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Illustration courtesy of the collection of Jack and Beverly Wilgus

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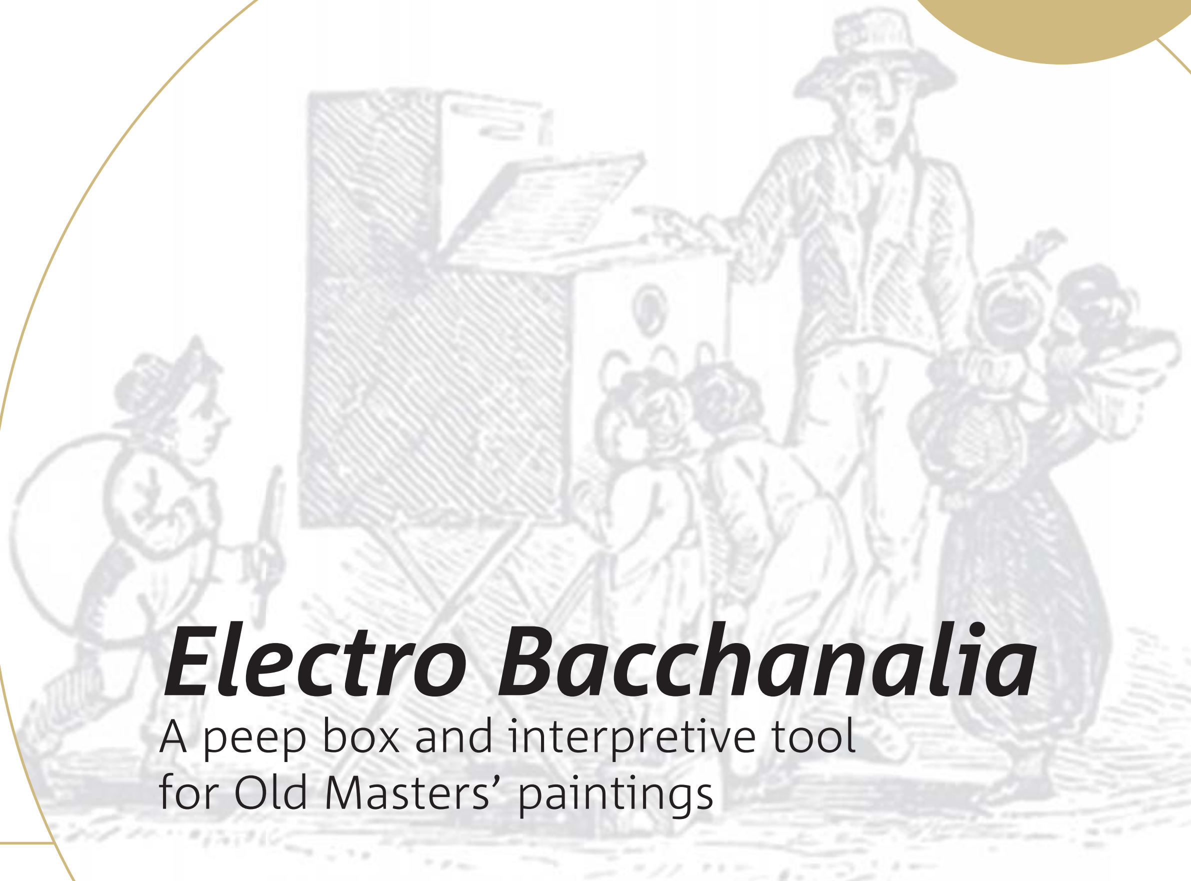

Electro Bacchanalia

A peep box and interpretive tool for Old Masters' paintings

Editor: Halina Gottlieb
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Electro Bacchanalia

Electro Bacchanalia is a museum installation that aims to stimulate visitors' interest in the motif of an Old Master's painting and makes a flirtatious reference to contemporary lifestyles. The installation consists of a reproduction of the painting in a peep box. The original painting was made circa 1640 by a French painter who belonged to Nicolas Chaperon's circle. The motif of this painting is Bacchanalia, a feast in ancient Rome in honour of Bacchus. The feasts led to such wild debauchery and excess that the authorities tried to undermine them. When peering into the box through a small hole, a stage-like setup of the painting is revealed. As music flows from the box, two of the characters from the painting are brought to life.

While it uses the aesthetics of the traditional peep show, Electro Bacchanalia is realised using modern technology and is based on video composites rather than the still images and objects used in historical peep boxes. The entire installation runs from a single computer with a TFT screen, and user interaction is controlled via a sensor and a micro-controller.

Introducing young visitors to old paintings in art and cultural history museums is generally conducted in the form of group tours with museum guides. Individual young visitors coming to museums, usually together with parents or other adults, make up about 40% of all visitors during weekends and holidays. It is clear that communication tools (for example, digital guides and interactive installations) can enhance young visitors' interest for the exhibition when compared to traditional labels that name the artist and motif. The positive function of these tools is especially apparent at permanent exhibitions where art is usually grouped by time period (e.g. 17th century French art). Temporary exhibitions often examine a specific theme, providing an accessible context through which the visitor can perceive art. Permanent exhibitions generally lack this and thus alienate visitors who do not possess the background knowledge necessary to evoke interest, learning and meaning.

The group of researchers from the Interactive Institute who developed Electro Bacchanalia experimented with various digital installations for the interpretation of Old Masters, modern art and contemporary art. Evaluations performed at the Interactive Institute for one demographic group (young visitors under 18 years of age) show that interpretive tools enrich museum experiences – young visitors remember more, and stay longer, after having experienced a digital application. From a pedagogical point of view, it is a challenge to provide tools in museum environments which:

- Feature interactivity for individuals and groups
- Narrate histories and stories related to artistic motifs
- Bridge the gap between an artist's message and visitor references
- Stimulate curiosity, fantasy and creativity
- Liberate something almost metaphysical from inside the visitors
- Activate visitors' own artistic talent

The Electro Bacchanalia project can be broken down into several fields of competencies: art and early film history, film production, interactive video player technologies, display solutions, physical computing and carpentry as well as museum pedagogy.

The unique point in a production such as Electro Bacchanalia is that these fields of competence rarely coincide. In this case, these disparate fields have had to influence one another in such a way that the knowledge of each field feeds into the conception of the artifact.

How it works: Experiencing Electro Bacchanalia

Electro Bacchanalia is a modern interpretation of a peep show, set in a traditional 18th century style wooden box placed on a pedestal table.

One side of the box displays a replica of the painting. In the middle of the painting the visitor finds a small peephole. When peering through the hole, a stage-like setup of the painting is revealed. Two of the characters – the faun and the nymph in the center of the painting – are brought to life in the scenery inside the box. As music flows from the box, the couple starts dancing. As soon as the viewer moves away from the peephole the music stops. If the viewer looks again, a different song and dance will begin to play.

