

ZoOHPraxiscope, Re-Inventing the Zoopraxiscope with an Overhead Projector

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ABSTRACT

The ZoOHPraxiscope is a modified overhead projector that can be used to show cinematographic animations. It allows blending and mixing of animated shadow play with cinematographic animation. Similar to the Zoopraxiscope that was developed by the photographer Eadweard Muybridge in the 19th century, the ZoOHPraxiscope combines a rotating picture disc with a Laterna Magica and shutter mechanism. The mechanical shutter of the original device is replaced by a high-power LED that can be turned on and off at the fraction of a second. The overhead projector acts as Laterna Magica. This new device is used as a performance instrument to combine sound, vision, shadow play and animation.

KEYWORDS

Cinematography; Media Archeology; Overhead Projector; Shadow Play; Zoopraxiscope.

1 | INTRODUCTION

The ZoOHPraxiscope is an audiovisual performance tool that allows shadow play to be combined with cinematography. It is based on a modified overhead projector (OHP) that can produce flickering light. A transparent rotating picture disc is mounted on the screen of the projector, when this picture disc is put into rotation and the OHP runs at the correct flicker rate, an animated series of moving images is created.

1.1 EARLY CINEMATOGRAPHIC DEVICES

The principle of cinematographic animation using rotating picture discs (see Figure 1) was first discovered by Simon Stampfer and Joseph Plateau around 1830 (Zielinski, 1999).

They made their discoveries independently, but were both influenced by the discoveries of the stroboscopic effects by Michael Faraday. The animation devices they developed were mass produced and popularized



Figure 1 | A picture disc for the Zoopraxiscope developed by Eadweard Muybridge (Wikipedia, 2015).

under a variety of names, including Wheel of Life, Phenakistoscope, Stroboscopic Discs or Phantascope.

In 1879 Eadweard Muybridge combined such a picture disc with a Laterna Magica that was enhanced by a shutter mechanism (Hendricks, 1975). The combination with a Laterna Magica allowed him to show animations to a larger audience.

He called this device Zoopraxiscope and used it mainly to show animations of animals in motion, hence the name, which is Greek for animal action viewing device (Prodger & Gunning, 2003).

But Muybridge was not the first to develop this type of device. A bit earlier Franz von Uchatiu invented the Phenakistoscope projector, and Ottomar von Anschütz the Electrotachyscope (see Figure 2). All these inventions and innovations share the technological combination of a picture disc (see Figure 1) combined with a Laterna Magica and a shutter mechanism. The devices appear in a timeframe of only 45 years between 1845 and 1890 (Füsslin, 1993).

This era is often designated as pre-cinema, but as Zielinski writes, this is a shortsighted reduction, because the variety of different approaches and of the motivations that drove the persons involved was too large (Zielinski, 1999). For example, people like Muybridge or the chronophotographers Marey and Janssen were not interested in cinema but had the idea of using chronophotography and projection devices to reveal a deeper truth about the world (Canales, 2011). This quest for truth is well demonstrated in the biography of the photographer Eadweard Muybridge (Muybridge, 1878). He used an array of photographic cameras connected to switches triggered by strings attached across the path the

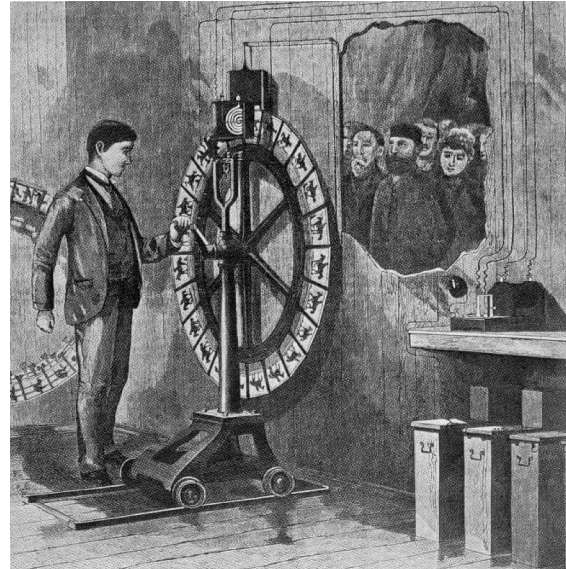


Figure 2 | Drawing showing the Electrotachyscope, by Unknown - <http://www.victorian-cinema.net/machines.html> first published in "Scientific American", 16th November, 1889, page 303. Licensed under Public Domain via Wikimedia Commons.

horse would run along. Using this technique, he succeeded in taking a series of photographs that demonstrated that a horse has all feet off the ground during gallop.

