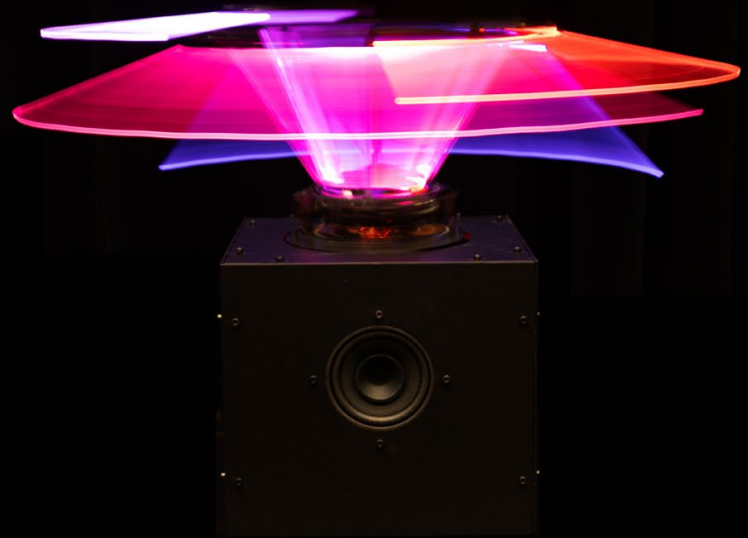


# Motionforms: A Kinetic Light and Sound Installation

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*Motionforms* is a kinetic light and audio installation. The installation consists of several identical objects, each comprising a cube-shaped base with four outward-facing loudspeakers and a rotating platform with articulated, illuminated acrylic rods. *Motionforms* exploits motion-induced perceptual illusions to control its visual and musical content. At high rotation speeds, the persistence of vision effect causes the illuminated rods to appear as smooth, radially symmetric surfaces. Simultaneously, the installation emits computer generated sounds whose onset rate is proportional to the rotation speed. At a high onset rate, these sounds form perceivable melodic patterns due to auditory grouping. *Motionforms* is also a generative artwork that operates autonomously. The installation progresses through scenes defined by specific visual and acoustic forms. Scene progression is controlled by a probabilistic finite state machine. This design allows for a predetermined aesthetic progression while maintaining variability and unpredictability in the installation's behaviour.

