Wilberforces, a different way of audio and video processing in the public space

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Abstract:

This article describes the theoretical and artistic foundations of *Wilberforces*, a work by Bosch & Simons, premiered at the exhibition "Winter Sparks", FACT, Liverpool, 2012/13. The Wilberforce pendulum, which the piece references, is an example of a coupled mechanical oscillator, often used as a demonstration in physics education. In *Wilberforces* three long metal springs are used for generating video and audio data. Below one of the springs hangs a video camera with a microphone, below the other two hang tiny loudspeakers. Images and sounds captured by the camera are projected in real-time. The work plays with and transforms a location in a way that is difficult to grasp what is real and what is manipulated, creating an environment wherein people are encouraged to participate without being aware of giving up something of their privacy: A mechanism that is used more and more in our society. Luckily, in this case, they are only taking part in the creation of an artwork.

Introduction

(1) "During the past twenty years we have focused in particular on the development of autonomous installations. We like to call our creations 'music machines'. Music to emphasise our interest in the quality and organisation of sound, machines to suggest the presence of mechanical elements and productivity. No trickery is involved. It is just the machines playing largely their own game in a fascinating world somewhere between order and chaos. The movements and sounds created by these machines can change almost imperceptibly from order into chaos and vice versa. In a certain way the machines themselves possess a creative potential. The role of the computer is paradoxical: although it controls the mechanics (often electric motors), it can only partly foresee the physical outcome of its decisions." In most of our works we don´t use sound or image processing and even no loudspeakers except for three cases: *Electric Swaying Orchestra* (1991-92), our first work with real-time sound processing, electronics and loudspeakers, *Aguas Vivas* (2001-07) combining real-time sound processing with live video projection and *Wilberforces* (2012-13). While technically it has several similarities with its two predecessors, conceptually it means a definitive new chapter in our work. So far people have often experienced our work as immersive, but "real interactivity" has never been present. In *Wilberforces,* however, people are invited to participate in the creation of the work. Our starting point was how to transform an inspiring phenomenon from

(1) BOSCH, P. and SIMONS, S. "Our music machines." In: *Organised Sound* (2005), n. 10-2, pp. 103–110.

science into an engine for the creation of a lively and unpredictable work, but in the end interactivity and interference with the public space has produced a much broader context. Therefore we will not only describe the position of *Wilberforces* within our own oeuvre but also discuss the social significance of its set-up and examine its place within the tradition of interactive and screen-based work.

Image 01 – *The Electric Swaying Orchestra*, MultiMediale2, ZKM, Karlsruhe, 1993.

Electric Swaying Orchestra

Ever since the (2) *Electric Swaying Orchestra* (1991/92), sound, construction and scientific background have been inseparable in our projects. The work consists of six huge pendulums which are activated by the up and down movement of their hanging mounts. Some similarities in the concept with the music piece *Pendulum Music,* written by Steve Reich in 1968, are remarkable. Reich describes his piece as follows:

> Four or more microphones are suspended by their cables above a loudspeaker. Each amplifier is turned up just to the point where feedback occurs when a mike swings directly over its speaker. The performance begins with performers pulling each mike back like a swing and releasing them in unison. The piece ends shortly after all mikes have come to rest and are feeding back a continuous tone. (3)

Not everyone who has seen the *Electric Swaying Orchestra* would think at once of *Pendulum Music*. Nevertheless, these projects have a lot in common. In both projects, the musical outcome is determined by the change in distance between sound input and sound output devices; here, however, the performers of *Pendulum Music* are replaced by motors and the analogue feedback by digital feedback. In Reich's piece, the small differences in periods and

(2) BOSCH, P. and SIMONS, S. "The Electric Swaying Orchestra." In: *Leonardo Music Journal* (1996), 6, p. 116–17.

