Spatial Reliefs: Cross-Scale Space-Scapes

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Abstract

Conceived as a peaceful and playful exploration of interstellar space, this augmented reality and sound installation invites the audience to access the experiential dimension of space technologies and how the huge amount of data derived from space exploration can be accessed, appropriated, integrated into the artist's poetics and experienced by the audience. The audience is invited to walk through a softly illuminated room where a few transparent cables come from the ceiling having small augmented reality markers in their extremities. Holding an iPad mini while exploring the space, one will find him/herself immersed in a soundscape populated with 3D models derived from actual micro scale images. The 3D models were generated via parametric design strategies from NASA's Stardust Discovery-class mission's database images of aerogel samples which have captured cosmic dust particles. The soundscape, or the soundtrack for navigating this Augmented Reality interstellar space, is a composition using a combination of sounds derived from images of identified stardust particles in nano scale from the same NASA mission. The installation is a tribute to Hélio Oiticica's radical series of red and yellow 'Spatial Reliefs' (1960).

1 Introduction

NASA's Stardust Discovery-class mission's spacecraft—a 300 kilogram robotic space probe—was launched aboard a Delta 2 rocket from Cape Canaveral Air Station, Florida, on February 7, 1999, flying through the cloud of dust that surrounds the nucleus of the comet *Wild 2*. The implementation plan was adapted to the schedule defined by finding a trajectory that would allow the comet to fly by the spacecraft at a relatively slow 6 km/sec. According to the NASA's scientists, "This would enable the capture of comet dust within aerogel. Successful particle capture up to 10 km/sec has been demonstrated at JPL. Capturing particles intact at this hypervelocity (about 6 times the speed of a rifle bullet) is a pretty incredible feat" [7]. En route to *Wild 2*, the craft also flew by the asteroid *5535 Annefrank*.

The spacecraft also collected interstellar dust from a flow of particles that passes through the solar system from interstellar space and was the first sample return mission of its kind, bringing cometary material back to Earth for the first time ever. The main intention in bringing this material to Earth was to investigate the composition of the collected stardust particles to determine the history, chemistry, physics and mineralogy of what we consider as nature's fundamental building blocks. The mission was effectively completed on January 15, 2006, when the sample return capsule returned to Earth.

Comets are considered to be the oldest and most primitive bodies in the solar system, a preserved record of the original nebula that formed the Sun and the planets. Additionally, comets are rich in organic material which potentially provided our planet with many of the molecules that could give origin to life. Recently, researchers from the University of North Carolina have shed new light on the evolution from building blocks into life some 4 billion years ago. According to the findings from Wolfenden et al. [12], there is a chance that, together with the primordial soup of amino acids, cosmic chemicals facilitated the emergence of the RNA molecule, giving rise first to short proteins called peptides, and then to single-celled organisms. In a paper published in the Proceedings of the National Academy of Sciences, they argue that RNA did not work alone and in fact, it was no more likely that RNA catalyzed peptide formation than it was for peptides to catalyze RNA formation.

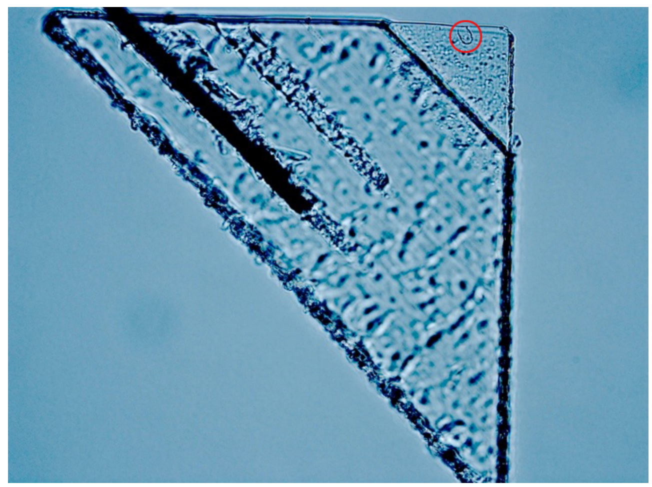

Figure 1: Interstellar dust track found in the Stardust aerogel collectors. Credits: UC Berkeley/Andrew Westphal [11].

