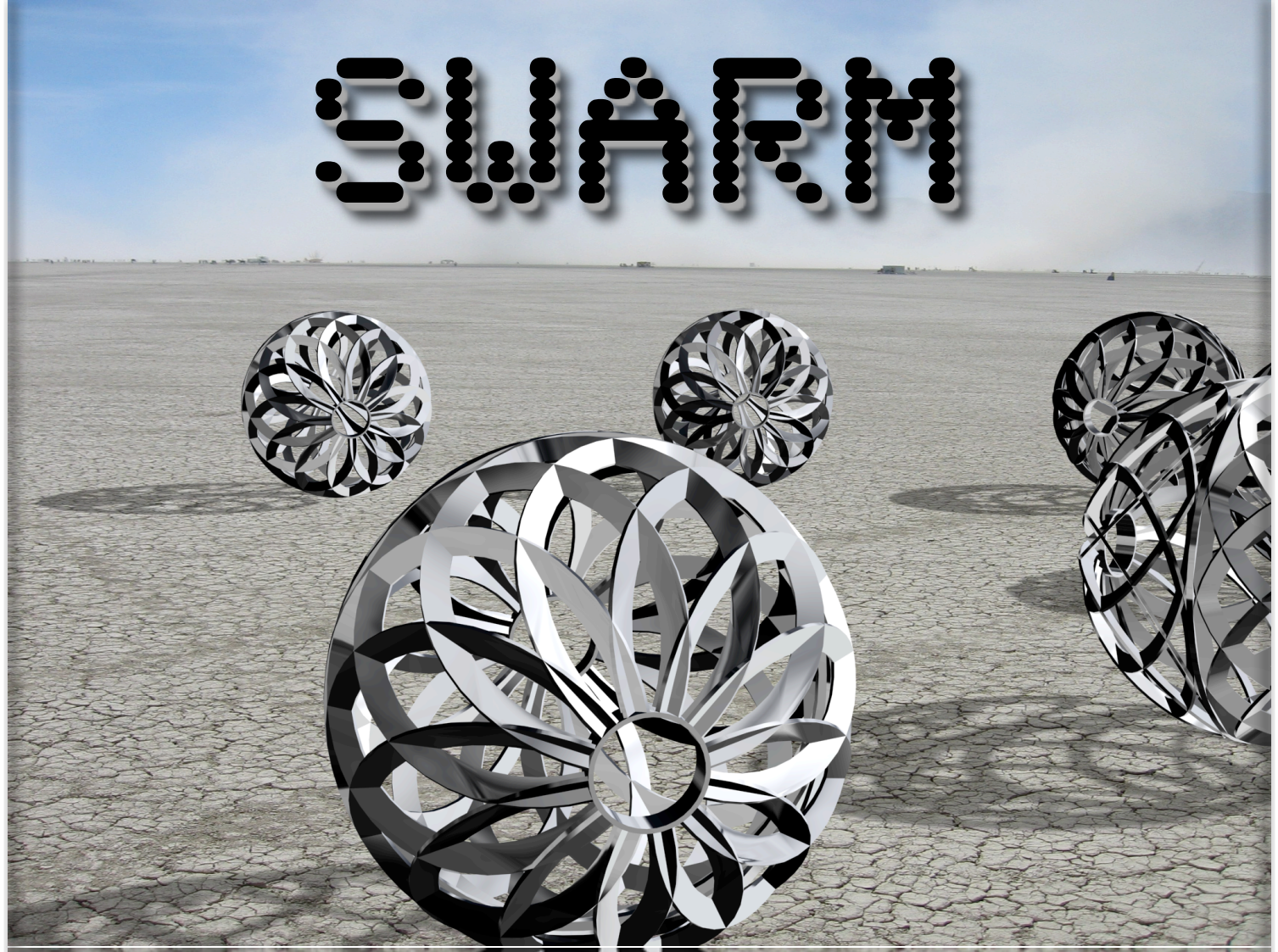
SWARM



SWARM, A KINETIC LARGE SCALE ART INSTALLATION AT BURNING MAN 2007

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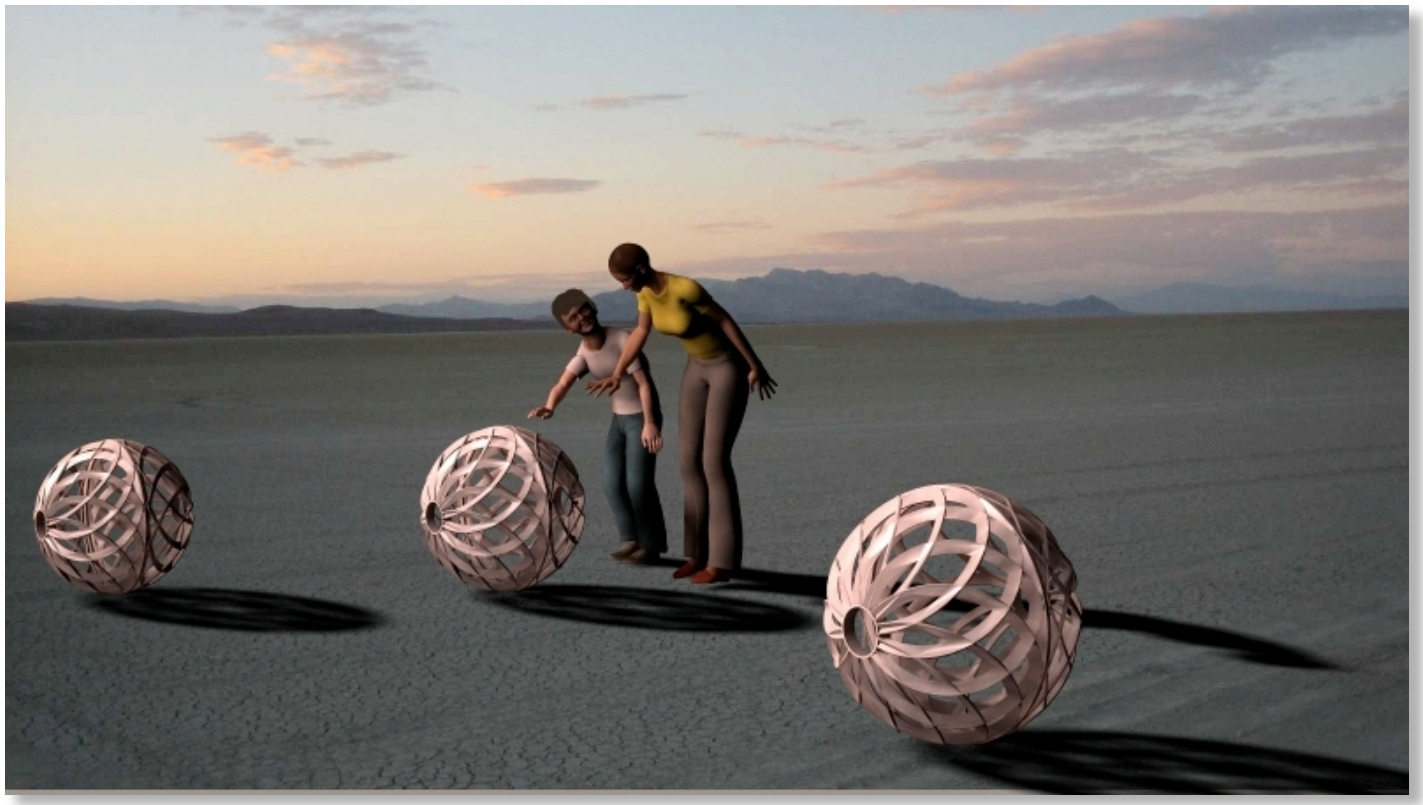
Nothing escapes the ineluctable embrace of **entropy**, the one-way trip of our Universe toward **chaos** and heat death. Yet at least on one small sphere, our planet, there is a rude and surprising exception: **LIFE**.

As time progresses, everything becomes less organized, but **LIFE** is an **exception**. It grows more complicated, and more interesting. Schrödinger calls this organizational drive negentropy – when things want to be **ALIVE**. **Negentropy** is a honeybee colony and a night at the opera. Negentropy is a Bronx cheer in the face of Death.

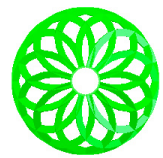
The **SWARM** of autonomous beings by their very nature will have emergent and complex behavior. They will **flock**, **flirt**, **dance** and **interact**, and their actions will **surprise** and **astonish** even us, their creators. They are simple, but together they will behave in ways more complex than we can predict.

A lot like **LIFE**.



"A motion and a spirit, that impels
All thinking things,
all objects of all thought
And rolls through all things."

W. Wordsworth



They Roll

They Change Color

They Sense Humans

A **SWARM** of **rolling** interactive robotic

ORBS evolving complex and adaptive dances

of **LIGHT** and **PATTERNS**.

