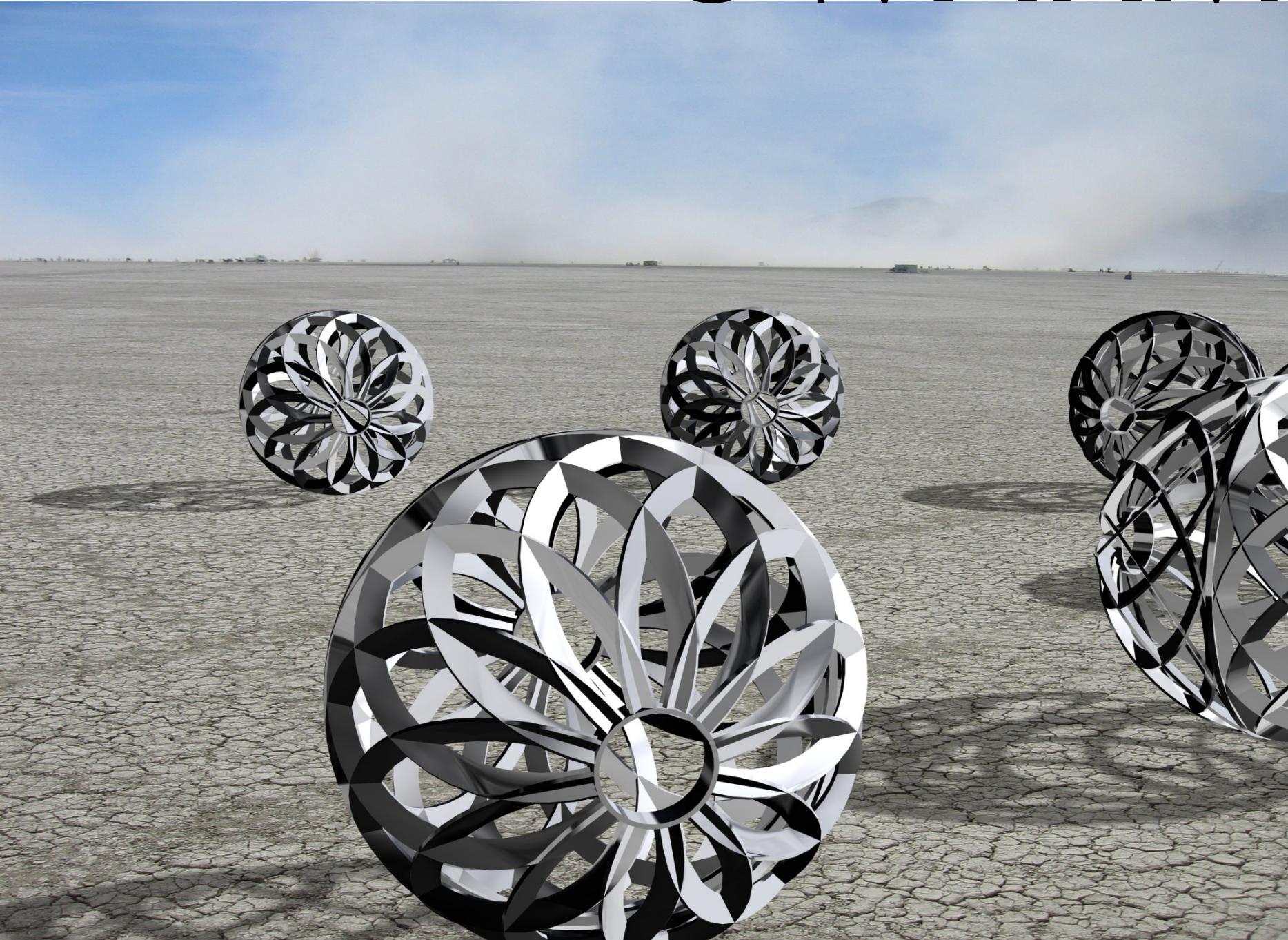


SWARM



what they are

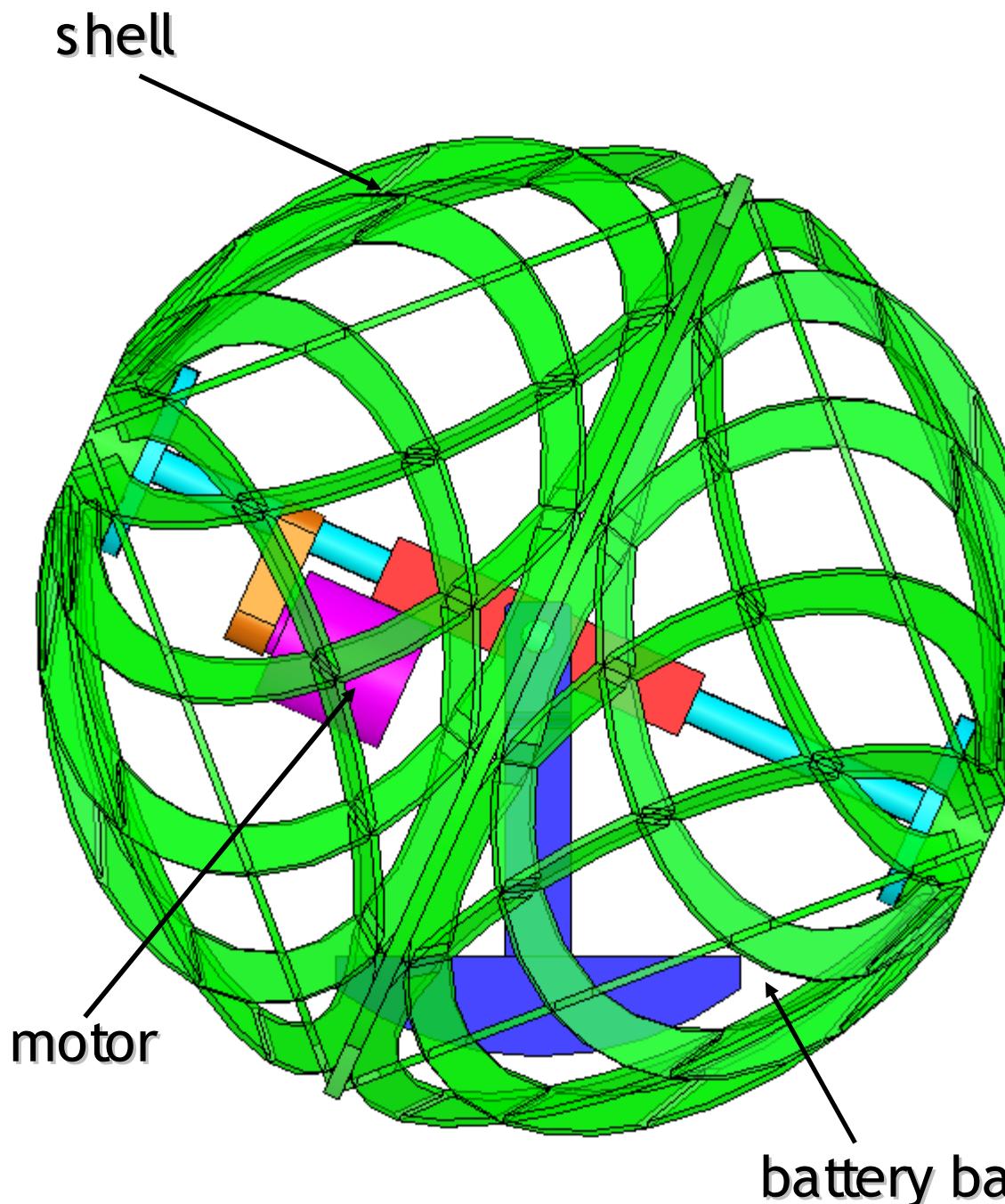


"A motion and a spirit, that
impels
All thinking things,
