



Solar Equation

by Rafael Lozano-Hemmer

A public art installation featuring an animated three-dimensional maquette of the Sun.

Premiered at the "Light in Winter" Festival
Federation Square, Melbourne, Australia
June 4 to July 4, 2010

SOLAR EQUATION CONCEPT

An animated three-dimensional maquette of the Sun, visible at night, hovers over Federation Square, creating an uncanny and spectacular urban landmark.

Solar Equation is a large-scale public art installation that consists of a faithful simulation of the Sun, 100 million times smaller than the real thing. Commissioned by the Light in Winter Festival in Melbourne, the piece features the world's largest captive balloon, custom-manufactured for the project, which is tethered over Federation Square and animated using five projectors.

The solar animation on the balloon is generated by live mathematical equations that simulate the turbulence, flares and sunspots that can be seen on the surface of the Sun. This produces a constantly changing display that never repeats itself, giving viewers a glimpse of the majestic phenomena that are observable at the solar surface and that only relatively recent advances in astronomy have discovered. The project uses the latest SOHO and SDO solar observatory imaging available from NASA, overlaid with live animations derived from Navier-Stokes, reaction diffusion, perlin and fractal flame equations.

Using an iPhone, iPod touch or iPad, people may disturb the animations in real-time and select different fluid dynamic visualizations.

While pertinent environmental questions of global warming, drought, or UV radiation might arise from the contemplation of this piece, Solar Equation intends to likewise evoke romantic environments of ephemerality, mystery and paradox, such as those from Blake or Goethe. Every culture has a unique set of solar mythologies and this project seeks to be a platform for both the expression of traditional symbolism and the emergence of new stories. Just like the installation depends on the world's brightest projectors to exist, conceptually the piece is open for the public to make their own symbolic projection and interpretation.

Some might experience the work as a traditional son-et-lumiere spectacle, other as a didactic visualization of natural forces, while others as a call to action to harness the sustainability of solar power. Coincidentally, the sun's generates its own energy by nuclear fusion of hydrogen nuclei into helium, the inert gas that is used to fly the maquette.