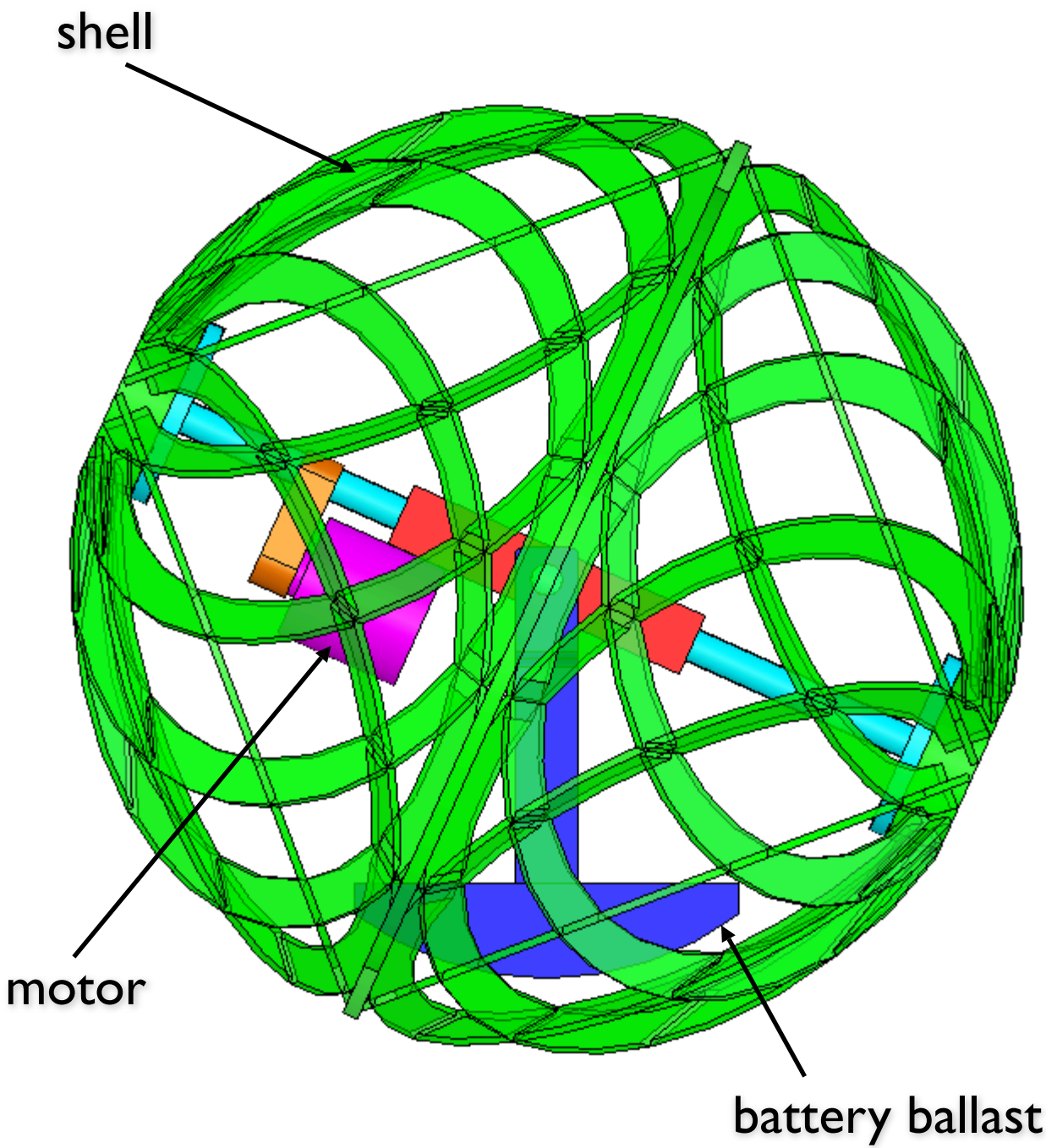
They Interact with Humans

They have Emergent Behaviors

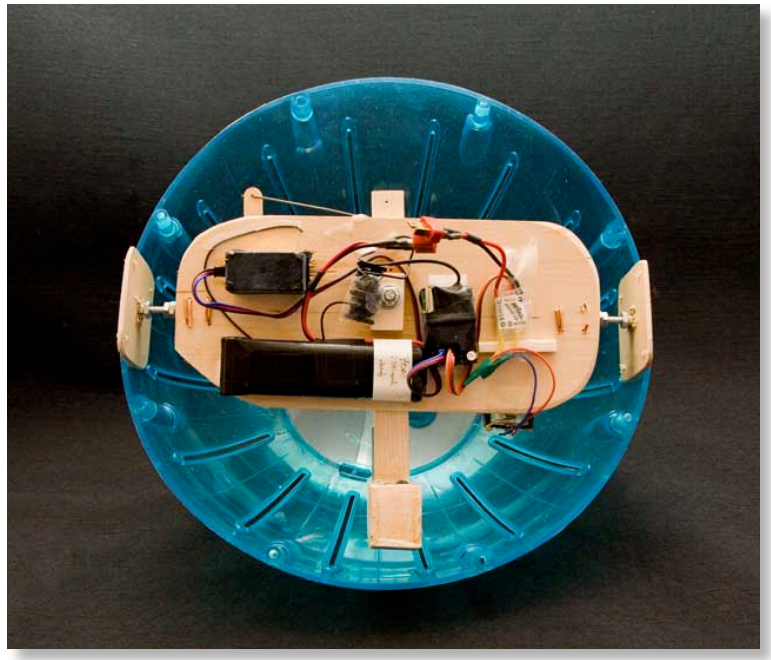
They make Otherworldly Sounds

They rearrange in Elaborate Formations

Rendering by Stefano Corazza



CAD by Michael Prados



Working Model, Jan. 2007
by Pete Burnight

HOW DOES IT WORK?

The motor drives the shell around the axis, causing the orb to roll.

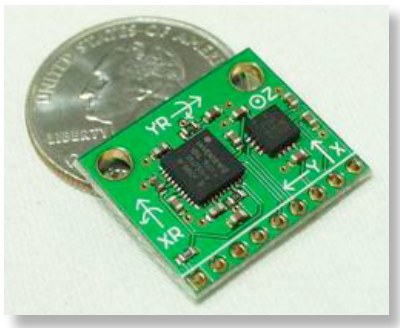
Tilting the counterweight off-center steers the orb.

The on-board navigation system controls the motors and thus speed and direction for every orb.

An array of **RGB LED**s illuminates the orbs at night.

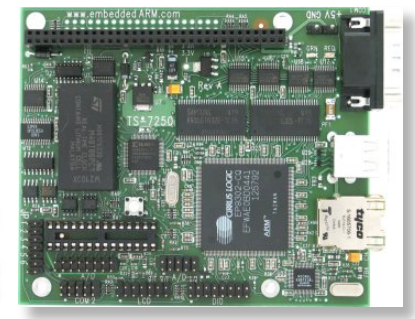
Ten short years ago, in the days of "HELCO" and "Temporal Decomposition", this project would not have been possible. What has changed?

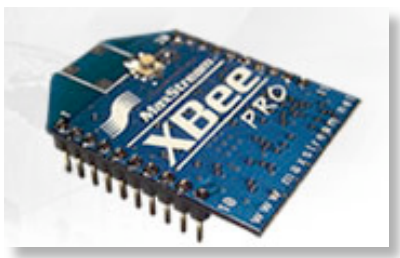
Accurate, Mass Produced Global Positioning System (GPS) modules



Micro Electromechanical (MEMS) Accelerometers and Yaw Rate Gyros

Embedded Open Source Linux Computing





Robust, 2-way Zigbee radio data communication network

"**Negentropy** is a **honeybee** colony."
The **mothership** is the **hive**.

