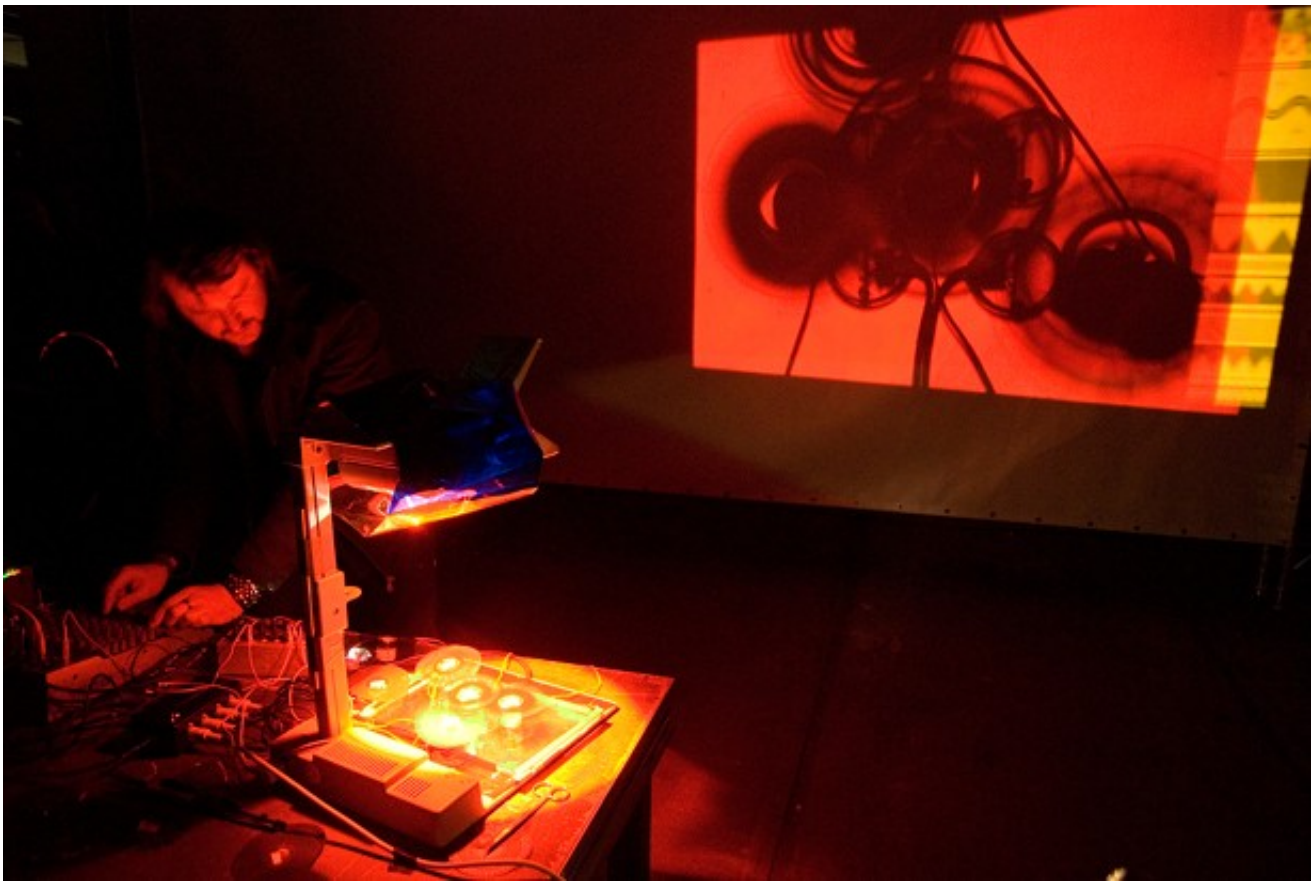

TONEWHEELS:
optical sound & light music

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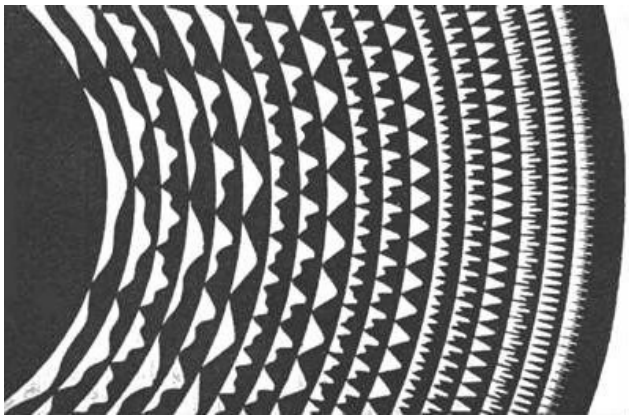


Painted glass wheel from Welte's Light-Tone Organ, 1936.

TONEWHEELS OVERVIEW

TONEWHEELS is an experiment in converting graphical imagery to sound, inspired by some of the pioneering 20th Century electronic music inventions, such as the *Light-Tone Organ* (**Edwin Emil Welte**, 1936 Germany), the *ANS Synthesizer* (**Evgeny Murzin**, 1958 USSR), and the *Oramics* system (**Daphne Oram,** 1959 UK). Transparent tonewheels with repeating patterns are spun over light-sensitive electronic circuitry to produce sound and light pulsations and textures. TONEWHEELS aims to open up the "black box" of electronic music by exposing the working processes by which the sound is created for the audience to see.

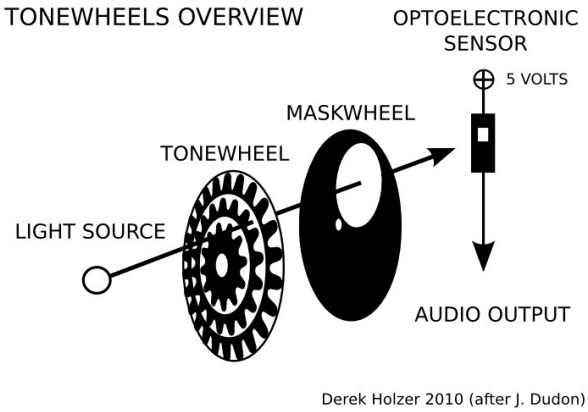
The technology of direct optical synthesis arose with the first sound-on-film motion pictures. In the 1930's, several designs for optical synthesizers were produced in the USSR, Germany and United States, with a handful even being commercially realized with to great amount of techno-utopian hype. The future of sound, we were assured, was made of light.

Apart from a few dedicated innovators such as Oram or Murzin, the use of optical synthesis for electronic music creation was abandoned after the Second World War in favor of techniques derived from new military technologies. One of the most advanced of these technologies was the analog computer in the nosecone of each missile launched over the English Channel towards London. One can imagine both Stockhausen and Kraftwerk were keenly aware that their instruments were the legacy of the V2 rocket and the atomic bomb. Thus, TONEWHEELS represents a media-archaeology of a "road not taken", that of a connection to the culture of film and music versus the science of destruction and death.

In performance, artist Derek Holzer introduces the TONEWHEELS instrument in a way which exposes the working processes of the performance for the audience to see. His live, purely improvisational sets are created without the use of digital technology. Often dramatic, always loud, they involve both a balance of control and chaos in relation to his instrument, and the overwhelming physicality of sound.

TONEWHEELS live at AS22, Providence Rhode Island (photo by Amy Hope Dermot).