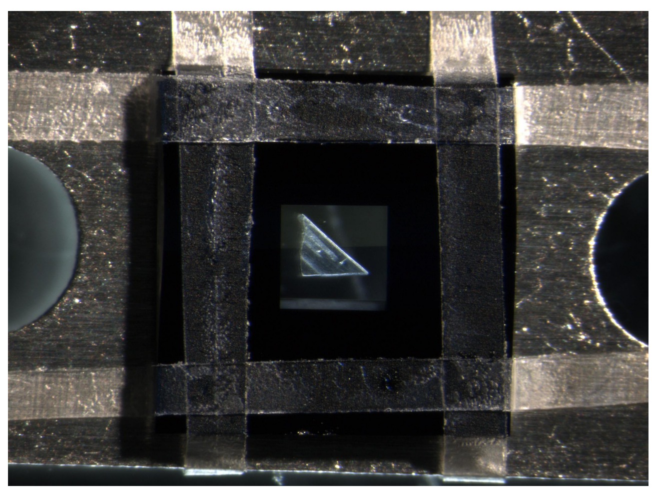

Figure 2: Aerogel fragment, Sample Number I1075,1,25,0,0. Source: NASA's Stardust Sample Catalog Database [2].

Including NASA's Stardust Mission database material into its poetics, *Interstellar: Cross-scale Space-scapes*, installed for the first time at ISEA 2017 in Manizales, Colombia, was conceived as an

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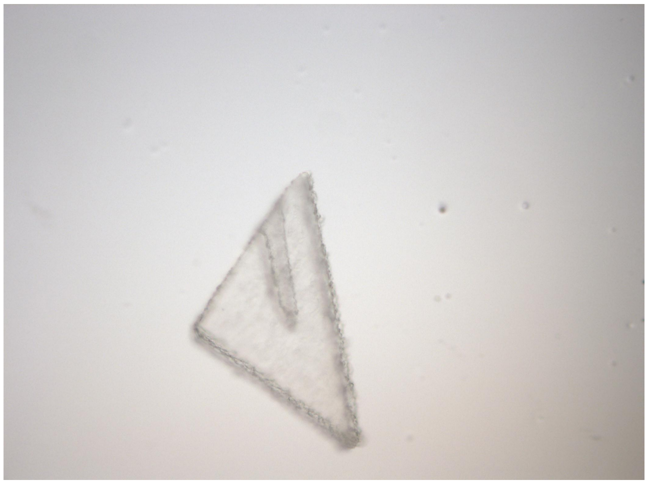

Figure 3: Aerogel fragment, Sample Number I1004,1,2,0,0, selected from NASA's Stardust Sample Catalog Database [2] to generate the one of the eleven 3D models.

invitation to reflect on the strategies we use to access the experiential dimension of space technologies and how the huge amount of data derived from space exploration can be accessed, appropriated, and integrated into the artist's poetics and experienced by the audience.

The work explores the idea of 'recombinant poetics' as proposed by Bill Seaman. Seaman initially (1995) called Recombinant Poetics, approaches in media arts that comprised a specific set of criteria in terms of generative virtual worlds. He had extended this definition to a larger class of generative works exploring differing media and their concomitant qualities. For Seaman, "Just as in a molecule, the combination of media-elements takes on a life and qualities of its own through intermingling—the participant conceptually projects meaning across the entirety of the ongoing experience" [9].

In *Interstellar*, holding an iPad mini while exploring the space of the installation, one will find him/herself immersed in a soundscape populated with 3D models using Augmented Reality (AR). For the version installed in Manizales, the application *Augment* that was used had a free academic license and could be downloaded by the audience from their smartphones' application online stores, allowing a collective and simultaneous exploration of the installation. The models were derived from actual micro scale images from NASA's mission database.