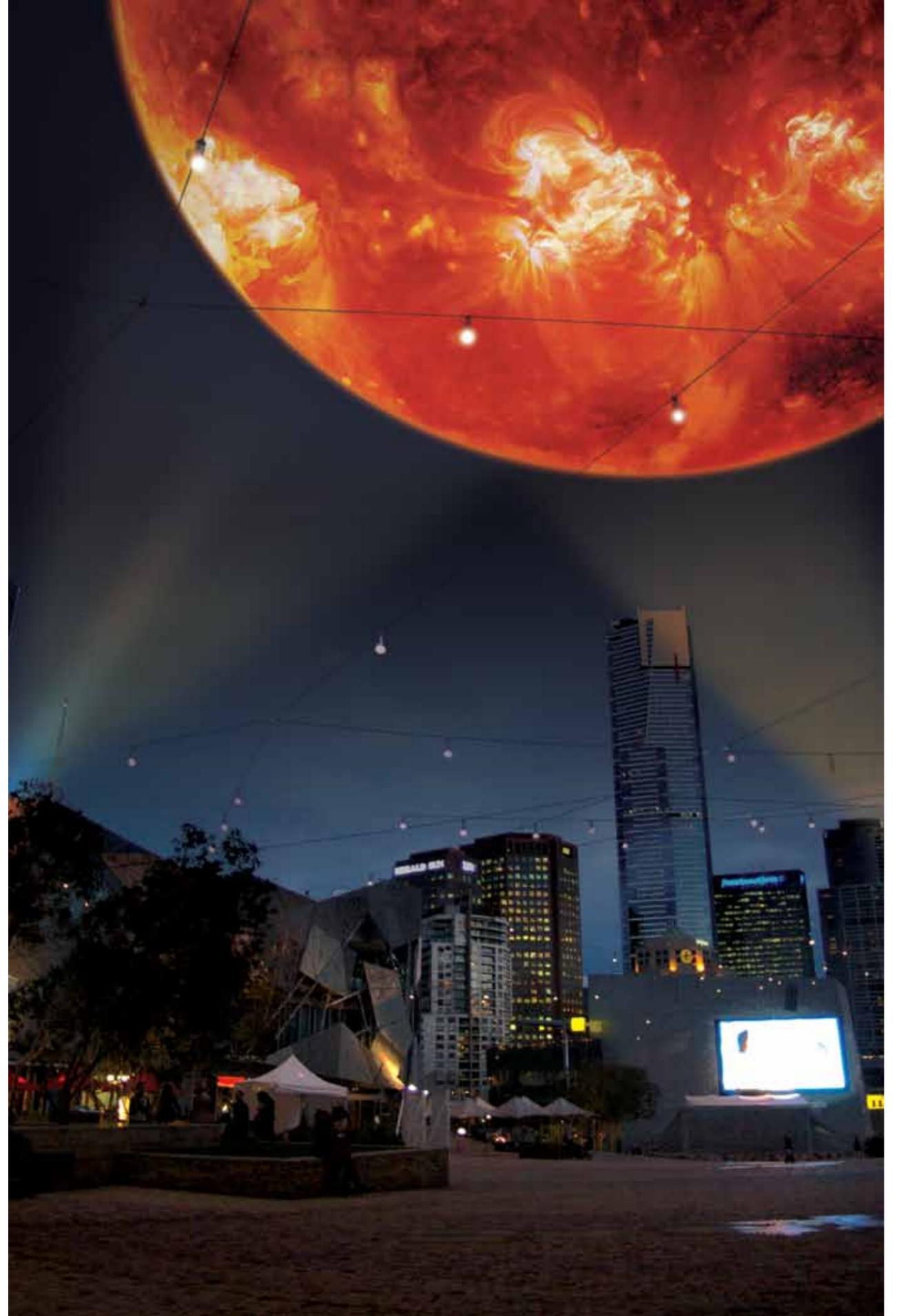
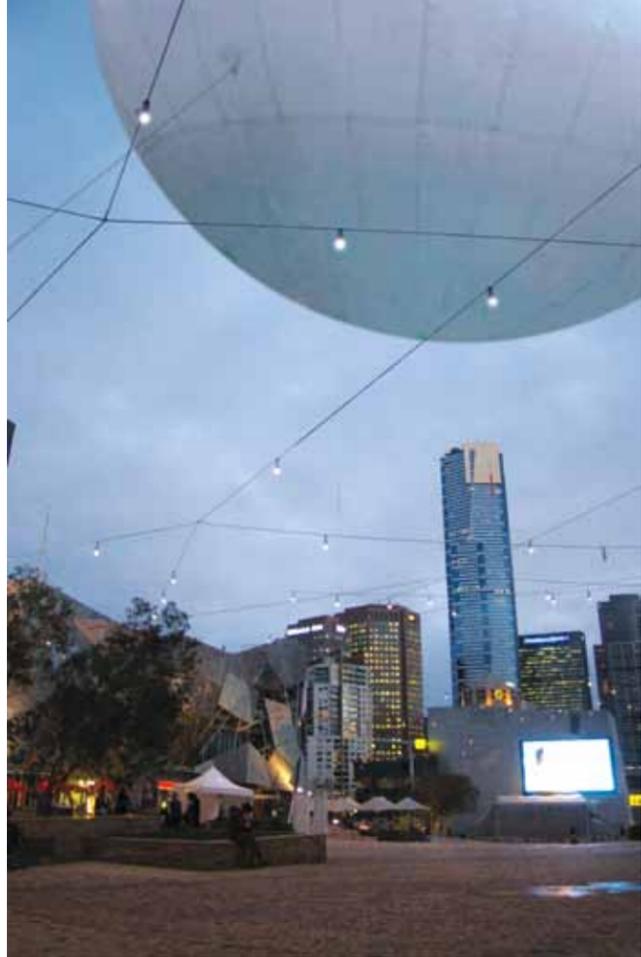




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SITE FOR WORLD PREMIERE

Placement

The site for the installation premiere is between the Australian Centre for the Moving Image and the Australian Racing Museum. The balloon is tethered so that it is 20 meters above the ground, which is already a higher location from the vantage point of the lower side of the slanted square, the busy Swanston Street. The piece can be seen from trains arriving into Flinders Street station, from the Southbank across the river, and from downtown Melbourne.