all objects of all thought
And rolls through all things."

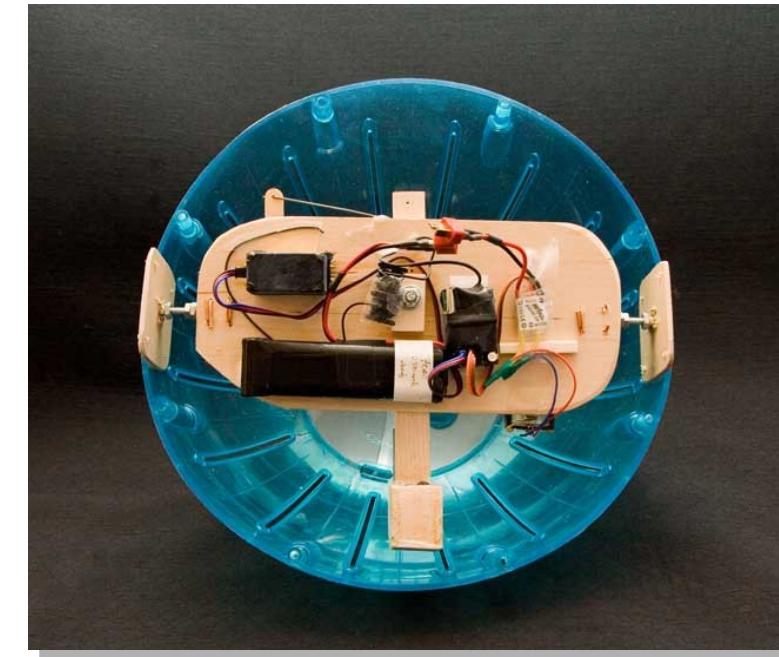
W. Wordsworth

A SWARM of rolling robotic ORBS
evolving complex dances of LIGHT and PATTERN.