In a reference to Hélio Oiticica's radical series of red and yellow 'Spatial Reliefs' (1960) [3] and at the same time an extrapolation from its original intent, in *Interstellar* the audience is invited to freely play with the eleven 3D models using the *Augment* platform for AR. Similarly to Oiticica's suspended wooden sculptures, the 3D models are virtually floating in the space. The subversion in relation to Oiticica's intention is that the artists in *Interstellar* give the audience the freedom to create compositions that use visual elements and a color palette derived from Kazimir Malevich's 1915 painting 'Suprematism' [6]. Malevich is a primordial reference to Hélio Oiticica's aesthetical and conceptual explorations; his influence sometimes is sometimes explicit, as in the work 'B22 Glass Bólide 10 Homage to Malevich Gemini 1, 1965.' In *Interstellar*, our intention extrapolates the fixed structures that we see in 'Spatial Reliefs', and the colorful 3D volumes can emerge from the markers and be freely customized by the audience—rotating, scaling, and positioning in superposition to the actual space. The virtual presence of the 3D sculptures involves the body in augmented reality conversations deeply entangled with individual and collective spatial visualization and perceptual experience.

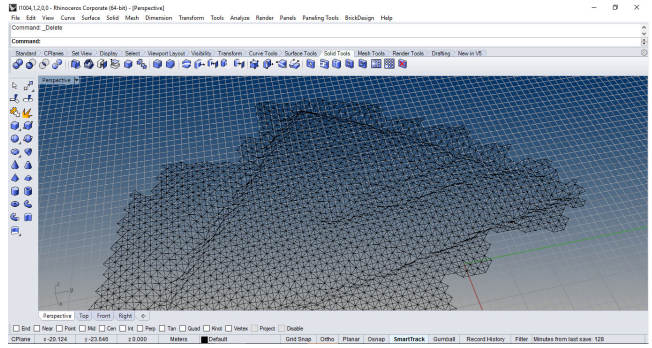

Figure 4: Complex mesh generated from the Sample Number I1004,1,2,0,0, selected from NASA's Stardust Sample Catalog Database [2] to generate the one of the eleven 3D.

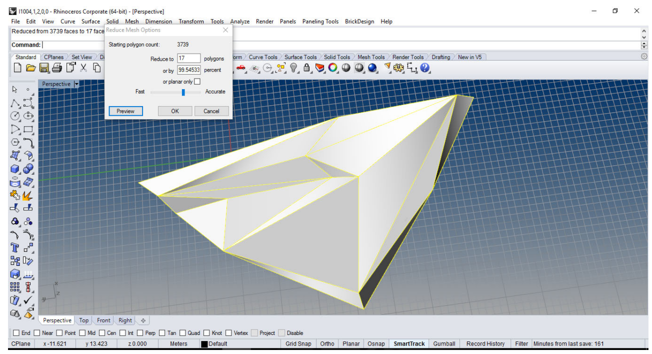

Figure 5: Mesh reduced to 17 polygons in *Rhino 5.0.* Image by the author.

2 Stardust at Home: Navigating the Database

According to a report written by a team of scientists from all around the world [4], seven particles captured by the Stardust collector and submitted to the laboratory analysis have features consistent with an origin in the contemporary interstellar dust stream. These fragments of cosmic dust were encapsulated in aerogel tiles and covering the surface of aluminum foil sat for nearly 200 days in space before returning to Earth. According to the scientists, the interstellar dust candidates can be distinguished from fragment impacts on the basis of elemental composition and/or impact trajectory.

To become familiar with the process, one of the artists tested her abilities in identifying candidate particles' tracks in aerogel fragments and passed the test. The test was developed by the project 'Stardust at home'—a citizen science project created by a small team based at the University of California-Berkeley Space Sciences Laboratory. The intention in developing the online test was to ask for help from talented volunteers all over the world to make it possible to search and find candidate particles in a lot less time than it would take a handful of scientists and lab technicians to do alone. To find the tiny particles in the aerogel collectors, they use an automated scanning microscope to automatically collect digital images of the entire Stardust interstellar collector. The team calls these 'stacks' of images 'focus movies'. Nearly a million of them are available online for volunteers at Stardust@home [10]. The focus movies can be viewed with the aid of a special Virtual Microscope (VM). According to the team, in recognition of the critical importance of the Stardust@home volunteers, the discoverer of an interstellar dust particle appears as a co-author on any scientific paper by the Stardust@home team announcing the discovery of the particle and the discoverer has the privilege of naming the particle.

