Ambiguous Topology: From Interactive to Pro-active Spatial Environments

Jia-Rey Chang* 
Delft University of Technology

Nimish Biloria**
Delft University of Technology

Dieter Vandoren***
dtr LAB, iii Organization

ABSTRACT

Ambiguous topology is an immersive multi-modal installation exploring the tendencies of swarms systems and volumetric projections to generate emergent geometric networks as a response to as well as a trigger for movement of multiple bodies in space and time. The installation operates on the subtle fusion of physical and digital media by means of harvesting and impacting the speed and frequency of movement of the participant’s body as a trigger for activating/disturbing a swarm of digital particles in space. The usage of volumetric light projection media in order to visualize this dynamic behavioral scenario renders abstract three dimensional topological nuances within which the body navigates and experiences new states of ambiguity, dis-alignment and proactive behavior. Technological, human and spatial agency/affordance thus unites into a never-ending looped process of inter-performance through the Ambiguous Topology installation. Ambiguous Topology has been developed under the ongoing EU Culture Research project: METABODY.

Keywords: Dynamic topology transformation, swarm simulation, pro-active behavior, volumetric projection, interactive environment, spatial narrative.

Index Terms: J.5 [Arts and Humanity]: Arts, fine and performing; J.5 [Arts and Humanity]: Architecture; I.3.m: [Computer Graphics]: Miscellaneous

1 UNDERPINNINGS

Computer graphics was invented as a data visualizing method involving the generation of graphical images using algorithmic structures for understanding and compiling raw data produced within computer simulations [1]. However, random mistakes and errors either within the scripts or through the plotting sequences within such visualization processes, gave an opportunity to several pioneering computer graphics artists to identify and creatively exploit and present the inherent beauty within these glitches as pieces of art. Artists such as Melvin L. Prueitt [7], A. Michael Noll, George Nees and Frieder Nake, back in the 60s already are well acclaimed in exploring such glitches as artistic projects using computational techniques of the time. Simultaneously, the world fair expo project at the Phillip Pavilion in 1958, experimented with the creation of a rich multi-modal experience by combining sounds, light, visual effects, and other applied media within architectural space to evoke, and stimulate human perception. Artists, composers, designers and architects have since then, been increasingly involved with understanding and experimenting with the domains of Interaction design and specifically the role of multi-modal interactions within spatial settings.

Taking inspiration from such a rich context of creative information art and architecture, Ambiguous Topology was conceived as a real-time proactive and fully immersive art + architecture installation. The installation was developed as a part of an ongoing European Union Culture grant, under the bigger research project titled METABODY (www.metabody.eu). The
installation harnesses Swarm computing techniques [4] to transform generative computer graphics into an animated, dynamic, fluid, space, which thrives on human interaction. An important aspect of the installation is the subtle transition from interactive to a pro-active mode of engagement with the audience. With a focus on non-verbal communication as a critical mode of expression to challenge conventional modes of perception, movement and associated behavioral attributes, the installation operates on the boundaries of science, art and architecture.

Visual graphics in this case acquire the medium of volumetric projection techniques. This technique (expanded upon in 2.) allows for an immersive experience of continuously transforming topologies constructed via autonomous light projections using four HD projectors located strategically in three-dimensional space. Topology transformation impulses are connected with tracking different aspects of movement of the human body in space and time. Besides this, the installation caters to multiple users, allowing them to democratically influence and get influenced by the novel topological formations they create and in the process develop novel movement patterns leading to emergent group dynamics. What is also of great value is the perceptual novelty associated with an everyday medium of light, which in this case quite literally operates as a tangible entity, affecting ones physiological and psychological behavior.

Instead of using common projection tactics involving projection of visual images onto 2-Dimensional surfaces to create the impression of 3-Dimensional space, this installation utilizes projected light beams, which immerse the participants in a literal 3-dimensional ever changing spatial structure created by their own selves. Swarm computing and associated real-time generative simulations play a vital role in the generation, resolution, dimensionality and scale of the light projections. This is inherently connected with the artistic premise of the installation, wherein the installation is conceived as constituting a set number of dormant virtual particles in space. The presence and movement of physical bodies within this space, impacts these particles by literally causing them to be displaced and collide into each other. Each collision, resulting in the generation of energy, which subsequently builds up via the particles hitting each other to dissipate and transfer their energy from one to the other. Eventually, the field of energy dies out (over time when these is no human presence detected to disturb the dormant field) and allows the particle systems to return back to a state of dormancy. Each particle is considered as an agent, which constantly transmit values pertaining to its position in space and maintaining values of separation, alignment and cohesion between its immediate neighbors. These values also form the basis for an algorithmic structure, which is responsible for establishing linkages between the particles in the form of line segments and NURB geometries. These particles in virtual space (in the simulations) are projected as light beams via the volumetric projection system deployed in the installation. Aspects of width of the beam as well as color of the beam are again directly connected with the nature of the swarm of particles, their position, energy level and distances between them.

