Research through Design and performance, where the development of experiments, embodied exploration, and a live performance become the way of generating knowledge.

2.3.3 Defamiliarization in Interactive Dance

Interactive dance proposes a new set of tools that allows the dancer to change his/her habitual perceptions of the world and themselves. It is about performing the movements with a new palette of colours. This brings to the artist a fresh encounter with dancing that can encourage new movement possibilities and break them out of traditional patterns. This approach resonates strongly with the concept of *defamiliarization* or "making the familiar strange," originally proposed by Victor Shklovsky, which aims to disrupt automatic perception and foster creativity.

Sheets-Johnstone, in 1999, extended this idea to the moving body, suggesting that "Through varying our normal movement patterns and processes we can unsettle our habitual perceptions of the world and ourselves" (Loke & Robertson, 2013). In interactive dance, technologies such as

motion sensors, real-time visualizations, or drones enable these variations, encouraging dancers to explore new forms of expression and the dynamic environment.

By creating situations in which dancers encounter their own bodies and movements in unexpected ways, interactive dance not only explores physical capabilities but also has the potential to transform perception itself. This thesis projects takes the concept of defamiliarization as inspiration for creating designs than can disrupt habitual ways of perceiving the relationships between the dancers' movements, visuals and the audience participation, in the hope of supporting the creative and knowledge making process.

2.4 The body as a site of knowledge in Human Computer Interaction

This section explores how the understanding of the body within Human-Computer Interaction has evolved from perspectives that primarily focused on cognition and representation toward approaches that emphasize embodiment, bodily experience, and the existing relationship between bodies, technology, and the environment. Drawing from phenomenology, embodied interaction, and somaesthetic approaches, the section discusses how the body can be understood not only as an input mechanism, but also as a source of knowledge.

2.4.1 Embodiment

Embodiment refers to the idea that human experience, perception, and meaning-making emerge through the lived and situated experience of the body in the world, rather than solely through cognitive processes.

These works lies within the field of embodied interaction in HCI. Paul Dourish, drawing on the phenomenological perspective of Maurice Merleau Ponty, introduced embodied interaction as shift away from purely cognitive and representational modes of interaction. He defines embodied interaction as "the creation, manipulation, and sharing of meaning through engaged interaction with artefacts" (Dourish, 2019). Following Merleau Ponty's work, according to Dourish meaning emerges through bodily engagement with the world.

Embodied interaction contributed to the development of the different conceptions of the body presented in 2.4.2 Conceptions of the body in HCI, by calling attention to the body, first-person lived experience and situated action. Dourish conceives the body as a source of knowledge rather than as an input device and argues that the design process itself is a way of generating knowledge. He critiques the previous focus on abstract reasoning and instead advocates for action and bodily engagement.

Embodied interaction serves as a foundation for the different conceptions of the body discussed in this projects and acts as a lens through which interactive dance is explored (Dourish, 2019).

2.4.2 Conceptions of the body in HCI

Attention to the body in HCI gradually emerged during the second wave, when attention was shifted toward the people with the intention of understanding their needs, their emotions and

creating solutions targeted to specific users. During this time, User Experience Design came to be seen as a key for economic success in any business and new design theories that viewed the user as an active participant in the design process started to gain popularity. Theories and methods from other fields such us ethnography, sociology or psychology were also integrated in design to better understand users' behaviours. It was no longer sufficient to make a system more efficient and people more productive, focus of the first wave of HCI, but to create experiences that motivate users to engage and interact.

As technology expanded outside of the work environment and started to form part of our daily lives, societal behaviours, politics, sport, health, personality, identity etc., its relationship with the body became increasingly significant. The proliferation of wearable devices like smartphones, smart-watches, mobile apps etc. meant that technologies were accompanying us everywhere we go, a shift is known as the *somatic turn* (Homewood et al., 2021).

2.4.2.1 From users to bodies, the somatic turn.

HCI implemented theories that involved meaningful presence and aesthetic qualities. The preeminent theory during the somatic turn was Embodied Interaction by Dourish (Dourish, 2019).

There are two main conceptions of the body that arise during this transition:

The performative body. The conception of the performative body come from the work of Maurice Merleau-Ponty on phenomenology. Phenomenology is the philosophical study that shifts the focus from the objective and measurable experiences from a third-person perspective, towards the more subjective and personal first-person perspective, claiming that "The world is shaped through our bodies". Susan Kozel, whose work draws on Merleau-Ponty's phenomenology, critiques the methodological frameworks of previous waves of HCI for reducing lived experience to conceptual abstractions in order to fit the academic field. In her pursuit of finding what she calls hybridization, she argues that instead of deciding between first-person experiences and third-person experiences, or between data and feelings, we should expand the scope to fit a wider range of methodologies and voices. Still, in her work *Closer*, she portrays and critics the existing tension between bodies and machines, and how we increasingly rely on the judgement of machines rather than on the deeper meaning of our own sensory experiences. This becomes particularly relevant in a context where knowledge emerges through human engagement with technological devices (Kozel, 2007).

During this transition methods from the performative arts, such as improvisation or body storming, were introduce, alongside approaches such as autoethnography and an emphasis on self-reflection to create new knowledge. Marika Hedemyr, whose work focuses on the intersection between choreography and interaction design in her Phd thesis, highlights how the field of HCI persists on conceiving the body as separated from the mind. She points out how, in choreography, the idea of the body and the mind as a holistic entity is so foundational that dualistic arguments feel outdated (Hedemyr, 2023, p. 54).

When it comes to knowledge creation, Susan Kozel argues that, through a phenomenological approach to bodies, "we can loosen our rationalist structures of meaning sufficiently to permit qualities that are associated with the pre-rational, such as ambiguity of meaning, fluidity of

existential and conceptual structures, scope for entirely new thoughts, perceptions, including contradictions, reversals of meaning and paradoxes" (Kozel, 2007, p. 15).

The sensing body. Following the previous conception of the body, and seeking to provide the tools for designers to reflect on their own sensed-experienced, the sensing body calls for a focus on our relationship to our inner states and improvement of all connections between sensation, feeling, emotions and subjective understanding and values (Homewood et al., 2021). Researchers that conceive the body through this lens share the belief that it is possible to train our awareness to our inner states, introducing methods from holistic practices and encouraging the practice of yoga, meditation, dance and somatic techniques.

Kristina Höök, drawing on Richard Shuterman's somaesthetic theory, developed the program Soma Design to address the lack of theory and practice in design in relation to the mind and body holistic view, and to improve our relation to our own somas. Soma Design is both individual and social, as by understanding and tunning into what our bodies feel, it becomes possible to develop empathy towards other bodies, leading to more sensitive and better designs "The promise is that designers who sense their own bodies will be more attuned to the bodies of others, and this knowledge will filter through the artefacts and devices they design" (Homewood et al., 2021). Susan Kozel also shares this perspective when she writes about the concepts of reverberation, resonance and repercussion. In her words, "It is possible for one's person lived experience to shed light on another's world" (Kozel, 2007).

Soma design also aligns with the phenomenological perspective related to the primacy of movement, to quote Kristina Höök "without movement, there is no life, no perception, no experience", "movement comes first, language second" (Höök, 2018). The pragmatic aim of Soma Design is that "we can live a better life through engaging with and learning through all our senses" (Höök, 2018, p.1).

2.4.2.2 From bodies to bodies

With the implementation of self-tracking applications seeking the optimization of health parameters, researchers began to question which bodies are being designed for. Are all types of bodies being considered, or are we generalizing and universalizing a particular type of body? This conception of the body considers that it is unethical to treat all the bodies as if all had the same experiences. This shift was influenced by cultural and societal movements like feminism, anti-racism and postcolonialism. In words of Homewood et al., in *Tracing Conception of the Body in HCI* "This points to data diversity rather than data homogeneity" (Homewood et al., 2021, p. 4).

The pluralising move led to a growing awareness of the interconnected nature of things, including bodies in relation to other bodies and bodies in relation gender, class, culture, race etc. Besides, it acknowledges how objects represent politics and societal norms that can either be reinforced or contradicted (Homewood et al., 2021)Therefore, emphasis is placed on the responsibility designers hold when designing as, "when you shape the interactive artefact you are, in a sense, also shaping future users' bodies and movements", Kristina Höök (Höök, 2018).

2.4.2.3 From bodies to more-than human bodies

Last, this awareness about the interconnection and interrelation between different factors evolves into the consideration of the relationship between bodies and non-human entities, referring not only to technological artefacts but also to other species. This movement is characterized by a non-anthropocentric view of the human body, where humans are no longer placed in the focus, but entangled with non-humans actors. Examples of perspectives within this line of work are feminist new materialism, object-oriented ontology, critical design, actor-network theory and posthumanism (Homewood et al., 2021).

This section has provided an overview of the different conceptions of the body and their evolution since the 2nd wave of HCI. While acknowledging the significance and influence of these perspectives, the project focuses on the following aspects when addressing the body:

- The body is conceived as a source of knowledge.
- The holistic understanding of mind-body as a single entity and, the balance between data-driven approaches and first-person experiences.
- The empathy towards other bodies.
- The human-technology entanglement.

3. METHODS

This chapter presents the methods used throughout the development of the project and explains why they were selected in relation to theory and goal of the project. Since this thesis explores interactive dance through practice, embodiment, and technological experimentation, this chapter gathers methods coming from Research through Design, interaction design, and performance practices.

3.1 Prototyping

Prototypes, often referred as research artefacts, are the primary means to ask research questions in Research through Design (RtD). They function as vehicles for generating knowledge, allowing designers to test assumptions, ideas and coming up with new insights. Prototypes are a manifestation of ideas, skills and knowledge put into practice and testing within an iterative process (Houde & Hill, n.d.).

From a design perspective, prototypes can take multiple forms, ranging from sketches and mock-ups to more refined artefacts used for material exploration. They serve as a medium for confronting abstract ideas with the real-world, bridging the gap between conceptual thinking and experience.

As presented in 2.3.1 Parallels between design and performance practices similar processes are used in science, where they are often called experiments, in art, where they can be called as explorations and in performance related practices, called rehearsal or improvisations. All

disciplines share a common goal with prototyping, to take ideas out our head and into the physical world (Houde & Hill, n.d.).

In dance, prototyping is inherently connected to the body. It is an embodied experience where dancers explore how movements feel in their body. This process is subjective and often leads to creation of choreographic material. Such material is then refined, shared, and evaluated through rehearsal and performance contexts.

In interactive dance prototypes extends beyond the body, involving media technology, therefore attention with these prototypes not only focus on the body of the dancer but on how they relate to the technology and how that relationship is perceived and felt. Meaning how movement influences technology, how technology responds, and how this interaction is perceived both by the performers and the audience.

Lately, in interactive dance, as a multidisciplinary field, prototypes are especially valuable as boundary objects, artefacts that support communication and collaboration between people from different disciplines. Their "stabilizing character" helps achieve a consensus among designers and non-designers. They help establishing a common language, minimizing misunderstandings and subjective interpretations. They allow the transformation of vague concepts into concrete tangible artefacts that can open up dialogue and participation (Houde & Hill, n.d.).

To conclude, in this thesis project and in interactive dance, prototypes are therefore manifold. On one hand they involve embodied exploration through movement and somatic awareness, and on the other hand, they include media technology, particularly visuals that are accompanied by music and the use of the tool TouchDesigner[1] as an orchestrator. Together prototypes in interactive dance are an integrated system in which the humans and the technology continuously influence each other. The term *experiment* is used to describe the different prototype iterations developed during the design process. This choice reflects the exploratory nature of Research through Design and performance practices, where prototypes function as experimental situations.

In this interactive dance project, the intend is to, not only involve human intervention through body movement, but also through actuators in the form of buttons that are accessible to the audience. Consequently, the *experiments* developed in this project aim at testing and exploring this additional layer.

3.2 Embodied exploration

When studying dance, body movement, and the interaction between the body and technology, the body becomes an essential piece in generating knowledge. Therefore, it is not enough to just convey observations on analyses, it is important to experience through the body.

[1] TouchDesigner is a node-based visual programming software commonly used for interactive installations, real-time visuals, and multimedia performances (Derivative, n.d.).

This approach aligns with embodied and somaesthetic perspectives within HCI, particularly the work of Susan Kozel and Kristina Höök, who emphasizes the importance of first-person lived experience, bodily awareness, and sensory engagement, in the process of interacting with technology in the knowledge production, see 2.4.2.1 From users to bodies, the somatic turn.

3.3 Reflective practice

In order to both generate new knowledge and share it back to academia as academic research, it is important to follow a systematic approach. As discussed by Henk Borgdorff in *Dialogues Between Artistic Research and Science and Technology Studies*, structuring and documenting the research process is essential for artistic practices to generate knowledge that is consider valuable in an academic context (Borgdorff et al., 2019). Therefore, the reflections made after each experiment will follow this structure:

- Description: explanation of the experiment, including technical aspects and the concept.
- Intention: what it is aimed to test.
- Outcomes: what were the results, how they are interpreted and what they suppose for the upcoming experiments.

3.4 User tests

User testing is a method used in interaction design and HCI to evaluate how participants experience, understand, and interact with a system or prototype. It allows designers to observe behaviours, gather feedback, identify challenges, and validate assumptions through direct interaction with the designed artefact (IxDF, n.d.).

To complement first-person inquiry and reduce potential bias, this project implements user testing as a method for gathering others' perspectives on the interactive systems. As presented in 3.1 Prototyping, it is important to engage participants for validating assumptions, generate new insights and see how they experience and interact with the system. In this thesis project user tests follow a systematic approach:

- Context: participants are introduced to the project and what is intended to test.
- Observations and documentation: notes of what is happening along with video recording.
- Questions regarding their experience: participants are asked a set of questions regarding their experience.
- Interpretation and open conversation: reflections are developed by opening a conversation between the designer and participants, creating the space for suggestions and additional thoughts.
- Design implications: findings are analysed and translated into design decisions for following iteration.

