

*Acoustic Pendulum*  
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# Introduction

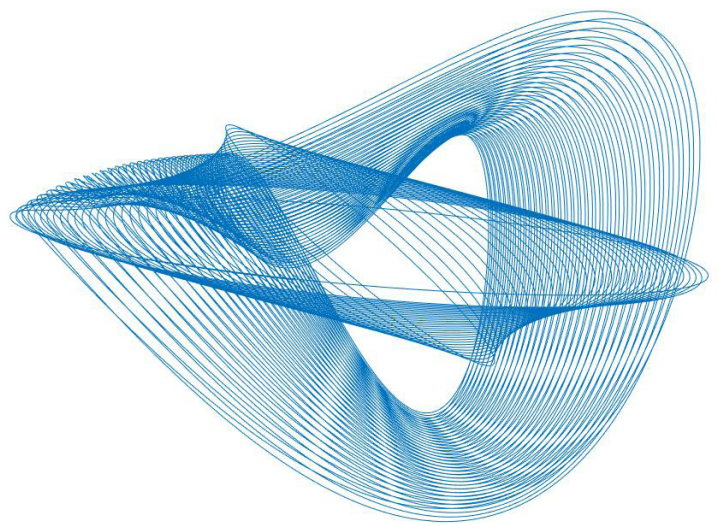
Acoustic Pendulum is an immersive and modular installation project for 1 to 4 pendulums, placing gravity and acoustics in a generative equation.

Echoing Foucault's pendulum, this kinetic installation is an extension of Steve Reich's "Pendulum Music" created in 1966, where hanging microphones oscillated over speakers put on the ground, depending on a timing principle limited by the influence of gravity on the duration of their swing. Here the device is reversed: the microphone stands located still in the room and the speakers arranged inside the pendulum move in the room space.

Unlike more recent works, such as "Nowhere" by William Fosythe and Ryoji Ikeda (2017), "Sonic Pendulum" by Yuri Suzuki (2017), Momentum from the UVA collective (2014) or "Pendulum Tuning" by Turcsany Villo (2012), Acoustic Pendulum animates a pendular system capable of generating, in both space and time, its own sound and movement from a state of motionlessness.

## Statement of Intent

Through the artistic diversion of a physical theory, Acoustic Pendulum offers us a sensory and contemplative experience in symbiosis with gravity. The installation becomes its own self-generating sound wave of poetic landscapes in fragile, connected and suspended equilibrium. This project is part of the slow motion, search for the right gesture, where time, movement and sounds come from the same interaction, as if in a dance. In addition, the in situ combination of the variations in the acoustic of the room and the spectator's activity inevitably shape the performance, wherein movement and sound can perpetually be redefined through the oscillating nature of the object.



# The basics of research

Stillness, as a starting point of any movement, dominates the origin of this research: how to give birth to a fluid pendulum movement and keep it going without any time limitation and without any outside help?

Physics tells us that  $\text{Frequency} = 1 / \text{Time}$ . Therefore the frequency principle of resonance is applied as the central element of the technical approach serving this plastic research. In the ambivalent enigma revolving around the presence of Eternity, what is the part of Balance and Permanence in it? And how can we apprehend these concepts aesthetically, dynamically and sonically within the ecosystem of the installation form?

## Aesthetic

Each pendulum imposes itself by its presence in space like a totem pole, with the difference that its anchor point is not a fixed point on the ground that connects it to the center of the earth, but an elevated point in height that radiates in multiple directions. Its dimensions remain within our human conception of volume: comforting in its form, yet destabilising in its movements.

Raw yet orderly, the materials, are mainly metal for the structure and plexiglass for the sphere. The object seeks a certain elegance in the simplicity of its lines and stripped down to its functionality. The transparent sphere renders the animality of the mechanism visible as it arouses a primal

function of our curiosity. When the functioning of the mechanism is assimilated, the viewers forget it and abandon themselves to the sonified movements of the unfolding landscape. The object is reminiscent of a certain science-fiction aesthetic and lends itself to an anthropomorphic imagination of robotics with its cyclops eye, moving parts, membrane ears, fluid movement and luminescent sensors.

## Dynamic

From the design phase, the project was significantly associated with the lexical field of dance, primarily the search for the "right gesture" in a time that takes the time to be here. A temporality which has no task other than to disappear, leaving a mark, much like the memory of a drawing, or the body during the choreographic act.

Lateral, elliptical or circular, the movement technically results from implementation of a double-pendulum, in which gravity cyclically rectifies the imbalance caused by the periodic shift of its balanced weight towards the center of the device.



The weight transfer that displaces the equilibrium point has long been explored in contemporary dance, as evidenced by the recent creations of Yoan Bourgeois with "Scala" or Angelin Preljocaj with "Gravity".