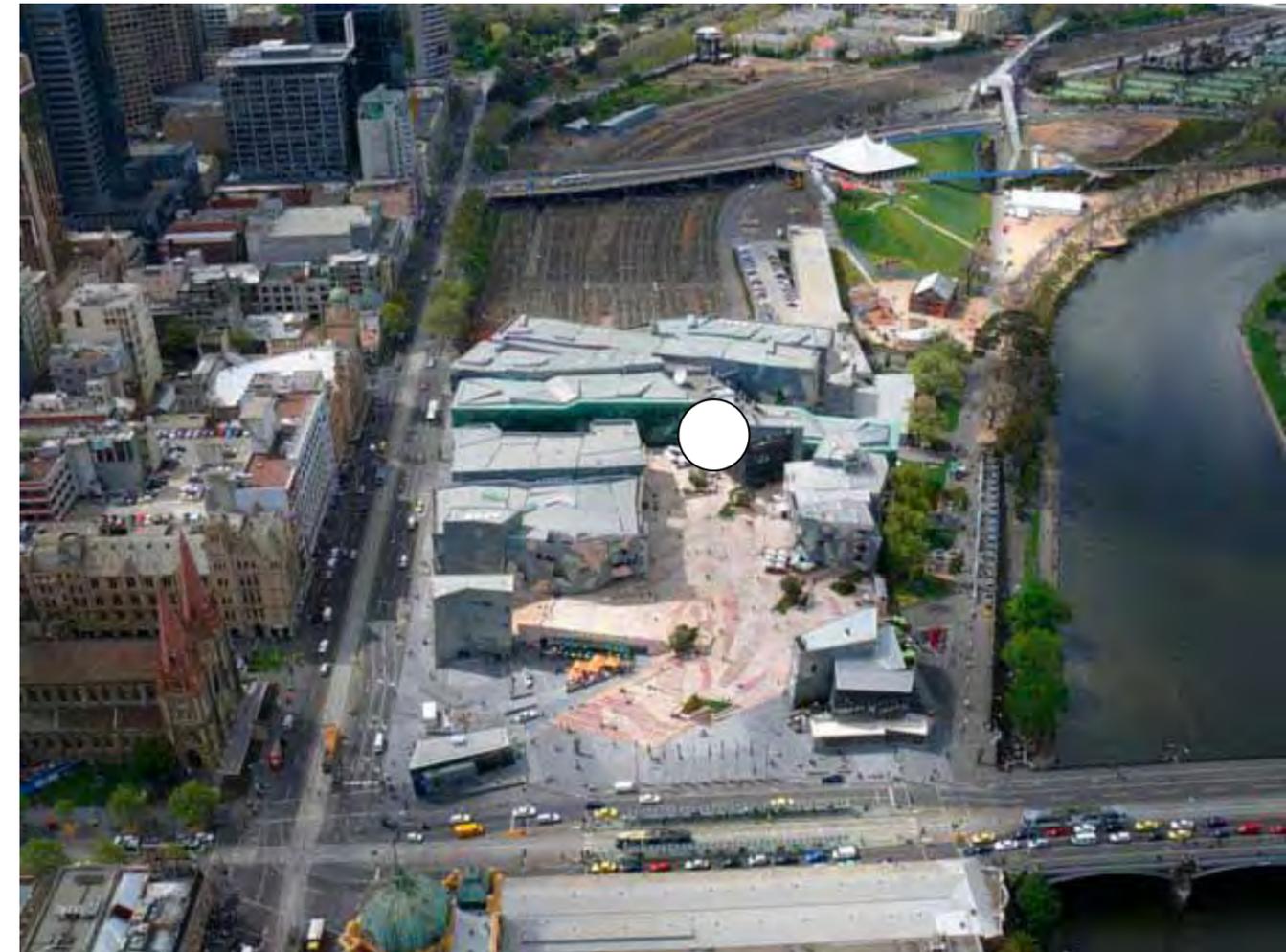
The tethering happens from the surrounding rooftops of all the buildings in Federation Square. The metal guy wires hold the balloon in place with only a couple of metres of sway, mostly vertical. For safety a few of the existing lighting catenaries are temporarily removed to eliminate the possibility of entanglement but also to avoid blocking some of the projection. Tethering is done with a proper engineering study that considers the wind drag, which withstands the record 90 kph gusts.

Design

The design specification of the installation itself is to have the minimum visual impact and encumbrance at ground level during the day or night. People are completely free to promenade in the square and all normal functions are not affected (shopping, concerts, pedestrian traffic, etc). The projectors, control computers, air pumps and tethers are all located far from the reach of potential vandals and are designed to withstand all weather conditions.

The solar maquette illuminates the square with 110,000 ANSI lumens of reflected projection. While this brightness is in itself a projection achievement only possible with the latest and most powerful projectors in the world, the size of the aerostat, the loss of brightness from tracking (explained below) and the urban environment's existing light levels all contribute to making the piece a calm, pleasant sight, as opposed to an aggressive assault on the senses.

The sound component of the piece is a live channel of rumbles, crackles and bursts. The sound is generated by a computer and, like the visuals, is not a prerecorded loop but a software simulation of solar activity. The sounds come from very directional speakers and are heard faintly under the maquette, at a volume that is decided upon with the community and stakeholders.