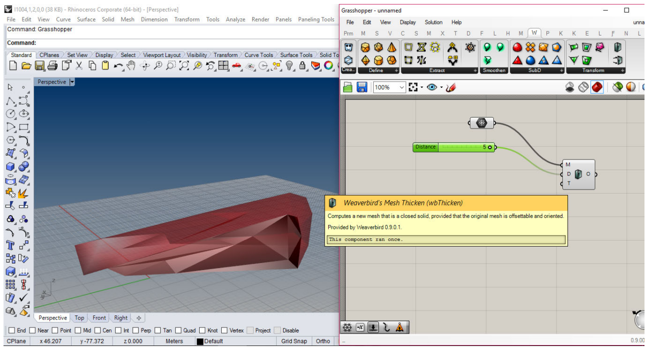

Figure 6: Script in *Grasshopper* using the add-on *Weaverbird*. Image by the author.

According to Westphal et al. [11], the largest interstellar dust track found in the Stardust aerogel collectors' fragments (Figure 1) was a 35 micron-long hole (red circle in Figure 1) produced by a 3 picogram speck of dust that was probably traveling so fast that it vaporized upon impact.

Accessing the NASA's 'Stardust Sample Catalog Database' [2] the artists selected a total of 11 microscopic images Aerogel fragments that captured potential stardust particles and 3 images of already identified and catalogued stardust particles from the total of 7. After selecting these images, each one (Figure 3) was converted into a triangular mesh using the online platform *Embossify* (Figure 4) and imported to *Rhino 5.0*, where the complexity of the mesh was reduced to between 11 to 17 triangles (Figure 5). A script in *Grasshopper* using the add-on *Weaverbird* (Figure 6) was designed to model the resultant simplified mesh into a 3D geometrically complex solid. Color was applied in Rhino 5.0 using a color palette from one of Kazimir Malevich's 1915 paintings (Figure 7). The final objects were exported together with these rendering parameters as an .obj file, and then uploaded to the Augmented online AR platform. There they were linked to markers produced by the artist using a process that combines hand drawing and ink painting with digital art, using references such as the southern hemisphere nebulae and other cosmological structures.

3 Sonification: Pixel as Raw Data

The soundscape, or the soundtrack for navigating this augmented reality interstellar space, is a composition using a combination of sounds derived from images of identified stardust particles in nano scale from NASA Stardust mission's database. We selected 3 images out of a total of 7 collected particles that were previously identified as originating from interstellar space, and adjusted the resolution of each image to 500dpi, using Audacity to import the pixels as rawdata for sonification. Each image represents a track in the final composition: Particle C2054,9,35,0,0 is integrally used, fragments of particle C2005,2,121,0 was used in several selected fragments that were repeated along the timeline. Particle FC6,0,10,0,0 was integrally used as a noisy continuous pattern in the resultant composition (Figure 9).

Duration and speed were edited differently for each track and the entire process was intended not to change the original data structure valuing the perception of the original source. We follow Thomas Hermann's definition for sonification and auditory display, which emphasizes the necessary and sufficient conditions for organized sound to be called sonification. According to Hermann, a technique that uses data as input to generate sound signals may be called sonification if and only if:

> "(C1) The sound reflects objective properties or relations in the input data. (C2) The transformation is systematic. This means that there is a precise definition provided of how the data (and optional interactions) cause the sound to change. (C3) The sonification is reproducible: given the same data and identical interactions (or triggers) the resulting sound has to be structurally identical. (C4) The system can intentionally be used with different data, and also be used in repetition with the same data" [5].