3.5 Interaction Flow Diagram

Interaction Flow Diagrams are used to map the relationships between inputs, outputs, and system behaviours within the performance. Through diagrams, the method visualizes how dancers' movements, audience inputs and visuals affect one another over time. In this project, Interaction Flow Diagrams were used to organize and understand how the interactive system works (UX Planet, n.d.).

3.6 Ethical considerations

This project involved the participation of interaction design students, dancers and audience members during user testing and the final performance. Participants were informed about the project and asked for permission before being video recorded for documentation and research purposes. No other sensitive data was collected.

During the final performance at Wisdome Malmö safety considerations were taken. Dancers were advised to do not look directly to the projector since it can cause eye damage. For this reason, a safe area for dancing was drawn on the floor with fluorescent tape. See Figure 34. Final design: Kinect camera placement and dancing area at Wisdome Malmö (Malmö Stad, n.d.)*Figure 34*.

3.7 Use of AI tools

AI tools, particularly ChatGPT, were used throughout the project as a supportive resource to ask about best approaches to achieves certain tasks in Touch Designer. However, since the software uses primarily visual programming, the use of AI focus on discussing approaches to achieve certain goals. Examples of questions were:

"Is there any component in TouchDesigner that can achieve this function?" or "Can I achieve this goal with a Math operator in TouchDesigner?"

4. DESIGN PROCESS

This chapter presents the iterative design process followed throughout the project, including the development of Experiment 1, Experiment 2, Experiment 3, and the final performance. The experiments were conducted using a Kinect camera to track body movements and TouchDesigner as the platform for integrating body tracking, audience inputs, visuals, music, and system behaviours. The experiments used the facilities of the Interactive Design Studio at Malmö University and Wisdome Malmö. The chapter describes the intention behind each iteration, the technical decisions involved, and the outcomes observed during user testing.

4.1 Experiment 1

This experiment consisted of testing the Kinect and explore how to make a simple prototype with the minimum mediums, just involving a projector, the Kinect camera and a keyboard. The prototype explored one person dancing by just moving the hands and the other person sitting in front of the computer changing colours through pressing keys.

4.1.1 Description

Experiment 1 involves two people, one acting as the dancer and the other acting as an audience member. The person performing as the dancer stands in front of the camera and see in the projected image two black spheres on the position of the hands. When dancer moves the hands, the spheres move accordingly. However, the spheres are inside a box made out particles, so their range of motion is restricted. When a sphere reaches one of the walls of the box it expands the particles around.

The other person sits in front of the computer and can control the colour of the particles with 5 keys on the keyboard.

At the same the particles that made out the box are moving at the rhythm of the music, and the box is expand as the performance progress. Making the metaphor that, through body movement, the dancer is breaking out of the box.

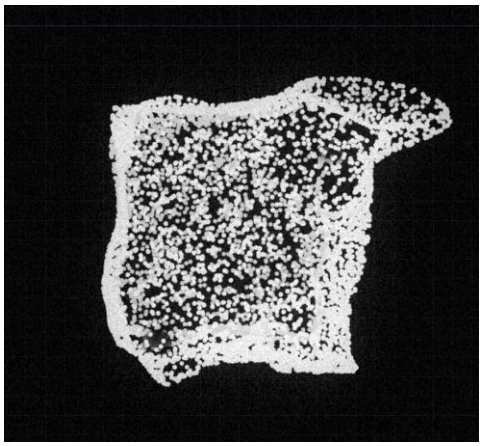

Figure 3. *Experiment 1: Hands inside the box*

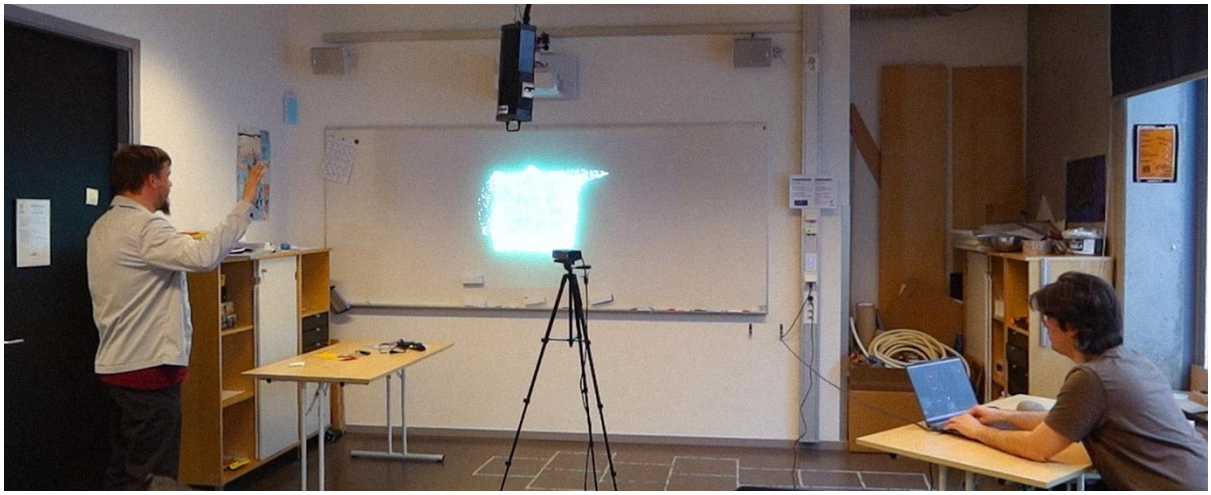

Figure 4. *Experiment 1: User test of Hands inside the box*

4.1.2 Intention

The intentions behind this experiment were:

- To test whether the dancer can understand the feedback loop and link the movement of the hands to the visuals.

- To test whether the interaction between the audience member and the dancer has an impact over both individual performances. Whether both try to find synchronicity and communicate through the medium.

- To test if there is a perceived difference in the level of agency over the performance.

4.1.3 Outcome

Participants shared that they experimented the principle of bidirectionality, to quote one of them, "At some point I started to feel how I was inside the visualization, moving inside the box and less in the real world", participant 1 acting as the performer. The feedback loop between movement and action was clear for the participants, even when music was affecting the particles more drastically. The level of agency was perceived as balanced as the participant representing the audience shared that he felt a similar impact over the performance as the dancer had. In those lines, a discussion opened on how it would be interesting for the audience not only to experiment with the colours changing but also with modifying the particles positions.

Overall, the experiment was perceived as an expressive medium by both participants and they shared that they got the sensation of communicating with each other at some instances and synchronizing their actions.

This experiment was further developed to explore the performance of two dancers. In this case, it was necessary to assign different colours to the spheres assigned to each dancer, as it was difficult to identify which ones belong to whom when being black.

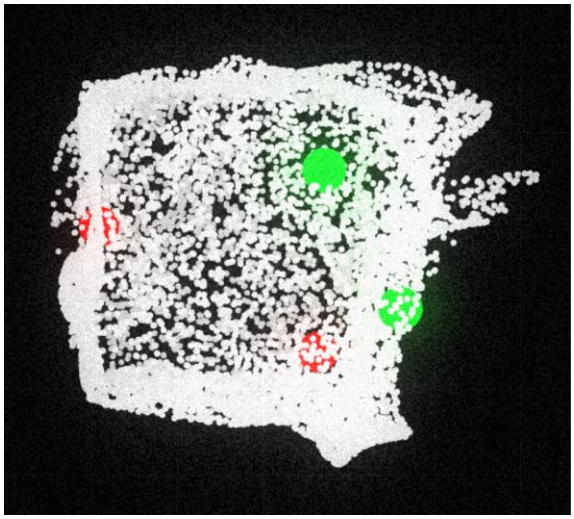

Figure 5*: Experiment 1: Hands inside the box designed for two dancers*

4.2 Experiment 2

This experiment explores the development of network connections drawn between body parts both within a body and between bodies. For this experiment, a simplified version of the idea was developed to test whether dancers were exploring the different connections and audience members were able to understand the interaction and communicate through the interactive medium.

4.2.1 Description

Experiment 2 involves two dancers. The body of each dancer is represented through white spheres on every part of the human body and connecting lines representing the joints. Both the lines and the spheres are white at the beginning. The audience through the interaction with the buttons on the seat can change the colour of the spheres. Each member of the audience has assigned a sphere to control. When two spheres turn into the same colour, the connecting line gets the same colour as well.

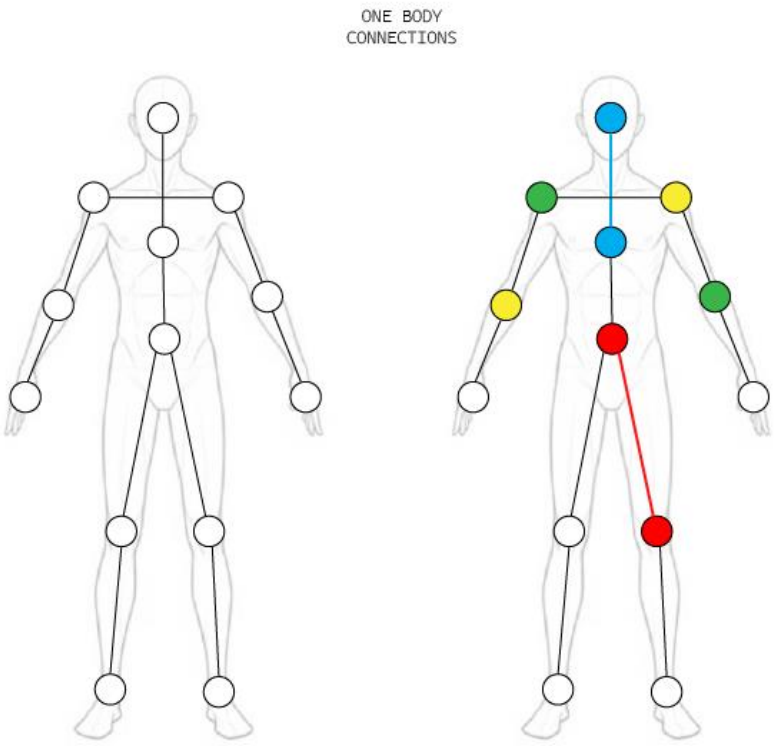

Figure 6. *Experiment 2: Illustration of body parts represented by spheres and colour assignment*

Besides, when a sphere from one body and a sphere from the other dancer's body share colour, a connection line is drawn between both bodies, sharing the same colour of the spheres. To give an example, if the Head of dancer 1 turns pink and the knee of dancer 2 turns pink as well, a pink connecting line is drawn.

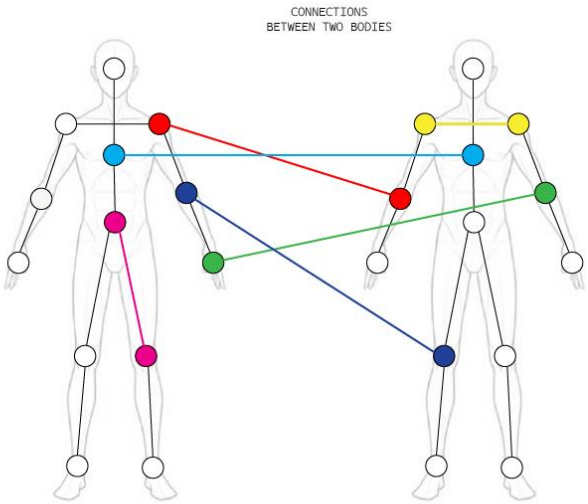

Figure 7. Experiment 2: Illustration of body parts and colour matches connections

Lately, the configuration of the lines representing the body of each dancer also varies based on the music and on random parameters. This makes unconventional body parts connections within each individual body, representing the transmutation that can occur when interacting with the technological medium and how the perception of the body can change. This feature is inspired by moving and making strange (Loke & Robertson, 2013), and on artists' descriptions on the perception of how their body feels transformed when exploring interactive dance.

"I emerged from the studio with new ideas regarding my own body, the materiality of digital data, and a shifted ontology by which I mean a shifted sense of what constitutes a being". (Kozel, 2007, p. 230)

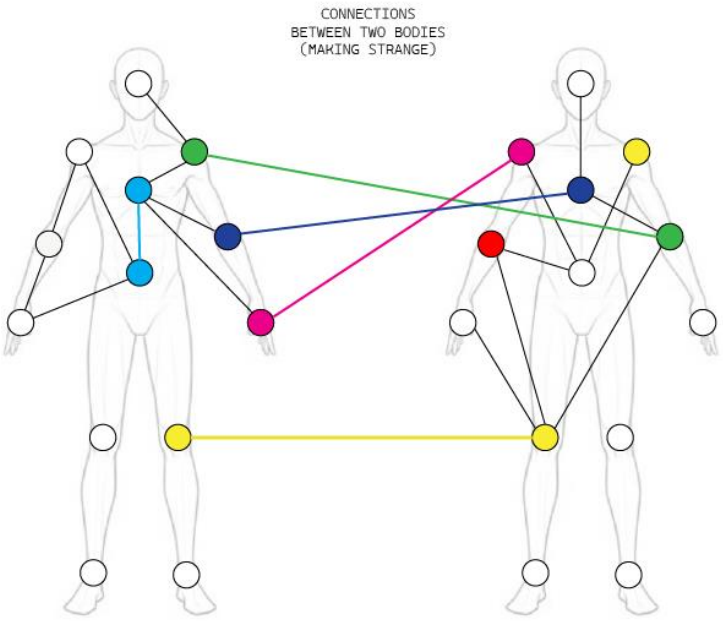

Figure 8. Experiment 2: Illustration of body parts and colour matches connections in a random configuration

4.2.2 Intention

The intention of this experiment is to test whether through the connections made dancers decide to explore the connections established between the body parts by closing the distance between them or playing with those new body connections.