TECHNOLOGY

Aerostat

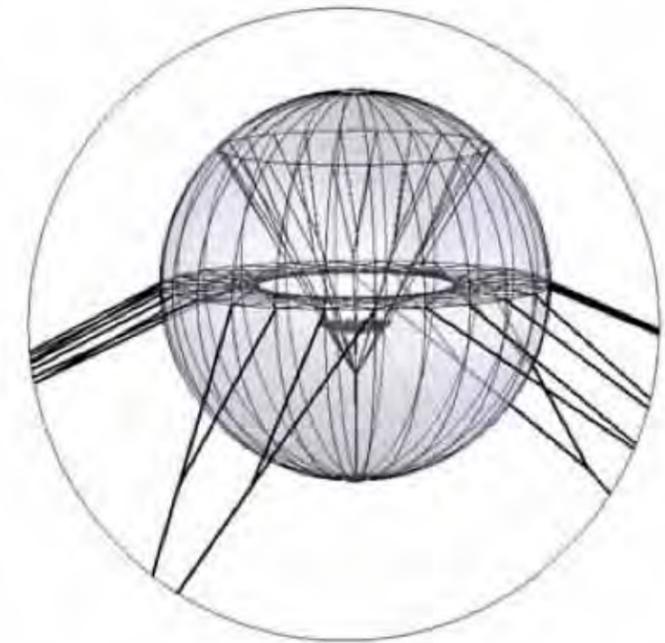
Solar Equation uses a 14 m diameter tethered aerostat custom-manufactured by Airstar Space Lighting, a french company whose balloons, airships and aerostats are available through a network of 120 distributors and 13 subsidiaries in more than 40 countries. They designed and engineered a specific solution for Solar Equation which has all necessary civil engineer certifications and insurance.

To give an idea of the existing technology, Airstar makes the 10 m diameter Solarc 1000 48000W daylight balloon (this contains 12 HMI lamps to illuminate special events and which are not necessary for Solar Equation). The balloon requires 6 radial rigging points out of which 4 are 1,200 Kg winches and 2 are 1,000 Kg static rigging, like sandbags. In addition a “locker” central rigging point is used with 1,000 Kg pull. This fixture is routinely used for sports events, entertainment industry lighting and special events, and it is set-up and inflated in two days.

A priori the aerostat for Solar Equation has a 1450 cubic metre volume, out of which around 600 cubic metres are Helium (which needs to be topped-up daily through a small permanent hose, around 6% per day). The envelope of the aerostat is waterproof and matte white to prepare it for projection.

Tracking system

The balloon sways and bobs slightly, —this is one of the reasons balloons are not used as projection surfaces more often. However, Lozano-Hemmer’s engineering team at Antimodular developed a 3D tracking system that determines the position and orientation of the balloon 30 times a second; this information is then be fed into the media servers so that they can correct in real-time the misalignments created by the motion. The result is a match between image and surface never before seen.



Graphics projection

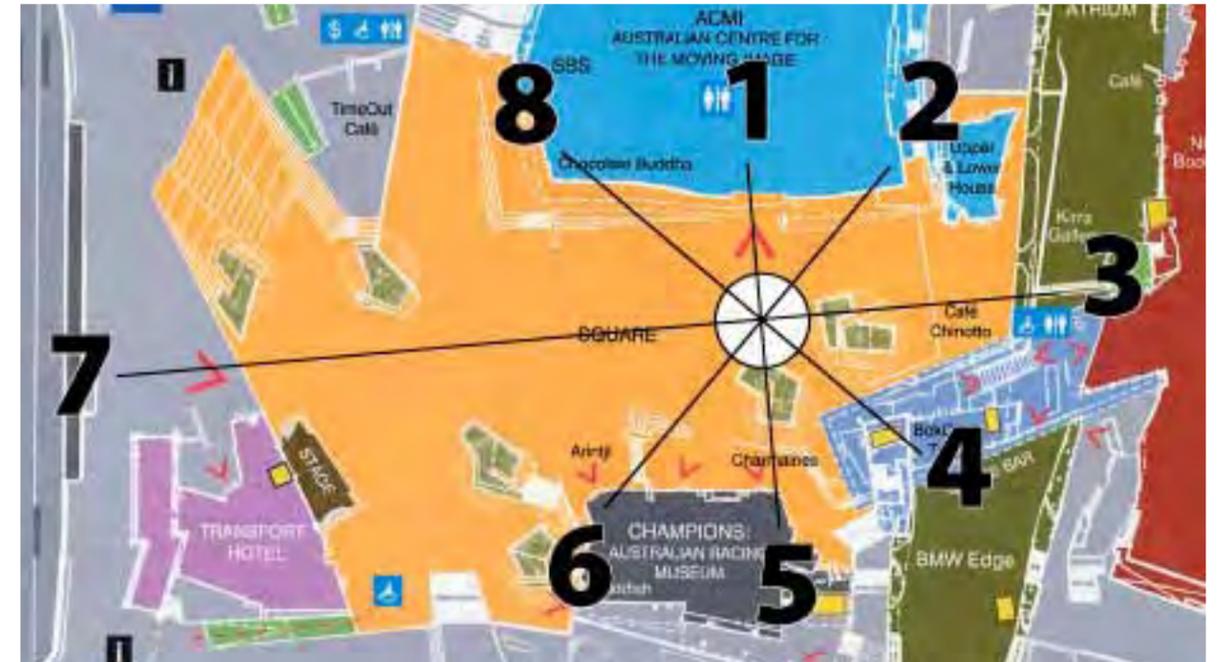
The piece uses 5 high definition 1920x1080-pixel wide-angle 30,000 lumen projectors from Christie, Digital Projection or Barco. Four of these are placed orthogonally along lines 2, 4, 6 and 8 in the diagram to the right at roof level. The fifth projector is directly under the balloon in a custom-enclosure with a mirror. All projectors overshoot the surface of the balloon to allow the 3D tracking software to compensate for motion. However, the overshoot is digitally masked in real-time so that no animation is spilled onto the surrounding buildings. The 5 projectors are connected to media servers which will be synchronized using a wired network and provide a seamless 3D image using OpenGL deformations and alpha blending.