(3) REICH, Steve. "Pendulum music." In: *Source, Music of the Avantgarde* (1971), 10, p. 31.

stop times of the pendular movements are unpredictable factors. In the *Electric Swaying Orchestra*, this unpredictability is realised by (4) parametrically driven pendulums, a well-known subject that has been thoroughly researched and documented by physicists within the cadre of order and chaos theories. These pendulums command an exceptionally wide range of movement; what starts off as a traditional to and fro swing can become an unpredictable and irregular motion or even a startlingly vigorous full circumrotation. A microphone or loudspeaker is attached to the end of each pendulum and electronic music is heard from the loudspeakers. The computer interprets the sounds received from the three swaying microphones and responds by playing new notes over the three speakers. The computer is constantly listening to itself in a repetitive process without end. The complexity and unpredictability of the system ensures that each performance is unique in both movement and sound. The project was developed in cooperation with students from the faculty of mechanical engineering of the University of Twente in Enschede, Holland. It was awarded an Honorary Mention in the section 'Interactive Art', at Prix Ars Electronica 1992, Linz, Austria.

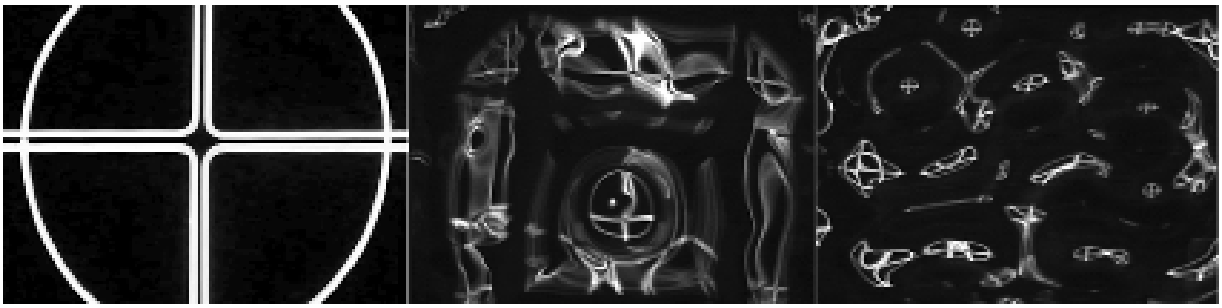

Image 02 – *Aguas Vivas*, "White Noise", ACMI, Melbourne, 2005: three stills from live projections.

Aguas Vivas

The installation *Aguas Vivas* (2001–2007) is, at least mechanically, simpler than any other of our works: One steel container filled with black oil, one oscillating motor, eight springs. Different to our previous projects, we started concentrating on the image rather than on the sound. Instead of creating a non-linear system algorithmically, we decided to build it physically. The oil is sent into vibration and the surface starts to undulate, changing constantly. Light reflected onto the surface of the oil is fragmented, instantly. The results are captured with a video camera and projected on a wall. The images are extremely energetic, never constant and very hypnotic. The first prototype of the work dates back to 1996, and the project has been changed and expanded upon several times since then. At the exhibition Midivisi (2001) in Z33, Hasselt, Belgium, we added electronically processed amplified sound for the first time. The container, light source (a white neon cross), camera and microphones were located in the same space. In an adjacent space, the video image was projected together

(4) NAYFEH, A.H., and MOOK, D.T. *Non-linear oscillations* (pp. 258–61). New York: John Wiley & Sons, 1979.

with amplified, processed sounds that were captured from the moving container, all realised in real time. At ISEA 2002, Nagoya, Japan, we premiered a new set-up with two simultaneous sound and image projections. One live projection is in the version of 2001, the other shows still images captured in real time from the ever-changing original material, revealing an otherwise hidden world. The relatively static second layer forms a mesmerising counterpoint to the energetic and hypnotising effect of the other projection. In 2003 the work was shown at the exhibition (5) 'Del Mono Azul al Cuello Blanco' at the Lonja del Pescado, Alicante, Spain. Here we added a circle to the image of a cross. This does not only alter the emerging light patterns, it also widens the psychological impact of the piece, reminding one of the many images from contemporary crusades of target marks in warfare, or simply of the traditional countdown at the start of a movie.

Image 03 – *Wilberforces*, FACT, Liverpool, 2012/13: The springs and the screen in projection booth.

Wilberforces

Wilberforces is a new product of our research into complex, unpredictable systems and unstable balances, a piece which is part physics experiment and part new-media installation. The Wilberforce pendulum, which the piece references, consists of a hung spring with central and eccentric weights. Once calibrated, vertical and circular movements alternate even without additional external energy. It is an example of a coupled mechanical oscillator, often used as a demonstration in physics education.