Representing each body with just 4 body parts, experiment 2 aims to test:

- Whether the logic of the code works and can successfully integrate members of the audience into the performance, with just a few possible connections between dancers and body parts.
- Whether trough colour changes and drawing connection lines, the changes in the visuals are interesting enough for the dancers to explore the new-made connections.

Participants were able to change roles between dancer and audience member.

Questions:

- Did the audience members seem to communicate through the medium and agree on which connections to keep?

- Were the dancers exploring the different connections drawn between their body parts and between bodies?

4.2.3 Outcome

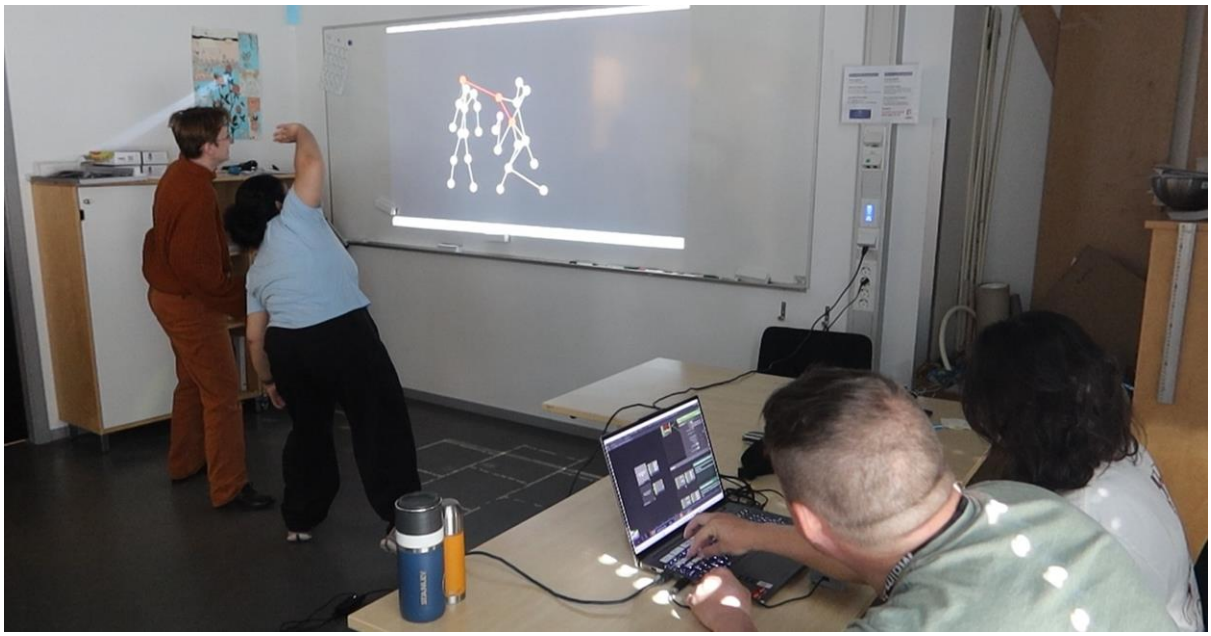

Figure 9. *Experiment 2: User test*

Missing connections made the interaction feel random and broke the interaction loop.
This experiment was not designed with all the possible connections that could be created between the body parts drawn by the dancers. Instead, only one connection per colour between dancers was implemented in the code. For example, if the head, right shoulder, and chest of one dancer were assigned the colour red, and the hips of the second dancer were also red, every matching combination could potentially produce a connection line. This generated six possible connection combinations between dancers. However, the system was only programmed to display one of these possible connections, causing participants to perceive the interaction as inconsistent.
From the dancers' perspective, however, attention was not primarily directed toward the specific colours assigned to their body parts, but rather toward improvising based on the connection lines that appeared. As a result, the dancers did not seem to notice when expected connections were missing.

In this experiment, each audience member controlled body parts belonging to both dancers. *Figure 10* shows the setup assigned to each audience participant. For instance, A1 (Audience Member 1) controlled the colours of the left shoulder and the left hip of both dancers.

Figure 10. *Experiment 2: buttons and body parts mapping per audience member*

Figure 11. *Experiment 2: buttons and body parts mapping per audience member, full set-up*

Although this experiment involved only two participants acting as seven audience members, making it difficult to follow every colour reaction and line creation while simultaneously pressing buttons, participants still found it challenging to follow the interaction outcomes even when focusing on the controls assigned to a single audience member. Therefore, the two participants acting as audience members proposed two changes:

1. Mapping body parts so that they are in close proximity to one another. For example, instead of assigning the right shoulder and the left hand to A3 (Audience Member 3), assigning the right shoulder and the left shoulder.
2. Allowing each audience member to control the body parts of only one dancer rather than both dancers simultaneously. Participants explained that it was difficult to track the colour changes of both dancers at the same time.

For this experiment, 28 buttons were used using keys from the keyboard that were not triggering any command in TouchDesigner and a MIDI controller developed specifically for this experiment, see *Figure 12*. Applying this suggestion and allowing each audience member to control two body parts belonging to only one dancer would require 56 buttons. This led to the development of an additional controller that was implemented in 4.3Experiment 3, see Figure 18. Experiment 3: buttons and body parts mapping per audience member, full set-up*Figure 18*.

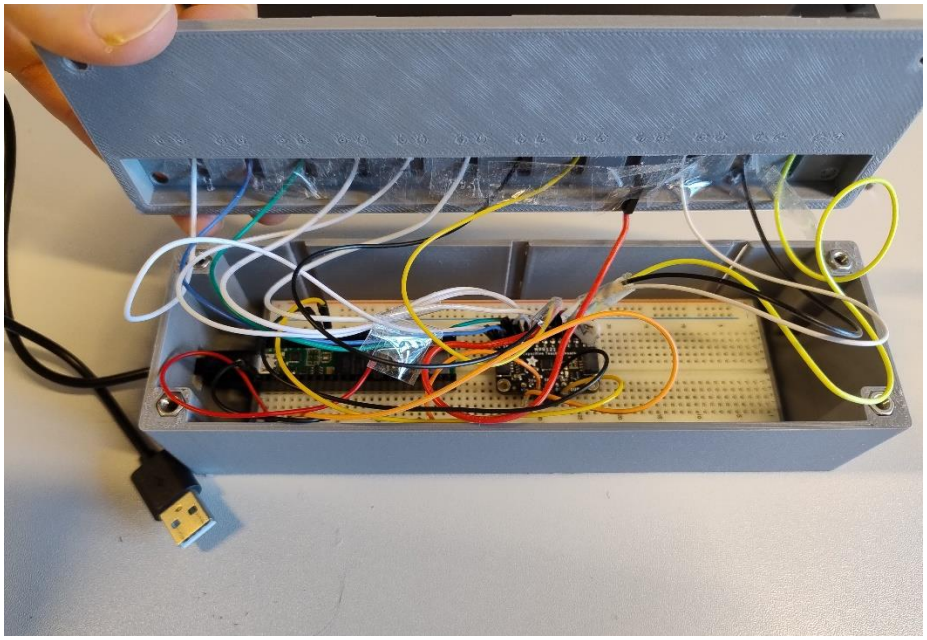

Figure 12. Experiment 2: 3D printed MIDI controller built with Teensy 4.1 microcontroller and the Adafruit MPR121 Capacitive touch sensor

Lately, as seen in *Figure 13,* the white lines connecting the body parts within each dancer changed configuration to a random one, after a few minutes, and then it continued changing periodically. This was intended to represent the system intervening as well in designing the performance.

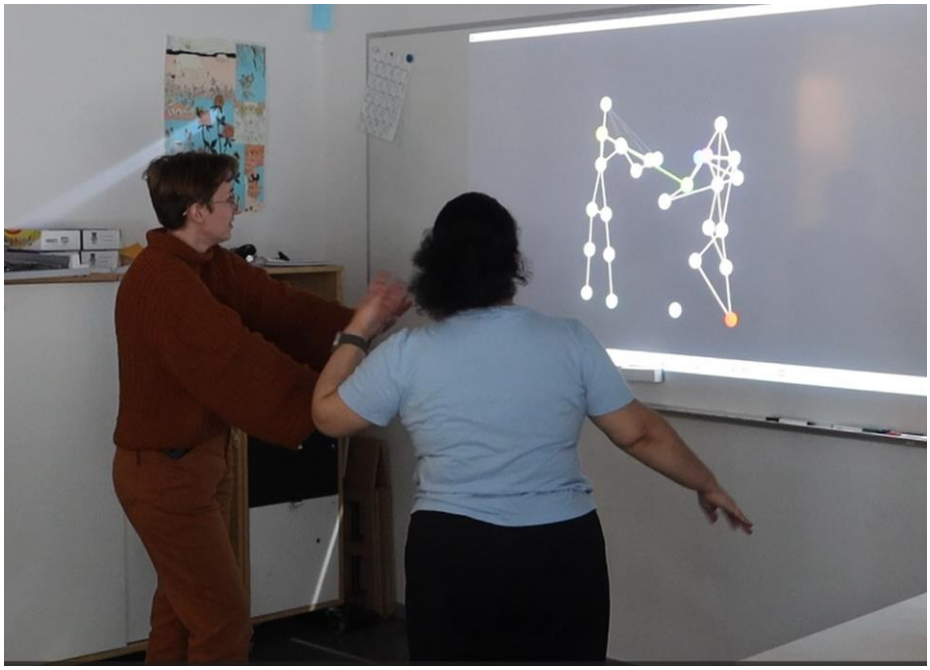

Figure 13. Experiment 2: participants dancing during user test

Participants were asked about their opinion of this feature. They shared it was interested but that they did not notice the change right away, since it was not accompanied by any visible cue. They suggested that some sort of effect, or blink in the screen should happen, for they to know instantly that something had changed.

4.3 Experiment 3

This experiment consisted of further developing experiment 2 by implementing the suggested changes. That meant:

- Re-mapping of body parts per Audience member based on proximity.
- Addition of more buttons, 56 in total, so that each audience member would focus on the body parts of only one dancer. This is also meant involving 14 audience members instead of the intended 7 audience members for which Experiment 2 was designed for.
- Reassigning colours according to body areas (upper, middle and lower body).
- Adding all the remaining connections between dancers that were not implemented in experiment 2.
- Adding a visual cue for when the system was reconfiguring the white lines connections within the bodies.

4.3.1 Description

The experiment was conducted at United Dance Studios, a dance academy located in Fredsgatan 12, 212 12, Malmö, during a Saturday bachata social event. Permission was given to set up a corner space where the visuals were projected using a projector and allowing participants to engage with the experiment in between dances.

Implementing all the remaining connections between the dancers' body parts that had not been created for Experiment 2 required the drawing of diagrams to map out colours, body parts, and connections in a way that minimized the number of lines required.

First, *Figure 14*. Experiment 3: Body parts configuration and connecting lines diagram shows all the connections that were mapped out within each dancer's body. There are connections that were intentionally not mapped out as that would later on imply more colour comparisons to be made when coding. For example, the lower body parts are only connected to the upper body through the spine and the shoulders, but not through the elbows, head or hands.

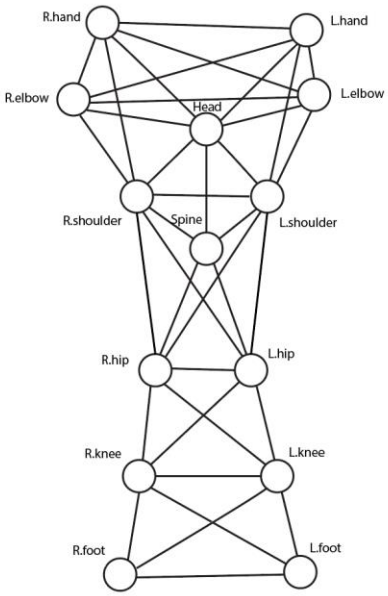

Figure 14. *Experiment 3: Body parts configuration and connecting lines diagram*

Next, colours were assigned to each body part according to body areas while minimizing the number of colours matches within the same body.

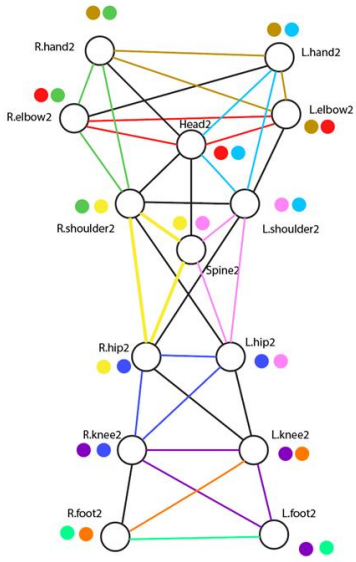

Figure 15. *Experiment 3: colour assignment and colour matches connecting lines*

Lately, a list of all the possible connections was created in order to implement them in the code in a more organized manner.