The engagement of users and the transformation from interactive to proactive modes is also connected with the swarm based energy gain and associated data communication per particle. During the engaging interaction process (explained in 4) between the user and the immersive light projection, the particles/light beams witness a dynamic transformation in the energy levels, which they accumulate and dissipate. A threshold is set within the simulation algorithm, which, once attained, assigns full autonomy to the light projections. This implies a shift in the engagement and perception of users, wherein, the earlier triggering of light beams associated with individual body movement is turned around such that the light projections now acquire the leading role and the body tries to follow its cues. A looped process of events unfolds in time where differences between technology, humans, sensing, actuation and control protocols fuse together to operate as one evolving body. This transformative experience is slowly unraveled to the participants via a narrative constituting interactive scenario in a chronological order. Ambiguous Topology, intends to dis-align, and amplify the bodily senses by exploring, discovering, and extending our proprioceptive abilities as well as engage us in choreographing novel movements.

2 PRINCIPLES OF GEOMETRY REALIZATION USING VOLUMETRIC PROJECTION SYSTEM:

The interpretation and production of 3-Dimensional simulated geometries using light projection system, or in other words ‘volumetric projection’, has been developed by media artist, Dieter Vandoren (one of the team members of the Ambiguous Topology project). This involved extensive use and customization of Max/MSP (Figure 2) based routines. In terms of hardware, four high-resolution projectors are located in four corners of the space in order to attain a fully immersive interaction zone at their point of convergence. Besides this, one Microsoft Kinect device is used for motion tracking and is placed at the center-front of the interaction zone. Within this physical set-up, specific ways of interpreting geometries, such as, points, lines, polylines etc. are stated below (Figure 2):

1. Point: A point in 3d space is visualized by the intersection of four light beams from the four projectors located in the corners of the space. As a result, participants will experience this specific point as four light beams’ instead of a single light pixel flying in space. This principle is mainly implemented for realizing each point’s location in space using different colors.

2. Line: A line in 3d space is achieved by the intersection of four light planes from four projectors located in the corners of the interaction zone. In other words, in accordance with the projection angle, the participants would see a spatial intersection line built up in the interaction zone as four triangulated planes.

3. Polyline: A polyline in 3d space is achieved by the intersection of light planes with a curvature from four projectors located in the corners of the interaction zone. Because of the original geometry’s curvature and the limitation of the projection angles, participants mostly will be surrounded in conical shape created by the light projections.

![Figure 2: Diagrams showing basic principles and setup for 3-Dimensional geometry realization based on the volumetric projection system.](image-url)

3 SWARM BEHAVIOR AND ITS SPECIFICITY FOR THE AMBIGUOUS TOPOLOGY INSTALLATION:

The particle system simulations responsible for the generation of the constantly transforming topology is essentially based on Craig Reynolds’ swarm (flocking) behavior [3] [4] principles developed in 1986 (http://www.red3d.com/cwr/boids/). By observing flocks of flying birds, Craig Reynolds developed a swarm behavior simulation to mimic numerous animal species, which intend to
move collectively as gigantic creatures, for example, birds, fishes, and bees, etc. Separation, alignment and cohesion are the three major principles of swarm behavior determining each single agent’s intelligence in the flock. Separation implies avoiding crowding next to each other, alignment implies steering towards the average direction of the neighboring flocks, and cohesion implies driving the agents’ movement towards the average position of the local agents (Figure 3). Using the combination of the above simple rule sets encoded within each agent, emergent clustering formations can be derived. Ambiguous Topology, and its inherent drive to generate continuously transforming topologies at a global output level, harnesses these simple rule set based behavior and embeds it within the each constituting particle in the simulations. Emergent topological formation as a result of local level interactions within the swarm of particles is thus a novel attribute that is exploited within the installation.