How to give life to an Old Masters painting

When presented with the task of giving life to a 17th century painting, we quickly decided to work with pre-recorded live characters inserted into a graphical world. There are, of course, other ways to make a still image vivid, but in our case we choose to go with characters rather than animating mere textures.

The painting contains a lot of characters and we discussed the possibilities of re-enacting the entire painting, with all living creatures such as fauns, satyrs, chubby women, goats and small baby-like cupids. We quickly concluded this would not only be overwhelming in terms of set design, costume, make-up, casting etc., but would also push us *too* far away from the actual task and would miss out on the inherent qualities of the painting. Thus, we decided to pick out the 'main characters' of the painting and let the others remain as they were – integral parts of the image.

One or two main characters is usually everything a 'story' needs – the rest can be boiled down to a backdrop, a scenery constituting the canvas on which to project the 'main action'. The presence of a 'real' character that moves/reacts also immediately

Still image from video composite (left), where the faun and the nymph from the original painting (right) have been replaced by actors.

invokes a personalized relationship to the mediated experience that a viewer/spectator is presented with. *People read people*. People are usually the first and main concern for the individual, and the rest will fall behind – viewers do not look first for other elements like natural objects or man-made artifacts.

A playful approach towards mixing media

The mixed media qualities that stem from this combination of different elements (painting, animation and video footage) we concluded would communicate a playful attitude towards the original motif, which in fact works with the themes of a Bacchus celebration in the woods – an antique equivalent of an open-air rave, if you please. The term *Bacchanalia* has, since the Romans, been extended to refer to any drunken revelry.

Different layers of this project can be found throughout history, since we were dealing with a Baroque period depiction of an antique custom – post-Renaissance ideas about the Bacchanalia – distilled through the

Peep boxes and raree shows

Peep shows, also known as peep boxes or raree shows ('rarity shows') trace back to ancient times (the 15th century in Europe, in the example of Leon Battista Alberti) and are known in various cultures.

The peep box usually consisted of a wooden box with one or several eyeholes. The peep box contained a set of pictures which the showman could set into viewing position by pulling on strings. The boxes could be decorated inside to resemble a theatrical scene and common subjects included exotic views and animals, scenes of classical drama or masques, court ceremonies, surprise transformations (e.g., an angel into a devil) and of course lewd pictures.

Raree shows were the precursors of the toy theatres, with movable scenes and paper figurines, popular in the 19th century. They were also the precursors of many types of optical toys, including the stereoscope and the magic lantern. (Wikipedia 2007-10-01)

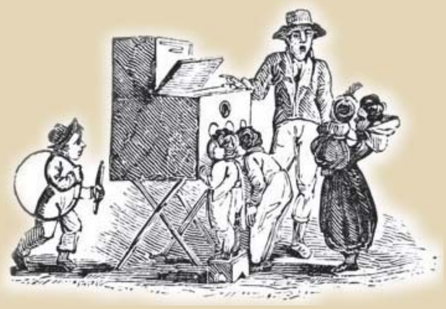


Illustration showing an early peep-box. Courtesy of the collection of Jack and Beverly Wilgus.

fashion of the period when the painting was made and seen through the personal glasses of the artist himself. We add further layers to the painting, a process we wanted to account for in a literal sense. This is revealed not only through the insertion of video in the painting but also through the cut-out technique. This was a way to 3-dimensionalize a still painting, but it also worked with the metaphor of the layer-on-layer process in art history; science fiction films made in the 1960s and 70s carry the aesthetics of flower power and the summer of love transposed into the future.

Linking past and present

As the original painting depicts a sort of party in the woods, one quite decadently depicted, the insertion of music into the piece came as a no-brainer. There were no doubts that the accompanying music would be contemporary, since the sentiment of the painting was found to be more important than historical accuracy in the insertion of additional material (we must not forget – as mentioned above – that the Baroque period interpretation of a Bacchanalian orgy already suffers from historical inaccuracies). Interestingly enough, one of the scores chosen for Electro Bacchanalia originates from the Balkans and is a Macedonian gypsy brass band interpretation of a type of music that very well could be similar to music played during Bacchanalian celebrations. The other scores were gathered from the world of electronic dance music, which should be in sentiment the Western equivalent to ecstatic music played while 'going wild out in the woods'.

Casting

The casting of the characters was not only based on resemblance to the characters in the painting, but also by imagining the way they would dance. Since we were replacing a pair, a faun and a nymph dancing in the painting, and presenting a snapshot, a fragment of time that would suggest the way in which they would dance, we went for a pair of 'actors' that would have matching body language while expressing themselves to music. Professional

dancers would be too mannered in their way of moving. It was of utmost importance to find a man and a woman that would just enjoy dancing, not be too shy but not too fashionable – and who would at the same time have some sort of charisma. The faun should be playful and the nymph ecstatic, dreamy.

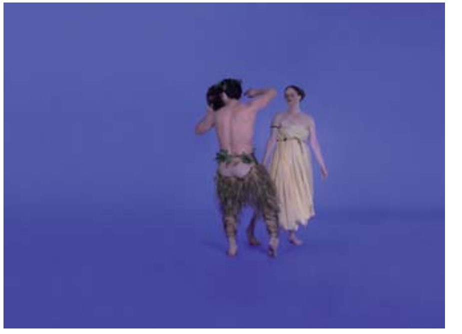
Blue screen and traveling matte

It was apparent that we would need to cut out the dancing couple from the video that we shot and insert them into the painting. As the motif would be moving, it would be far too complex to mask the dancing couple out by hand – we had to consider using a blue screen technique.

To set the actors into the painting, a technique called *traveling matte* or *blue screen* was used. This technique allows actors and scale models to find themselves in totally imaginary situations – in spaceships, dangling from rope bridges over gorges, flying through the air à la Superman – and have it look completely real. The technique is used so often now that you don't even realize it. News reporters are made to look like they are on location when they are not – complete segments in TV shows can be created this way to make it look like the segment was filmed on location when, in fact, no one left the studio. The blue screen technique lets you combine two or more pieces of film into one piece that looks very real.

How bluescreen works

To use the blue screen technique, you first need a *background plate* (which in this case consists of the original painting). You then film the actors in a studio against a bright blue background screen (hence the name ‘blue screen’). You end up with two plates that look like this:



Using post-production software, you can easily use special filters to form two mattes from the shots of the actors. One shows the actors’ silhouettes in black, the so-called *matte* (left), and the other is the *reverse matte*. (right)

These mattes are easy to create because the bright blue color, when run through a red filter, turns black. By using high-contrast black-and-white film to create the mattes, you can create the silhouettes. So now you have four pieces of film: the two originals and the two mattes. By combining these pieces of film in layers you can create the final piece of film for the shot. First, you combine the background with the actors' silhouettes (left), then you lay the actors into the 'hole' that the matte created, and – voilà – there you have your final shot! (right).