how they work



CAD by Michael Prados



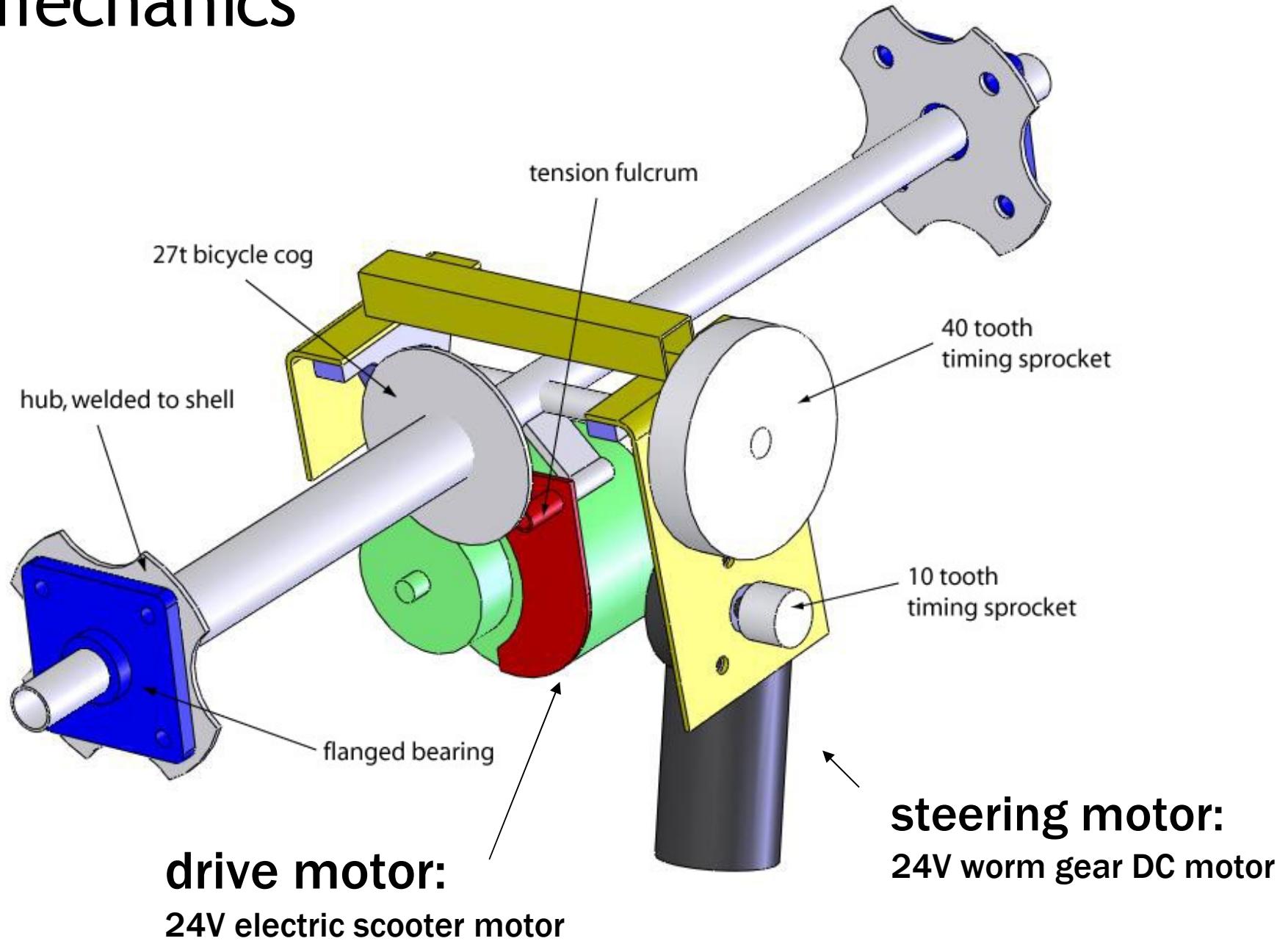
hamster ball prototype
by Pete Burnight

A heavy battery pack provides a reactive ballast.

A drive motor spins the shell against the ballast, causing the orb to roll

A steering motor tilts the ballast, allowing the orb to steer

drive mechanics



Swarm Kinematics

For no slip:

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

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

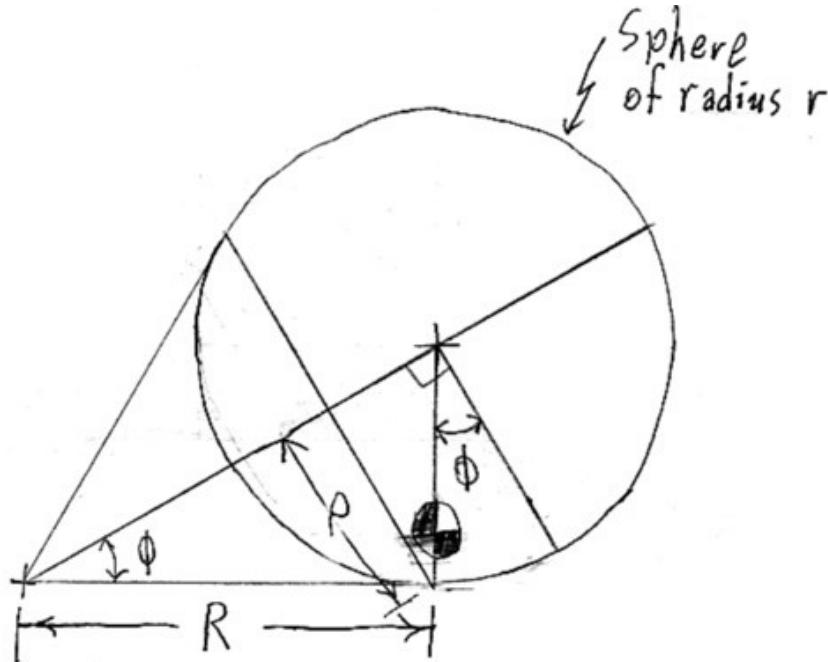
$$R = \frac{r}{\tan \phi} = r \cot \phi$$