1.2 THE OVERHEAD PROJECTOR

As Zielinski writes in "Over the head" (Zielinski, 2014), the overhead projector produces or projects the particular, the dispersed and the heterogeneous in contrast to the homogeneity of today's presentation software. This heterogeneity of the OHP stems from the fact that the space where the projection happens is a space and not just a surface. Here it is possible to act, to layer information, to drop a picture, to place an object, to annotate, to comment or as Zielinski writes to construct a 'fragile thing of thought'.

Not so surprisingly, when taken out of the context, where the overhead projector is known best, the classroom, the overhead projector is very refreshing and has a lot of magic to offer, instead of being boring as we remember it.

This freshness is best documented in the various artistic re-appropriations of this device as they have, for example, been featured at the festival "the Art of the Overhead" in 2005 and 2009 (Gansing, 2013).

The performance group Loud Objects (Loud Objects, 2015), use the space on the OHP for a soldering session, assembling electronic circuits that produce sound on the overhead projector. While one follows a

shadow play of hands, soldering irons and smoke, at some point these shadow objects start to emit sound, rhythms and become loud.

Klaske Oenema a singer-songwriter and storyteller uses the space above the OHP in a different way. While she sings, she unfolds a story filling the space on the OHP with images that are scratched or drawn onto found transparent objects.

Even though these two examples are very different in style, one being loud, noisy and experimental whilst the other is silent, harmonic and poetic, both share the same magic, the magic of the *Laterna Magica* and of the shadow play.

1.3 CONTEMPORARY ARTISTIC USE OF PRE-CINEMA ANIMATION

Zoetropes and Phenakistoscopes have not lost their appeal for artists and there is quite a number of artistic projects that revive these technologies.

With the advent of 3D printing and LED technology, three-dimensional Zoetropes have become very popular (Dickson, 2003; Smoot et al., 2010). Another example of technology reviving the principle of cinematographic animation is the use of ubiquitous computing for projects such as *Agit P.O.V.* (2015).

Agit P.O.V (Petit Objet de Vélo) is a microhack for bicycles relying on the persistence of vision (POV) effect, the propaganda tactics of the russian avant-garde (AGIT Prop) and the SpokePOV Project by Limor Fried (LadyAda).

Agit P.O.V. uses an array of LEDs equipped with a micro-controller that is attached to the spokes of bicycle wheels. When the wheel turns, the micro-controller flashes the LEDs so that a virtual writing appears on the bicycle's wheel.

The group *Sculpture* (*Sculpture*, 2012) created mesmerizing performances using the *Phonotrope*. The *Phonotrope* is a combination of a record player with picture-discs, a high-speed shutter camera and a video beamer.

The installation *Kiss-o-scope* by artist Amanda Long (Long, 2015) is yet another example for the creative use of the principle of the Phenakistoscope. She

developed custom software to render live streams of camera images into a Phenakistoscope display projected by a beamer.

2 | TURNING THE OVERHEAD PROJECTOR INTO A ZOOPRAXISCOPE

I have been working on a technological update of the overhead projector, primarily driven by the wish to reduce its energy consumption in the context of a project for creating a mobile overhead projector [1]. With the development of high power LEDs it has become possible to reduce the power consumption by a factor of ten and still deliver enough light intensity for classroom presentation. But most importantly for this project, it has also become possible to easily switch the light source on and off at the fraction of a second. While standard halogen bulbs have a non-negligible afterglow, a LED may be switched on and off at high frequency. The complicated mechanism of a film projector's shutter may be realized simply by turning the LED on and off.

Combined with a rotating disc it is possible to easily create an animation based on the principle of the Phenakistoscope. Through the projection with the OHP it is possible to show the animation to a larger audience, similar to the *Zoopraxiscope*, hence the name *ZoOHPraxiscope* (see Figure 3).