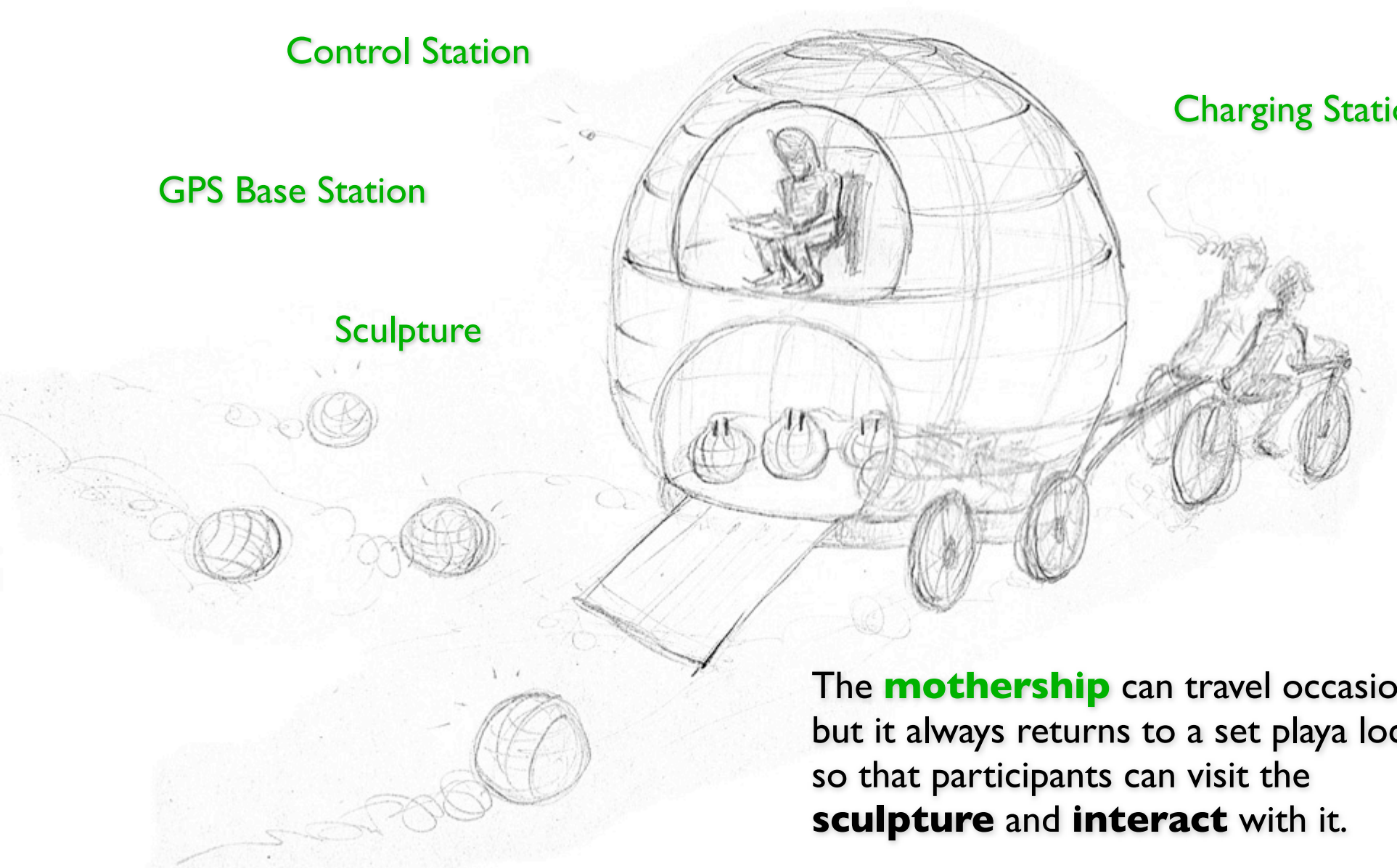
Gathering Place

Control Station

Charging Station

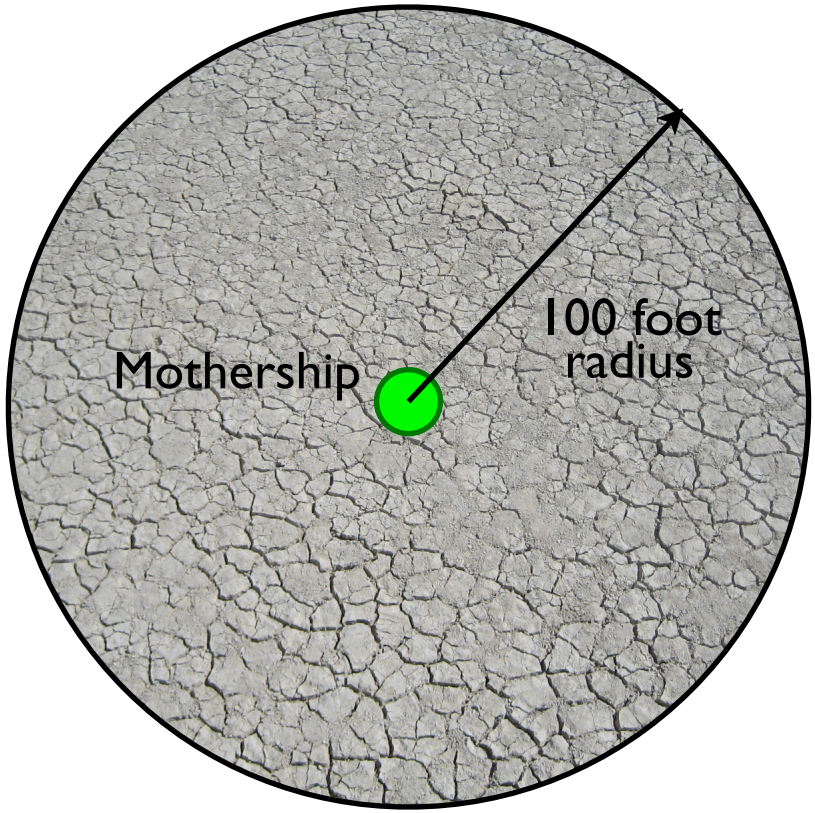
GPS Base Station

Sculpture

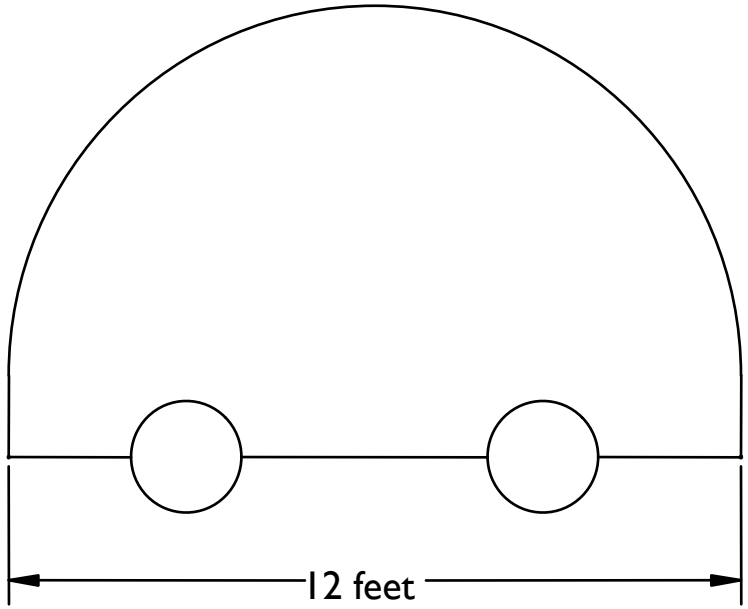


The **mothership** can travel occasionally, but it always returns to a set playa