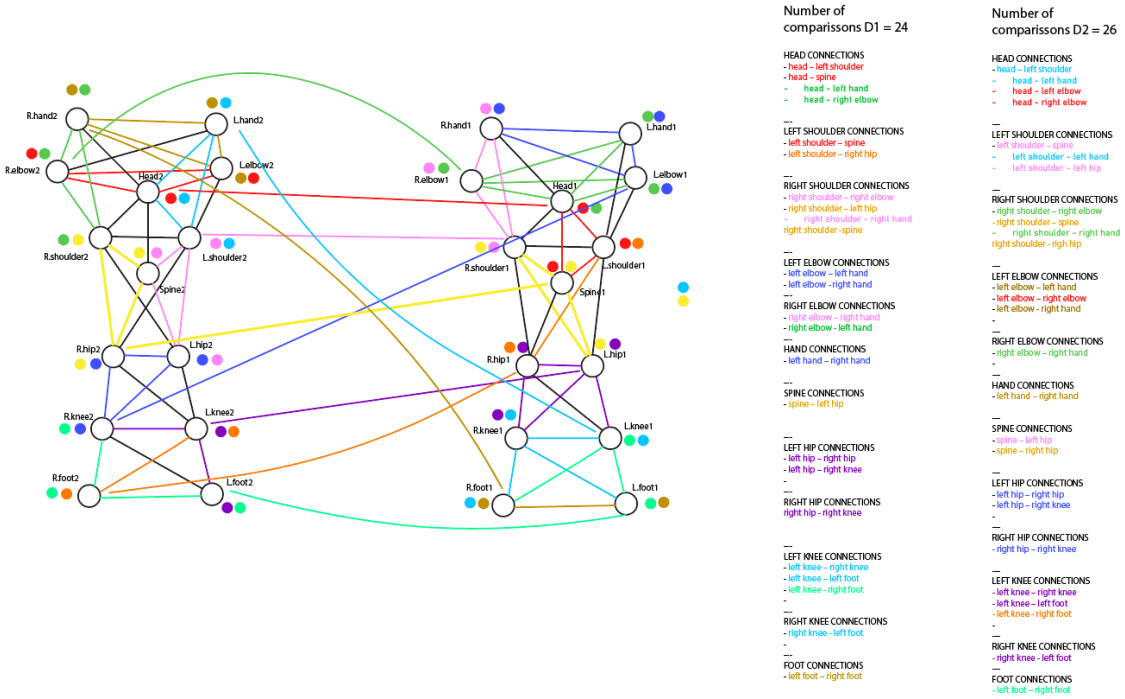

Figure 16. *Experiment 3: list of all possible connections within the body*

Figure 17. *Experiment 3: list of all possible connections in between bodies*

For this experiment, it was once again expected that only a few participants would act as audience members. To make the controls easier to follow, the keys were colour coded. Since 56 buttons were necessary this time, an external keyboard was bought to be used alongside the MIDI controller built in experiment 2. It was no longer possible to use the laptop keyboard, as many keys triggered TouchDesigner commands that could interfere with the experiment.

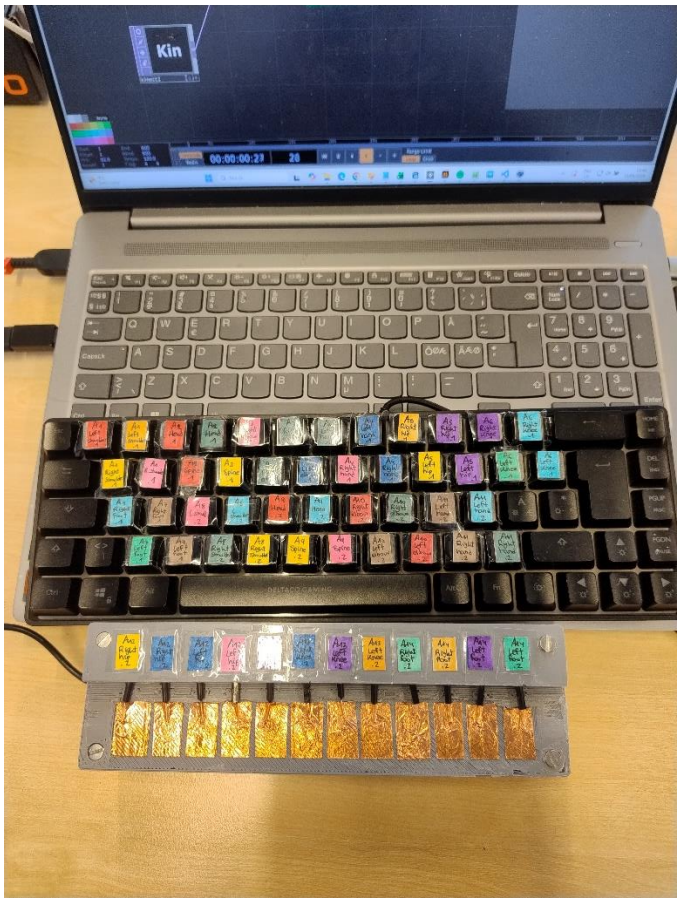

Figure 18. Experiment 3: buttons and body parts mapping per audience member, full set-up

Lastly, a glitch effect was added as a visual cue for those moments when the system was creating random configurations. See *Figure 19*, to visualize the transition.

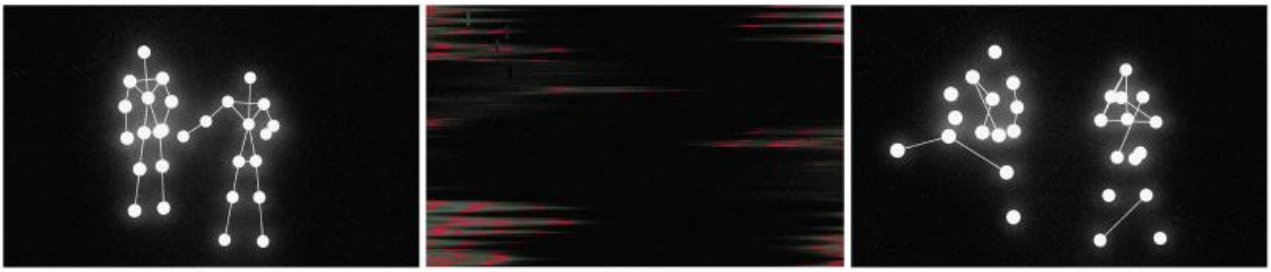

Figure 19*: transition from normal configuration to a random one generated by the system*

4.3.2 Intention

The goal of the experiment was to test whether implementing the suggested changes from Experiment 2 improved participants' ability to follow and understand the interaction outcomes. A secondary goal was to test the experiment with dancers.

4.3.3 Outcome

Figure 20. *Experiment 3: user test at United Dance Studios' bachata social*

Dancers reported feeling lost when the configuration within their body changed into random ones. In those instances, exploring the connection created by the audience member was experienced more as a guessing game. There were some connections within the body that dancers found difficult to physically explore, such as, head to elbow or chest to knee to name a few. From the audience perspective, it was easier this time for them to have control over the performance. Thanks to the colour-coded stickers, they could identify beforehand which colour combinations were likely to generate matches and connections. Therefore, although this setup, was aimed for 14 audience members, one person at the controllers could still feel engaged in the performance.

Overall, participants reported to have fun and frequently laughed during the experiment. This was likely influenced by the social setting of the bachata event and probably because they were dancing popular bachata songs but in a completely different manner.

Lately, this experiment included a smooth fade in of all the body parts, appearing one by one starting from the head and finishing at the feet. Participants reported that that transition helped them in understanding the experiment and the behaviour of the system, before transitioning into full body engagement.

5. FINAL DESIGN

This section provides a detailed explanation of all aspects of the design that were not included in previous experiments, such as, how the logic of the code works in TouchDesigner, how the particularities of the dome setup were taken into account and how the design elements were synchronized with the music to accompany the different moments of the performance.

5.1 The concept

The concept is inspired on constellations in the night sky. Each sphere placed on a body part could be seen as a star and the connections draw between them representing how humans create imaginary lines to form the different constellations. At the beginning of the performance, the analogy is not easily identified, since the connections joining the spheres are the ones that represent the human body. Besides dancers are dancing in front of the visuals so the visuals are directly linked to them. As the performance progresses the visuals are increasing in brightness and stars start to appear in the background, making it look like the night sky. Then the human figures start to move upwards towards the top of the dome and once the system starts creating random configurations within the body, it is easier to identify the visuals as constellations in the sky.

The intention is that as the performance progresses the distinction between audience participation, the dancers' movements and the system actions, blurs and it becomes more difficult to identify the different entities, as if all participants were getting entangled forming, one being.

5.2 The code

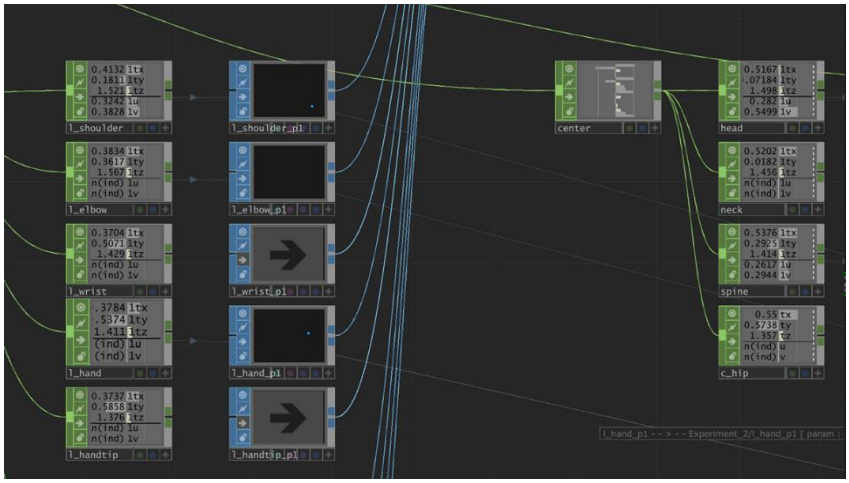

Figure 21. *Final design: 3D coordinates of the body parts tracked by the kinect camera*

TouchDesigner provides a component that automatically tracks the 3D coordinates of each body part representing it by points in the space. The first task before coding consisted of organizing those points into a coherent structure that separated one body from the other.

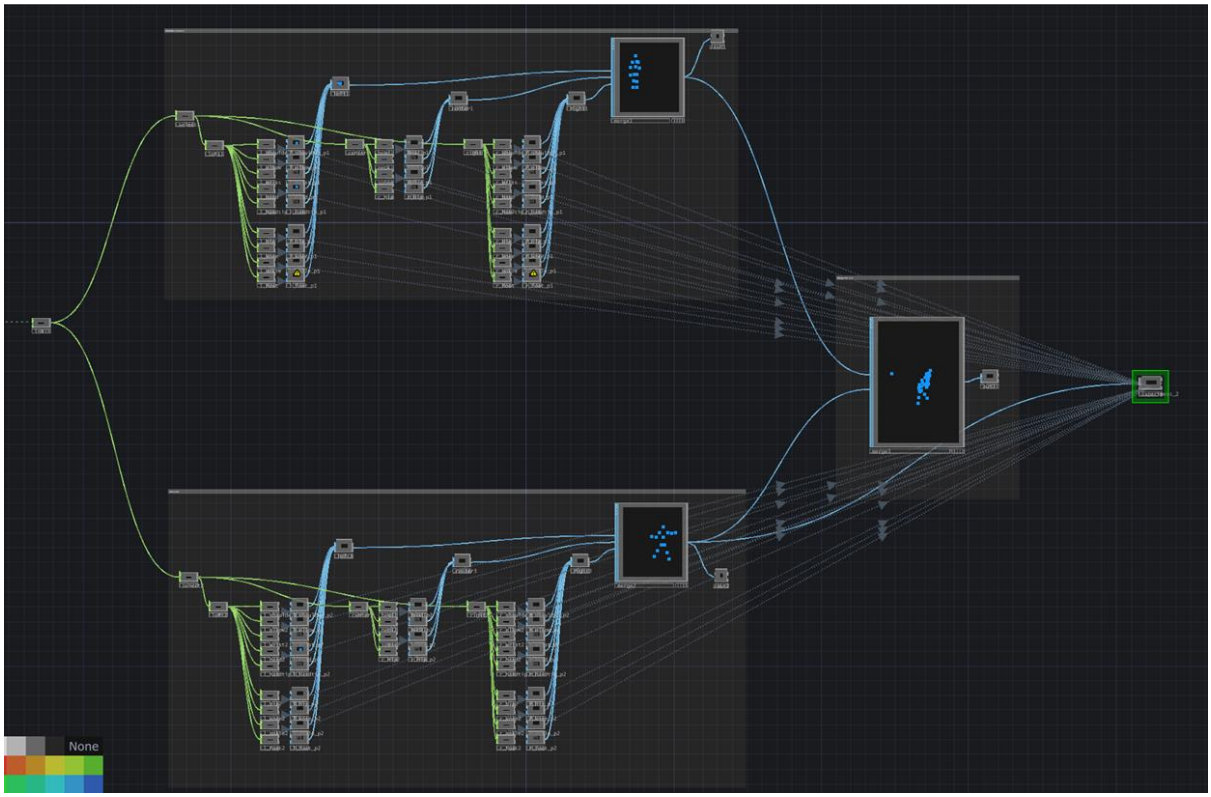

Figure 22. *Final design: separating and structuring 3D coordinates per body parts and per dancer*

Instead of points, spheres were positioned over those coordinates and connecting lines were drawn in between them.