Furthermore, as an interactive installation, the particles/agents within the installation specifically relate to participant’s body movements in real-time. Therefore, the propulsion of agents are not only influenced by their internally coded rule sets in accordance with the swarm behavior principles, but also extremely driven by the participant’s reactions. In other words, participants can create attracting or repelling forces by propelling the agents to affect their 3d location, velocities and accelerations through different narrative scenes in the installation. In order to communicate the state of each agent’s locomotion and energy levels to the participants, color gradients within the projections are utilized as a clear visual cue. Aggressive colors, such as red and yellow indicate high value of locomotion compared to blue and green, which express relatively passive and stable agent movement. As regards the 3-dimensional projection of agents, all agents are exhibited as "Points" using the aforementioned projection logic with the color gradient representing their energy and movement state. These colorful light beams strongly encourage the participants engage in the Ambiguous Topology installation without any external persuasion.

4 Basic Setup and Narrative Scenarios Exhibited in Ambiguous Topology:

After meticulous development and user testing at the TU Delft, Netherlands, Ambiguous Topology, was successfully set up as a real-time immersive public installation at the Media Lab, Prado, in Madrid, Spain. The event was a part of the EU Culture project; METABODY’s annual conference in Madrid, 2014. METABODY is a 5 years research project, which started in July 2013, with the support of the European Commission and the participation of 38 partners from 16 countries, coordinated by Reverso (http://metabody.eu/).

The site allocated for the installation allowed, an effective interaction zone (the convergence point of the four projectors) as 6 meters in width (X-direction), 5 meters in length (Y-direction) and 5 meters in Height (Z-direction). 640 agents/particles embedded in the space wait to be triggered by the influx of participants. The duration of the experience, and the number of people allowed to enter the installation space was decided upon together with the Media Lab’s curators. Two participants were thus allowed entry for a total duration of five minutes, in order to embrace the narrative and go through the transformative stages of interaction to proactive behavior. The participants were not introduced to any detailed information in advanced, about the installation and had no audience (like a performance piece) around to influence, inhibit or guide them. This allowed the participants to freely experience and explores gestural nuances and reflects on their own sensory abilities by interacting with different unfolding narratives in the Ambiguous Topology installation. Seven fundamental narrative modes were developed and arranged in a fluent sequence in order to facilitate a holistic experience to the participants. These narratives are sequenced in chronological order as shown below:

- Rain Mode
- Follow Mode
- Spike Mode
- Disturb Mode
- Attract Mode
- Nurbs Mode
- Rain-Up Mode

The following section shall describe the contents of each interactive narrative in detail correlating them with the participant’s experiences.

4.1 Rain Mode

Two participants enter an entirely dark space. Their presence is tracked by the installed kinect, which triggers a high velocity downpour of 640 agents/particles constituting the installation akin to heavy rainfall. The agents gradually reduce their speed of falling and completely cease to do so in certain locations in space. This is accompanied by a change in the color gradient of the agents (from magenta to dark blue), indicating the change in the velocity levels of the agents; from rapid downpour to stable and calm.

Figure 4: Above; Actual volumetric projection system showing the Rain Narrative. Bottom; Corresponding 3 Dimensional real-time simulation of the Rain narrative.
The main goal of the Rain mode is to convey a message to the participants that the space is filled with numerous intelligent entities. Participant reactions to this narrative, as observed by the authors involved slow movements akin to holding your palm out to feel the rain-like droplets of particles/agents (Figure 4). The artistic + technical conception of a point in this case takes the dimension of a floating particle in space and this, upon discussing with the participants was perceived by the users as digital rain/data droplets. 

As an initiation stage, the participants felt that they themselves were the trigger for the digital rain and were hence; via slow hand gestures were absorbing this experience.

4.2 Follow Mode:

Although the agents/particles constituting the installation lose their velocity during the Rain Mode, they continue to abide by the swarm behavior principles once they are triggered to move by the participant’s body movements. This is the first instance that participants provide an impulse to the agents. Each and every movement of the participant (including the slightest gestural change), create a flux in the agent field within which they are immersed. This implies influencing the nearest agent’s location by shifting their positions, because of the participant and his/her occupancy of the space within which the agent was located. The swarm logic further entails that the agent propels its movement to the nearest neighbors and thus a ripple is sent through the virtual field. Over time, the agents in space seem to follow the average movement of the participants. For instance, if both participants move to the right side, the whole point cloud of the agents would correlate to the participant’s movement direction and shift towards the right. However, if the two participants attempt to move in opposite directions, agents remain stable (Figure 5).