location so that participants can visit the **sculpture** and **interact** with it.

Drawing by Rebecca Anders

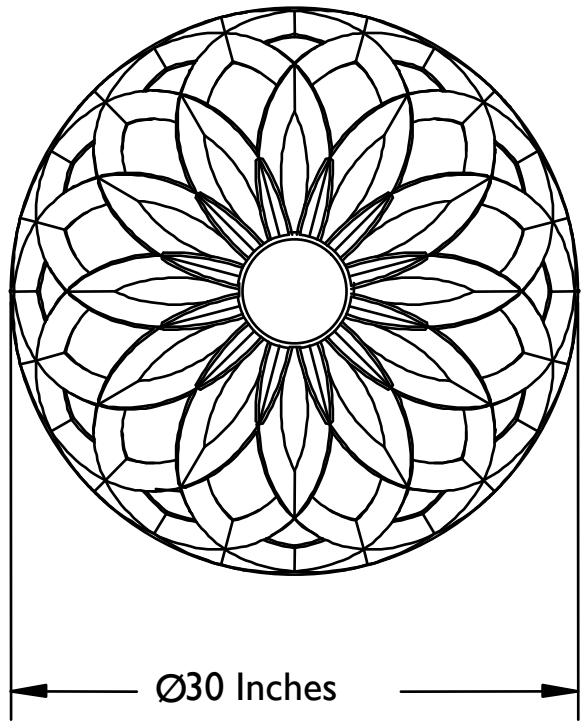


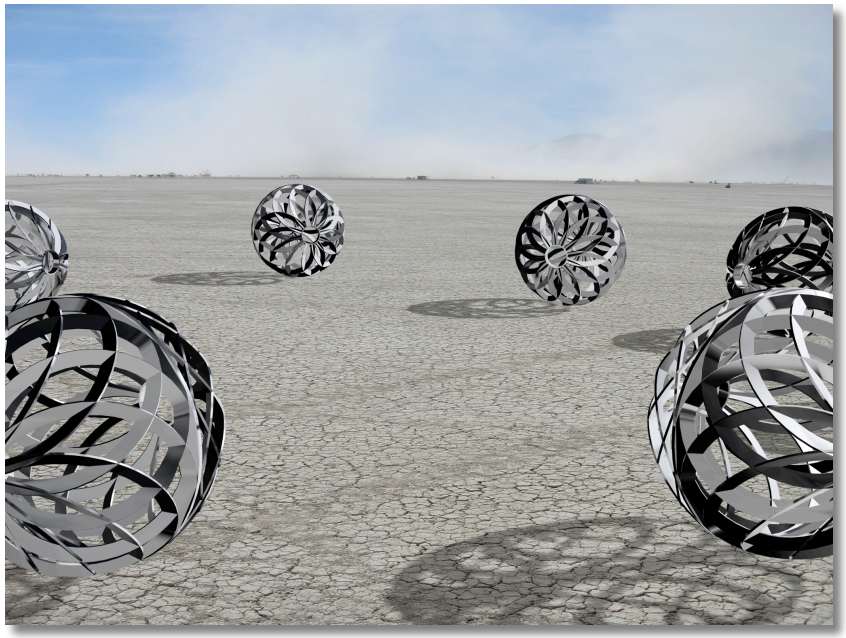
Performance Range from the center of the art installation (300 feet probably possible)