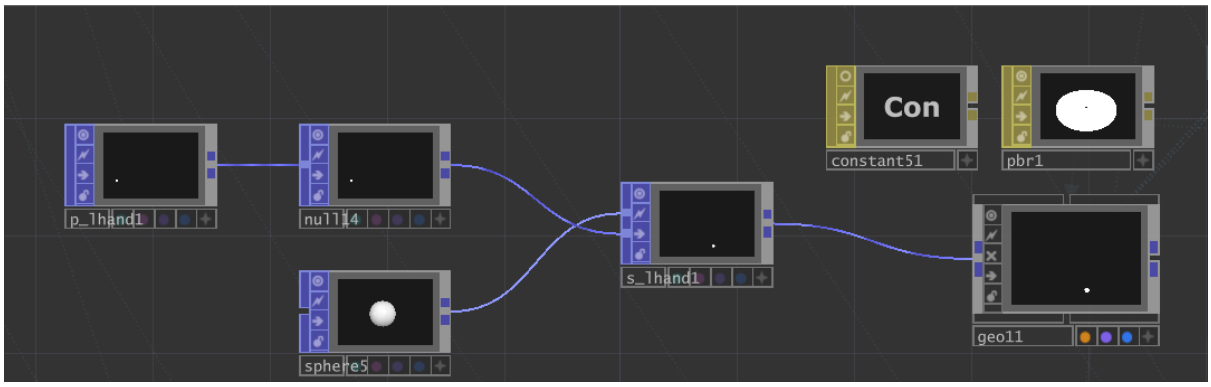

Figure 23. *Final design: generation of 3D spheres on top of body part coordinates*

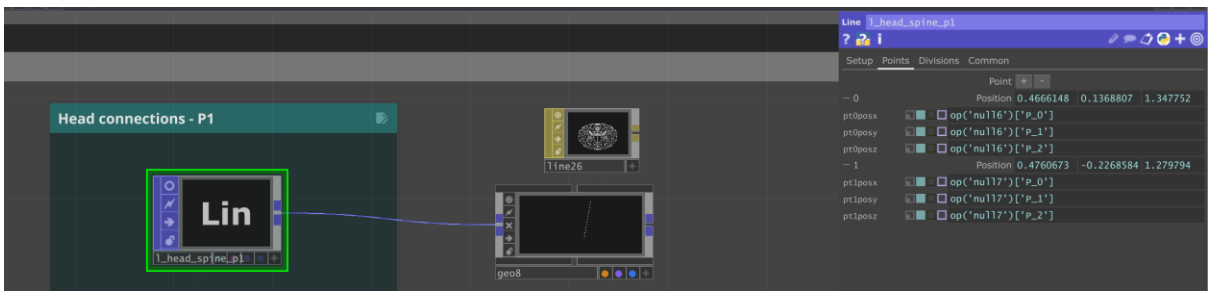

Figure 24. *Final design: generation of connecting lines between body parts*

The buttons of the audience were assigned to control the colours of the spheres. Each body part had two colours assigned to it. *Figure 25* shows the tracking of the buttons state. In the example, one of the buttons for the right shoulder was pressed. There is also a switch for changing the configuration between the home setup (MIDI controller and keyboard) and the setup at the dome in purple (buttons by the seats).

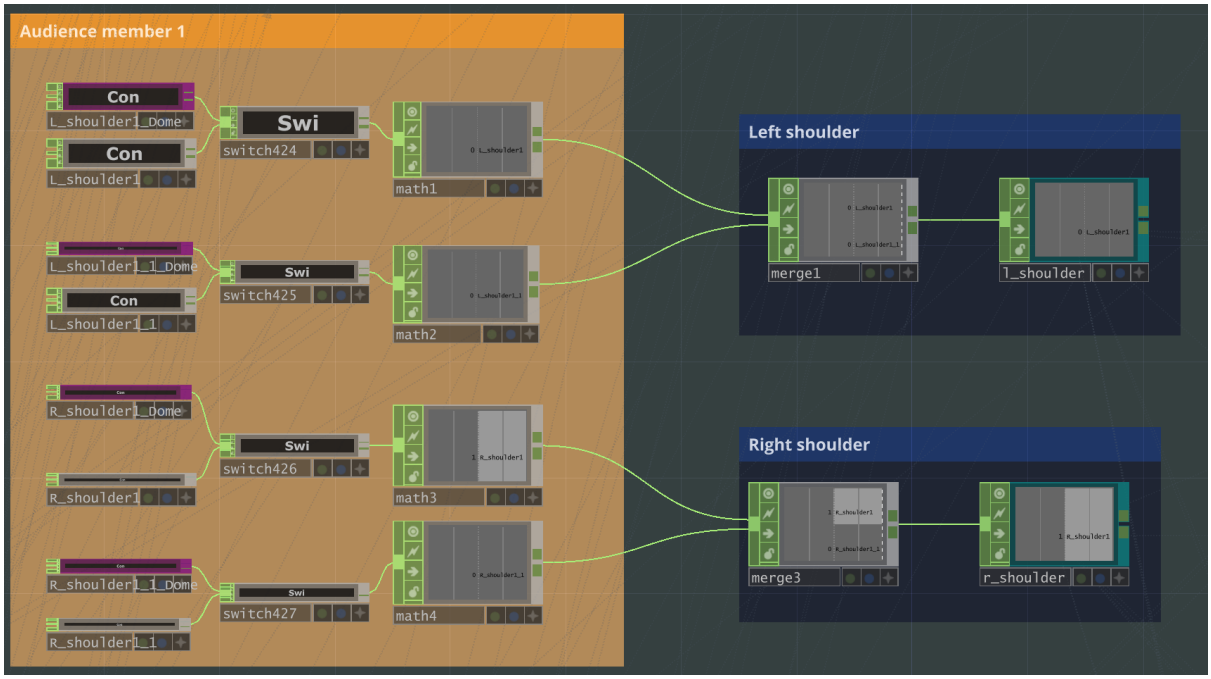

Figure 25. *Final design: mapping buttons to body parts in TouchDesigner*

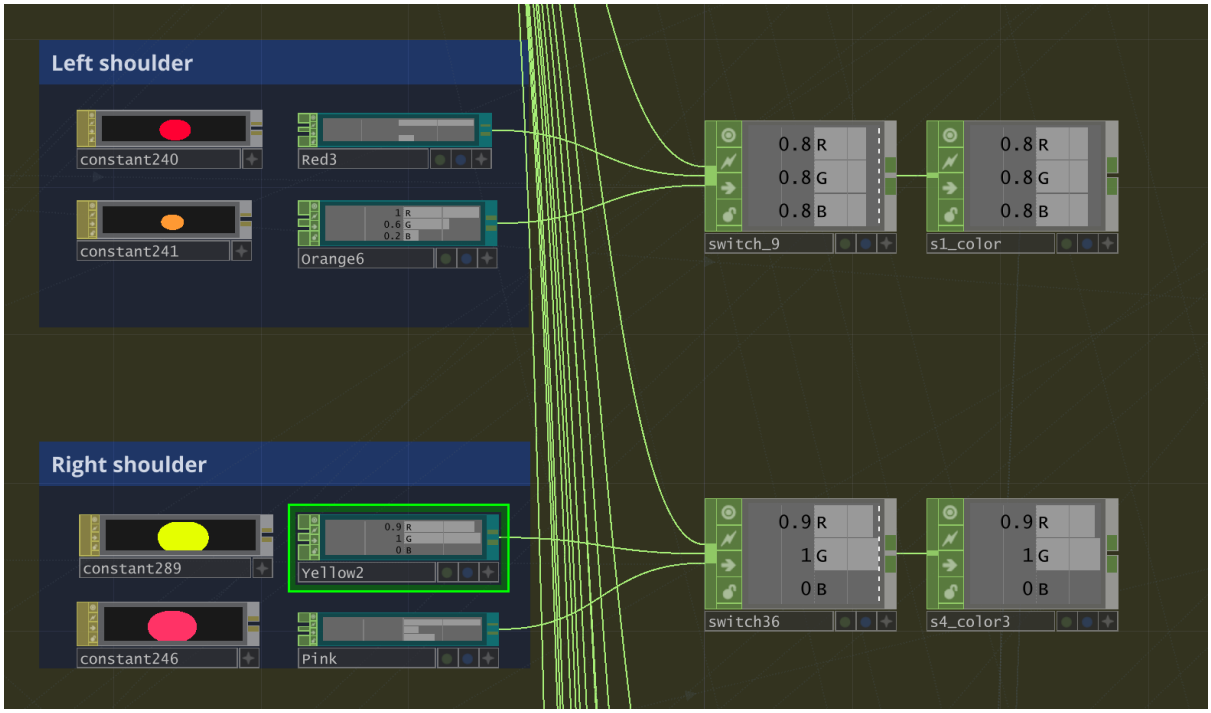

Figure 26. *Final design: mapping colours to body parts*

In Picture X, since the button that changes the right shoulder sphere to yellow was pressed, *s4_color3*, is assigning those RGB values to that sphere.

Lately, the colours assigned to each body parts were constantly compared against each other as the code was running.

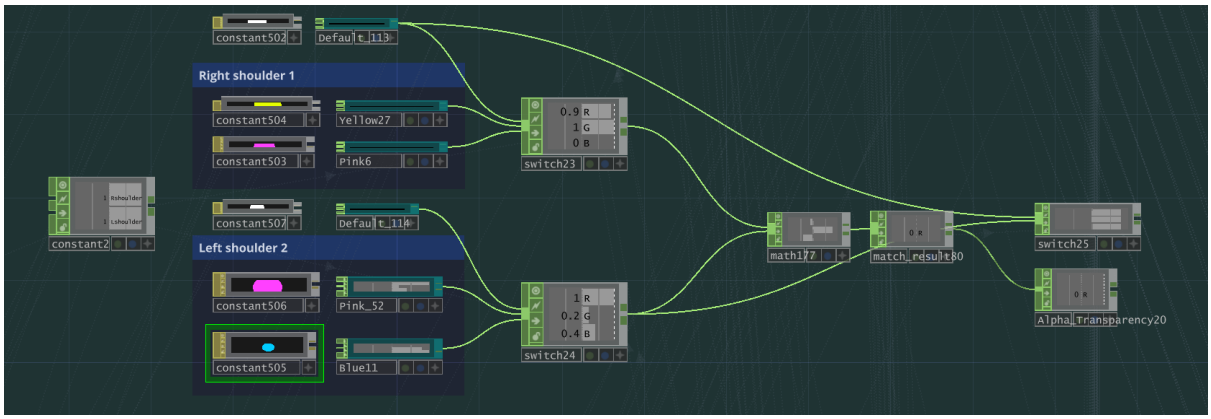

Figure 27. *Final design: colours comparison and alpha control of the lines*

If colours were the same, the *match_result* will provide the value 1, that same value is assigned to the alpha value of the lines, so when it is 1, the line is visible and when it is 0, the line is invisible. *Switch25*, will provide the matching colour instead of the white colour by default, and those RGB values are assigned to the ones of the connecting line between those body part.

This explains the core functioning of the code. The process consisted of repeating the same structures for each body parts and each possible matching. Assigning colours a drawing invisible lines according to the diagrams shown in *Figure 16*.

Access to the code can be found in the Appendix.

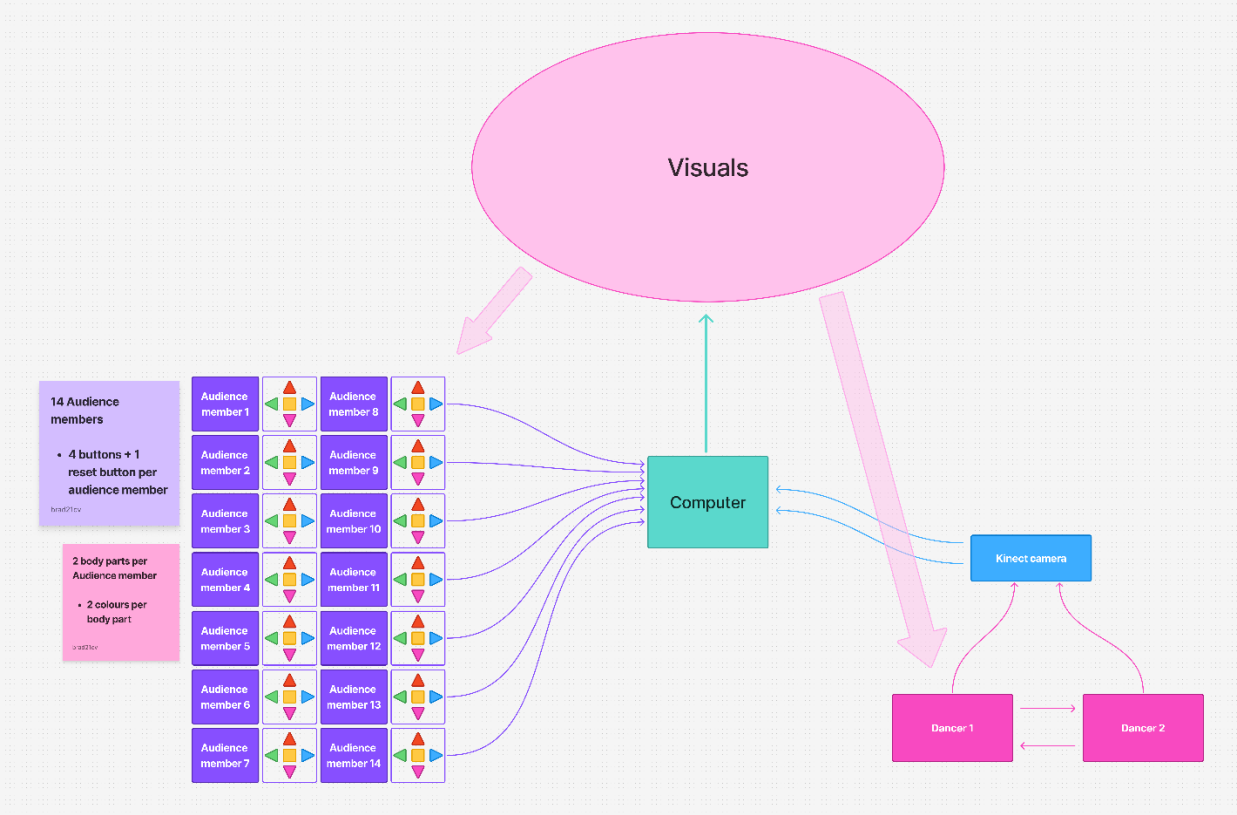

Figure 28. *Interaction flow diagram*

5.3 The dome

The author got permission to work at the Dome every Friday morning. However, one of the experts in TouchDesigner, *Supermarket_salad* (supermarket sallad (simon david ryden), n.d.), who was contacted throughout the process, provided a visualizer component, that gave a preview of how visuals would approximately look at the Dome, which was particularly useful when working from home.