First we had to choose what type of *keying* (another term for the insertion of a foreground image with a green screen or blue screen background) we would use. Both blue screen and green screen have positive and negative features, depending on what kind of foreground material is the subject of the shooting. In the case of Electro Bacchanalia it was most suitable to use blue screen, since both of our characters were dark skinned and dark haired and the clothing (which consisted of brownish, red, yellow, warm colours) would pick up less 'spill light' from a blue background and the light that reflected from it.

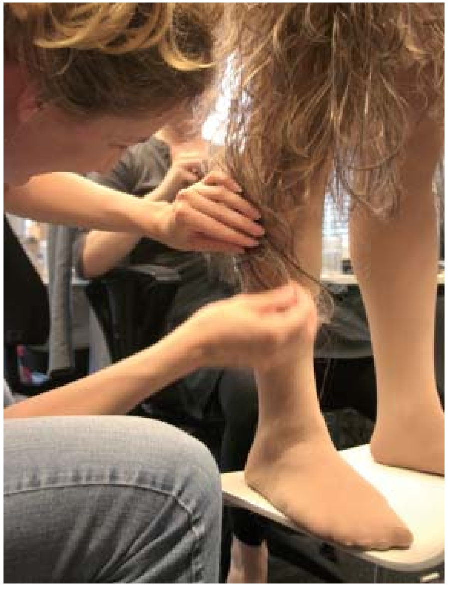
Another task was to find a studio space where we could put up the blue screen. We decided to use a paper background and to roll it from the ceiling onto the floor in order not to get any corners, since there is no framing of the characters – they are inserted as whole, from the tops of their heads to the bottoms of their feet, into the painting. An issue was to be able to get rather far away with the camera – in this way, we would be able to use a narrow angle with the camera lens and 'squeeze' the characters into the same proportions as the ones in the painting. A camera picks up the image on a rather small surface and, therefore, the effects of the optics and the angle have a great impact on proportions. A proper studio space solved these issues as it allowed for a seven meter distance between the camera and subjects.

Costumes, make-up, and the issue of hairy legs

The main characters that we intended to reenact were Baroque interpretations of a faun and a nymph. Clothing for the female character would be made up of draped fabric in a suitable colour (as mentioned above, warm tones that would not pick up too much of the cold blue light reflected from the blue screen). Finding the proper cloth and trying it out on the actress/dancer was quite a standard procedure. A headpiece, a bracelet and a belt helped to recreate the original painting.

Finding a costume for the male dancer turned into quite a challenge.

Finding a solution for the faun was more of a challenge. Being half man and half goat, we would need to equip him with enlarged pointy ears, a grapevine wreath, a tendril of a vine and – above all – goatlike legs. Researching different costume solutions and doing an inventory of Stockholm-based theatres and



their costume departments did not provide any satisfying solutions – we had to create the legs from scratch. As a basis for covering the legs of the actor in hair, we came to the conclusion that fur (or fake fur) would be the wrong way to go. Even though goat-style fur would fit in terms of authenticity, the actual hairs would be too short and not give the proper 'texture' on film. Eventually the decision was made to use a pair of flesh coloured ice-skating tights and a wig. We used a cheap wig made of fake hair, cut it into 2-4 decimeter wisps, and then sewed them directly onto the tights. This solution did a good job of turning the legs of the actor/dancer into the furry limbs of a mythical beast.

Both actors/dancers had full body make-up. A warm, terracotta-coloured body make-up was used to even out differences in skin tone, and to make the skin tone similar to that of the painting. Even though colour can be manipulated in the colouring and compositing process during post-production, it is harder to influence incoherent dynamics and shifts in colour tones than it is to completely replace a solid colour. Paintings have a limited number of colour tones, a sort of solidity in colour, whereas a straight-up video recording of real skin and body (without makeup) would reveal a complexity of colour grading.

Lighting to resemble the painting and for blue screen shooting

The lighting in the original painting is quite dynamic, going from the dark parts in the foreground (where the light is filtered by dark trees) to the light in the background (where the open air and sea is emitting a strong ambient light). Needless to say, the picture does not deal with any backlight issues, and there are no halos around the focal characters. The light falling on the faun and the nymph is quite flat and unrealistic – clearly revealing the contours of the characters as if they are shining from within. There is some highlighting from the upper left corner, but no shadowing from

the treetops and no shadows cast by the characters themselves.

The lighting of the scene had then to be made in such a way that the actors/dancers would be evened out by a flat light emanating from the front, not giving too much contrast without marking their bodies and faces – as if they were painted with a flurry of brush strokes. A bit of extra light emanating from the upper left would be created with some additional lamps and later enhanced in the post-production process. Creating this effect entirely on set would raise the level of contrast in the image, which was to be avoided.
The set was lit in two separate planes: one lighting setup for the foreground characters, and one for the background. As with the characters, the blue screen background would need to be evened out by a very flat light coming from all directions in order to give as little texture to the blue surface as possible. Another issue was to remove shadows cast by the actors/dancers, who were lit from the front. Above all, we had to make sure there were no 'double shadows', which are a dead giveaway. Some shadow was left at the feet of the actors/dancers, in order to give a little bit more 'grounding' to the characters. This resulted in a slight difference in light level when composited onto the background, a shadow on the painting reflecting the movements of the characters.

Choosing the right camera

MiniDV and its 25 Mbps variations (DVCAM, DVCPro) are notoriously poor performers when it comes to bluescreen or greenscreen compositing. The difficulties stem from the PAL/NTSC 4:1:1 digital sampling format – for every four luminance samples, there is only one sample for each of the two colour difference channels. In order to avoid this one can choose to use a better video format that supports 4:2:2 sampling. In our case, we used a Panasonic HVR200 and shot the material in the standard definition format DVCPRO50.

The camera was mounted in a vertical position (portrait format) on a tripod. The intersection of the imagery needed was two people standing (and dancing), which doesn't call for shooting in horizontal (landscape) format. By tilting the camera to the side, a plentitude of pixels are gained – shooting only what is to be used allows you to use more of the frame.

The possibility of shooting in progressive scan mode (no interlacing) was also utilized – giving 25 full frames per second as a basis for the compositing, rather than 50 fields PAL (only half resolution). Interlacing, which is an older technique used by TV displays and which has been standard for video production, creates unwanted artifacts ('combing', 'sawtooth') with movement. It also significantly diminishes crispness in the image.