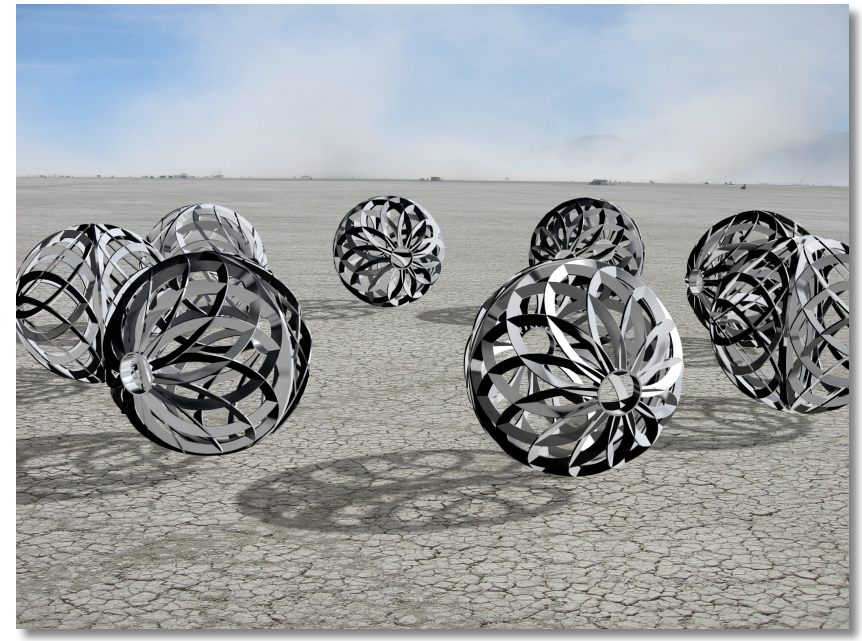


Mothership Dimension

Sphere Diameter



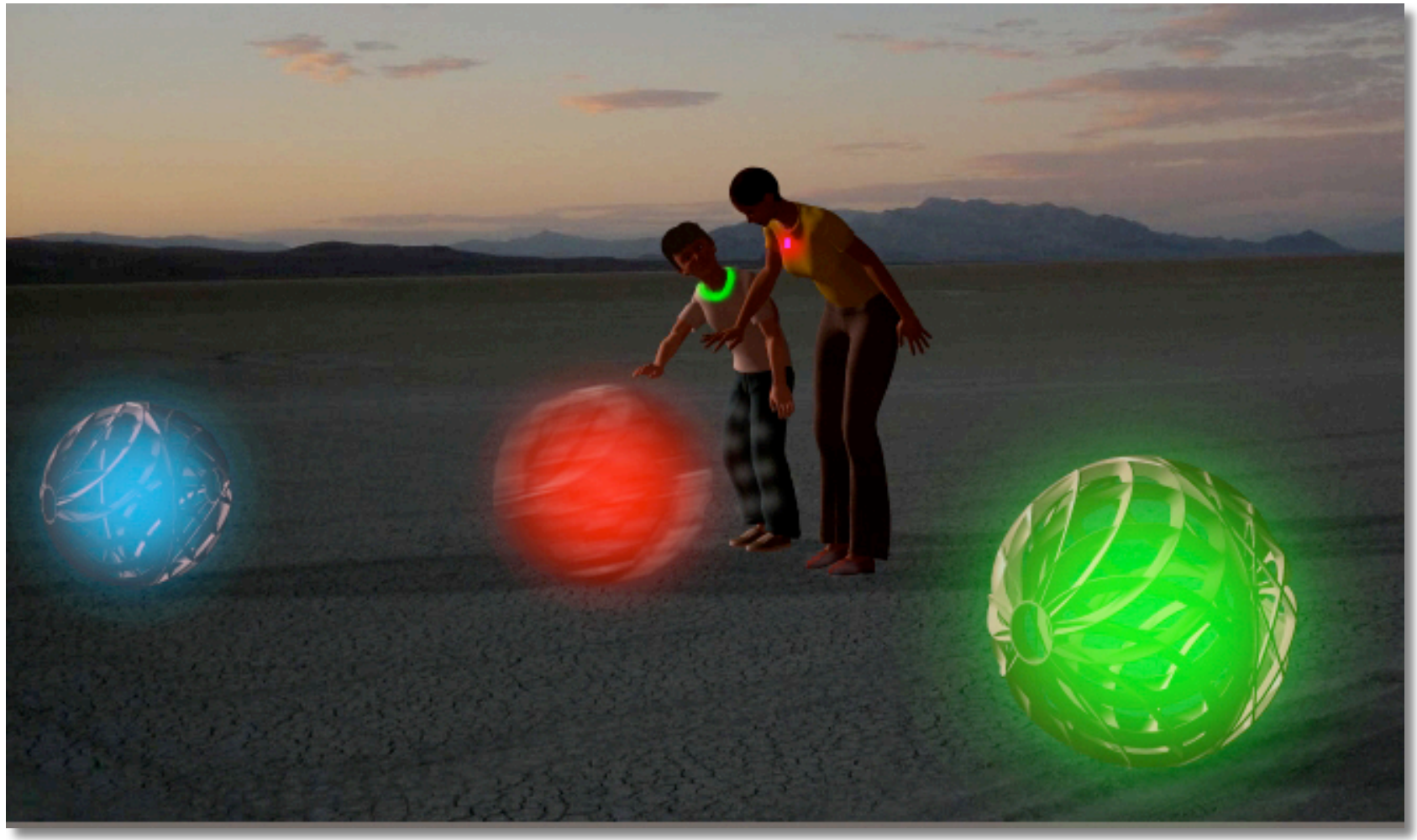




Choreographed formations **expanding** and **contracting**

Swarming
Choreographies
Dancing - Telling Stories
Suggesting Animal Behavior
Sending a Message
Rolling Around
Evoking ***Emotion***
the ***Motion*** of ***Life***

Renderings by Phil Spitler



Non-contact ultrasonic sensors allow **participants** to **play** with orbs, **pushing** them away with their **approach**.

Rendering by Stefano Corazza

The **Magic Wand** allows **participants** to control **SWARM** directing formations like a **sorcerer**.