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

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

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

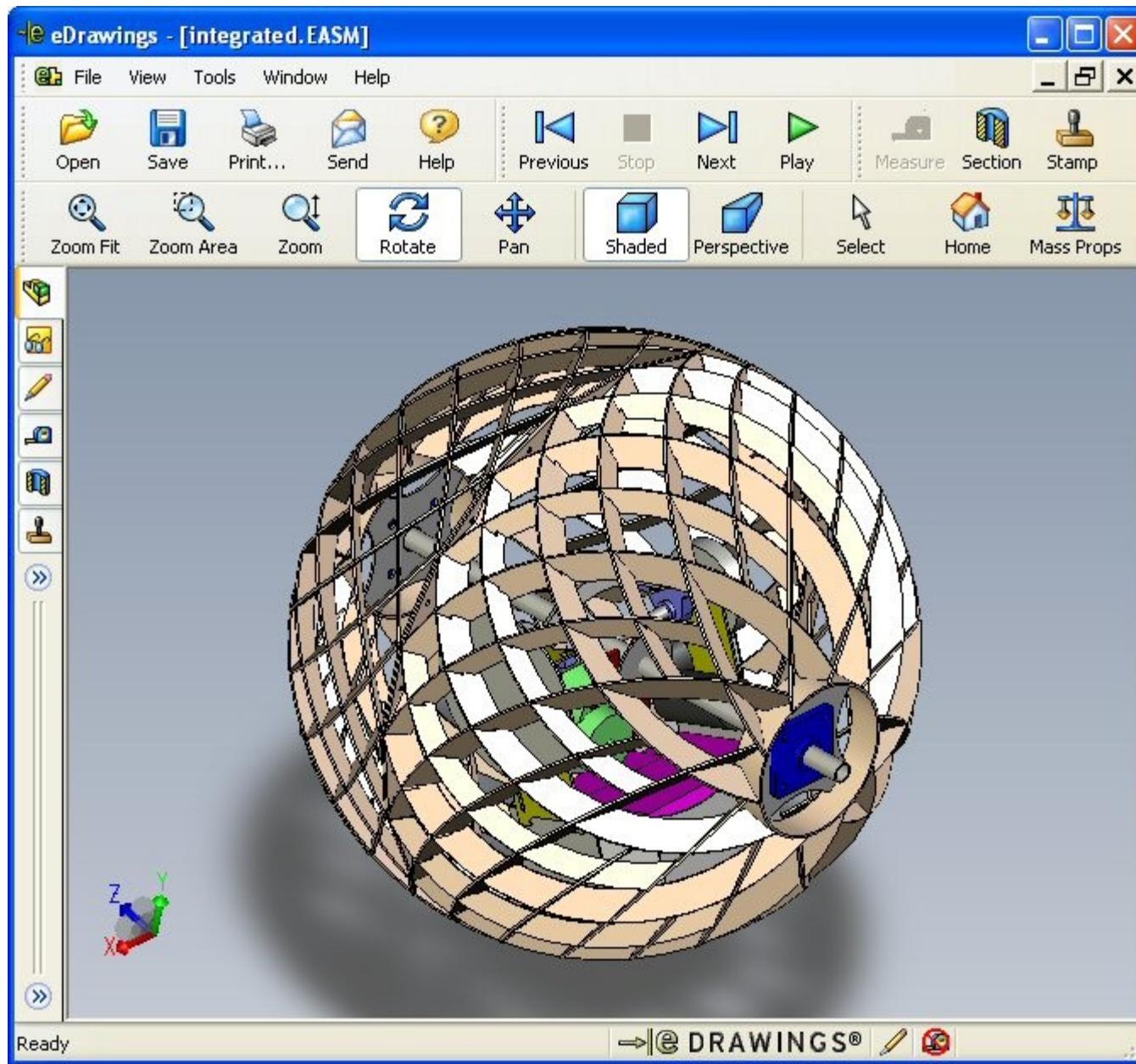
$$y = \dot{\theta} r \cos \phi \sin \psi$$



Rolling Cone Model

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

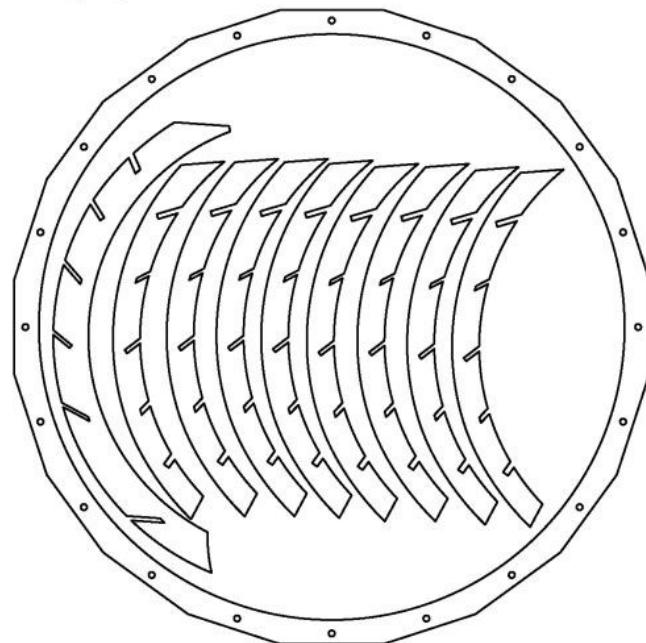
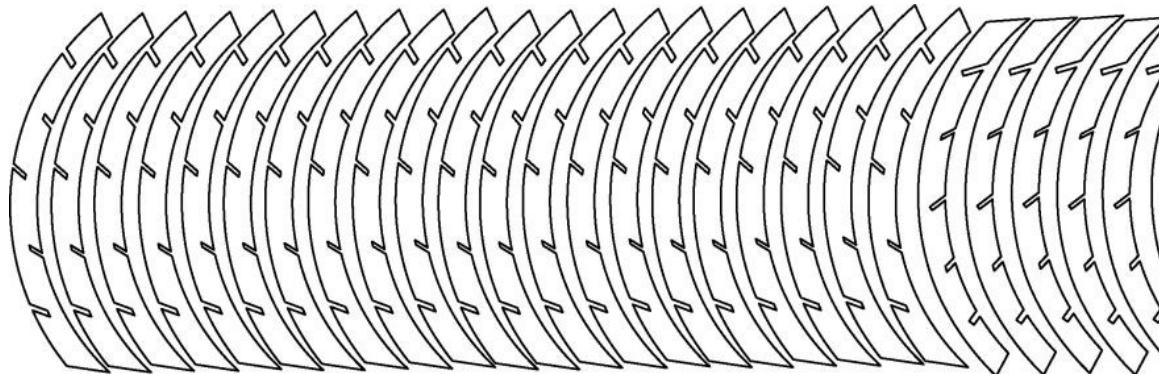
from design...