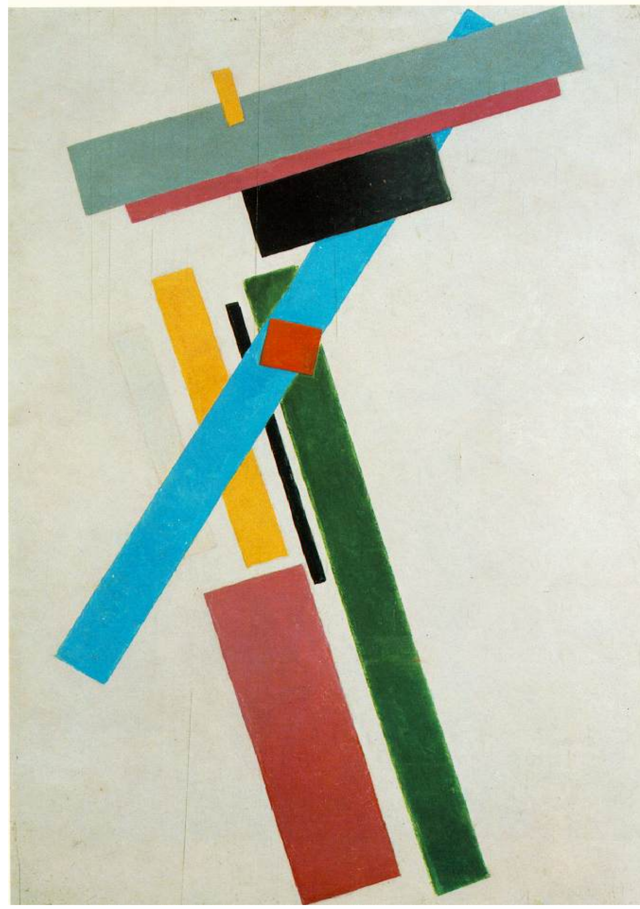

Figure 7: Kazimir Malevich's 1915 painting 'Suprematism' [6] from which the color palette for the 11 3D models generated from aerogel samples was derived.

4 Interstellar (2017)

In the installation, as it was setup for ISEA 2017 in Manizales, Colombia [8], the audience is invited to walk through a softly illuminated room where a few transparent cables come from the ceiling, having small augmented reality markers in their extremities. Using an iPad Mini, the audience was invited to scan the markers using the online application for AR Augmented [1] to bring the 3D models to the actual space (Figures 10 and 11).

Using the AR application, the 3D models were linked to markers produced by the artist via a process that combines hand drawing and ink painting with digital art using references such as nebulae and other cosmic structures (Figure 11).

5 Final Considerations

The relation with Hélio Oiticica's series 'Spatial Reliefs' (Figure 12) opens up the possibilities of aesthetic explorations by the audience instinctively involving the body in the last step in the construction of an emergent or recombinant poetics [9].

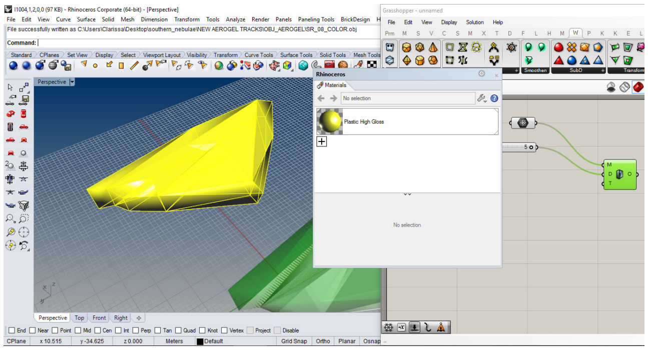

Figure 8: Final 3D objects ready to be exported together with its rendering parameters in *Rhino 5.0*. Image by the author.

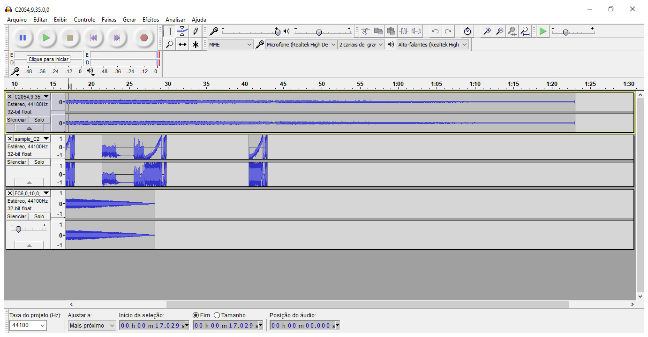

Figure 9: Screenshot showing the 3 layers of audio tracks derived from stardust particles' data. Image by the author.