Mathematics

The entire imagery is generated by well-known equations that simulate fluid dynamic behaviour at the solar surface, such as Navier-stokes, reaction-diffusion, perlin noise and fractal flames. As these equations are quite processor-intensive the software has been coded to use both cpu and computer gpu for the production of animations in real-time.

Sound

A live software analyzes the visuals generated by the mathematics and provide a changing soundtrack made out of synthesized and sampled rumbles, fire crackles, wind, flares, vents and bursts. The treble sound is bounced off the balloon and into the ground, the bass comes from one subwoofer placed beside the ground projector. Except for opening night when the volume may be louder temporarily to have more public impact, the rest of the time the sound component is designed to be quiet and almost imperceptible, so that other square functions can proceed without interference.



Sample graphics projector:
Christie Roadie HD+35K
DLP projector

OPERATION AND MAINTENANCE

Operation

Once the piece is set-up, operation of the installation is mostly automatic. The computers are programmed to start-up and shutdown at certain times, or just to remain ON all the time, with only the projectors needing powering on and off. A local technician can take care of maintenance. Every day mixtures of helium and air are to be pumped into the balloon, around 6% daily top off. It is not necessary to have attendants as all elements are out of reach of the public.

Weather

The balloon is tethered to sustain Melbourne's wind gusts. All projectors are housed in weather proof enclosures, so no action is needed in the event of rain.

Vandalism

The projectors, tethers, hoses, speakers, cameras, and all control computers are out of reach of the general public. The only element at ground level is the booth containing a winch, a zenithal projector, its media server and the subwoofer. This booth has a small footprint, is elevated by short scaffold and is protected by Heras fencing.

Pollution

While the piece uses the World's brightest projectors, the net light pollution in the area is negligible because of the saturated colours used, because of the large area covered and because other bright public lighting is turned off. The sound pollution is likewise not an issue as the sound levels are determined in consultation with the neighbours. A dream for this project is for all the required 25,000 Watts of power to be generated from solar energy and if that is impossible for other renewable energy sources to be used. The project budget includes an item for carbon offsets so that the installation has zero carbon footprint. One single televised football game uses more electrical energy than the daily exhibition of Solar Equation for a month.



INSPIRATION AND PRECEDENTS

As an artist with a degree in science, Lozano-Hemmer wants to recontextualize the majesty and unpredictability of natural phenomena. The concept of feedback in the theory of cybernetics, first postulated at the Mexican Institute of Cardiology by Norbert Wiener, opened the door to a new set of recursive algorithms to describe self-regulation. Complexity theory, fractals, chaos, genetic algorithms, cellular automata and non-linear dynamics in general represent entirely fresh approaches to understand nature in its indeterminate state. This revolution in contemporary mathematics can have enormous implications to the visual arts, perhaps akin to the importance that euclidean space had for Brunelleschi's linear perspective. Today kinetic sculptures may not need to be preprogrammed according to a particular repeatable animatronic score (like for example a Paul McCarthy installation) nor do they depend on randomness (like a Calder mobile); instead the new mathematics allow for emergent behaviours to arise, given particular initial conditions, constraints and perturbations. Artists that use these techniques (Knowbotic Research, Christa Sommerer, Ulrike Gabriel, Golan Levin, for example) generate ever-changing environments that can seem life-like.