...an early prototype

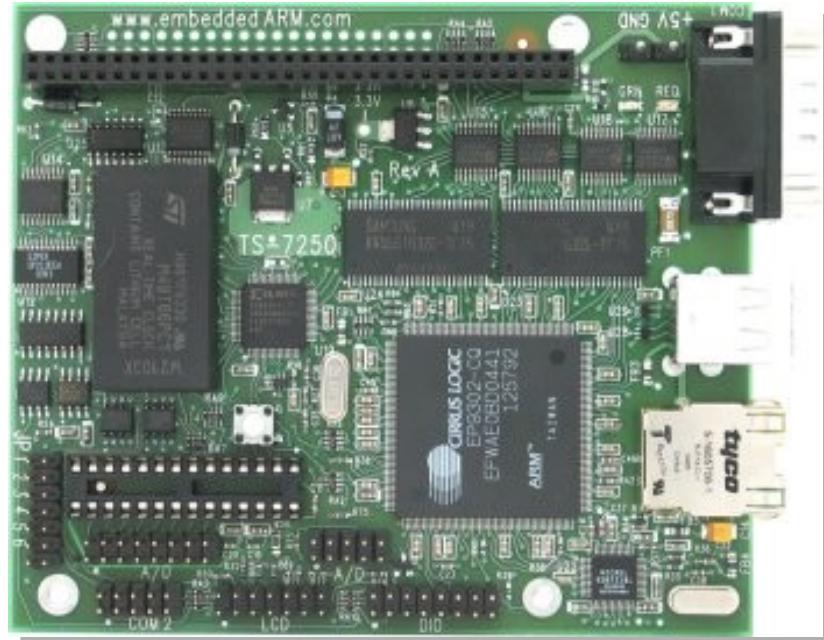


finally...

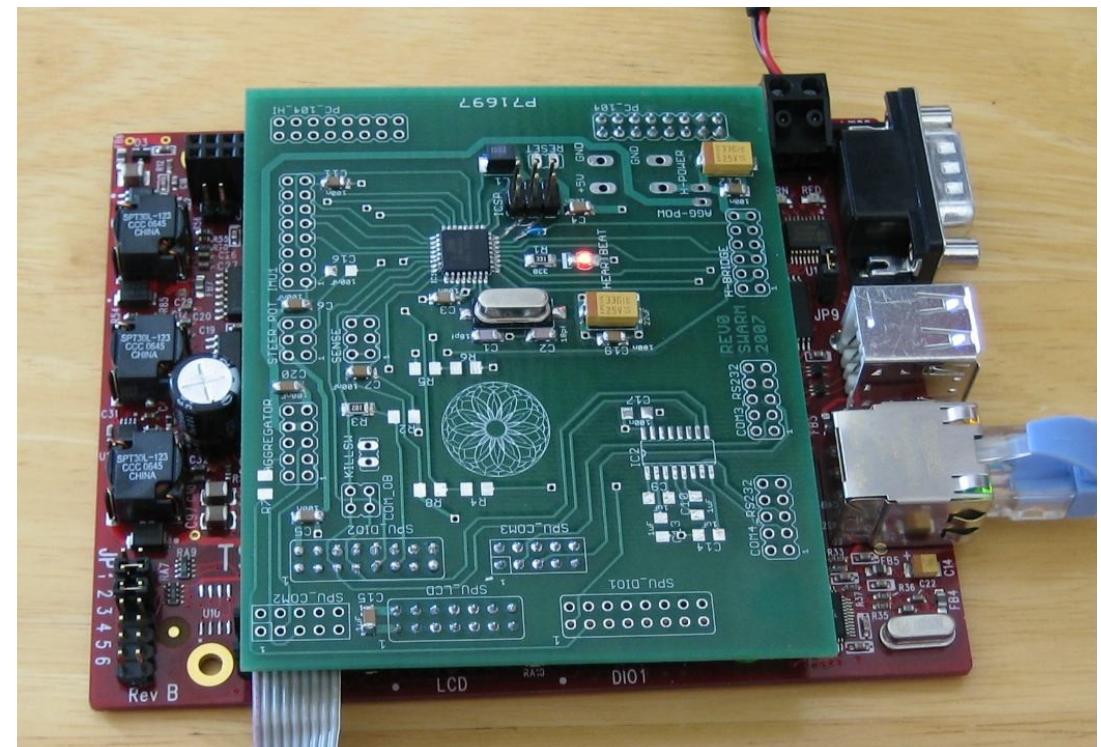


waterjet cut 1 /8 inch
aluminum sheet

the brains of the operation



SPU – Swarm Processing Unit
200 MIPS Linux ARM processor
less than 1 watt power consumption
embeddedarm.com