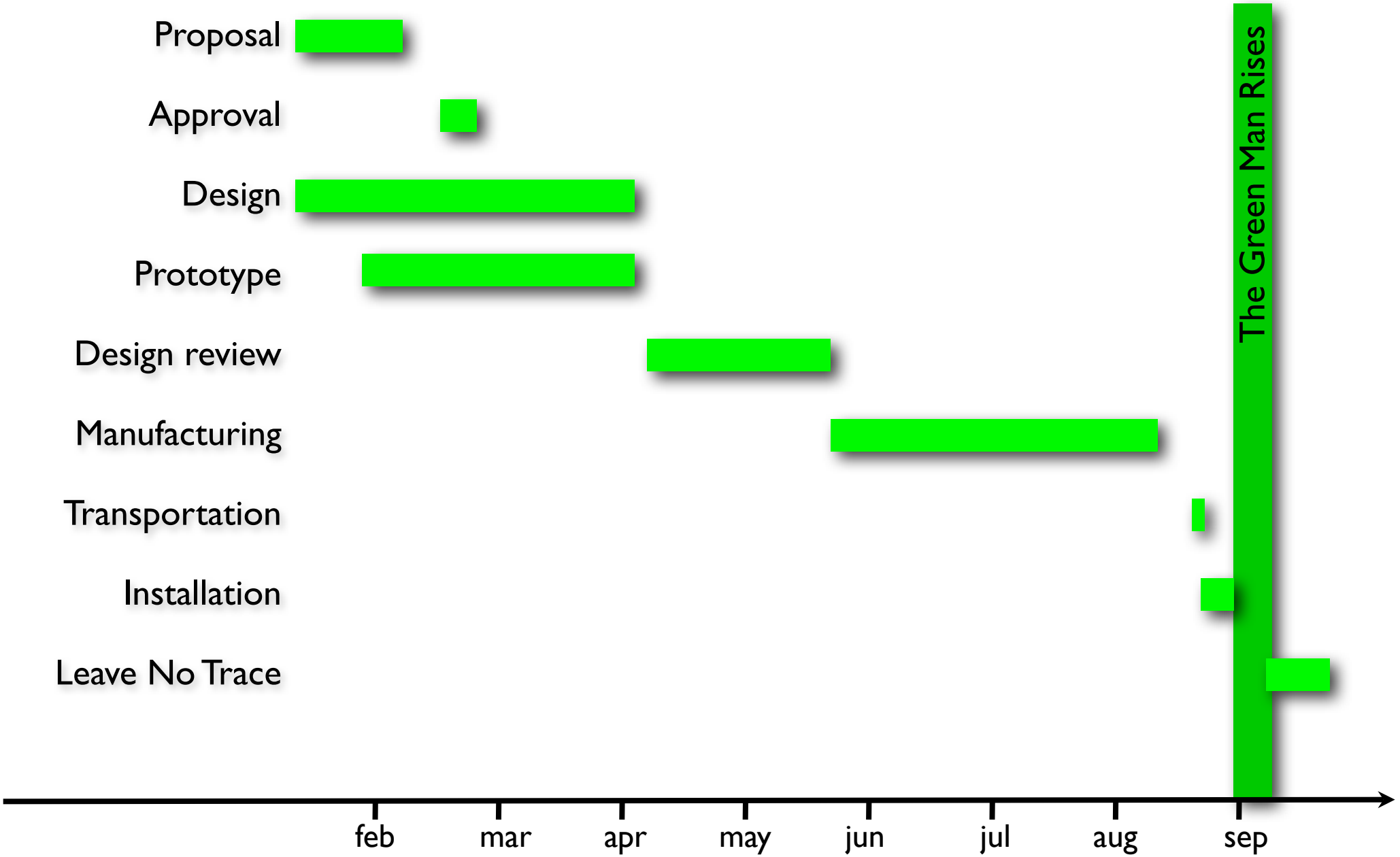
Rendering by Stefano Corazza and Phil Spitler

SWARM is an inherently low polluting art project. Only a moderate quiet electricity is used by the system which will be on the whole **carbon-neutral**. Nothing is burned. SWARM is **lightweight** and **efficient**, and carbon credits will be purchased to offset our impact. We are putting considerable effort into **energy flexibility**. Our Orbs will use the latest in **battery** technology.

We have been in contact with Tom Price to investigate getting a portion of our energy from the Burning Man **photovoltaic installation**.

We are also investigating **photovoltaic leasing** arrangements from Snow Koan Camp.

If these options are not available, we can recharge our batteries from any mains or generator source including **biodiesel.** Though it is not practical to consider it our primary energy source, we are planning at least one **bicycle powered** charging station for participant interaction. In keeping with our low impact approach, our Mothership is **pedal-powered.**


Proposal
Approval
Design
Prototype
Design review
Manufacturing
Transportation
Installation
Leave No Trace
The Green Man Rises
feb
mar
apr
may
jun
jul
aug
sep

Most elements of our **installation** are **mobile**. Playa **impact** is **negligible** beyond area demarcation and nighttime anti-collision lights. **Nothing is burned**. Clean-up is therefore straightforward:

Monday 3rd:
All Orbs are collected and packed for transport.
Mothership is broken down for loading.

Tuesday 4th:
Truck loaded. Any playa impact (stake holes, etc.) is remediated.
Installation area and surrounding area swept for MOOP.
Artery staff inspect area and check off Swarm project.

No trace will be left. **We will Leave no trace.**

SWARM is a **collaborative project** featuring members of the **Flaming Lotus Girls**, the **Sunflower Robots Project**, members of the **robotics and kinetic art communities**, and **new burners**.