In Lozano-Hemmer's opinion the sun's turbulent surface, as seen from a variety of contemporary solar observatories (NASA's Solar and Heliospheric Observatory in particular, launched 1995 and the brand new SDO), is the defining image of our time: a stellar nuclear fusion that synthesizes most elements of our universe, —as demonstrated in a seminal paper published in 1957 by Margaret Burbidge. Clearly every civilization has a sophisticated set of solar mythologies, from the Yolngu "Walu" or Sun-woman, to the Aztec sun-god "Huitzilopochtli". A large number of structures and artworks react to the sun, marking solstices or equinoxes: megaliths in Egypt and Stonehenge, the prehistoric human-built mound of Newgrange in Ireland, and the pyramid of El Castillo at Chichén Itzá in Mexico. Representations of the sun itself are numerous, even within a single historical category such as hermeticism.

Contemporary visual artists that have worked with solar imagery, perhaps most notably Olafur Eliasson's beautiful installation at Tate Modern's Turbine Hall, owe much to the pioneers of "sky art", in particular Otto Piene, who in a 1961 article in ZERO, wrote "Why is there no art in space, why do we have no exhibitions in the sky? ... Up to now we have left it up to war to light up the sky ...". His inflatable works, light sculptures, fire and smoke pictures are an inspiration to anyone seeking to work with space and the intersection of nature and performance.



Otto Piene "Electric Rose"
1965 New York.



Otto Piene Sky Art
Flotables and Centerbeam

Contemporary visual artists working with flotation and flight, such as Tomás Saraceno, Takashi Murakami, Kazuhiko Hachiya, Peter Coffin and Usman Haque to name a few, likewise build on the work of 70s pioneers like Ant Farm, Mark Fisher and José María Yturralde. Perhaps Nietzsche was best in describing the inspiration of flight beyond the spiritual flight described in most religions: “He who one day teaches man to fly will have shifted all landmarks. To him will all the landmarks themselves fly into the air. The earth will be christened anew as a light body.”

One final practice that inspires this work is Sky Writing, invented in 1922 by Captain Cyril Turner of the Royal Air Force in England. Many artists have used pilots to draw in the sky, notably a large-scale experiment “En el cielo” commissioned by Trans>projects for Venice in 2001 and with designs by Valie EXPORT, Paul McCarthy, Gabriel Orozco, Jeff Wall and others. Recently Bruce Nauman used skywriting over Pasadena, leaving the message “Leave the land alone”.

Within Lozano-Hemmer’s own practice questions of scale and perspective have been addressed frequently, in particular his embrace of technologies of amplification to create alternate, temporary, “alien” readings of urban spaces. His Relational Architecture series of public art projects have often used powerful searchlights (Vectorial Elevation, Pulse Front, Voz Alta), the brightest projected imagery (Displaced Emperors, 1000 Platitudes, Make-out) and huge shadow plays (Re:Positioning Fear, Body Movies, Frequency and Volume) to create platforms for participation. He has extensively used non-linear algorithms to create complex emergent behaviours, like in his kinetic sculpture “Synaptic Caguamas” which uses cellular automata to create unpredictable but not-random robotic motion, or his interactive chandelier “Pulse Spiral” inspired by Vladimir Shukov’s distribution of surfaces in three dimensions.

Outreach and Education

Solar Equation can be accompanied by a variety of initiatives to involve local communities and contexts. Lozano-Hemmer can direct a workshop on Sky Art for example, inviting the general public to reflect on aesthetic, environmental, political and scientific issues associated with the practice. A series of lectures or publications can be organized featuring astronomers, thinkers and practitioners of Sky Art, such as astrophysicist Roger Malina, curators Rob La Frenais and Nicola Triscott, artists Otto Piene and José María Yturralde, media archeologist Erkki Huhtamo, philosopher Manuel de Landa and others.



Olafur Eliasson “The Weather Project”
2003, Tate Modern, London



Jose María Yturralde “Flying Structure,
Octahedron” Venice Biennial 1978



Lozano-Hemmer “Pulse Spiral”,
2008 Moscow

TOURING

The installation can tour. Below are some images showing how the project would look in Lower Manhattan, over the Brooklyn-Battery Tunnel approach. Some sites such as the one shown here may have their own rigging challenges which will be addressed on a per case basis. For Manhattan, at the shown location there is the possibility of some vertical and lateral guy wires from existing buildings, but ballast might be needed on Battery Park, for instance.