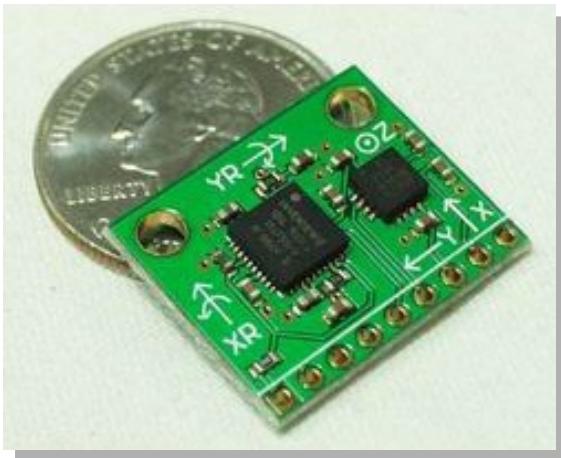


**Custom AVR daughterboard
for motor control, plus custom
H-bridge motor drivers**

P.S. All our software is open source: www.orbswarm.com

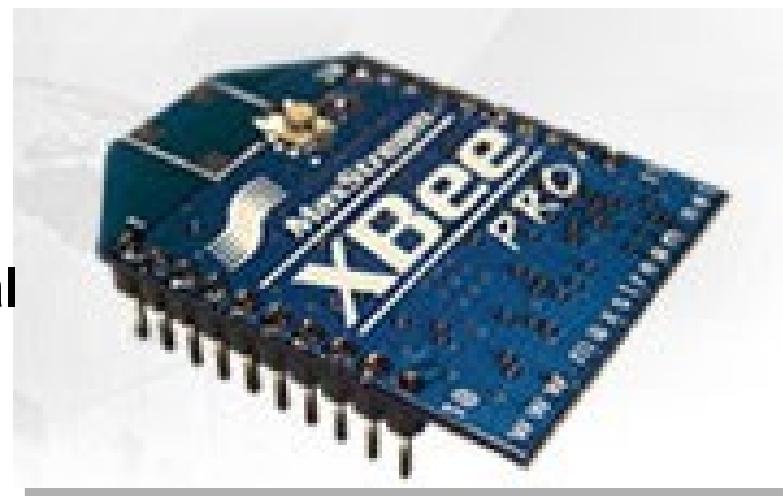
sensors working overtime

Global Positioning System (GPS) modules

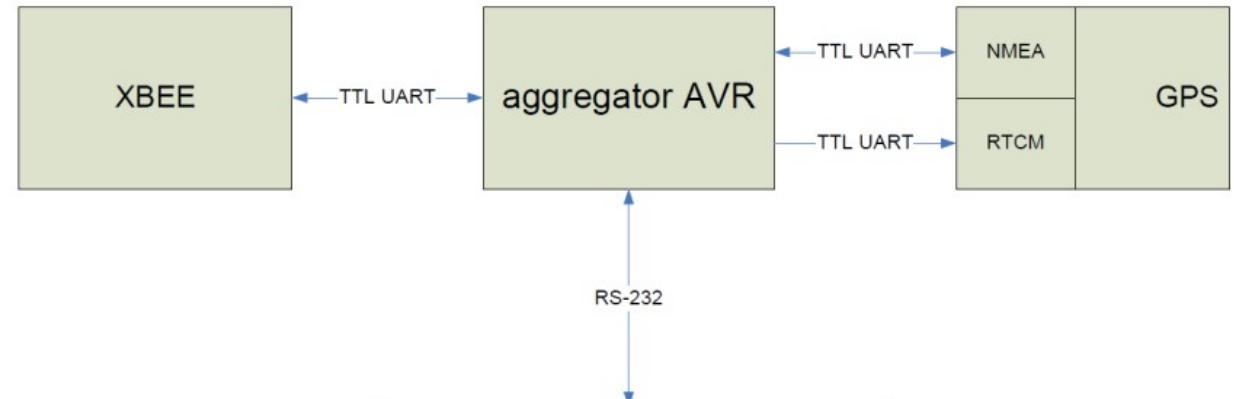


Micro Electromechanical (MEMS)
accelerometers and yaw rate gyros
(sparkfun.com)