The camera was in a fixed position seven meters away from the dancing couple. The focus was set to the same distance and the dancing couple instructed not to move more than one meter in each direction while performing. The result was a clean and accurate recording which could be taken further into the post-production process.

Turn up the volume – creating the right music scores

The music producer prepared a set of musical scores based on the ideas of the group. This consisted of sampled and original sounds and covered a range from Balkan-style brass music to electronica. Together with the blue screen, the lighting and the camera setup, a sound system was installed to give the proper bass and beat resonance – crucial for the actors/dancers to get a proper feel for the music and to give a party mood to the entire setting. The music was recorded while shooting the scenes in sync with the actual footage as a referential sound track for the dubbing (see below) done in post-production, where the original scores would be inserted into the final film.

Compositing and animation

The original painting was photographed and then imported into digital format as a high resolution .TIFF still image. The acquired image then needed to be prepared for the compositing work.

Preparing the assets

The first part of the compositing process – preparing the assets (the photograph, the 'plates') – was done in the imaging software **Photoshop**, used for all kinds of manipulation of digital still images.

Removing the characters from the painting

One of the first tasks was to take away the characters in the painting, as they were to be replaced by the two actors/dancers. Of course, the original painting doesn't reveal any visual material behind the characters, and the way to make them vanish is to make small patches from other parts of the image, putting them on top of the characters ('cloning'). By extensive layering and blurring the edges of these patches, combined with additional painting, the characters were slowly erased from the image. As the image was cleared, a clean plate emerged.

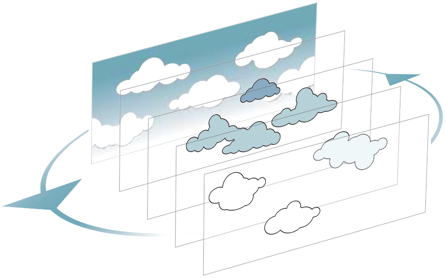
The cleaned-up background plate was then to be cut up into different layers in order to prepare for the animation.

Illustration from work-in-progress in Photoshop: by taking patches from parts of the image and putting them on top of the characters, 'cloning', the characters were slowly erased from the image.

Preparing for animating the sky

The background of the image consists of a sky. We decided to make that into an animation of a sky rolling horizontally from right to left. First the sky (complete with all of its clouds) needed to be cut out and recreated as a solid plate. The 'holes' created by the characters needed to be filled and the cut-out sky needed to be extended in all four directions. This was done by cloning as described above, by taking patches from other parts of the image of the sky, filling up the blank spaces, and adding soft edges (blurring the distinguishing marks between different layers placed on top of each other).

A solid rectangular strip was made of the irregular cut-out of the sky.
This sky-strip was to be rolled horizontally in the animation and, as such, the left and



right side of the strip needed to be evened out (again by patching and cloning) at the edges so that they could invisibly wrap into a circular field that could loop indefinitely. This was, again, made with the patching and cloning technique.

Once the basic sky set was made, individual clouds were cut out and copied onto separate image plates. Each set of clouds was saved with a transparent background and soft edges with partial and gradient opacity. The individual cloud image was to be used as the second layer in the animation – adding some irregularities to the moving sky.

Adding the third dimension to the painting

The next layer in the animation consisted of the sea together with the waterfront and some vaguely distinguishable people. This layer was cut out and an edge operation was made in order to give a certain contour to the layer as a separate entity in relation to the sky. This would give a three-dimensional effect to the flat scenes made from the original painting. This process was repeated several times: layer by layer was cut out based on the level of depth in the original image. Contours were given an edge treatment with a virtual light source coming from the upper-left direction. Each layer was saved with transparency and added to the prepared batch of plates.

As all of the still image plates were prepared for compositing and animation, the work continued into the next phase, where the compositor would use compositing software to put all the parts together. The compositor in this case used a tool called **Apple Shake**, which in itself includes all basic tools for layering. It also contains basic colour correcting features for moving imagery, and, above all, the necessary plug-in tools for *chroma keying*.

But, as you can see in the image, one layer in the composition is missing: one more asset needed to be prepared before the actual compositing and animation would start, and that was the video of the dancing couple. The video footage was imported from the camera, converted to the *Quicktime* format, and then imported into Shake where the basic chroma keying operations were to be made.

Chroma keying

The chroma key process in postproduction starts with the basic step of *pulling a key* – deciding the exact colour that constitutes the ‘background matte’. This is done by taking a sample of the colour of the blue screen in the original video footage – not the darkest part and not the lightest, but something average. From this, a whole series of values needs to be adjusted to make a decent and automatically generated matte background.

Usually, pulling a proper key lies in finding some balance in what span of blue is going to be considered the ‘background’. If the piece is too big, parts of the foreground image (the one we want to keep) are going to become watered down and punctured with holes, since there is often a bit of blue in most colours. One trick in this case is to create a very solid foreground matte, which will pick up some of the background, to do an eroding operation which will eat into the edges of this solid matte, and then combine it with a more transparent foreground matte that leaves holes in the foreground image. In any case, this is in essence a procedure a bit like cooking – adding a bit of salt, some spices, subtracting by adding sugar, adding salt again, and finding the proper balance.

Once the key had successfully been pulled and the selected video footage was set with its travelling mattes to mask out the dancing couple, it was time for the actual compositing and animation to begin.

Compositing – putting the layers together

All the layers of images were placed on top of each other in the proper order – the video footage somewhere in the middle of this chain (sky, sea, waterfront/trees/dancers, nude woman, fauns, cupids and goats). The layers were assembled through basic over-operations where all still images contained so-called *alpha-channels*, a fourth colour channel that contains a black and white (and gradient greys) reference image which tells the over-operation which pixels to put over the underlying image background and which not to include in the composite, and which

ones were to be mixed and to what extent. The dancing couple were placed on top of background trees (but underneath foreground trees, nude woman, fauns, cupids and goats) with another over-operation. The chroma key plugin had placed a travelling matte in a frame by the frame alpha channel, which gave a nice fluent outline of the characters.

Colour correction

When the video footage was in place in the composite, the next step was to perform a basic colour correction. The side scene layers were treated as the reference colour scheme and the task was now to separately correct the colours of the video footage so that it would fit into the image as a whole. The colour correcting operations consisted of replacing one colour with another and cranking different gamma values, contrast values, hue values, intensities and saturations in different directions. Colour correction was done on the original source video material, while looking at its effects further down the post-processing chain. By doing this, the compositor would get the visual

affirmation that the video material became more or less coherent with the rest of the visual material. Once the colour corrections were made, the material was set for basic animation.