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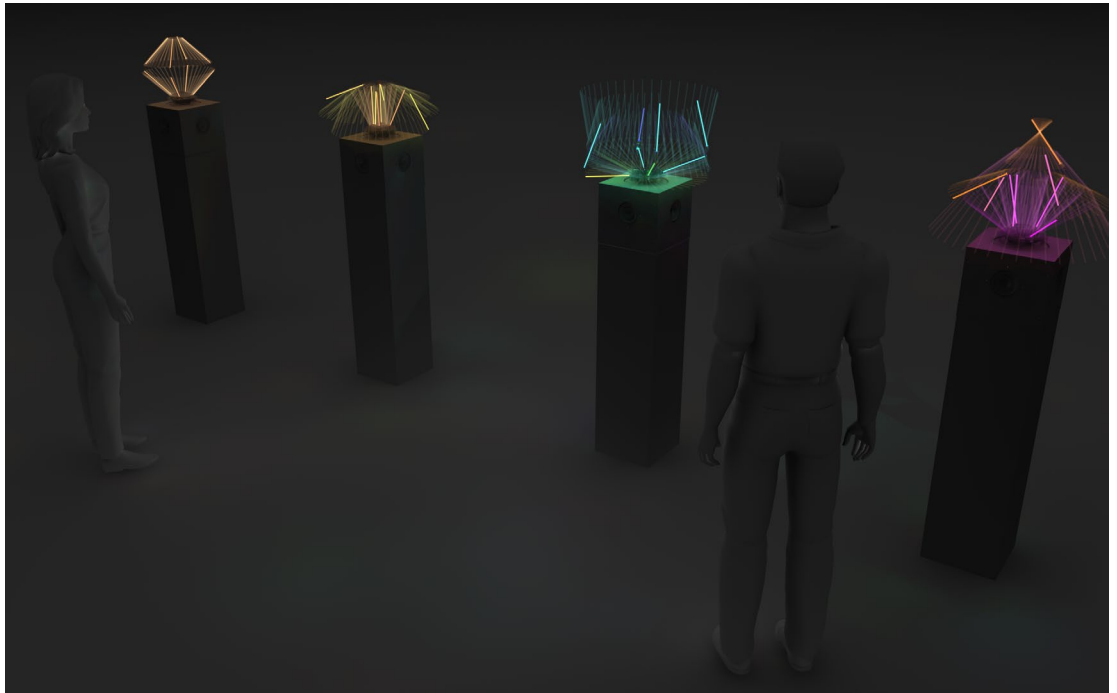
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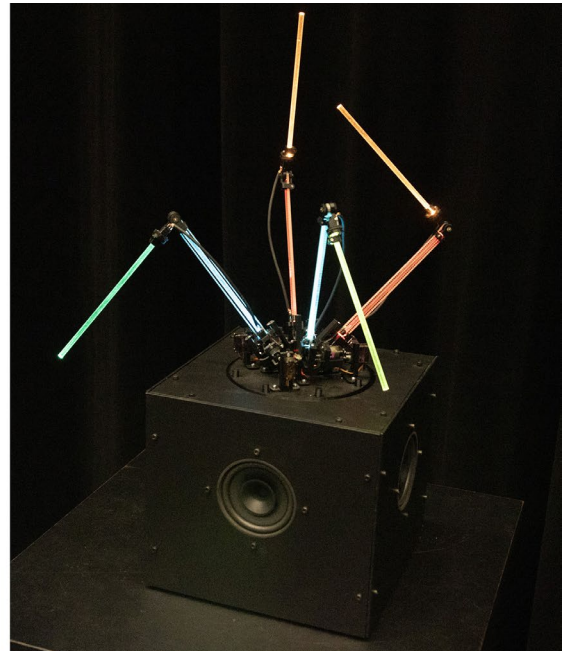
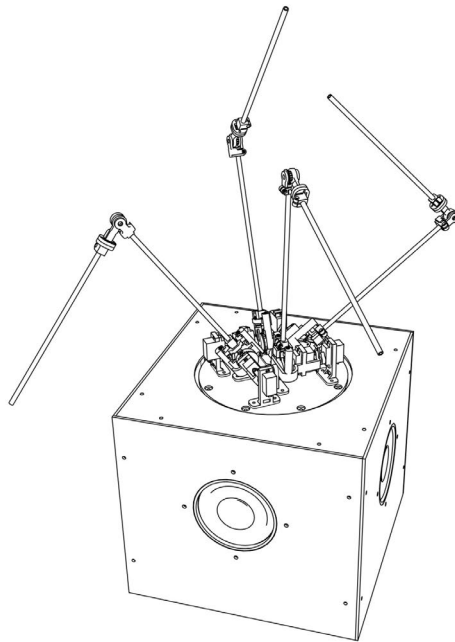
**Fig. 1.** Installation Setup. The graphical rendering depicts four kinetic objects arranged in a line and placed on top of pedestals. Each object rotates and shows a different visual form. The audience observes the installation from a small distance.

## Description

*Motionforms* is a kinetic light and audio installation that demonstrates how perceptual illusions can be exploited for artistic purposes. The installation employs motion to evoke the appearance of visual and musical forms. These forms are the result of perceptual effects that occur when presenting the elementary visual and auditory stimuli at high motion speed. The installation consists of four objects, each equipped with rotating illuminated rods and stationary loudspeakers. Above a certain rotation speed, the persistence of vision effect (Hardy 1920) causes each rod to appear as a smooth surface that possesses radial symmetry. The installation emits a pattern of sounds whose onset rate is related to the rotation speed. Based on the Gestalt laws of grouping (Snyder 2000, 31–46), above a certain rate, the pattern is perceptually subdivided into several auditory streams that appear as independent sub-patterns. During the exhibition, the installation progresses probabilistically through a variety of visual and musical forms, each one characterised by a distinct combination of elementary stimuli and speeds. A possible setup of these objects in an exhibition is depicted figure 1. Several videos are available online that demonstrate the formation of visual and musical forms. Each example video corresponds to one of the configurations depicted in figure 3.