In addition to this, all the agent velocities are also associated with participant’s movement velocity and thus tend to speed up or slow down. The change in color gradient principle is still in play and represents a relatively high velocity state as magenta and low state as blue.

![Figure 5: 3D simulation images showing how the participants interact with the agents: while the participant is moving toward one direction, the cloud of agents would follow the same direction and modify their color according to their velocity.](image)

The target of this mode was set to provide the participants with an initial impression of responsive interaction and hence to subtly provoke physical movement in the participants. Upon interviewing the participants, we found that it took a relatively small amount of time for them to identify the linkage between their own body movement and the impact it had upon the panning of the ‘digital rain’. However, it was also observed that this realization was much more apparent for single performers rather than two performers, who, via personal/verbal negotiations of their position in space realized the direct impact of their movement on the point cloud. However, the overall experience of being able to manipulate an immersive particle field via their own body as an interface was perceived as a highly effective mode of interaction.

4.3 Spike Mode

In the “Spike Mode”, the realization of line geometry using the volumetric projection system is introduced for the first time. In this narrative, along with all the existing colored agents, pure white lines are exhibited. These lines are directly connected to the distances between the nearest agents triggered by the participant’s joints. Both hand and feet joints of their skeletons (as seen via Kinect) are specifically chosen to be the trigger points for affecting the nearest agent movements. For instance, while waving one’s hands and feet, any two agents falling within this waving path, which are triggered establish a connection depicted by a white line to be drawn between them. Because of numerous autonomous agents floating around the participants, they can freely and easily generate these flashing lines and start manipulating them once they unravel this simple logic (Figure 6).

Some characteristics of the Follow Mode, such as the panning effect and color gradations are retained in this narrative and tend to seamlessly blend with the characteristics of the Spike Mode.

![Figure 6: Above; 3D simulations showing how the participant generates line-based connections via their body joints. Below; The white line connections visualized via volumetric projection](image)

This mode allows the participants to start exploring novel body movements by negotiating their body movement in order to establish connections between the swarm of agents. The white line per se is not conceived as a hard geometric line by the participants, but is rather seen as a white colored light plane. Establishing connections between the agent swarm thus becomes an intuitive rather than a precise geometric operation for the participants.

4.4 Disturb Mode

The “Disturb Mode” is the narrative where a shift from responsive to pro-active interaction germinates. Firstly, the participants lose
the overall control over the agent movement in this narrative; the behavior of panning produced by the Follow Mode is rendered non-operational, making the participants feel that they are not able to manipulate the agents' movement by their motions anymore. Secondly, without corresponding to the participant’s body movements as constraints, all the agents begin to react independently as individual entities and start losing their energy. Because of the energy loss, the agents gradually turn transparent and become almost invisible in space. In reality, all the agents without momentum become imperceptible but acquire a state of readiness for new stimulation from the participants. By touching, pushing, swinging the invisible agents, the participants actually feed/pass the agents energy and trigger their movement again. Each participant's hands and knees become the activating nodes with a certain range of influence. This range of influence corresponds to the momentum produced by the movement of the participant’s joints. The faster the participants move, the larger the area of influence, and thus the impact on the agents is also stronger (Figure 7). Therefore, re-activating the agent’s acceleration and color gradients becomes directly correlated with the impact, which is exerted by the participant’s movement. The agents with yellow color are meant to be more active than those with a darker green color. After gaining energy to move, the active agents seek to influence other passive ones closer to their moving path based on the swarm behavior principles. Broadly speaking, the participants are passing the energy to the agents by their direct movement, but also indirectly influence the other agents according to the swarm behavior rules.

Even though the participants involved in the installation might not realize the conceptual idea of the Disturb Mode, they tend to become keen and keep trying different body postures and movements to gradually gain an understanding of the interaction between themselves and the agents. It does take time for the participants to witness the shift from reactive to interactive to pro-active mode of behavior. However, the aim of the installation was not revolving around making such behavioral shifts explicit. Considering this, the observed behavior of the participants was commendable. Participants also negotiated their position in space themselves in order to activate the agents as and when they lost energy. A mutual communication between the installation and the participants thus emerged via this mode.