Animating the sky

We had decided that the sky, together with the clouds, would be entirely, and above all *visibly* animated, by rolling sideways from left to right at a steady pace. The sky portion of the image was wrapped around itself and could loop indefinitely (see above). The same principle applied to the plate with separately animated clouds, which would come in from the left side in order to disappear on the right, and then reappear after a while from left again. This behaviour was controlled by a preset scroll operation that differs from a straight-up pan operation in that it does the wrapping of both ends automatically. The compositor gave the moving sky a steady constant value, but then inserted through Shake's own expression language (a scripting language with extensive mathematical-logical operations and operators) random functions that would speed up or slow down each animated element in an unpredictable and 'organic' way. Using separate random functions and amplifying them to different extents for each sideways-scrolling element would give more of a vivid feel to the movements than manually laying out the pathways by keyframing (setting start and end positions for moving objects, where the movement is interpolated between these positions). Manual keyframing has a tendency to look 'constructed' in such animations as a sky moving or wind blowing in trees. Trying to be unpredictable usually ends up in predictable patterns – in this case it is more useful to use mathematical random functions.

Adding a 'trembling' effect to the scenery

The video was not to be moved around or animated in any way. But the rest of the background scenes would need to be moved around a bit, so that the contrast between 'video' and 'still image' would not be too great and ruin the coherence of the visuals as a whole. The idea of the compositor was to make the trees, goats, etc. move but not really move – the visual elements would be given a trembling effect in all three directions (sideways, up-down, in-out) but only by a few pixels in each direction. The trembling effect was created with a 3D-matrix function on each background element, where a frame-by-frame seeded random value was given to x,y,z-movement and to angle of rotation. This value would be 'amplified' not to exceed 5 pixels in terms of moving the plate, or 0.01 degrees in rotation.

Adding visual noise

One final operation was to be made on the material before rendering. All video recordings (as well as film recordings) contain a kind of *visual noise*, measured in a signal-to-noise ratio, an inherent effect of the limited (finite) possibilities to store the infinite colour grading spectra of 'real life'. If properly lit and recorded with decent equipment, this visual noise is hardly something the viewer would notice. But when video (or film) is put as a layer between sections that consist of still images, the difference between still and moving (noisy) images becomes apparent. Fortunately (which may sound strange) noise can also be added in the post-production process. A decent noise generator is able to analyse and copy one specific kind of noise sampled from a video, and apply this to another video. By 'transferring' the video noise from our recordings onto the still image-based background scenes, the compositor is able to even out the different 'natures' of the constituent elements of the composite.

With all this set – the different recordings together with all still image plates – the operations and functions were placed in neat scripts, saved and backed up. The ultimate step in the compositing process was then to render non-compressed and properly sized movies of each composite that would become the final movie clips for Electro Bacchanalia.

Resizing

All side scene layers were resized with a Photoshop tool for resizing, using the *bi-linear* filter operation which is one of the best for shrinking images. Other filters apply for making an image larger. The side scene layers are much larger in resolution than the chroma keyed video and the size was adjusted to make a proper fit.

One final resize operation is made on the composite and the animation as a whole in Shake using the *Viewport* tool. This resize was done as the last step in the compositing chain, which gains from having as much pixels to work with as possible. The final resize is used for making the right resolution for the clip to be played from a PC – since computers always have some limitations in data transport and decoding. Another limitation is the actual resolution of the screen on which the video will be played. When resizing video, one should keep both vertical and horizontal resolution at even multiples of 16 (such as 1280x720 or 768x576). That both pixel width and height is divisible by 16 is an absolute requisite when compressing the material into MPEG1/2-format (see 'Resizing in-depth').

Resizing in-depth

When working with video that doesn't have standard formats (SD – standard definition – or standard HD –high definition), it can be a bit of a hassle to find the proportions that keep the aspect ratio (the relationship between height and width – such as 720/576 = 1.333333 or 1280/720 = 1.777777777); otherwise the resized video will be squeezed in either direction.

The clips of Electro Bacchanalia allowed for a size of 1088x800 – an odd aspect ratio of 1.36. The decision to adjust the video to this size was weighed on several factors. First, the video that was chroma-keyed was shot in standard definition in portrait format, which meant that the dancing couple could not extend past 768 pixels in height (standard PAL definition is 768x576). Since the dancing couple vertically as well as horizontally are just a mere part of the larger image – the entire image without any resizing could allow for at least 1059 pixels in height. This was deemed to be too large since the total resolution would land at 1439x1059, a rather irregular resolution not divisible by 16. We decided to resize down a bit, keeping the same aspect ratio (1439/1059 =1,358829....).

We started out with the vertical size, shrinking it from 1059 to 800. The basis of this is that 800 pixels in height are divisible by 16 as well as a preset and common resolution of a computer screen. The custom-built software video player used in our projects (see below) uses full screen display technology and as such it is a good idea to match existing screen resolutions, which then allows for full hardware acceleration.
As an example another option could have been 960 pixels in height, but multiplying this with 1,358829.... (the factor of 1439/1059) gives us a pixel width of 1304,475... which is nowhere near divisible by 16 (nearest values are 1296 or 1312 – both are 8 full pixels away from 1304,475...).

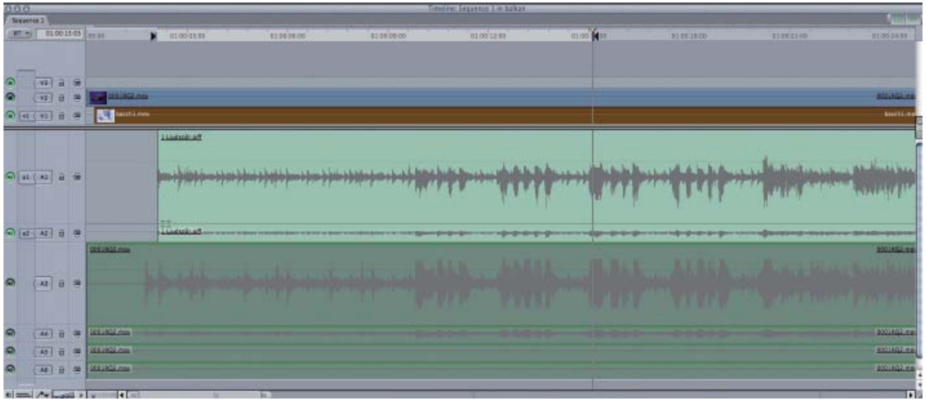
So with the vertical pixel resolution set to 800 we multiply this with 1,358829... and consequently this gives us 1087,0623.... Resolution can not be set to subpixel values and luckily 1088 (less then 0.94 pixels mismatch) happens to be divisible with 16!

Dubbing

The composites were rendered out in a *non-lossy intermediary codec* (which means that no image information is lost or degraded – yet!). Intermediary files of each dance clip contain the complete chroma key plus the composites and animation.