The data appropriation and translation reaches a different stage where the plastic qualities of the experience and the resultant visualizations (3d models and sound) assume a central role. The poetics of the piece reaches an extreme amplification in relation to Oiticica's series—the production of possible compositions by the audience is endless.

More than enabling the audience to interact with an artwork that is essentially open, in Interstellar the audience can assume the role of a curator, exploring combinatorial possibilities (Figures 14 and 15) and scenarios, mixing the real and the body with data visualization transposed into an aesthetic exercise. In Interstellar, the principles that guided the Brazilian Neo-concrete movement are exaggerated, expanded and virtualized—relational objects in an endless space superposed, interlaced, and viscerally entangled with the 'actual' space through the camera apparatus, inviting infinite unfolding.

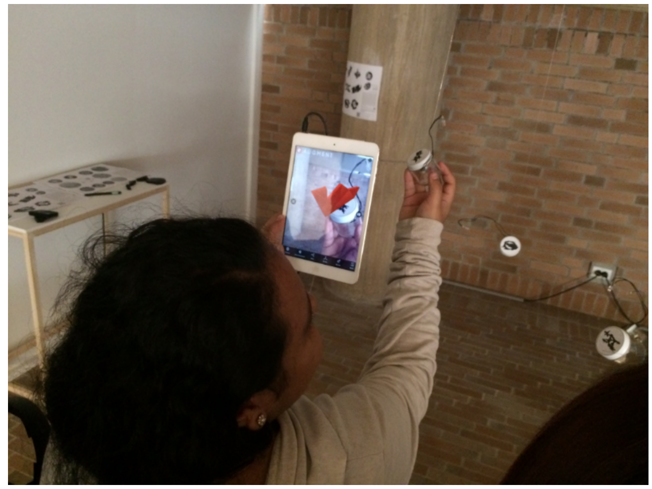

Figure 10: Scanning a marker with using the application Augmented installed in an iPad mini. ISEA 2017, Manizales, Colombia. Image by the author.

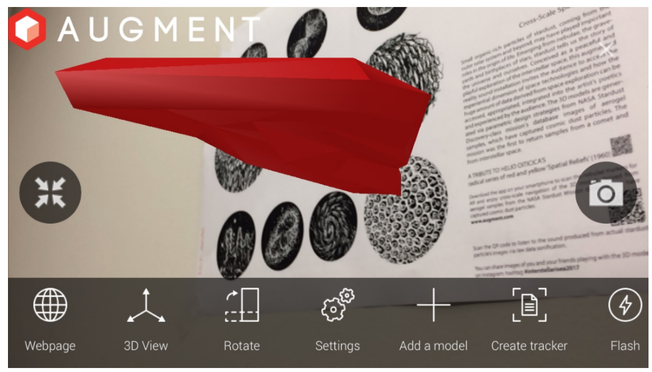

Figure 11: Scanning a marker with using the application Augmented installed in an iPad mini. ISEA 2017, Manizales, Colombia. Image by the author.

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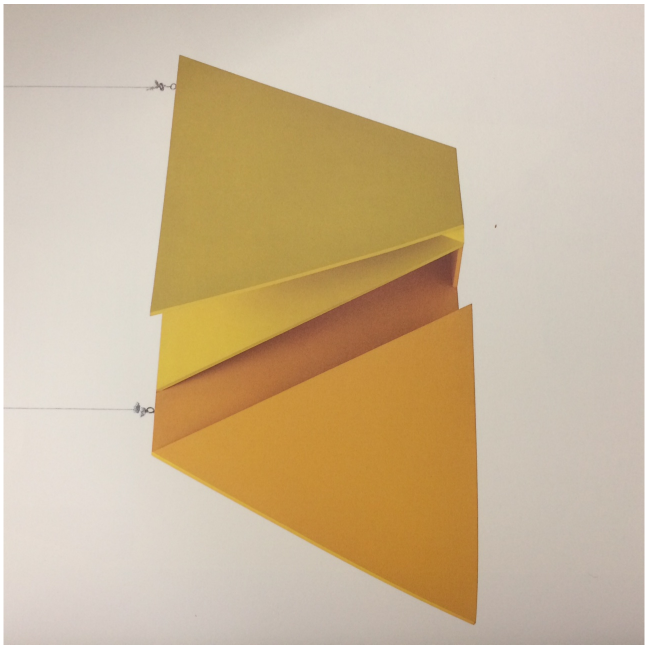