Zigbee radio for serial digital
communication
xbee.com



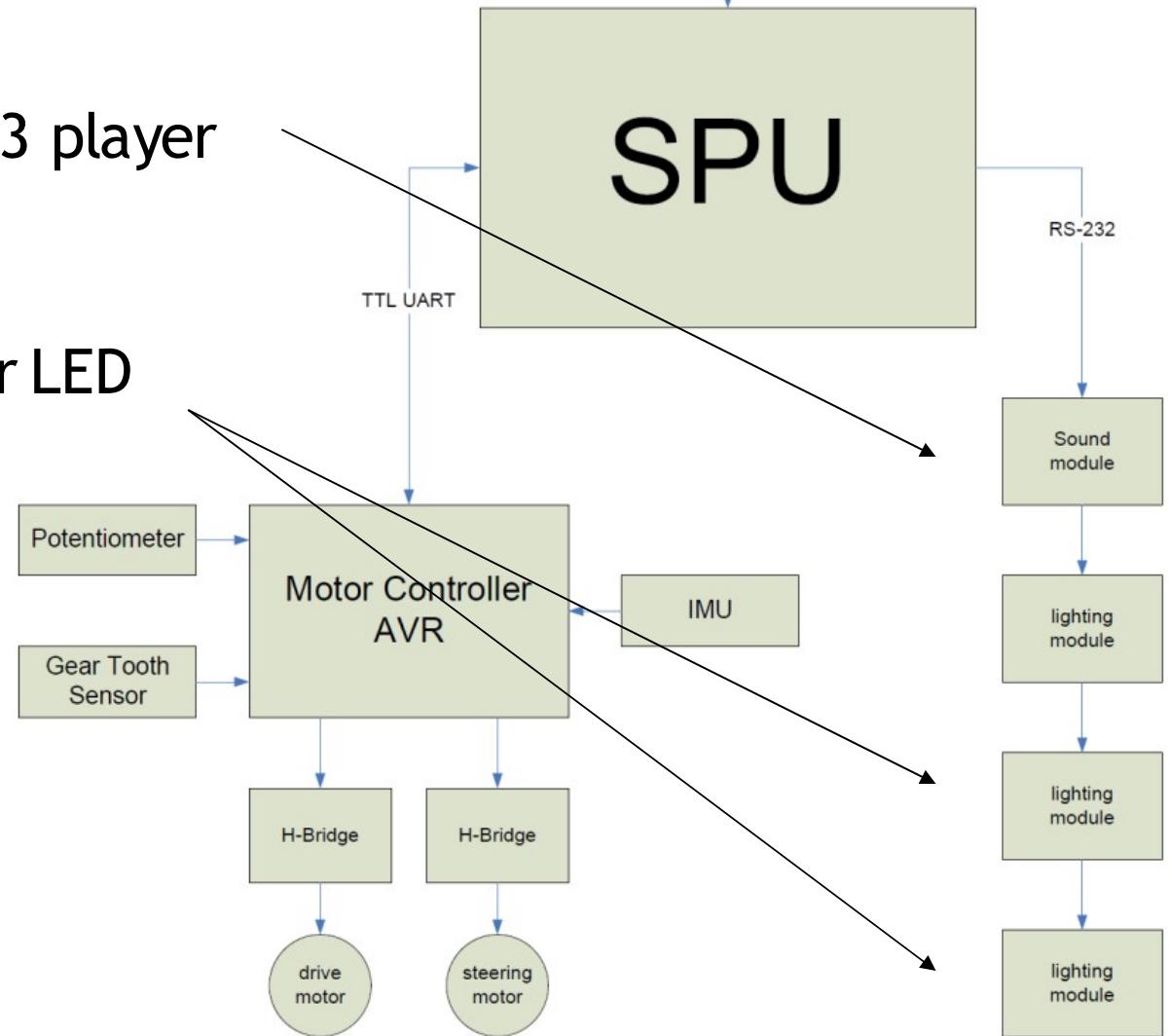
information flow



artistic payload:

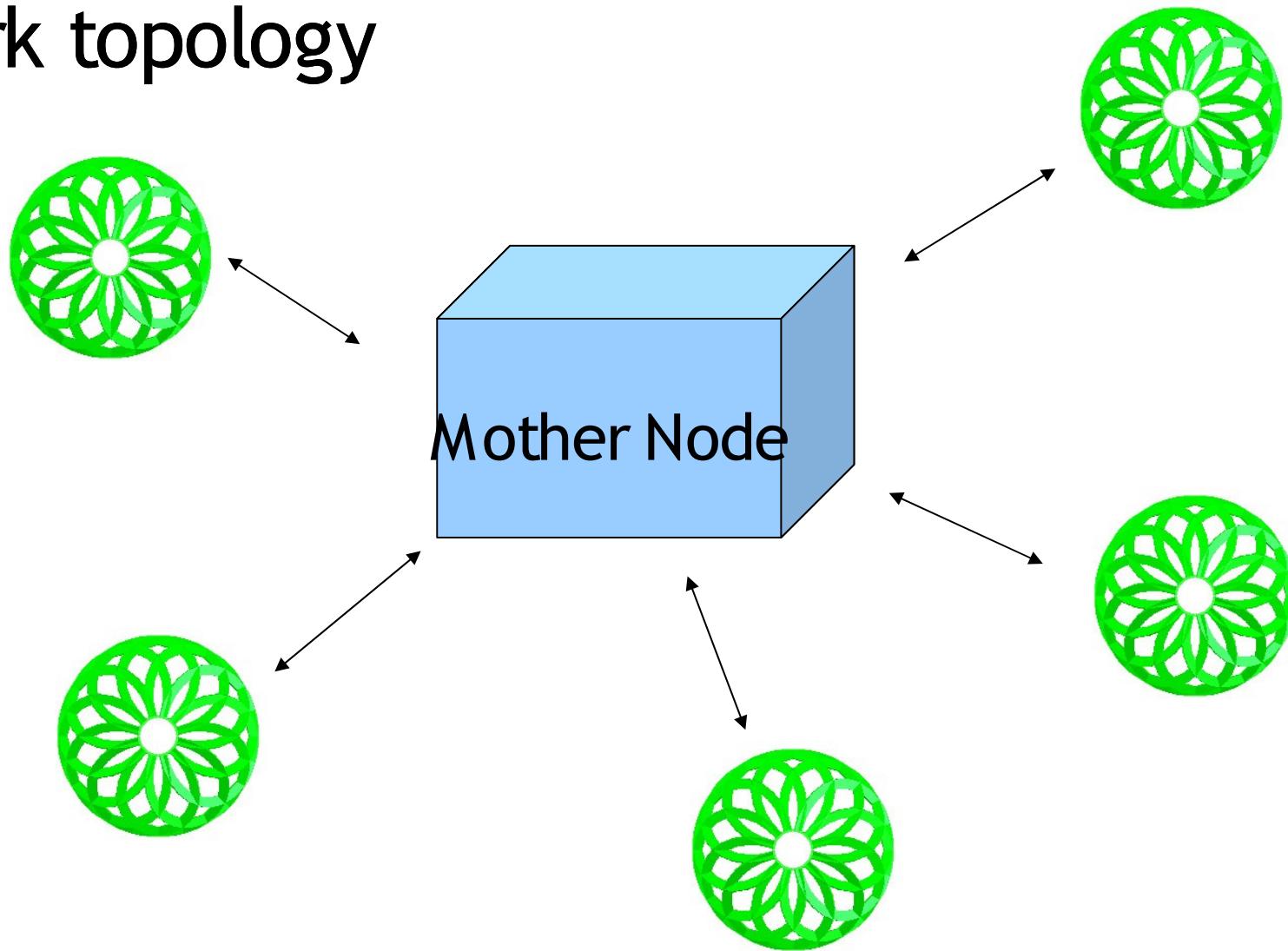
serially-controlled MP3 player
and amplifier