These files were then imported into **Final Cut** (the leading Mac video editing software) for dubbing. Other imported files were the original video files that contain the soundtrack from the actual shooting, as well as the sound files for each musical score that was played at the video shooting.

The soundtrack recorded during the video shooting was used as a reference track for sychronising the music files. Each dance clip is laid onto a timeline together with its original soundtrack which contains both video and audio. These tracks are adjusted on the timeline with the pure sound file of the musical score.



Once all tracks are in perfect synch (checking by eye, listening, adjusting frame-by-frame and adjusting the sample; a visualisation of the sound file is of much help – showing the sound tracks as a wave pattern with distinct spikes revealing the beat), only the sound track that contains the original musical score is rendered out as a separate sound file.

This sound file has the exact length of the intermediate video clips – both beginning and end are padded with the right amount of silence – so when the video file and sound file are put together (which in digital video terminology is called *muxed*) and interfoliated, a perfect synch will result.

Muxing and compressing

If you would try to play the intermediary files (compressed in a non-lossy codec) you would see that even a pretty strong computer would have a problem keeping up with the frame rate – this means that the amount of data shuffled through the system to give a full frame in this large resolution of 1088x800 25 times each second is simply too much. If we calculate 1088x800 we will get a total amount of 870.400 pixels for each frame – each pixel needs at least 24 bits (8bytes) of information – if we multiply the total amount of pixels with 8 and then divide it with 1024 in order to get the amount of kilobytes we will get 6800 KB (6,64 MB) per frame. Multiply it again with 25 (the frame rate) and we have roughly 166 MB (!) each second that needs to be transported from storage (hard drive) through the system to the graphics card display buffer. This is without the sound data...

Luckily, what the computer lacks in so-called bandwidth it compensates through its ability to do swift calculations. Enter the codec!

In the case of Electro Bacchanalia we used the **Mainconcept for Mac** encoder, which gives the encoder the possibility of feeding video files and audio files separately. The encoder will *mux* – interfoliate the video and the audio data – and encode the video in mpeg1 or 2 format, as well as the audio, where we can choose different compression schemes (such as mp3 or PCM).

The mpeg codec

The mpeg1 and mpeg2 codecs are standard to PCs because of the DVD player function that is included in most computers. As such, they have been developed to use the hardware in the most efficient way and to average and smoothen out pixel roughness, blockiness and noise in order to give us a good viewing experience of our DVDs.

MPEG 1/2 codecs in most cases have the ability to use hardware acceleration and to do most of its operations onboard the graphics card – which gives great time advantages, since decoding in the computer's CPU is equally fast but transporting the decoded frames to the graphics card gives time penalties. MPEG 1/2 codecs were initially developed for standard definition video and some encoding software might give you a hassle when encoding video of a non-standard format, but the secret is that the pixel width and the pixel height of the image simply need to be divisible by 16! (see above).

The dancing movies were muxed, compressed and packed into a *MPG* file format, which is interchangeably used on Mac, Windows and Linux OS computers.

The video files are now finally ready for use and will hopefully play with the full frame rate, with no stuttering, and will perform smoothly in terms of movement, colour and synchronisation with sound.

Video player – VOS scripting

Performing Pictures artist and developer Robert Brečević has been continuously working with creating a set of software tools for displaying video – **VOS (video-on-surface)**

– that contains extended functionality in terms of real-time editing (cutting on the fly from video file to video file with minimal delay). It is essentially a 'video jukebox', where several clips can be played side-by-side and where each video clip can be changed with immediate effect. All changes are based on input control events such as keyboard strokes, mouse movements and clicks or data sent by microcontrollers connected via USB. The software tool comes with the ability to read a special format of *scripts* – this is a predefined set of commands saved in the form of simple text files. The script defines what is to happen when the player software is initiated. These behaviours include which video and audio files are going to be played, on how many screens, in which position and other properties. The script controls the sequence of video and audio files. It also defines the behaviour of the files: if they should loop or if simply play out and shift to another clip. The script also states input events, such as a keystroke or data coming in from a microcontroller.

The software is very simple but versatile. The VOS player uses all the hardware acceleration features that the PC system supports, and talks directly to microcontrollers with no intermediary linkage in between.

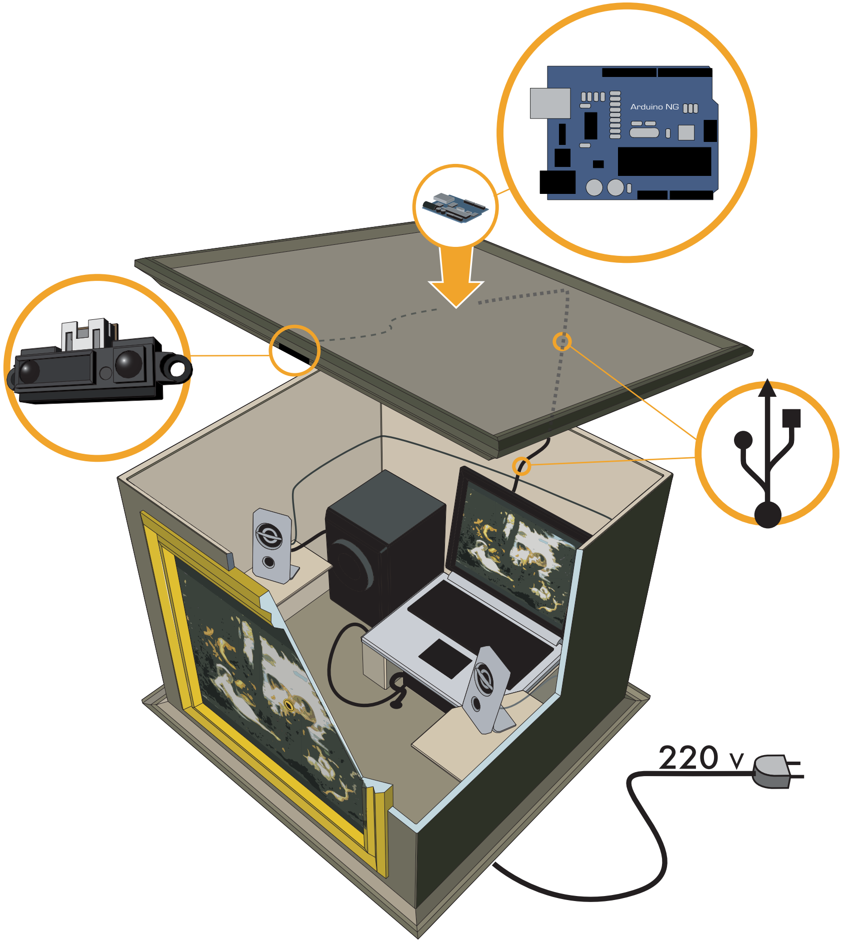
Once the video files were ready for use, they needed to be imported onto the target platform (the PC that was going to play them) and put into a specific folder, which is then stated in the VOS script. Files were given different names; in this case no special taxonomy needed to be followed other than that they should all have different names, since they have to be stored in the same directory.