Figure 7: Above; 3D simulations showing how the participant influence the agent’s behavior with their hands and knees. The sphere shapes represent the areas of influence, which increase and decrease in accordance with the rate of the participant’s movement. Below; the actual volumetric projection result in the physical environment.

Figure 8: 3D simulation showing how the agents rapidly move towards the participant in the “Attract Mode”.

Figure 9: Above; the 3D simulation showing how the participant starts playing with the attracting agents with the virtual polygon constructed by their hands and one foot position in 3d space. Below; A captured moment, where the participants interact with the colored agents while the simulation driven white polygonal geometry connects with their hands and feet positions.

4.5 **Attract Mode:**

After evoking most part of the agents, all of a sudden the agents with embodied motion move rapidly towards the participants without providing them with any hints. Only the agent’s color switches to a relatively aggressive yellow and red gradient to inform the participants about this behavioral change (Figure 8). The first striking impression from the participants’ point of view is...
that the agents tend to become keen to attack them as targets and thus the participants attempt to escape this forceful embrace. Subsequently, the participants notice that these active agents are attracted towards virtual polygonal geometries created in the simulations by geometrically connecting their hands and feet. Over a period of time, these virtual polygons unknowingly produced by both participants also appear in white along with other colored agents to give the participant a clearer picture of this mode. Once the participants have the idea of how the narrative unfolds, they instinctively play with the agents by making strange but interesting movements, such as changing moving direction rapidly, jumping up and down radically, and curling or stretching bodies oddly (Figure 9). Unlike the parallel/average movement between participants and agents in the "Follow Mode", agents in the "Attract Mode" act aggressively. The beautiful mixing of colors; yellow and red by the volumetric light projection strongly suggests the participants to constantly wonder, move, expand and contract their bodies. The "Attract Mode" plays an important role in the installation by keeping the curiosity levels and engagement levels of the participants via its strong persuasive quality.

**Figure 10:** 3D simulations showing the generation of Nurbs in space. The big green dots represent the densest spots in the aggregation of agents, which gives rise to the green spline construction connecting them.

### 4.6 Nurbs Mode:

In the "Nurbs Mode", the participants are allowed to push, wave, and touch the agents similar to the Disturb Mode. In addition to this, a continuous transforming nurbs (spline-line) is materialized based on the agent aggregation based density in space. On an average, ten spots coinciding with ten densest locations of the agents in space are selected as determined control points to construct the nurbs. Since the agent densities can be impacted directly by the participant’s influential movement through space and time, the nurbs geometry fluidly morphs from one to another shape accordingly (Figure 10). Within the constrained projection angles, the volumetric projections appear as highly interesting curvilinear light cone shapes in space, which rarely exists in one's daily experience. After few minutes of this relatively contemplative "Nurbs Mode", the "Attract Mode" is introduced back again and operates simultaneously with the "Nurbs Mode" in order to give the participants a stronger sensory impetus to manipulate the spatial Nurbs with their body movement. The "Attract Mode" is switched off during the last few minutes of this narrative, and only focuses on the Nurbs and the agents in space to give the participants a little more time to enjoy this special spatial experience. In addition, this calming down, also results in a smooth transition to the next narrative. Observational analysis of the participants suggests unpredictable but interesting movements which unfold during this narrative. Movements depicting the desire to touch the light beam generating the Nurbs with one’s hands, inserting one’s head inside the light cone created between two light beams, or moving their bodies along the boundary of the Nurbs (Figure 11) are some representative examples. Overall a highly engaging environment, which encourages a bi-directional communication between the installation and its participants, is thus generated in this mode.

**Figure 11:** Image showing the exact environmental atmosphere of the "Nurbs Mode".

### 4.7 Rain-Up Mode:

Before the "Rain-up Mode", the "Follow Mode" is exhibited again to gently inform the participants that the experiential installation is nearly towards the end. After a few minutes of "Follow Mode", the participants entirely lose their control over all the agent movements and can only witness the agents flying back up to the sky. All the agents will fly up with high velocity and gradually slow down and cease in a certain location in space. In terms of color, all the agents start with magenta representing higher speed and become dark blue corresponding to the velocity each agent embodies. Towards the end, all the agents lose their momentum, turn transparent and tend to fully disappear. Hence, the whole space returns back into an entirely dark state awaiting the next group of participants to engage with. It was seen that the participants, upon witnessing the rain-up mode, automatically felt that the interaction time frame was coming to its conclusion and thus tend to be more static or rather in an observational state.