Lozano-Hemmer "Solar Equation"

Lozano-Hemmer

BIOGRAPHY

Rafael Lozano-Hemmer (Mexico City 1967)

Mexican-Canadian electronic artist, develops large-scale interactive installations that are at the intersection of architecture and performance art. His main interest is in creating platforms for public participation, by perverting technologies such as robotics, computerized surveillance or telematic networks. Inspired by phantasmagoria, carnival and animatronics, his huge light and shadow works are “antimonuments for alien agency”. His work has been commissioned for events such as the Millennium Celebrations in Mexico City (1999), the Cultural Capital of Europe in Rotterdam (2001), the United Nations’ World Summit of Cities in Lyon (2003), the opening of the Yamaguchi Centre for Art and Media in Japan (2003), the Expansion of the European Union in Dublin (2004), the memorial for the Tlatelolco Student Massacre in Mexico City (2008), the 50th Anniversary of the Guggenheim Museum in New York (2009) and the Winter Olympics in Vancouver (2010).

His work in kinetic sculpture, responsive environments, video installation and photography has been shown in museums in four dozen countries and Biennials in Venice (Italy), Sydney (Australia), Liverpool (UK), Shanghai (China), Istanbul (Turkey), Seville (Spain), Seoul (Korea), Havana (Cuba) and New Orleans (USA). His work is in important private and public contemporary art collections such as the Daros-Latinamerica Collection in Zürich, the Jumex Collection in Mexico, the Speyer collection in New York, the Cisneros Fontanals Foundation in Miami, Tate in London and the Museum of Modern Art in New York.

At the Prix Ars Electronica in Austria, his pieces have received a Golden Nica, a distinction and two honourable mentions. He also won two BAFTA British Academy Awards for Interactive Art in London, a distinction at the SFMOMA Webby Awards in San Francisco, “Artist of the year” at Wired Magazine’s Rave Awards, a Rockefeller fellowship, a Langlois Grant, the Trophée des Lumières in Lyon and an International Bauhaus Award in Dessau, Germany, among others.

Lozano-Hemmer was the first artist to officially represent Mexico at the Venice Biennale, in 2007, with a solo exhibition entitled “Some things happen more often than all of the time”.

www.lozano-hemmer.com



QUOTES

Lozano-Hemmer's work requires us to reassess our notions of the analog and the digital, of language and code, meaning and force, human and nonhuman communication. But it does so not by commenting, critiquing, or sending a message itself. It does it aesthetically, by which I do not mean "beautifully" (although his installations always are that, too). Rather, I mean "aesthetic" in something closer to the etymological meaning: as in aesthesis, "making sensible."

— Brian Massumi, critic and writer, Artforum Magazine.

His work succeeds in giving the unchoreographed the power of a full orchestra. Go look him up, go be part of his next project!

— CK Kuebel, NY Arts Magazine

Provokes tantalizing questions with light and electrons...his work may in fact be a perfect opportunity for us to not only visualize technology...but also actively join in creating an artistic expression of science's modern advances. We can even control it for once.

— Ayako Karino, International Herald Tribune newspaper

There are only a few contemporary artists who can use new technology in a way that is not a gimmick, who can display a deep insight on its potential as an artistic resource, as well as an awareness of the social implication of technical innovations. Rafael Lozano-Hemmer is certainly one of those few.

— Manuel de Landa, Author, "A Thousand Years of Non-Linear History" and "War in the Age of Intelligent Machines", Mexico

Lozano-Hemmer demonstrates that barriers between digital and physical realities are not always immutable. [His work is] a monumental representation of our electronic connectedness.

— Gary Hill, John Maeda, Aaron Betsky, et. al. SFMOMA Jury, USA

What is definitive is the artistic energy that Rafael Lozano-Hemmer unfolds in his work: the force of spatial suggestion, the play of reality and projection, and his poetic capability to evoke a place without a site.

— José Jiménez, Author / Curator, El Mundo Newspaper, Spain

Lozano-Hemmer's projects form publics, explore agencies and non-localities, reconsider presence and provoke questions.

— Tim Druckrey, Theorist and curator

Extraordinary...Here is a work of art that reinvents the public sphere... one of the brightest social interventions in Latinamerican Art. I say this to transmit the excitement of participating in Lozano-Hemmer's installation and experiment a new form of interaction alternative to the authoritarian space of mass media.

— Cuauhtémoc Medina, critic and Associate Curator, Tate Collections, UK

Lozano-Hemmer's works, replete with luscious imagery and erotic engagement, never shock or confront the participant but playfully seduce him to question.

— María Fernández, Art Historian, Cornell University

Truly exceptional. Any art that competes with the Super Bowl merits special attention!