THE TECHNOLOGY of DIRECT OPTICAL SOUND



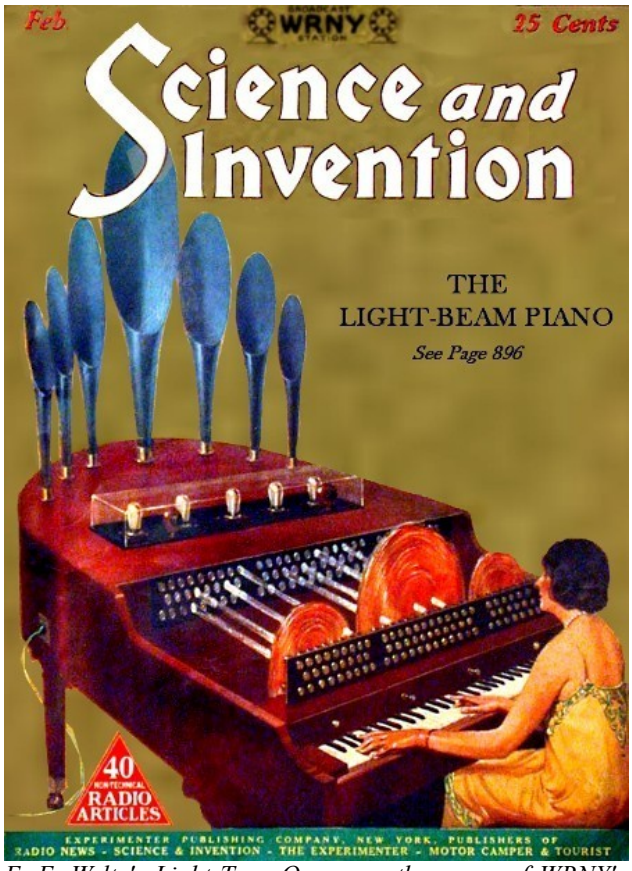
Technical overview of TONEWHEELS system (D. Holzer after J. Dudon).

The astonishingly simple technology employed by the TONEWHEELS project creates sound directly from light by means of an optoelectronic sensor. In the diagram above, a *LIGHT SOURCE* is directed through two transparent, spinning disks. The first disk, the *TONEWHEEL*, has patterns representing sound waves

printed on it. This disk modulates the light in a similar manner as the optical soundtrack of 16mm and 35mm motion picture film. The tone produced depends on both the number of peaks printed on the disk, and the speed at which the disk rotates.

After the first *TONEWHEEL*, any number of secondary *MASKWHEELS* may be used to further filter or modulate the light before it reaches the sensor. These *MASKWHEELS* create the same kind of amplitude modulation as the low-frequency oscillators in analog synthesizers, and are heard as anything from a rhythmic pulse to additional sonic frequencies.

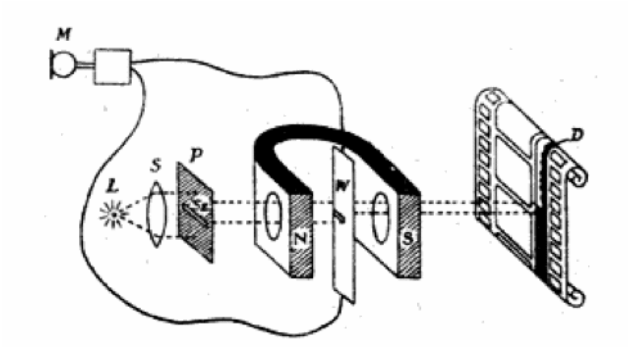
Once the light has passed through these various wheels, it falls on the *OPTOELECTRONIC SENSOR*, typically a phototransistor or photodiode. This sensor allows five volts of direct electrical current to pass through when exposed to light, and blocks the current when in shadow. From there, the modulated current may be used as an audio signal by connecting the *AUDIO OUTPUT* to an amplifier and speaker, or it may be sent through a mixer and various other electronic effects for further treatment.



E. E. Welte's Light-Tone Organ on the cover of WRNY's Science and Invention Magazine, 1936.

A BRIEF HISTORY of OPTICAL SOUND

The world of electronic music has always been represented as a utopia--or a twin utopia, in fact. The 20th Century development of electronic music instruments has focused on two ideals: that music may be created without need of an orchestra, and that sounds may be created which have never been heard before. These utopias also form the biggest popular criticism of electronic music: that you don't see anyone playing anything and you have no idea where the sounds you are hearing come from.