We have an experienced, diverse, and technically sophisticated crew featuring many veteran Burning Man artists and engineers. In past years, crew members have made major contributions to the following Burning Man artworks:

A Field of Sunflower Robots (2006)

The Flaming Lotus Girls' **Serpent Mother** (2006), **Angel of the Apocalypse** (2005), **Seven Sisters** (2004), **Hand of God** (2003)

The Mad Scientist's **L3K** (2006) and **STS** (2004)

Al Honig's **Hope/Fear Gauge** (2006)

proposal team:

Drago Anguelov
James Stauffer
Jonathan Foote
Lee Sonko
Michael Prados
Pete Burnight
Phil Spitler
Ray Sykes
Rebecca Anders
Stefano Corazza

founding crew:

Aimee E
Anne Geluardi
Ben Thompson
Caroline Miller
Charlie Gadeken
Dan Sandberg
David Fine
Drago Anguelov
James Stauffer
Jessica Hobbs
Jill Manthei
Jonathan Foote
Josh Hunter
Lee Chubb
Lee Sonko
Liam McNamara
Mark Farrier
Matthew Cline
Michael Prados
Michelle Palmer
Olivia G. Sawi
Olivier Bonin
Olya Myhaylovska
Paul Rowan Walker
Pete Burnight
Peter Luka
Phil Spitler
Pouneh Mortazavi
Ray Sykes
Rebecca Anders
Rich Humphrey
Rick L
Sameer Al-Sakran
Stefano Corazza
Stella Rubenstein
Steven Nelson
Tad Rollow
Tasha Berg
Tom Kennedy
Vanessa Montiel

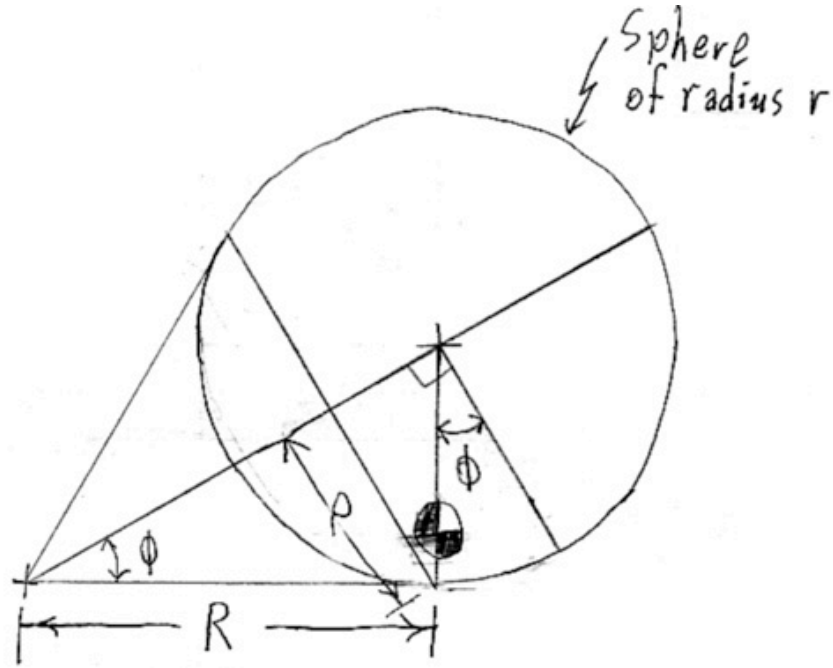
Leave no trace.

10. APPENDIX

"What is life?" asked eminent scientist Erwin Schrödinger. A good question. For the physicist, the Universe is a thermodynamic engine on a one-way trip to heat death. Nothing escapes the ineluctable embrace of entropy. Yet on one infinitesimal sphere, our planet, there is a rude and surprising exception: life. The Second Law of Thermodynamics insists everything gets less organized as time progresses. But life doesn't. Life gets more complicated -- and more interesting. Bacterial colonies emerge from primordial goop; vertebrates evolve from single cells, mind arises from animal brains, culture evolves from intelligence. Schrödinger called this organizational drive "negentropy" -- when things want to become more complicated, more organized -- when things want to be alive. Negentropy is the sound of birdsong in a forest on a planet that the Second Law of Thermodynamics insists should be sterile rock. Negentropy is a honeybee colony and a night at the opera. Negentropy is a Bronx cheer in the face of Death.

Some optimists insist that technology is the next step; that the relentless drive towards complexity doesn't stop with one particular primate species. We don't know about that, but we do know we are driven to push the boundaries of what is possible, to make things in the future that don't exist now. We want to make -- we will make -- things that that want to be alive. We, like artists and creators everywhere, say "screw you" to the Second Law. More details follow, but we propose a swarm of autonomous beings that by their very nature will have emergent and complex behavior. They will flock and flirt and dance, and their actions will surprise and confuse even us, their creators. They are simple, but together they will behave in ways more complex than we can predict. They will be vehicles for beauty and unpredictability. A lot like life. Are they alive? What is life?

Swarm Kinematics



Rolling Cone Model

For no slip:

$$\rho = r\cos\phi$$

$$v = \dot{\theta} r\cos\phi = R\dot{\psi}$$

$$R = \frac{r}{\tan\phi} = r\cot\phi$$

$$\dot{\theta} r\cos\phi = \dot{\psi} r\frac{\cos\phi}{\sin\phi}$$

$$\dot{\psi} = \sin\phi\,\dot{\theta}$$

$$\dot{x} = \cos\psi\, v = \dot{\theta} r\cos\phi\cos\psi$$

$$\dot{y} = \dot{\theta} r\cos\phi\sin\psi$$

$$\psi_{des} = a\tan\left(\frac{y_{des} - y}{x_{des} - x}\right)$$

Chart showing why the orbs won't be blown away by play winds.