## Kinetic Objects

*Motionforms* consists of several kinetic objects. Each object comprises a base in the form of a cube and a rotating platform (see figure 2). The base houses four loudspeakers, each mounted to one of the four side panels, facing outwards. The rotating platform is embedded into



**Fig. 2.** Kinetic Object. The two images depict a single kinetic object of the *Motionforms* installation. The image on the left represents a schematic drawing of the object. The image on the right is a photo of the built object.

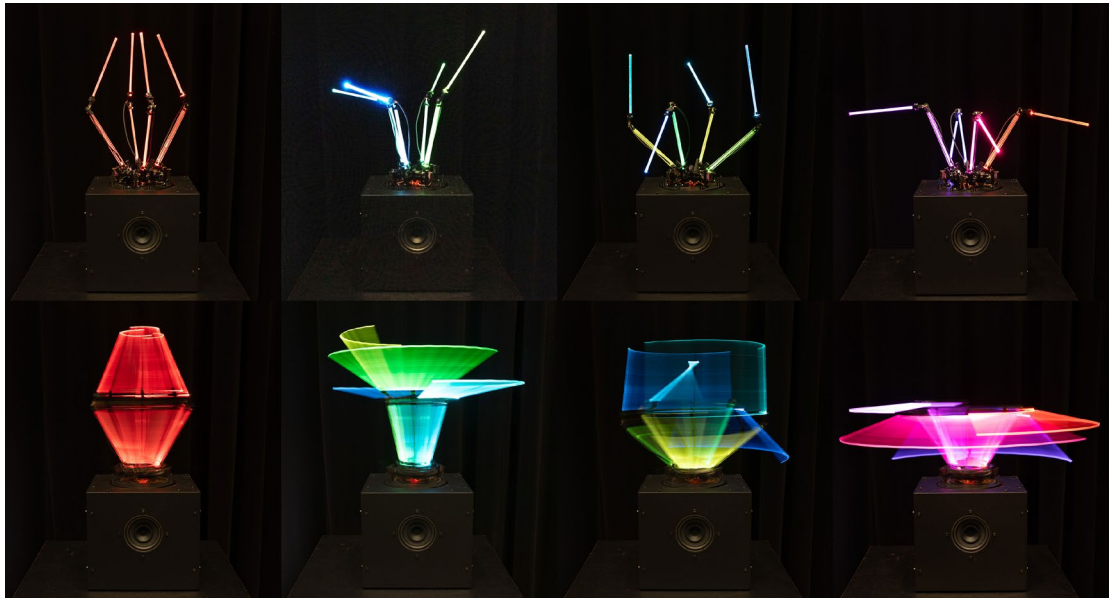
the top panel of the cube. Its rotation is driven by a stepper motor. Attached to the rotating platform are 8 acrylic rods. In pairs, these rods form four articulated arm-like structures that are oriented at 90 degrees from each other. Each arm possesses two revolute joints. A first joint connects the bottom rod to the rotating platform, and a second joint connects the two rods together. Both joints are actuated with servo motors. Attached to the base of each rod is an RGB LED that illuminates the rod. The rotation speed of the stepper motor, orientation of each servo, and the colour and intensity of the light emitted by each LED can be controlled individually.

## Light

The colour and intensity of the illumination of the acrylic rods, their orientation, and the speed of their rotation are the main factors that affect the visual appearance of each kinetic object (see figure 3). When the rotating platform is immobile or slowly moving, the acrylic rods appear as lines that are arranged in geometric configurations. Changes in the orientation and illumination of the rods lead to new geometric configurations. If these changes happen gradually and continuously, the configurations appear animated. As the speed of the rotating platform increases, the lines become increasingly blurry. When the rotation speed exceeds the temporal resolution of human visual perception, persistence of vision effects cause the formerly distinct lines to appear as nested rotational surfaces.