— Erik Adigard, MA Design, USA

The combination of a high-level of conceptualization and amazing technical expertise beautifully tie the "real" and "virtual" worlds together with a presentiment of the internet's role in the exhibition of an individual's creativity to an unprejudiced society. The gift of a dream.

— Masaya Fujita, CG-ARTS Society, Japan

A wizard at merging slick technology with high-brow art, Rafael Lozano-Hemmer is one of the faces of the future of art. He was the first artist ever to represent Mexico at the Venice Biennale, in 2007. He has become the go-to guy for a certain type of contemporary monumentality.

— Ben Davis, Artnet

Rafael Lozano-Hemmer's approach falls into the ephemeral, instant architecture, entirely based on networks from conception to realization and sustenance. Vectorial Elevation's results are spectacular and also metaphorical. They provide us with a radically new understanding of an aesthetics of networks proper.

— Derrick de Kerckhove, Director, McLuhan Program, U. of Toronto, Canada

Rafael Lozano-Hemmer is a cyclone taking over the artworld.

— Roberta Bosco, El País Newspaper, Spain

Outstanding among the installations by International Artists at the Shanghai Biennial was the work of Rafael Lozano-Hemmer.

— Richard Vine, Art in America Magazine

QUOTES

Sensational, best of Art Basel
— Isabelle de Wavrin, *Beaux Arts Magazine*, France

The most striking work at Art Basel Unlimited
— Samson Spanier, *Apollo Magazine*

One of the artists most representative of current research into art and the city.
— Achile Bonito Oliva, *NY Arts Magazine*

The work of Rafael Lozano-Hemmer demonstrated how computer technology can unite people in the way a hymn or an anthem does.... Lozano-Hemmer, a nephew of the poet Octavio Paz, is the son of nightclub owners, and his fascination with such playful poetry in the night sky is understandable. But it's the subtle, proletarian, democratic power of the work —especially in Mexico— that is so alluring.
— Zahid Sardar, *San Francisco Chronicle*

His installations actually work!
— Bruce Sterling, writer

The communal, public nature of Lozano-Hemmer's work contains a hint of ritual, like modern-day secular ceremonies.
— Thomas Daniell, *Archis Magazine*, Holland

The work of Rafael Lozano-Hemmer opens the doors to a new theatricality: it gets us closer to Mayakovsky and Bertolt Brecht.
— Raul Ferrera Balanquet, mexican curator

I got infected by Lozano-Hemmer's energizing enthusiasm for a technology which is never sterile, never authoritarian, always open, playful, almost grotesque: a magnificent blend of Latin popular festivity and Western techno perfection.
— Geert Lovink, media critic

The interest in Lozano-Hemmer's work resides in its application of technology not as an end in itself but as an actualized tool for the intervention of urban environments in ways that are at the same time analytical and festive, perhaps anti-authoritarian, integrative of a wide public's potential for play.
— Enrique Jezik, *Art Nexus Magazine*

Lozano-Hemmer's work allows us to experience digital representations in physical and sensual ways, a process that helps us cognitively map the labyrinthine dimensions of the electronic realm.
— Daniel Canogar, *Public Art Review*

Lozano-Hemmer's work shows] the great range of human emotion on display. I feel twinges of Hogarth, the great 18th-century artist who held a vivid mirror up to English society.
— Mark Irving, *The Times of London*

No one has asked me. But if someone would like to know who I consider the most important (intelligent, entertaining, deep and critical) Mexican artist today I would say it is Rafael Lozano-Hemmer.
— Mónica Mayer, *El Universal Newspaper*, Mexico.

Playful, smart and strangely seductive
— Sandra Ban, *Artnews Magazine*

The fastest rising art star... Lozano-Hemmer is like an anarchic whistle-blower exposing the sophisticated devices used to control us.
— Jessica Lack, *The Guardian*

Mexico, too, has long been absent from the Biennale, and their reappearance is marked by some incredibly high-tech works by Rafael Lozano-Hemmer. Using closed circuit video surveillance cameras, radio-electric scanners and multichannel mixers, he creates installations that are truly interactive with the visitors. Anyone still holding on to a stereotype of Mexico as a land of low-skilled labor needs to spend five minutes in one of Lozano-Hemmer's artworks.
— Preston Thayer, *Roanoke Times*

Hardware-heavy and technologically agile.
— Marcia E. Vetrocq, *Art in America*

Lovely, poignant.
— Christopher Knight, *Los Angeles Times*

A moment of brilliance [at the Sydney Biennale].
— Daniel Palmer, *Frieze Magazine*