Figure 29. Final design: Dome preview made by supermarket_salad (supermarket sallad (simon david ryden), n.d.)

However, there were still differences in between what was projected in the preview and how it looked like at the dome. For instance, the visuals were expanding in size and moving to the sides as the performance progressed, and the parameter that marked the expansion range was different in the preview than at the dome. That parameter was dependent on the speed of expansion, the duration of the song and the inclination of the camera, and was established so the spheres were not trespassing the edges and disappearing from the spectator's view.

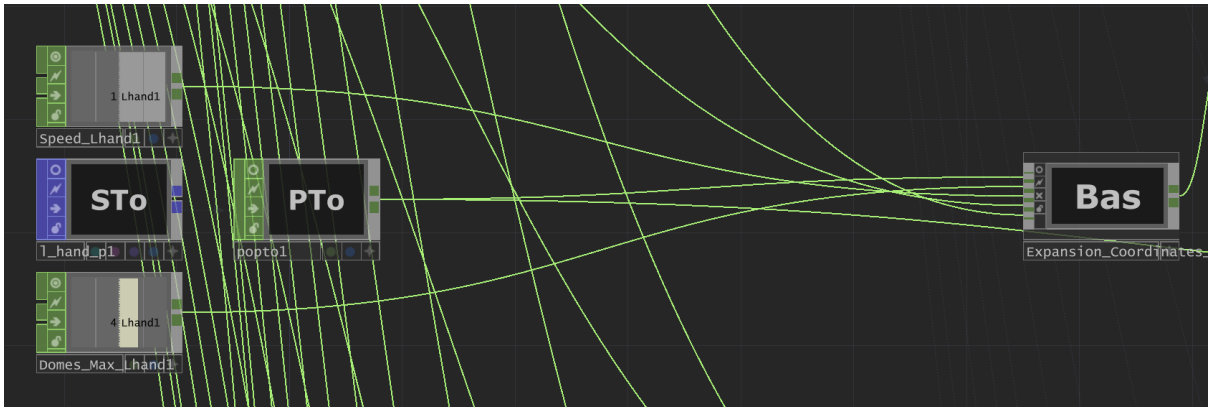

Figure 30. Final design: controlling speed and maximum range of expansion

Another difference was the brightness of the spheres and the stars. It resulted to be less bright at the dome than what was shown in the visualizer. Therefore, brightness was increased accordingly once preparing the final performance.

5.4 The music

Once all the comparisons between body parts were made, the next step was about selecting an appropriate music and adjusting some design aspects of the code, so effects were synchronized, and things were occurring in a way that fitted the music.

The author mixed two songs, one was classical piano music, for the introduction and the slow fade in of the body parts, and the other one was a bachata song, once all the body parts had appeared and the dancing started.

- Introductory song: *Lost Memories* by Marc Hanania. Body parts fading in, background changing from blue to black, tiny stars appearing in the background as it gets darker.
- Bachata song: *In the stars* by DJ Dimen5ions. Marking the expansion of the bodies, bodies moving towards the edges of the dome and camera tilting upwards giving the effect of bodies moving towards the top of the dome.

The whole mixed lasted a total of 5 minutes and 50 seconds, being the introduction 1 minute 50 and the second song 4 minutes. Once the introduction song finished, the camera focusing to the dancers started to tilt upwards and the visualization of the bodies started to expand. The first break of the bachata song marked the beginning of the system starting to modify the inner connections within bodies and from then on, every low of the songs, was accompanied by a gradient that cover the whole dome, as a special effect.

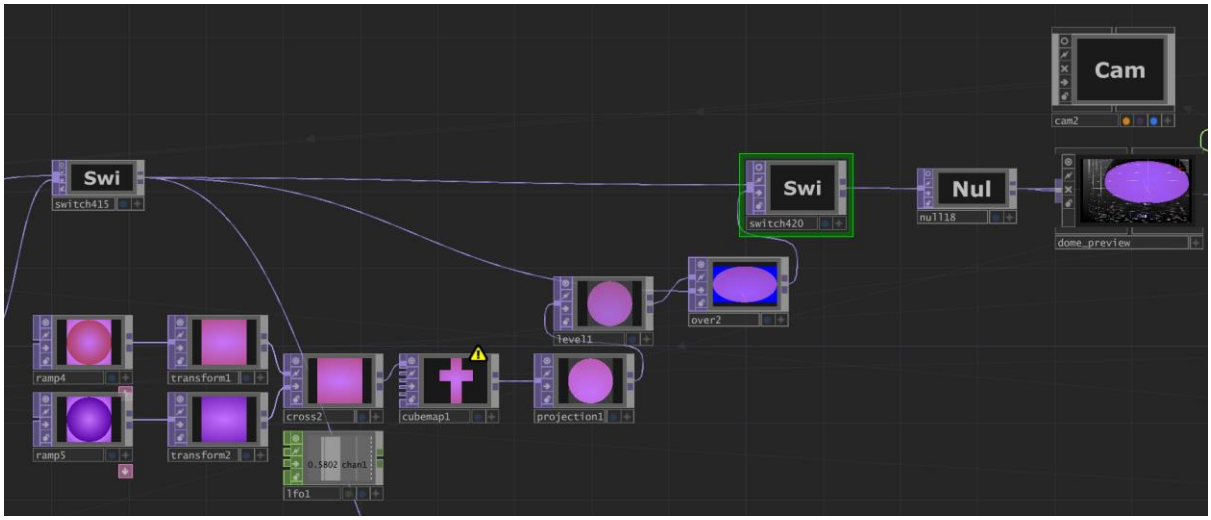

Figure 31. *Final design: gradient effect when lows hit in the song*

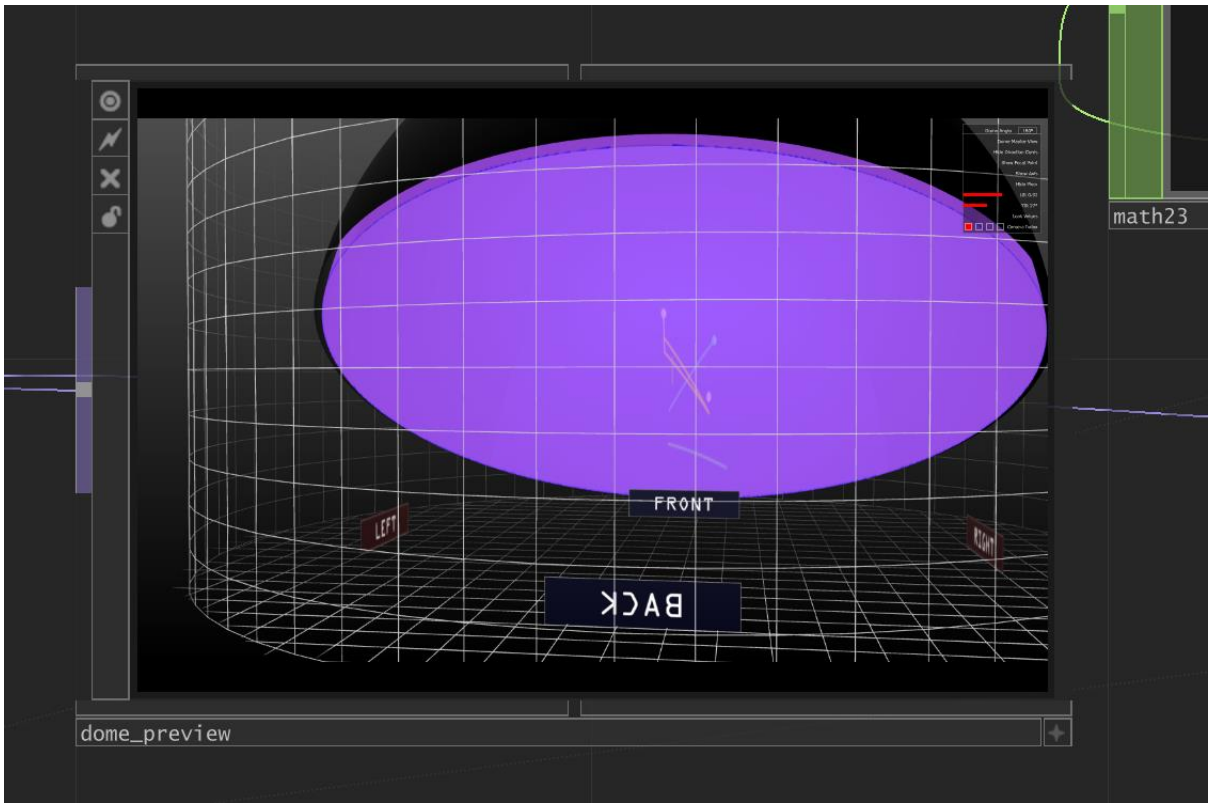

Figure 32. Final design: gradient effect when lows hit in the song. Dome preview by supermarket_salad (supermarket sallad (simon david ryden), n.d.)

5.5 Setup at the Dome

For all previous experiments the functioning of the buttons was that when press and hold, the colour of the corresponding sphere would change and stay with that colour until the button was released, using a total of 4 buttons.

At the dome that functionality was not possible to reproduce, instead, when a button was pressed once, the colour of the corresponding sphere changed and stayed with that colour until a reset button was pressed, which turned that sphere back into white.

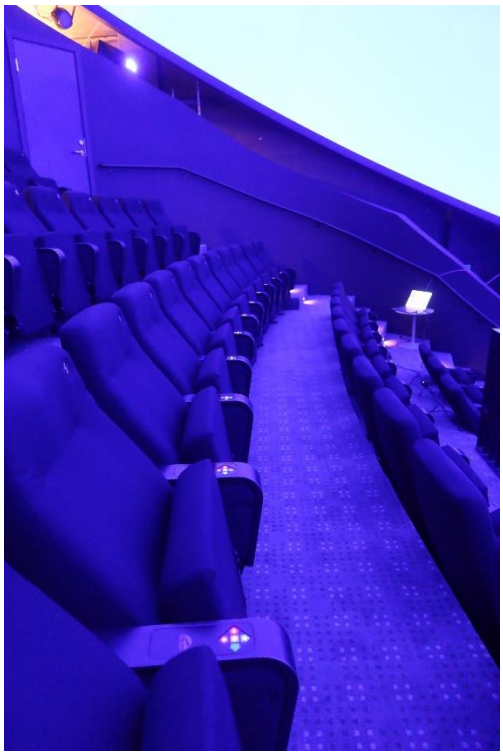

Figure 33. Final design: buttons at the Wisdome Malmö. Row of participants, 14 in total (Malmö Stad, n.d.)

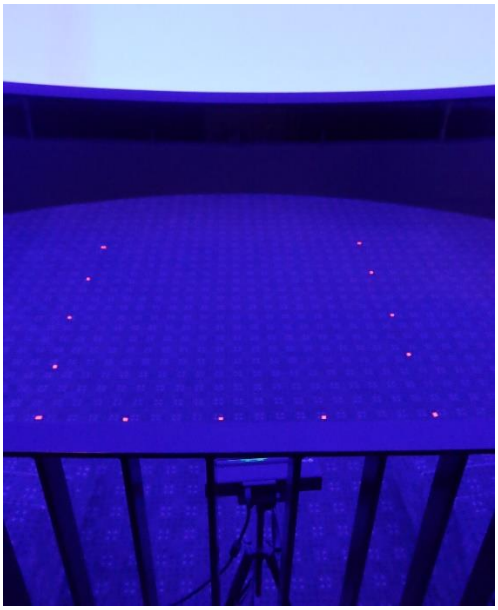

Figure 34. Final design: Kinect camera placement and dancing area at Wisdome Malmö (Malmö Stad, n.d.)

5.6 Application of Interactive Dance Design Principles

The design principles for interactive dance presented by Berto Gonzalez, Erin Carroll, and Celine Latulipe (Gonzalez et al., 2012) presented in 2.1.3 Design principles for interactive dance were integrated into the design process in the following way:

The principle of **Connected Kinetics** was implied in the intention of making the relationship between audience interaction, dancers' movements, and visuals perceivable. The representation of the body through spheres and lines, the colour matching logic, and the coloured lines generated by the audience were designed so that participants could recognize that the environment was reacting to their actions.

The principle of **Augmented Expression** can be observed in the way the interactive environment suggested the exploration of unconventional movements and interactions between dancers by connecting body parts. Whether that is considered to augment the capacity of expression of the dancers can be debatable. From the authors perspective, the final result aligns more with "Making Strange" presented in 2.3.3 Defamiliarization in Interactive Dance (Loke & Robertson, 2013)

The principle of **Aesthetic Harmony** strongly influenced the balance between visuals, music, interaction design and choreography. Throughout the performance, the visuals progressively expanded across the dome, the music synchronized transitions within the system, and the dancers body representations gradually became more abstract and entangled. Instead of maintaining an equal balance between dancers, technology and audience participation throughout the whole performance, what was considered the focal point changed through time.

The principle of **Interactive Build**. The complexity of the visuals and their expansion, the rhythm of the music and the special effects were gradually introduced over time. Starting with the body-part appearing progressively and ending with abstract configurations that covered the whole screen.

Lately, the project also reflects the principle of **Integrated Process**, since the development of the performance required the integration of different disciplines, such as dancing, coding, interaction design, music, and technical considerations related to the dome environment.