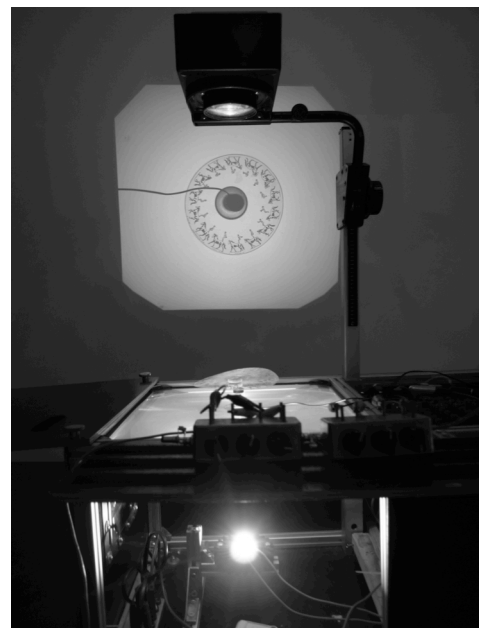


Figure 3 | The ZoOHPraxiscope, A custom build overhead projector with a high power LED as light source and a Zoopraxiscope-disc printed on a transparency.

2.1 REPLACING THE LIGHT BULB WITH A HIGH-POWER LED

A standard overhead projector is equipped with a 250 Watt light system. It uses a 24 Volt halogen lamp that is operated with a current of 10 Ampere. To provide such large amounts of current requires a big transformer that converts the 220 Volt AC current into 24 Volt DC current. Because the halogen lamp is an incandescent lamp a lot of heat is produced. As a consequence most overhead projectors are equipped with an active cooling system. Because the lamp emits light in all directions a mirror is placed behind the light bulb to reflect the light in direction of the Fresnel lens. In front of the lamp a diffusing lens is mounted that spreads the light so that the Fresnel lens is illuminated homogeneously.

With the introduction of affordable high-power LEDs it has become possible to greatly simplify the overhead projector and to drastically decrease its power consumption, while providing approximately the same light intensity.

To run a 20 Watt LED, a constant current provider is needed, these are widely available and can be easily purchased. A 20 Watt LED that runs at 14 Volt will draw a current of 1.4 Ampere, which can be provided by a very cheap and very small switch-mode power supply. High-power LEDs are arrays of LEDs that are mounted on a surface. The light they emit is directional and covers an angle of approximately 120 degree and no extra lens is needed to homogeneously illuminate the Fresnel lens. High-power LEDs may be passively cooled; it is sufficient to mount them on large cooling block. All in all, replacing the halogen lamp with a LED is very simple and also simplifies the projector. The active cooling fan, the big transformer, the optics with the bulb can be removed and leave ample space for installing a bigger cooling body with the LED mounted on.

2.2 CONTROLLING THE HIGH-POWER LED

All standard constant current drivers for LEDs offer a pulse width modulation (PWM) interface for dimming. This interface is intended for dimming the LED, by turning it on and off at a high frequency at which no flicker is perceived. But it can be operated at any frequency. In order to create the illusion of continuous motion from discrete images, the rate has to be at around 18 frames per second as in standard cinema.



Figure 4 | The bi-core unit, left potentiometer controls on-time of the LED, right potentiometer the off- time.

A second parameter besides the frequency at which the LED is turned on and off is the duration of the on-state of the LED. This is an important parameter for continuously rotating picture-discs. In order to have stable image without motion blur the on-time has to be very short. This short on-time corresponds to the thin slits in the classical zoetrope cylinder. When the slits are too wide the animated image is blurry (Füsslin, 1993). Analogously when the on-time is too long the image becomes blurry.

Both parameters, frequency and on-time, can be controlled with a very simple analog circuit, the bi-core oscillator (Hasslacher & Tilden, 2002) (see also Figure 4). While there exist other oscillator circuits, I use the bi-core, because it can also drive motors. This offers the possibility to couple the flicker frequency with driving the motor, in order to synchronize both. With the two variable resistors of the bi-core circuit, the on-time and the off-time can be controlled independently.

2.3 DRIVING SPINNING DISCS

To spin the picture-discs, I use standard DC-motors with a gearbox that directly drives the discs. The motors are mounted on a holder with a vacuum cup, so that the motors can be quickly positioned on the overhead projector. The motors carry an acrylic disc that holds the picture-disc printed on a transparency (see Figure 5). For controlling the rotation speed,



Figure 5 | The Picture-disc is mounted on a dc-motor. The motor is fixated with a vacuum cup on the screen.

again I use a bi-core oscillator. To create a continuous rotation instead of an oscillation the potentiometer for the right spin is set to zero, so that the motor will only turn to the left. The speed can be controlled by a third potentiometer that controls the current for driving the motor.