(5) BOSCH, P. and SIMONS, S. "Aguas Vivas." In: *Del Mono Azul al Cuello Blanco*. José Luis Pérez Pont (ed.). Valencia: Generalitat Valenciana, 2003. pp. 240–7

> The device's intriguing behavior is caused by a slight coupling between the two motions or degrees of freedom, due to the geometry of the spring. When the weight is moving up and down, each downward excursion of the spring causes it to unwind slightly, giving the weight a slight twist. When the weight moves up, it causes the spring to wind slightly tighter, giving the weight a slight twist in the other direction. So when the weight is moving up and down, each oscillation gives a slight back and forth rotational impulse to the weight. In other words, during each oscillation some of the energy in the translational mode leaks into the rotational mode. Slowly the up and down movement gets less, and the rotational movement gets greater, until the weight is just rotating and not bobbing. (6)

In the same way all the energy is transferred back from the rotational mode into the translational mode. *Wilberforces* builds further on this scientific experiment. Three long metal springs are used for generating video and audio data. Below one of the springs hangs a video camera with a microphone, below the other two hang tiny loudspeakers. Signals from the moving camera, mike and speakers provide the basic material for the sound and image projections produced by the work. The springs have a length of around six meters, a size normally not found in physics laboratories and resulting in spectacular large and slow movements. Each spring is hung from above and attached to a pneumatic actuator that adds energy to the system. Images and sounds captured by the camera are projected in real-time. The irregular motion of the springs can be tracked and experienced in an adjacent space or anywhere when emitted live on the Internet. Within our oeuvre *Wilberforces* is, like *Aguas Vivas,* in the first place a vibratory project, forming part of a series that arose from our collaboration with students of the University of Twente in Enschede, Holland within the framework of TARt, a technique and art festival that was active in the nineties. As a consequence of physical properties –all of these works being sprung constructions– the movements and sounds created by the machines can change almost imperceptibly from order into chaos and vice versa. The keyword of the series is resonant frequency (7). Mechanically produced vibrations bring these constructions into motion by stimulating its resonant frequencies.

The construction –not much more than some long springs and actuators- is simple but effective. We initially introduced the camera, speakers and electronics to “magnify” the magical behaviour of these springs, by translating their movements into image and sound, not fully being aware of the effect of creating an interactive installation at the same time. At its first appearance, at FACT, Liverpool, the work’s power, caused by its resemblance to interactive games, came alive. The work was placed in a public hall, next to the bar of a film house/exhibition space and hundreds of people who would not normally go to a new-media exhibition got in contact with the work. This way the public space was being transformed into a playful, but at the same time monitored area. The work plays with and transforms a location in a way that is difficult to grasp what is real and what is manipulated, creating an environment wherein people are encouraged to participate without being aware of giving up something of their privacy: A mechanism that is used more and more in our society. Luckily, in this case, they are only taking part in the creation of an artwork.

(6) *Wikipedia.*< https://en.wikipedia.org/wiki/Wilberforce_pendulum> [consulted October 4, 2014].

(7) MEIROVITCH, Leonard. *Fundamentals of Vibration.* Singapore: McGraw-Hill Book Co., 2000.

Processing techniques used in *Wilberforces.*

The techniques used in the processing of the live video material are unconventional but simple. The great variety of movements of the camera itself in combination with its upside down position delivers a footage that already without any further processing is exciting and inviting. All signals from the camera are being sent to a projector with a low-cost wireless system. This introduces some side effects like distorted lines that now and then move vertically over the screen and a relatively low image resolution. Both effects evoked associations with CCTV cameras to some people, making them think about pro and contras of these devices that are abundant in our current society.

The processing of the audio material is much more complex. Like in the *Electric Swaying Orchestra* feedback is the central technique. Audio feedback is a process that is generally difficult to restrain, but in this set-up it works really well, helped by the built-in audio compressor of the camera that keeps the sound levels within an acceptable range for a public space. Sounds captured by the camera are mixed with sounds from a DSI Evolver synthesizer and sent to the hanging speakers with different sound effects, produced by the classic Yamaha SPX 90 sound processor. This mix is picked up again by the mike of the camera together with new appearing sounds in the space, etcetera. In order to make the system workable for a public space the installation was working at unpredictable intervals, not continuously.