## Sound

The installation emits a sequence of computer-generated sounds that are organised in a cyclic pattern. There is a twofold relation between these sounds and the visual appearance. First, the properties



**Fig. 3.** Visual Forms. The photos show different visual forms that result from different rod configurations. These configurations vary along the rows but are identical in each column. The rotating platform is stationary in the top row and moves at high speed in the bottom row.

of the sounds, such as timbre, duration, and temporal shape, are coupled with the colours and the orientations of the acrylic rods. It is, of course, impossible to define an unambiguous analogy between the visual and the acoustic. However, since every change in one realm is matched by a change in the other, a clearly perceivable connection is created. The second relationship is that the onset rate of the sounds corresponds to the speed of rotation of the platform, which becomes particularly apparent when the speed increases or decreases.

The psychologist Albert Bregman coined the term ‘auditory scene analysis’ to describe the process by which the human auditory perception organises the received overall sound into meaningful elements (Bregman 1990). “Streaming” denotes the mechanism by which the perception combines sounds that share certain similarities because they originate from the same sources into coherent groups. Two factors facilitate streaming. First, sufficiently large differences between sounds that belong to different groups, and second, a rapid succession of sounds. These differences may concern pitch – most relevant in music – but also any other parameter of the sound, such as timbre, temporal envelope, or loudness. In fact, any systematic perceptual difference can stimulate streaming, provided the onset rate is sufficiently high (Moore and Gockel 2012).

Since the speed of rotation of the platform is related to the playback speed of the sound pattern, several perceptual states are experienced as the speed changes. At a very slow speed, it is almost impossible to detect the overall cyclic pattern, and the successive sounds seem unrelated. At a medium speed, the pattern becomes audible. At a high speed, streaming occurs, and the overall pattern is subdivided into two or more separate streams, each of which is itself a shorter cyclic pattern.

## Installation Behaviour

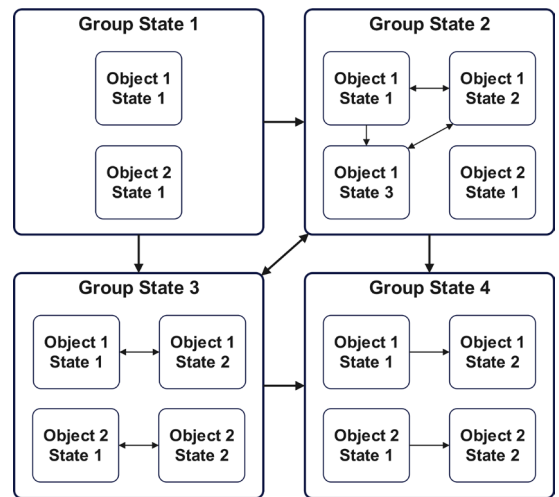
The installation is not interactive and instead operates autonomously by progressing through a sequence of scenes. Each scene is characterised by a particular combination of visual and acoustic forms for all installation objects. The scene progression is based on a probabilistic finite state machine (Vidal et al. 2005) (see figure 4). There exist two types of states: object states and group states. An object state corresponds to the visual and acoustic form of a single kinetic object. This state defines the settings for the illumination and geometric arrangement of the rods, the speed of the rotating platform, and the sound synthesis parameters for sound events. A group state corresponds to a scene which consists of a combination of the visual and acoustic forms of all kinetic objects. Each group state possesses its own internal state machine that controls transitions between object states. A global state machine controls the transition between the group states. For the exhibition, these states and their transition probabilities are designed in a manner that causes the installation to follow a chosen aesthetic progression while maintaining a degree of variability and unpredictability.

## Notes

1. Example Video 1: <https://vimeo.com/1056073456>.  
Example Video 2: <https://vimeo.com/1056073567>.  
Example Video 3: <https://vimeo.com/1056073296>.  
Example Video 4: <https://vimeo.com/1056073375>.

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**Fig. 4.** Installation State Machine. The schematic drawing depicts a possible combination of group states and object states. For simplicity reasons, object states are shown for two kinetic objects only. Boxes represent states and arrows represent possible transitions.