2.4 SPINNING DISCS AND FLICKERING LIGHTS

Being able to control both the flicker of the LED and the rotation of the spinning disc allows to play and search the magical moment when the animation appears. There is a huge parameter space in which the illusion of continuous motion is perceived. It starts at around 12 frames per second and goes up to 40 frames per second. The number of single images on the picture-disc and the rotation speed of the disc determine the number of frames per second. The flicker of the LED then needs to be adjusted accordingly, for example a picture-disc with 16 images that makes one rotation per second requires 16 flickers per second.

2.5 COMBINING SOUND AND VISION

When used in the shadow play animation mode, the combination of sound and vision is based on directly listening to oscillatory signals that generate movement of a robotic structure, or to couple these signals to analog synthesizers. This technique of combining sound and vision is described in more detail in the paper *Rhythm Apparatus on Overhead* (Faubel, 2014).

The same set-up is used for driving the spinning picture-discs. Using an oscillator circuit to drive the rotation of the picture disc may seem counter-intuitive at first sight. But it allows adding rhythm to the continuous rotation of the picture disc. At naked eye this rhythmic structure is not visible, the motor just seems to turn. But when the rotation is combined with flicker from the LED, not only the cinematographic animation becomes visible, but also rhythmic discontinuities in the movement of the picture disc.

A second way to add rhythm to the rotation is the use of a step sequencer to drive the motors of the spinning discs. The step sequencer itself is driven by the rhythmic structure of a bi-core oscillator. With a step sequencer it is possible to skip steps and to create more complex rhythmical structures.

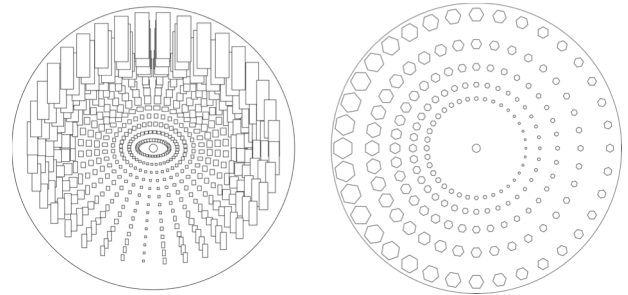


Figure 6 | Example picture-discs generated with the software. The left disc, shows rotating and expanding rectangles, the right disc produces expanding hexagons.

3 SOFTWARE SCRIPTS FOR CREATING ZOOPRAXISCOPE PICTURE-DISCS

I developed software scripts to generate Zoopraxiscope picture-discs, using the software framework Processing (Reas & Fry, 2006). These scripts generate minimalistic animations of simple shapes, such as expanding hexagons, rotating and expanding rectangles, or triangles moving in circles. Figure 6 shows two examples of such picture-discs.

4 | FUSING SHADOW PLAY WITH CINEMATOGRAPHIC ANIMATION

The core contribution of this project is the possibility to blend and mix shadow play with animation. I have developed an audiovisual set entitled *rectangular rotation* that I performed at the Algorave of xCoAx in Glasgow (xCoAx, 2015). *Rectangular rotation* is a minimalistic audio-visual set based on adding rhythm to the rotation of rectangles. The rectangles either rotate directly driven by motors mounted on the OHP or they rotate through cinematographic animation. The latter is realized through picture-discs that have the phases of rotation engraved or cut-out.



Figure 7 | Still from the performance at the xCoAx Algorave. On the left of the projection screen are two rectangles that reverse rotation when hitting the vertical line, on the right are two picture-discs with engraved rectangles. (Photograph reproduced with permission from Claire Quigley.)

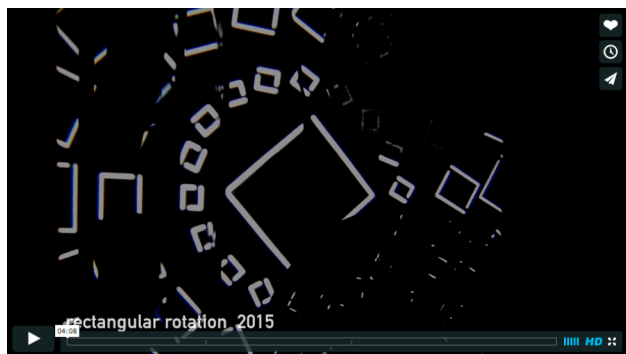


Figure 8 | A frame of the video showing the second part of the set rectangular rotation (<https://vimeo.com/136086099>).