### 5 General Technical Interpretation:

The agent-based simulation was created using an open-source programming language, Processing, developed by Ben Fry and Casey Reas since 2001 [2]. It is mainly designed for graphic designers, architects and interactive artists to develop a range of 2-Dimensional and 3-Dimensional visual graphics. Hardware wise, the motion tracking system in Ambiguous Topology is set up by
utilizing the Microsoft Kinect device, and correlated with SimpleOpenNi which is a motion tracking library of Processing. In this installation, only one Kinect device was utilized to process the motion tracking. All computational processes were calculated and simulated in Processing 3-Dimensionally based on swarm behavior principles which, were directly networked with skeleton tracking based data from Kinect. During the computational process, Processing simultaneously transmits the required data to the platform set up in Max/MSP though OSC (Open Sound Control) protocol. By establishing a communication protocol between Processing and Max/MSP, the X-Y-Z coordination of each swarm agent’s location can be synchronized with the projection system to realize the 3-Dimensional geometries in space using the aforementioned volumetric projection principles. Furthermore, after receiving the input data from Processing, the Max/MSP patches are able to adequately implement it with the render mode for the HD projectors (Figure 12).

During the interaction process, novel movements, group dynamics and gestural novelty came to the fore. The team was thus able to engage sophisticated examples of digitally controlled, interactive projection systems. However, unlike these projects, which, project on 2d surfaces, a vital angle to Ambiguous Topology is its spatiality factor. As Xenakis, Granular Synthesis and related have shown, electronic media can expand into space. It can define space. In doing so, it can connect with the whole body instead of just the eyes and ears. Yet the majority of digital media remains stuck in a 2-dimensional screen and speaker paradigm. Projection mapping aims at escaping from the projection surface but never truly achieves it, no matter how slick the production. Spatiality holds another promise for digital media: to ‘extract the interaction from the locked-in, impenetrable virtual space to the human-scale physical space’ [5]. While digital tools allow for highly dimensional generative processes for unheard and unseen media creation, the majority of interfaces remain 1-dimensional (sliders, buttons) or at best 2-dimensional (XY-pads, MIDI notes). What if those processes are expanded into physical space and sculpted, molded, grabbed and pushed around by the full range of human motoric capabilities?

This shift opens up countless interaction channels to the performer and at the same time lets the audience get a view at the connected mental and bodily processes involved in live performance. Electronic media performance could be read at the bodily level, just like acoustic instrument performance, which cannot be said from laptop performances and similar. Ambiguous Topology presented a perfect opportunity for the team to experiment with the spatial aspect at an intricate level. This immersive/interactive environmental experience, gave the participants opportunities to introspect, engage, influence and explore their perception and inner creative instincts in an engaging experience.

6 CONCLUSION:

Ambiguous Topology is an innovative experiment conducted under an ongoing EU research project called METABODY. The installation tends to challenge conventional modes of perceiving space as a dormant object and abolishes the subject-object relationship, which has long been associated with it. Space, in this case, acquires a pro-active character and most importantly is built up via a non-tangible entity: Light. The installation also physiologically and psychologically appeals and instigates our regulated behavioral selves resulting in the generation of novel reactions and interactions. Ambiguous TopologyThus attempts to create a fully transformable topology composed of numerous autonomous agents to achieve a unique e-motive spatial environment. Different geometric instances of the fluid environmental topology are generated via the interplay between the participants and the conceived system, and are materialized via the immersive light projection (volumetric projection) system as a meta-narrative. As a result, an intimate relationship between the overall environment and participants naturally appears during the experiential phase. Meanwhile, an information feedback loop is at play, which binds the physical interactions of the participants, with soft simulation and computation processes to ultimately impact and influence the participants' behavior in real-time. During the interaction process, novel movements, group dynamics and gestural novelty came to the fore. The team was thus able to address an individual's innate bodily and mental experiences.

Contemporary projects like Pathfinder [8], Seven Senses [9] and Hakanai [6] engage sophisticated examples of digitally

REFERENCES
[9] Seven Senses by Anarchy Dance Theater (https://www.youtube.com/watch?v=iiQIDEPLPpyQ)