Each file is then annotated in the script with a specific behaviour.

The function of the Electro Bacchanalia box is pretty straight forward: a short looped sequence of the couple (not yet dancing) is displayed. When a viewer peeps through the hole, the couple immediately 'wakes up' and starts dancing.

In scripting terms we have a file that is given the behaviour of 'looping' – each time it plays out it starts all over again, with no block frame or stuttering other than potential mismatches between the last and the first frame. Another behaviour is annotated for this file in the script – that if the player registers a input event, such as 's' (as in 'start'), the player immediately starts to play the next file in the list (go to +1). Now, if the viewer takes away his or her head from the peephole, the dancing should stop. Depending on how long s/he was watching, the application will be ready to a) play the next musical and dance score or b) (in the case it was just a short peep) play the same musical and dance score all over again.

In the script this is done in such a way that the video file with the dancing is given two input events, such as the key strokes 'n' (go to next= +1) or 'b' (go back = -1). If the player returns to the previous clip, it will be ready to go one forward again – if the player skips to the next clip, it will learn to know that this



is another looped clip which will skip forward further on in the playlist if given the input ‘s’.

One major advantage of the VOS player is that all video files can be loaded into RAM memory (that is when the application is initiated) and as such the delays caused by reading and accessing file data are at a minimum.

A methodology which is easily implemented in working with the VOS player is that the video application is scripted and tested with key strokes, using the ever present input device of the keyboard as a reference of how the final application is going to work, which means that while trying out the playability of the responsiveness of the videos, no external or additional input devices need to be plugged in – this work can be kept separate from the usage of microcontrollers and sensors.

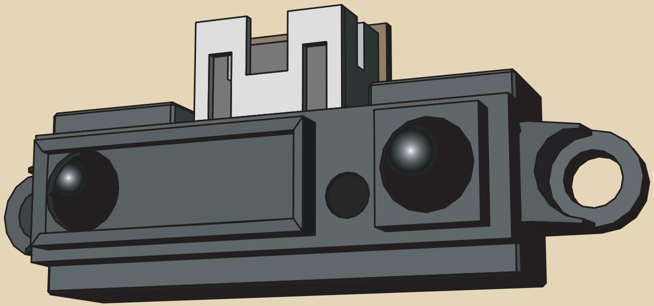
‘Sensing’

Once the script is ready and tested using a keyboard, we want to add another input device, since the Electro Bacchanalia peep box is not going to feature a keyboard or

How it works: Infrared sensors

Infrared distance measuring sensors are precise at short distances and they are very easy to use. The Sharp sensor that was used in the Electro Bacchanalia project continuously measures through triangulation how far away an obstacle reflects its infrared beams. It has three ‘pins’. One pair of pins are the +5 volt and ground circuit feeding the sensor with a steady electrical charge. The third pin gives back a variable output voltage – depending on how far away its triangulating infrared beams sense an obstacle.

By feeding +5 volts into the sensor and continuously measuring how much voltage is returned through the output pin of the sensor, we can keep track on what is happening in front of the sensor. The device simply outputs the voltage corresponding to the detection distance.



a mouse as the input. In this case the videos would be triggered as soon as someone makes a forward leaning movement and puts his/her eye towards the peephole.

There are several methods of continuously measuring (‘sensing’) such an event. We decided to use *infrared distance measuring sensors*. In order to peep into the box, a viewer would put the entire head towards the peephole and this could be detected by a distance measuring sensor placed somewhere above the frame, pointing downwards. As soon as a person’s head is placed in such a position that he or she is able to peep into the box, the top of the head will be closer than 20 cm to the sensor – within the distance we programmed the sensor to detect an object.

In order to perform such operations we need some sort of device, which can be instructed to do these tasks. Since personal computers are not exactly designed for doing such things, this needs to be an external device that can alert the PC of any findings. Such devices are usually called microcontrollers and are in effect a ‘computer-on-a-chip’, cost-effectively designed to perform a specific set of tasks. The microcontroller is similar to the microprocessor, which is an integral part of a PC and the only difference between the two of them is that the microcontroller has additional elements such as RAM and ROM, making it into a self-sufficient unit.

The microcontroller used in Electro Bacchanalia is an **ATmega8** fixed on an Arduino board. The **Arduino** board is a physical computing platform based on a simple I/O board and a development environment that can be used for making stand-alone interactive objects as well as connect to software on a personal computer (PC). The Arduino I/O board implements a USB interface, which can be accessed through virtual COM ports as well as directly as a unique identity device.

The microcontroller onboard can be programmed with the Arduino programming language (based on the Wiring language) to perform the task of measuring the analogue voltage. The Arduino board has several digital input and output ‘pins’ as well as ‘analogue’ pins where measuring of a variable voltage is allowed for.

The **Sharp infrared sensor** is connected to the Arduino. The board feeds the sensor with a +5V-to-ground current. The output voltage pin of the sensor is connected to one of Arduino’s five analogue input pins.

The microcontroller is now instructed to do the following task: read the output voltage given back by the sensor – is it more than a stated threshold value? We don’t need any advanced linear conversions of the values received since we are only looking for the transgression of this single distinct threshold value.

If the value received from the sensor is less than the threshold value, the microcontroller keeps sending characters corresponding to the VOS-script (see above); it can be ‘n’ or ‘b’.

If the value received is more then the threshold values this means that we have detected an object 20 cm or closer to the sensor – in this case the microcontroller writes ‘s’ (as with the keystroke for ‘start’) via USB to the computer. The microcontrollers clocks this occasion and stores the value for later purposes. The microcontroller makes a small delay of 50 milliseconds and starts all over again.

If any of the next measurements should be less than the stated threshold value, the microcontroller clocks this occasion and checks how much time has passed. If it is less than 10 seconds, the next character it will send is ‘b’ (as in ‘back’), otherwise it sends the character ‘n’ to the computer. And so on.

The microcontroller is thus mapping the keystroke behaviour used to test the VOS script and the video application. The program for the Arduino is written on a PC, compiled, and then flashed onto the microcontroller via USB connection. The microcontroller is now set to make use of a single IR sensor and to communicate with the computer it is connected to.