5.7 Results from the final performance

The final performance took place on the 22nd of May at 14:30, a total of 22 people joined that day to watch the performance. 14 participants seated in the middle row to press buttons and control the colours of the spheres and two dancers danced in front of the Kinect camera. People were given a short introduction about the project and about the author and the people involved and then were invited to pass into the dome. At the dome the idea was explained to them similarly to

how it was described in 4.2 Experiment 2 and instructions were given on how the buttons functioned.

After the final performance, a 15 minute discussion was conducted with audience members and dancers in order to gather reflections regarding the interactive system, audience participation, and the overall experience of the performance. This section provides key observations and some of the participants reflections.

Participants found it difficult to identify which body parts they were controlling.

“I didn’t know which part I was controlling. It would have been nice for you to tell us in advance which part each of us was controlling.” - Audience member

“When a sphere changed its colour, I didn’t know if it was me who did that action or if it was someone else.” - Audience member

The lack of immediate feedback weakened the understanding of the interaction system.

“When I pressed the reset button, I couldn’t see any immediate feedback on that action.” - Audience member

Participants reported that interaction became easier to follow over time.

“It was easier to make patterns intentionally when everything became crazy. By then I had found my dots and felt comfortable knowing which buttons changed the colours.” - Audience member

“I needed time to master my control before I started seeing myself in the visuals.” -Audience member

Audience members gradually shifted their attention from the dancers toward the dome visuals.

“By the end I wasn’t looking at the dancers anymore. I had no idea what you guys were doing down there. I was looking all the way up.” - Audience member

“It is not that the dancers don’t matter anymore, but it feels like we all go together somewhere else.” - Audience member

Several participants suggested allowing more time for experimentation before the performance became complex.

“You could have given the audience much more time to figure it out before the performance starts.” - Audience member

“In the first act you could let people experiment with the controllers first.” - Audience member

Participants found the colour mappings confusing when they did not correspond to the button colours.

“The colours were not correlated with the colours on the buttons, which was confusing.” - Audience member

Dancers also reported difficulties following the increasing number of body connections.

“It became difficult to follow because of the amount of connections going on, and also because the visuals moved upward, making it harder to identify which body parts I was controlling.” - Dancer

Overall, participants described the experience as playful, immersive, and engaging, while also highlighting challenges related to interaction clarity, complexity, and understanding of the system behaviour.