Figure 12: Hélio Oitica's Spatial Relief (1959) Ricardo Rego Collection, UNIFOR exhibition catalogue p. 79 [3].

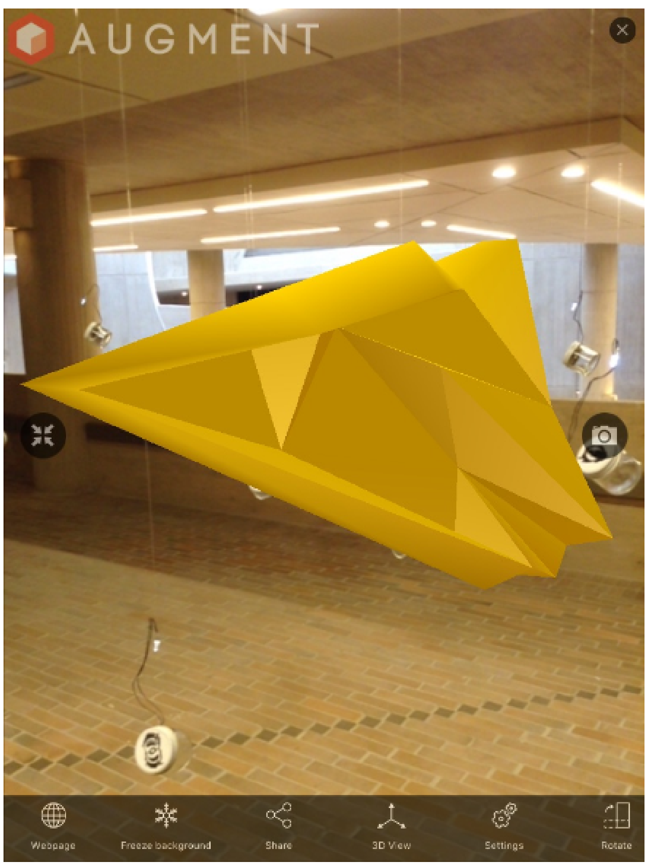

Figure 13: Interstellar: 3D model floating in the space of the collective exhibition, CCU Rogellio Salmona, ISEA 2017, Colombia. Image by the author.

Figure 14: Audience playing with the 3D models in AR. In the picture: Esteban Garcia. Collective exhibition. ISEA 2017, CCU Rogellio Salmona, Manizales, Colombia. Image by the author.

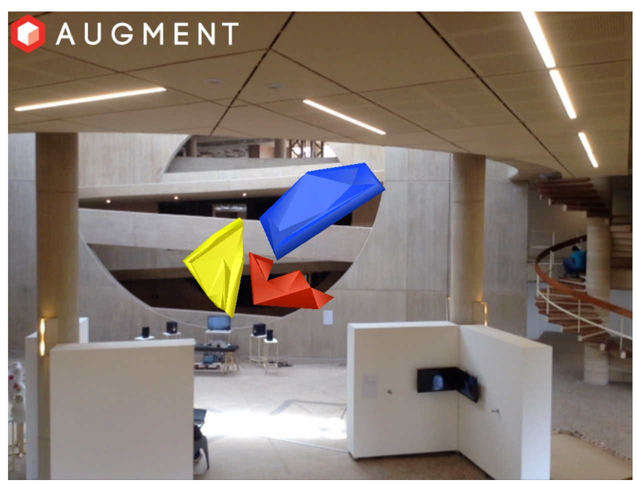

Figure 15: Interstellar: 3D model floating in the space of the collective exhibition. ISEA 2017, CCU Rogellio Salmona, Manizales, Colombia. Image by the author.