Just as a dancers work with their gravitational consciousness combined with an increased knowledge of their bodies, each pendulum constituting the work invariably requires a resonance frequency at all times to precisely modulate its amplitudes. To do this, its frequency is recorded, then updated in real time by a sensor which tracks all accelerations of the x, y and z planes of sound oscillation. When going in the opposite direction, the pendulum crosses a brief moment of immobility which the sensor registers with a 0, which is then transformed into a Bang (trigger). Thus, between two Bangs (triggers), the patch calculates a Time (= Frequency).

This time is applied to the swing of the balanced weight in 3 angular speeds (acceleration, constant and deceleration) as we can see in the video (1'08 "). Each angular velocity is thus calculated in order to cover the correct distance between the ends of its amplitude: the apexes. The fluidity of its progression is obtained by allowing the natural inertia of the pendulum to complete each of its oscillations. To do this, the engine executes 60% of its course during the first 25 degrees of its progression, then up to 40% for the next 25, leaving it to inertia to bring the pendulum to the moment of immobility to be analysed, so that the patch will translate into a Bang to relaunch a new command in

the opposite direction, and so forth. The pendulum begins to oscillate, increasing its angle and speed by one degree every five oscillations. In this way, the pendulum can come to life on its own up to an amplitude of 2, 3, 4, etc ... meters above the ground, depending to the height of its range. So, it is through the conjunction of electromechanical, gravitational and inertial forces that the pendulum finds its natural fluidity, a kind of animality sought through the diversity of its behaviours. Finally, each pendulum has at its hook a rotation motor, used alone (video at 43"), or combined with the oscillation motor (video at 0 "). These rotations allow ellipses or circles in space visible on the video at 2'02 ", and favour a mobile projection of the sound in 3 dimensions.

**V i d e o   L i n k**

**Acoustic Pendulum**  
(groundwork)

# Sound

Acoustic Pendulum creates a favorable environment for the sequential generation of sound landscapes which are sensitive to the situation, capturing and restoring the acoustics of the location. The sound emitted is the result of the continuous acoustic field between the speakers and the microphone, so that there is neither sampling nor memory involved. The audio engine multiplies the incoming signal in 4 matrix programmable units. Within each unit, the signal is fed back on itself with a 10 seconds delay, creating a continuum. The data from the inertial unit (gyroscopic & accelerometric sensor) is routed to the audio engine and, depending on the sequences, stimulates various sound modulations, especially time feedback resulting from relatively granular effects. So the pendulum becomes the interpreter of the sound installation. At times, it manages to achieve a perfect synchronization between movement and sound, causing all sorts of natural phenomena, such as phasing and doppler effects, as if the spectator had been immersed inside a Leslie cabinet. In the 2'10 " video, we sometimes hear melodies, made by major second or third intervals, fifths and octaves, etc ...

These are purely aleatoric electroacoustic variations of the natural harmonics of the fundamental feedback, which the movements of the pendulum modulate within the acoustic character of the space. Most of the sound work is focused on a spectral approach to timbres and on the projection of sound.

The sounds can sometimes bear resemblance to acoustic wind instruments, electric bass or chimes, or else modular

or additive synthesis. In addition, the engine's drive belt is audible. It shows the metronomic character of the frequency of the pendulum, and participates in the sound material, like a pulse.

Technically, two speakers per pendulum are wired in stereo (1 or 2 pendulums) or in mono (3 to 4 pendulums). The choice of the speakers was decisive for prototype. These are Focal 100-ICW6 high definition models, designed to work without VAS, so as to avoid forcing the sphere to act as a speaker in expressing all frequencies in an optimal way. Low frequencies, are outsourced to one or two subwoofers which impart an immersive feeling of the installation due to the natural spatialization of sound.

Finally, any other exogenous sound at installation is able to enter the loop reinjection, such as the birds that we hear in the video at 1'27 ". So the installation also interacts with the sonic context of its surroundings.

## Ecosystem

Acoustic Pendulum induces a global circular conception between the machine and the living; the computational part is designed in max/msp, which constitutes the brain of the loop. Other software is also involved, such as Python for the concatenation of messages sent by serial link to the steppers, as well as C for Arduino for programming the sensors. The general principle of the programming comes alive like a body composed of different organs, each of which plays a precise role in coordination with others.

The part that calculates the frequency of resonance thus imposes itself as the organic heart of the global system. The part which mainly deals with the movement and the sound is sequenced in the form of phases called "Landscapes". They each succeed one another, as in a score, offering a time frame for the installation. This last one finds its permanence in balancing the predictable functioning of the movement and the chaotic behaviour of the sound, all synchronized through the rhythm of the oscillations that gravity imposes to the pendulum(s).

## More Information

[Dedicated Webpage](#)



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