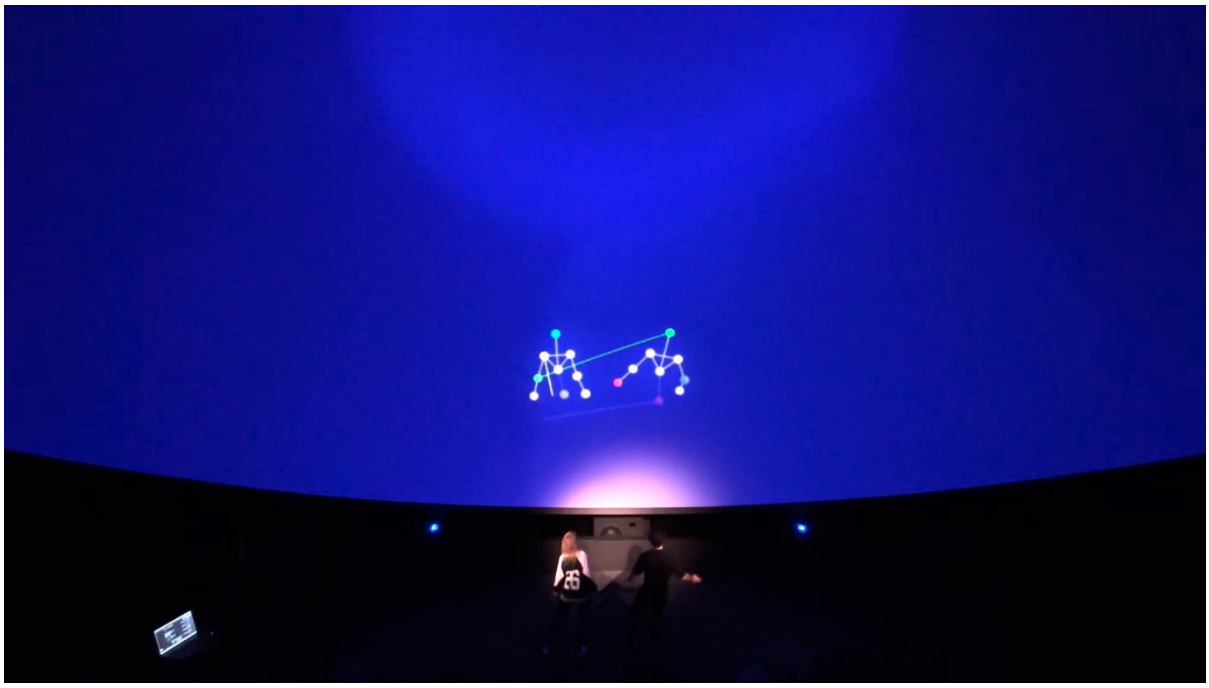

Figure 35. *Final performance*

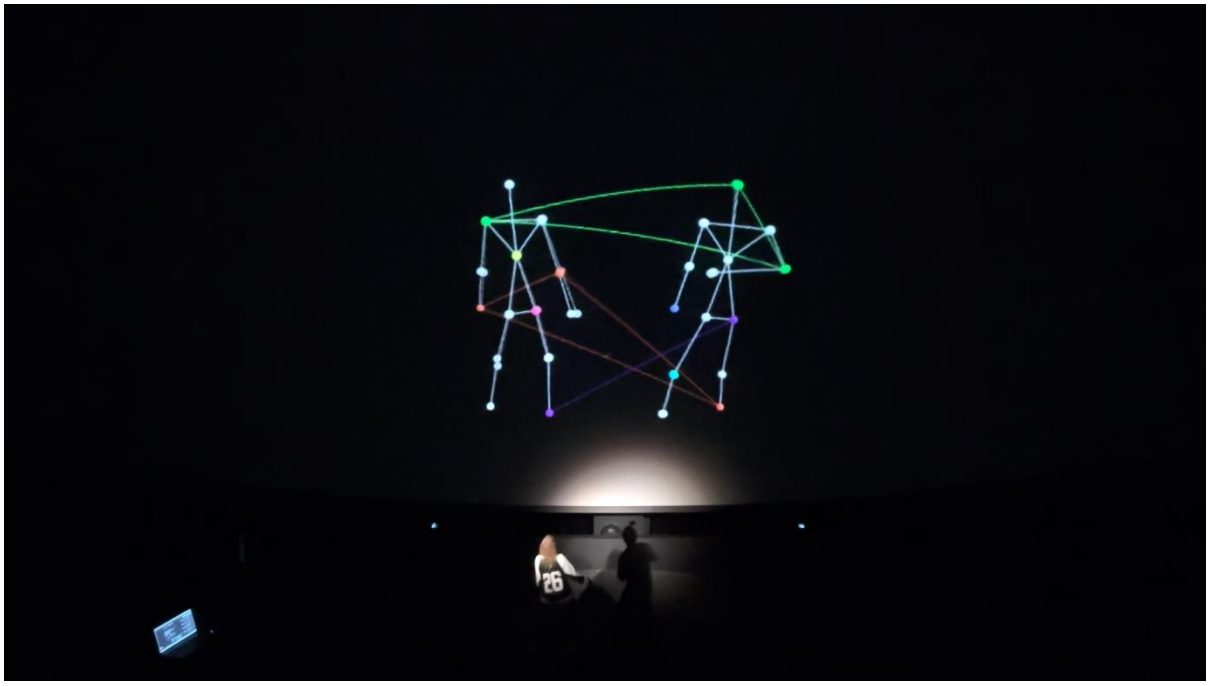

Figure 36. *Final performance*

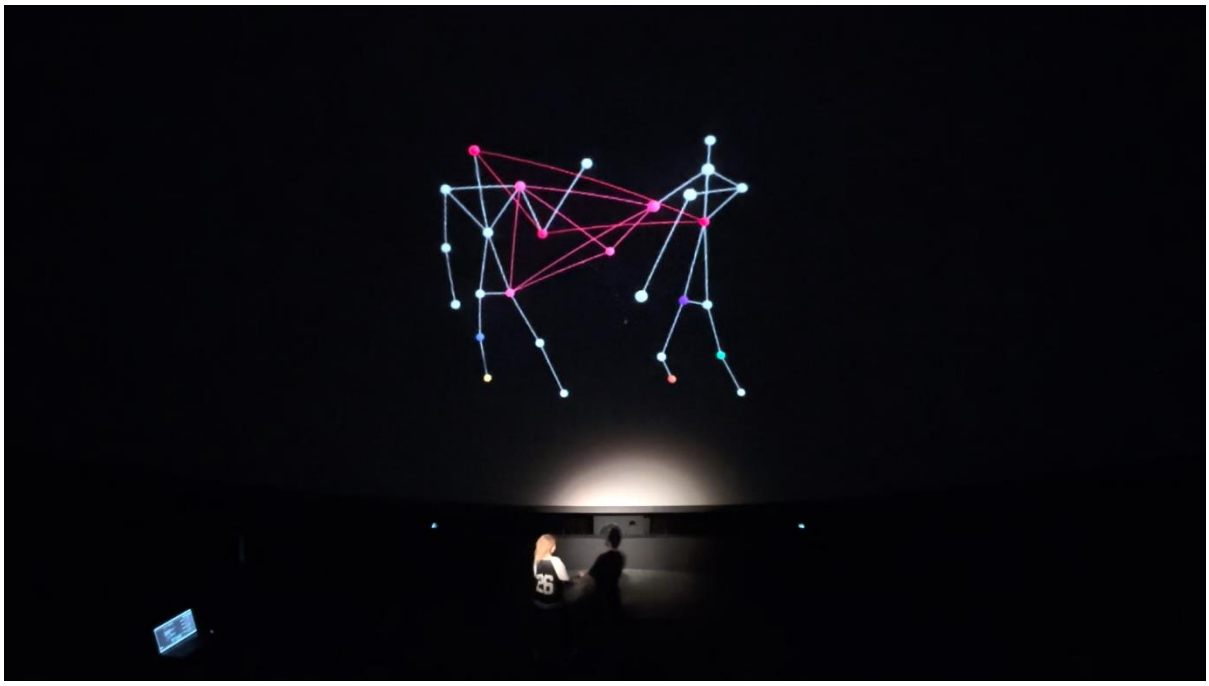

Figure 37. *Final performance*

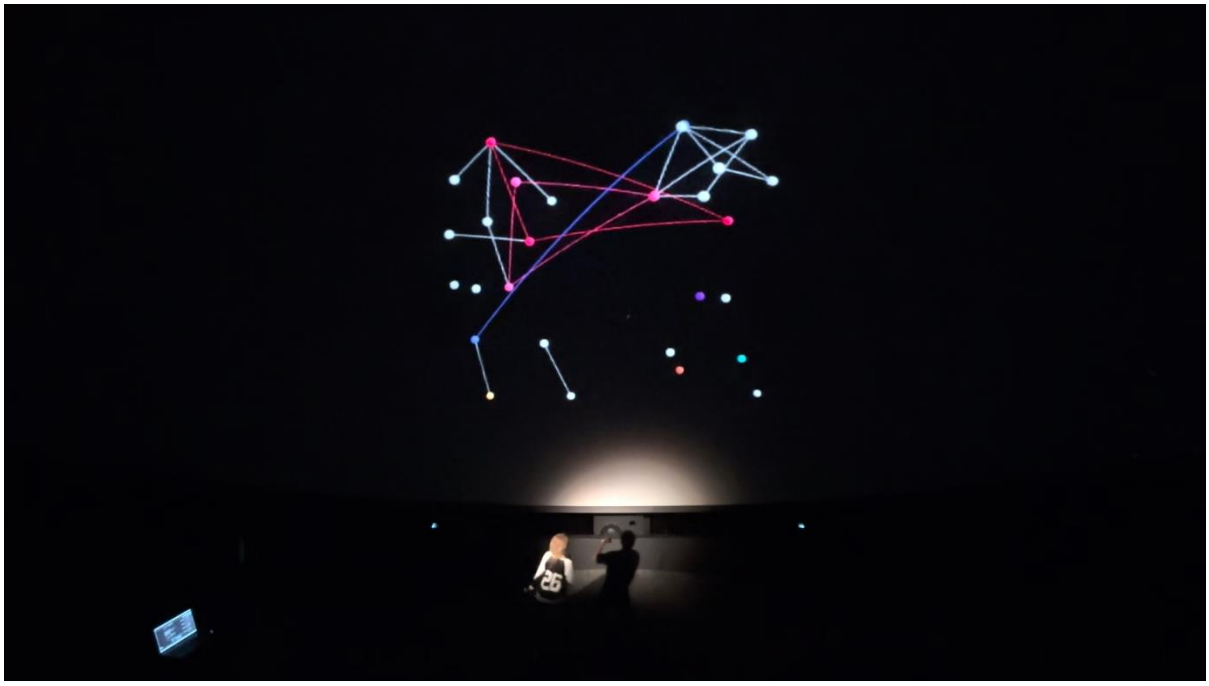

Figure 38. *Final performance*

Figure 39. *Final performance*

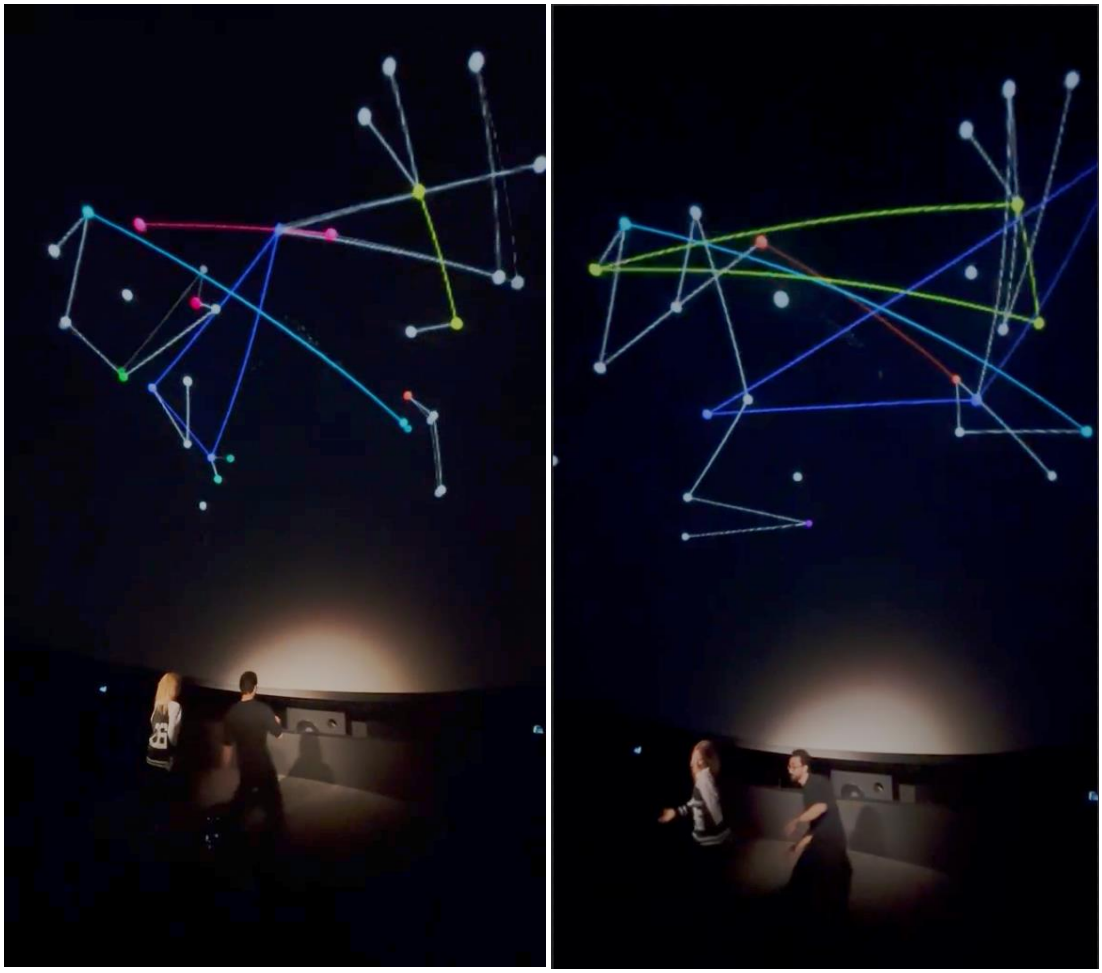

Figure 40. *Final performance*

6. KNOWLEDGE CONTRIBUTION

This section presents the knowledge contributions coming from the creation of experiments, user tests, and the final performance developed through a Research through Design approach. This thesis contributes to the fields of interactive dance, mixed reality, and embodied interaction by exploring how the design of an interactive system shapes the relationship between dancers and audience participants within an immersive dome environment. The section includes both technical and experiential findings that may support future research and design practices within interactive dance and embodied interaction.

Complexity vs. embodied understanding

As the performance progressed and the number of body connections increased, participants described the interaction as becoming progressively more difficult to follow and predict.

From the dancer's perspective, the increasingly amount of visual information, and particularly the reconfiguration of their inner connections, compromised their ability to interpretate the connecting lines that were drawn and therefore difficulted their exploration. As the visuals became more complicated, they could not easily identify their body parts on the screen, making them focus more on the visuals instead of on their bodies. In those instances, exploring the

connections drawn became a form of guessing game. However, that made them explore new moves and focus as well on how the other dancer was interpreting those moves, trying to find a common understanding. This reminds to the concept of making strange (Loke & Robertson, 2013) 2.3.3 Defamiliarization in Interactive Dance, since although they were dancing a bachata song that they knew, they were exploring it in a completely different way.

From the audience perspective, participants also reported difficulties in understanding the feedback as the performance became more complicated. Participants frequently lost track of their assigned body parts and it was difficult for them to know whether the visual changes were caused by their own actions or someone else's actions. Some shared that it was easy for them by the end of the performance although the visuals were more complex. But it is concluded that this was due to the amount of time they had to figure out their controllers and find their assigned body parts.

At the same time, the increasing complexity and the unpredictability of the interactive system, was not necessarily experienced as something negative. Both dancers and audience members shared that it was an interesting quality of the performance, and that it was aesthetically engaging. It seems that there is an inverse correlation between the aesthetic complexity of the performance and the participants understanding of the interaction. Therefore, it can be concluded that when designing these types of experiences an excessive complexity can disrupt the bodily awareness of the dancers, reduce predictability, and weaken the reading of the different interactions that occur.

Audience engagement depends on clear mapping and time

In all experiments, participants agreed that the engagement in the performance was better when they were able to link their actions to the visual outputs. For instance, in 4.2 Experiment 2, the missing connection made participants perceive the connection drawn as random and they felt a lack of control over them. It is therefore important to have consistency when designing for colour matches and mapping out the buttons.

Although, Experiment 3 provided a set-up that was colour-coded and this addition was positively received in comparison to 4.2 Experiment 2. The final performance didn't offer this colour-coded setup, it was the complete opposite, since the buttons had colours but those were not correlated to the colours assigned to the body parts. This was something that participants reported as misleading and emphasised the importance of allowing for time before the performance for them to understand how the inputs are mapped to the outputs or a clear explanation prior to the performance. The mismatched between the colour of the buttons at the Dome and the colour of the body parts was due to the need of more than 4 colours in order to minimise the number of possible connections and simplify the code. See *Figure 14*. Experiment 3: Body parts configuration and connecting lines diagram

Some participants explained how their engagement in the performance increased gradually as "found their dots" and understood which buttons controlled which colours. They were able then to intentionally create connection lines, and the experience became more fun for them.

The experiments prior to the final performance revealed that assigning to many body parts to each audience member difficulted their ability to keep track of the visual outputs they were generating.

These aspects highlight the importance of balancing complexity and clarity of mapping and explanation, especially if participants are not provided with enough time for them to master their controllers.

Shared entanglement between dancers and audience

From the experiments and particularly in the final performance, as the performance developed and became more complex, both dancers and audience members felt that the experience turned more unpredictable.

Audience members shared that towards the end of the performance their attention progressively shifted away from the dancers and focused more on the visuals. Some reported that this made them feel more integrated into the immersive experience, felling more as co-creators with the dancers rather than spectators. One participant shared that this transition felt as if they "were going together somewhere else", suggesting that environment gradually transformed the relationship between performers, spectators and media as the performance developed.

This finding contributes to the discussion around embodied interaction and mixed reality by serving as an example of how interactive systems can create spaces for co-creation when involving multiple actors and how uncertainty and improvisation have the potential of making the interaction more playful and unique.

Balance between aesthetic features and audience participation

Design aspects such as the randomization of the line's configurations within bodies, expanding visuals and the abstract compositions that were created contributed positively to the aesthetic qualities of the performance but weakened participants' understanding of the interaction. Therefore, it is possible to extract that interactive systems of this type and that seek to involve audience participation in the performance requires careful balancing in the design between:

- Unpredictability and legibility.
- Immersion and perceptibility
- Abstraction and control.

A successful interactive system of this type not only depends on visual complexity, but on the design of interactions that are understandable and perceptible while still giving some space for unpredictability, playfulness and exploration.

Designing for immersive Dome environments

The project also generated findings related to designing for immersive experience at dome environments. As the visuals progressively expanded across the dome surface, participants reported a stronger sense of immersion in the environment. At the same time, the dome architecture significantly influenced the attention of the spectators. Because audience members looked upwards and focus more on the visuals as the performance progressed, it became difficult for them to simultaneously focus on the dancers. Several participants reported that, toward the end of the performance, their attention shifted almost entirely to the visuals rather than the dancers. This is not something negative but it is a consideration to have when designing for interactive dance in dome environments, it depends on where the focus is required. The

inclination that the visuals have and the size of them play therefore an important role. In this project, the smaller, simpler and closer to the dancers they were, the easier was for the audience to focus on both simultaneous. The higher the visuals and the more complex and bigger they got, the more attention were demanding.

Another important aspect concerns the pacing of immersion. Participants reported needing time to understand the interaction before fully engaging with the performance. Gradually introducing body parts, visuals, and interaction complexity can helped participants in slowly feeling more immerse in the experience.

Future lines of work

The final performance at Wisdome Malmö provided a lot of insights that encourage the further development of this project. Positive feedback was that participants found the experience interested, immersive, fun to participate and wanted it to last longer. The following list provides suggestions and future directions that have the potential of improving the interactive performance, starting with direct suggestions from the participants and ending with ideas that eventually remained unexplored:

- Provide the audience with more time to familiarize themselves with the interaction system before the performance becomes visually complex or even before it starts.
- Correlate the colours of the buttons with the colours projected in the visuals to improve interaction clarity and engagement.
- Improve the visibility of interaction feedback, particularly for actions such as resetting or reconfiguring the system.
- Reduce the number of simultaneous body connections in order to improve the legibility of the interaction.
- Providing feedback when dancers are exploring the connections generated. For instance, dynamically change the thickness of connection lines as dancers physically explore them. From the audience perspective, the sphere that have received more connections could increase in size as the performance develops.
- Investigate alternative body-part mappings that feel more natural and less awkward for dancers to explore physically.
- Explore other forms of interactions. For the dancers instead of a Kinect camera, it could be wearable devices that measure acceleration. For the role of the audience smartphones could be an interesting option to explore as it is a common tool in mixed reality.
- Further explore the relationship between the dancers and the visuals, thinking on where the audience focus is.
- Although dancers have to improvise based on the audience participation, preparing a choreography that is open for improvisation could enrich the dancers' performance.
- Some sort of narrative or storytelling along with the visuals could guide the audience attention and participation.
- Dividing the performance into different acts where the first acts focus on the audience introduction to the system and understanding of their controllers.

Answering the research questions

1. What design features of the interactive system influence the balance between audience participation, dancers' embodied engagement, and technological mediation in immersive dance performances?

The findings suggest that the balance between audience participation, dancers' embodied engagement, and technological mediation is strongly influenced by the clarity and complexity of the interaction system. While increasing visual complexity and entanglement contributed positively to the immersion and aesthetics of the performance, excessive complexity involving abstract configurations, multiple connections happening simultaneously and multiple stimulus calling for attention also reduced participants' ability to understand the interaction and compromised dancers' embodied awareness. The findings therefore highlight the importance of balancing unpredictability and abstraction with legibility and perceptible feedback when designing interactive dance systems.

2. How do input mechanisms, such as seat-based buttons, shape the audience participation, engagement and influence within the performance?

The project demonstrated that audience participation through seat-based buttons can successfully support engagement and influence within the performance when the relationship between input and visual response is understandable and perceptible. Participants required time to learn and adapt to the interaction system, and the engagement increased once mappings became recognizable. At the same time, unclear mappings, inconsistent visual feedback, and excessive simultaneous interactions reduced participants' understanding of their influence on the performance.

7. CONCLUSION

This thesis explored how interactive systems can enable audience participation within live interactive dance performances in the context of an immersive dome environment. Through a Research through Design approach, the project investigated how dancers, audience members, and the interactive system can co-create an immersive experience.

The project demonstrated that audience participation in interactive dance can be an area of exploration that offers a lot of possibilities to the field. Through the experiments conducted and the final performance, it was concluded that, in order to maximize audience engagement and participation, the interactions should be understandable, perceivable, and easy to follow. The use of seat-based buttons demonstrated that even limited forms of input can support audience participation in the performance. To give participants a sense of co-creation, the visuals must be linked, not only to the dancers' movements, but also to the actions of other audience members. Although visual complexity can promote immersion, it can compromise audience engagement and sense of agency. Similarly, too much complexity can make dancers loose connexion to their bodies.

Another important contribution of the thesis concerns the role of immersive dome environments in interactive performance. The dome architecture significantly influences the attention of the audience and the dancing. As the visuals expanded progressively across the surface of the dome, dancers struggled more to follow the created connections. This happened not only because of the increased complexity of the visuals, but also because they had to look constantly upwards. At the same time, the expansion of the visuals shifted the focus away from the dancers and into the visuals, transforming the relationship established between performers, audience and the media as the performance progresses.

This project demonstrated the value of embodied and practice-based approaches within interaction design research. Through iterative prototyping, embodied exploration, reflective practice, and a live performance, the project generated situated knowledge. In this sense, the thesis positions interactive dance not only as a performative practice, but also as an approach to investigate embodied interaction, audience participation, and technological mediation.

Ultimately, this thesis suggests that interactive dance and dome environments can serve in the creation of shared spaces for playful exploration and co-creation between dancers, audience members, and interactive systems. However, to design engaging participatory experiences, it is required to carefully balance immersion, complexity, aesthetic qualities, and the clarity of interaction. Rather than replacing the role of the dancer, the interactive environment is perceived as an agent that reshapes how performers, audience, and technological systems related to each other and become entangled.

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Appendix

The video of the final performance and final the version of the code done in TouchDesigner can be found in this Google Drive folder:

https://drive.google.com/drive/folders/1AFrPPwX-c1GUILs73UU-ogLNzxmeLiWh?usp=sharing