The set consists of two parts; in the first part I use transparent acrylic rectangles and acrylic picture-discs that have the contours of rectangles engraved by a laser cutter (see Figures 7 and 8). The second part is the inverted version, that uses non-transparent rectangles and cardboard discs that have phase images cut out.

In the first part of the set, the signals that drive the motors are made audible by sending them through a voltage controlled band pass filter. The resulting sounds are twittering, high pitched variants of motor noise.

In the second part signals driving the motors are used to trigger sounds on an old circuit-bend drum synthesizers that has very deep sounding bass and kick-drum sounds.

The cut rectangles are driven by the microcore circuit and react to a vertical obstacle that carries a contact microphone. In the projection the vertical obstacle is just a thin line. The vertical line is pushed towards the rotating shapes; on contact, the shapes reverse their rotation direction until the other side hits the line again. A beat is created through the interaction of the shapes with the vertical line. A third motor carrying a disc with engraved shapes is mounted, the motor starts to spin, in synchrony with the oscillating shapes, every eighth beat, the motor makes a rotation and disc starts to spin.

Adding more and more motor events, the disc goes faster and faster, the engraved shapes smear out and can't be resolved by the eye anymore. Then flicker is tuned in, first at high frequency, barely perceivable softly going down. With the introduction of flicker, the shapes become visible again but now they are dancing, rotating back and forth.

The basic setup is established: a robotic structure providing a basic beat and shadow play, rotating picture discs creating a cinematographic motion animation. From then on the performance is about playing with the different parameters, tuning in and out the cinematographic effect by modifying the flicker rate, varying the basic beat of the robotic structure adding or removing steps from the step-sequencer (see Figure 8).

5 | CONCLUSION & FUTURE DIRECTIONS

To conclude I would like to quote André Rangel's comment on the paper "ZoOHPraxiscope, turning the overhead projector into a cinematographic device" submitted to the xCoAx conference (Faubel, 2015):

The presented ZoOHPraxiscope, as a system, merges new and traditional media, new and traditional techniques and new and traditional thoughts proving an untimely point of view, where the age of the media has no longer any sense, because all media were young and will become old, all media were high-tech and will become low-tech.

Re-implementing old technologies such as the animation of pictures with a Laterna Magica deepened my own understanding of the process creating the illusion of a moving image. Before building this device it was not clear to me that in order for the images to move they have to stand still. If they don't stand still as in the current prototype I have presented, the time for the light flash has to be extremely short otherwise the image will show motion blur. Only with a light flash shorter than 3 milliseconds no blur is perceived. As a consequence the projections are not very bright. The best way to manage this is to introduce a mechanism to really stop the picture disc on each phase image. This can be done with a Geneva drive as in the later Electrotachyscopes from von Anschütz (Ristow, 1986) or as in standard analog film projectors. Adding such a mechanism is an improvement I plan to add to this device in the future.

As the modification is really simple and cheap, I plan to develop a workshop for children and adults on modifying the OHP into a cinematographic device. One part of this workshop will be the technical modification, a second part the design of picture discs. Instead of using software, participants will

draw the phase images by hand and create their very personal animations. The idea is to use the workshop to convey the tangibility of animation and to mix arts and science.

ENDNOTES

[1] “Overheads on bike” - A project in collaboration with Tina Tonagel and Ralf Schreiber, funded by ON - Neue Musik Koeln e.V.

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BIOGRAPHICAL INFORMATION

Christian Faubel is an interdisciplinary researcher and artist. He is currently working at the Department exMedia within the Academy of Media Arts Cologne. He holds a PhD in electrical engineering and has

completed research on autonomous systems in the interdisciplinary lab, the Institute for Neural Computation from 2002-2012. In 2002 he founded derstrudel as a framework for the mediation of a relaxed approach to electronics. He is also part of the overhead projector band Ray Vibration together with Ralf Schreiber and Tina Tonagel. In his work he is interested in what enables autonomous behavior and how complex autonomous behavior may result from the interaction of very simple units and from the

dynamics of interaction between such units. In his artworks and performances he tries to convey insights about theoretical concepts such as emergence or embodiment along an aesthetic dimension. He considers his artworks, workshops and performances to be in the tradition of philosophical toys as they combine the mediation of scientific concepts with pleasure and amusement. His Workshops, Performances and Installations have been shown internationally.