The sound in the projection space is processed even further, delivering a live soundtrack with the live footage by adding echo and reverb with ordinary guitar effect pedals and by transposing part of the incoming sound two octaves down, being played through a sub-woofer. The result was not only perceived by the public as intriguing, but sometimes also as frightening. For readers that have a special interest in the devices used in the set-up please refer to image 04.

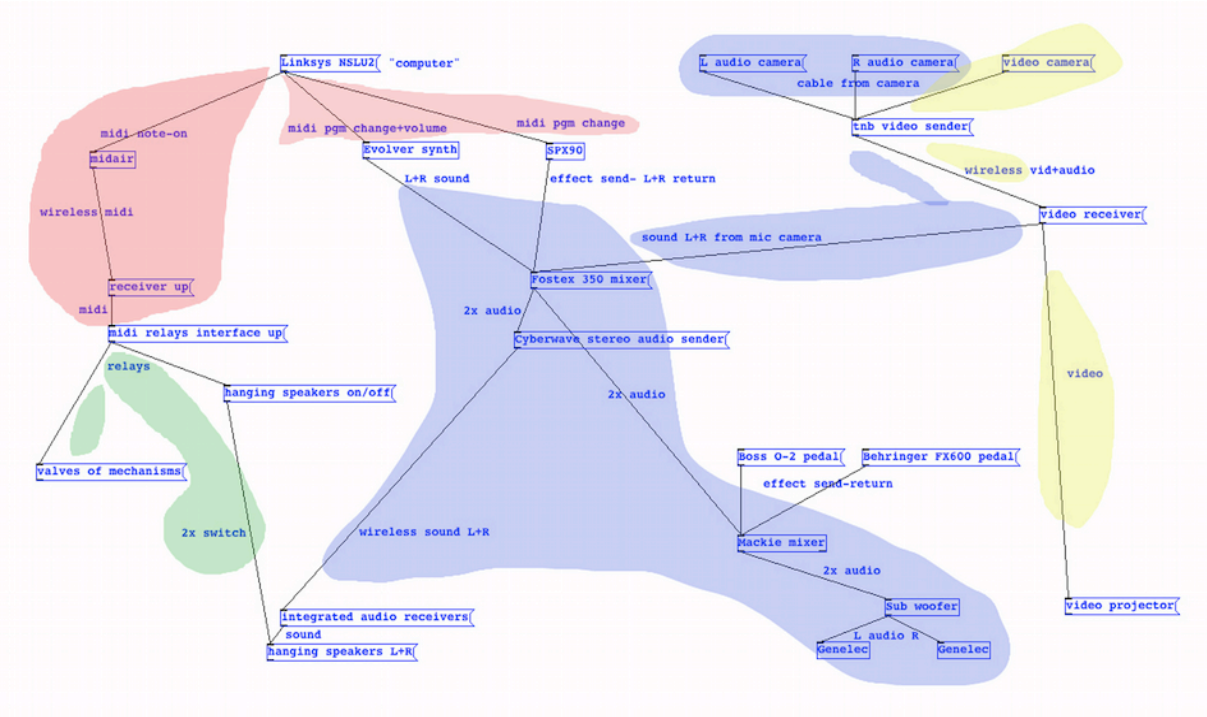

Image 04 – *Wilberforces*, FACT, Liverpool, 2012/13: scheme of devices and connections.

Discussion

While computers, networks and electronics in general keep on being faster and faster, at the same time artists, technicians and the public keep getting more and more demanding, a never-ending spiral of progress, satisfaction and discomfort. However the development of *Wilberforces* and especially its final appearance in the public space made us aware of the fact that there still are, to the contrary of what one would expect, many tools available for creating lively and exciting interactive works, without the use of any expensive hi-tec. With this article we hope to have inspired the reader, inviting him/her to consider the use of mechanical and analogue components in his/her work. "Real" materials and analogue processes still have a directness and purity that, in spite of impressive progress, are still difficult to equalise with digital means.

Acknowledgements

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