fully controllable color LED
modules





network topology



star network with round-robin polling
Mother Node is any PC (playa-proofed)
Orbs controlled with simple serial API



right... so how did they work?



they worked pretty great, actually



current capability: remote control



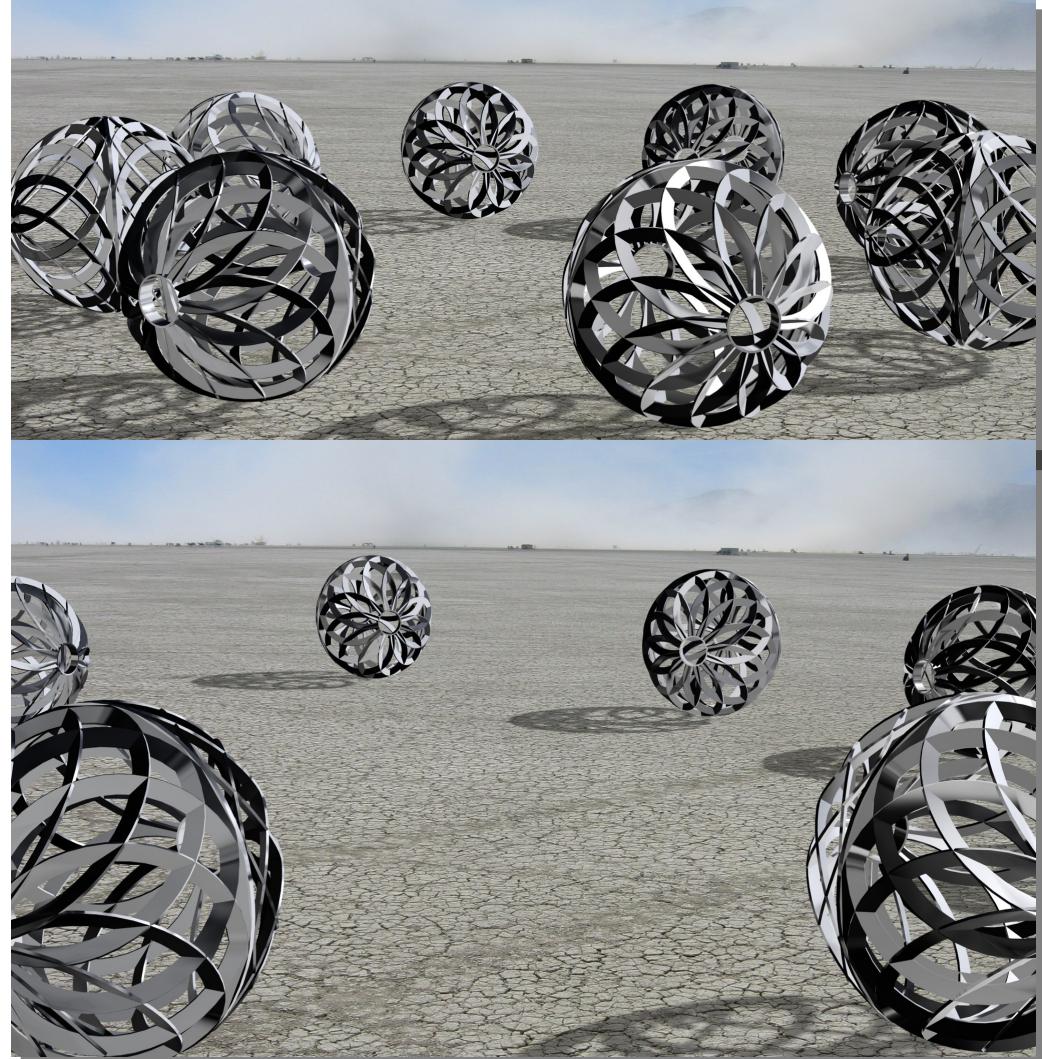
future vision: interactivity



The Magic Wand allows participants to control SWARM and direct formations like a sorcerer.

future vision: autonomy

location-aware orbs
from GPS and inertial
sensor fusion,
permitting:



- interactive synchronized choreography
- autonomous and evolutionary behaviour

An art form for the 21st century

thank you

www.orbswarm.com