PC and OS

In the case of Electro Bacchanalia we decided to use a laptop as the combined computer and display solution. Laptops are a good solution since the PC technology is kept to a minimum size and since the CPUs, hard drives, and other parts of laptops are designed to generate less heat than those for desktops. Display is integrated, which means less hassle with loose parts and cables. Disadvantages include cost efficiency. 'Laptop performance' is more expensive. In the case of Electro Bacchanalia, where the computer is to perform just two distinct tasks – playing a single high-resolution video and listening to a microcontroller via USB – the choice of a laptop was justifiable.

With 1 GB of RAM on the laptop, all the video files can be loaded into memory when the application starts – since the computer will not be engaged in other tasks, we can be sure that memory will be sufficient – thus a great workload in repeatedly reading data from a hard drive can be taken away.

The laptop we used runs Windows XP and had to be prepared for 'kiosk mode':

- all desktop animation features disabled, OS set to 'best performance'
- all energy saving settings off
- standard OS services that enable redundant tasks such as surfing the web disabled
- software updates and error reporting disabled
- login set to 'no password' mode
- booting of computers set to minimal features, no graphical splash screens
- removal of all startup programs other then the VOS player with the Electro Bacchanalia script preset for playing

Design of the box

During the development of the concept we discussed different ways to display the digital reproduction of the painting. We finally came up with the idea of creating a contemporary peep box with inspiration from a 17th century peep box in the collections of the National Museum in London.

Our first thought about the design of the box was to use elements from old furniture, such as the foot of a pillar table, wooden boxes, etc., and together with new materials modify it into the peep box which we had in mind. But, after consulting a carpenter, we decided to design and build a new box from scratch. In this case it was the easiest and probably the best solution.

The carpenter constructed the peep box from our drawings and an inspiration image of the old peep box. We used lightweight plywood for easy transport and handling. To evoke the aesthetics of an old object, we painted the box with dark brown stain.

The box itself holds all of the electronic equipment (computer, speakers, etc.) leaving only the box and the painting with the cut-out peephole visible for the visitors. Several air holes were drilled into the bottom and top of the box to avoid the equipment being overheated. Four small spacers were placed on each corner of the bottom of the box to provide airflow underneath the box.

We designed the lid of the box to be hollow, so that it could hold the sensor and the Arduino card. This way these components are both easily accessible and protected. The sensor was placed in the frame of the lid; we drilled a small

hole through the frame and placed the sensor over the peephole facing down over the viewer. By placing the sensor in the frame of the lid, it is fairly protected and hidden from users.
When looking into the box you see only the screen of the computer. To exclude the viewer from everything in the box but the screen, four paperboards were cut to form a 'tunnel' from the screen to the peephole. The boards are of dull black colour to prevent any light reflections from the screen on the boards.

Ideas for implementation

The peep box can be displayed in several ways. One suggestion is to place it centrally at the entrance of a museum, to give the visitors a fun and surprising experience right away. One can use the box in a similar way but in more definite areas, such as by placing the box at the entrance to, or in the center of, a specific exhibition space. With the right content and concept in connection to the exhibition, the box could serve as an 'eye opener' for the rest of the exhibition.

While we chose to bring an old oil painting to life, there are different media that could be worked with in similar ways. For instance, the concept can be used to bring old photographs to life by highlighting parts of the images in different ways. One can work by colouring parts of black and white images, animating elements in the picture, replacing people or objects, adding content, etc.
Another medium that could fit the concept of Electro Bacchanalia and could be set into a larger context could be typical museum objects that often carry interesting stories

but fail to deliver them through the exclusive use of traditional museum exhibition design.

By using the peep box as an interpretive tool you can provide the viewer with a new entrance to the work on display and, in the end, stimulate greater curiosity.

Electro Bacchanalia

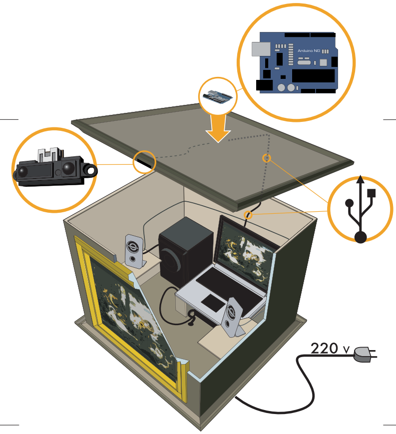
Technology/Interaction

Video composites through bluescreen technology. Played out on single laptop and external loudspeakers. A sensor connected to the computer through a microcontroller controls the input from the viever.

Ideas for implementation

In connection to permanent exhibitions, entrance halls, coffee shops and walking halls with the aim to:

- Stimulate curiosity, fantasy and creativity about the themes or objects
- Narrate history/stories related to motifs of art
- Bridge the gap between an artist's message and visitor references
- Indicate what questions to raise regarding objects and topics



Required competencies

Costume
Mask
Dancers
Camera
Carpenter
Video artist
Interaction design
Musician
Art historian
Project manager
Lightning
Post-production

Summary

Electro Bacchanalia is a multi-modal installation, with the aim to stimulate young museum visitors' interest in the motif of the old master's painting and make a flirtatious reference to contemporary lifestyle.

Resources

Manhours 200 hours

Technology €1200

Project material & production costs €800

Electro Bacchanalia
Project team

Initiator: Halina Gottlieb
Concept: Halina Gottlieb, David Nilsson, Geska Helena Andersson, Robert Brečević
Costume and make-up: Geska Helena Andersson
Dancers: Charlotte Åberg, Robert Brečević
Direction: Geska Helena Andersson
Camera: Gesa Friederichs-Büttner
Post-production: Robert Brečević
Assistants during shooting: Andi Muka and Andreas Beijer (lighting and gaffing)
Box design and museum staging: David Nilsson
Video engine and interaction solution: Robert Brečević
Music: David Nilsson
Illustrations for booklet: Andreas Beijer
Proof-reading for booklet: Alison Gerber

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By creating a flirtatious link to contemporary lifestyles, Electro Bacchanalia stimulates visitors' interests in the motif of an Old Master's painting within a unique museum installation.

Incorporating the aesthetics of the traditional peep show, Electro Bacchanalia transforms this vision into a modern experience. In place of the still images and objects used in historical peep boxes, the painting is brought to life through technology based on video composites and sensor input.

The KNOWHOW booklets are an inspirational series cataloguing existing examples of a variety of projects which use ICT for the recording, display and interpretation of cultural heritage. These booklets highlight functional information covering the design, development and implementation of ideas and their solutions, and give thoughtful suggestions for alternative applications within the cultural heritage sector. The KNOWHOW booklets aim to support people working in the area of museums, heritage sites and monuments. The information covered within the booklets benefits managers, exhibition producers/curators, pedagogues and professionals working with digital restoration, as well as those working with communication and audiences. These booklets cover projects developed by the partners of EPOCH, and are divided into the following categories: MUSEUMS, HERITAGE SITES and MONUMENTS.

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