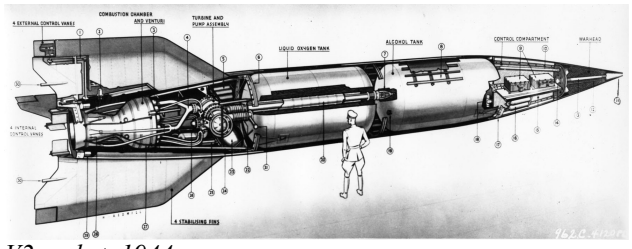
Printing an optical soundtrack on 35mm film.

With the development of sound-on-film technology for spoken motion pictures in 1919, several inventors realized that this technique could be appropriated from the world of cinema towards the aim of realizing these musical ideals. Thus, many of the first American and German opto-sonic instruments, such as **Edwin Emil Welte**'s *Light-Tone Organ*, focused on the middle-class aspirations of bringing the authority and power of that "emperor of instruments" (**J. Wozencroft**, Touch Records)--the pipe organ--into their parlors. In the 1930's, several designs for optical synthesizers were produced in the USSR, Germany and United States, with a handful even being commercially realized to a great amount of techno-utopian hype. The future of sound, we were assured, was made of light.

Evgeny Scholpo and his Variophone machine, USSR 1930's (image courtesy of A. Smirnov).

In the Soviet Union, the production of the first spoken motion picture in 1929 provided a myriad of avant-garde artists with pathways towards both ideals, according to the detailed research of **A. Smirnov** of the Theremin Institute in Moscow. The work of **Evgeny Scholpo** and **Nikolai Voinov**, for example, focused on using techniques of optical sound to create synthetic soundtracks for animations and films. Visual artists such as **Arseny Avraamov** and **Boris Yankovsky** (like their contemporaries, the Germans **Rudolf Pfenninger** and **Oskar Fischinger)** became fascinated with both the search for meaningful correspondence between sound and image, as well as the creation of tones and timbres impossible to create with acoustic instruments.

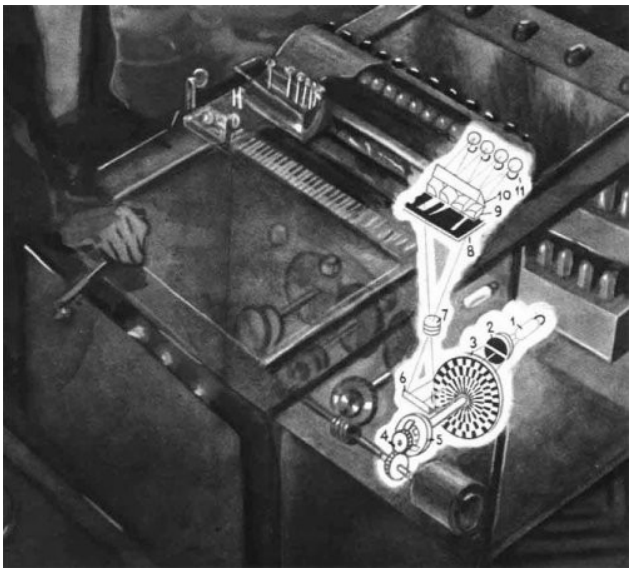
Others, such as the British physicist **E.A. Humphries,** created the first artificial speech synthesis by re-painting an optical film soundtrack, in effect "overdubbing" new names for characters in the film (**T. Y. Levin,** "Tones from out of Nowhere"). All this created a rich environment for experimentation which was cut short by the outbreak of the Second World War.



V2 rocket, 1944.

During the war, advances in the science of more precisely dropping bombs on other human beings (particularly on the American, British and German sides) brought about sweeping technological changes. One of the most advanced of these technologies was the analog computer in the nose cone of each missile launched over the English Channel towards London.

The need for smaller, faster, more reliable and eventually cheaper communications and computing circuits shows its legacy to this day in electronic music, mainly in the form of the oscillators, filters, clocks and counters used by analog synthesizers and their digital emulations in the area of laptop music. One could imagine both **Stockhausen** and **Kraftwerk** were keenly aware that their instruments were the descendants of the V2 rocket and the atomic bomb.

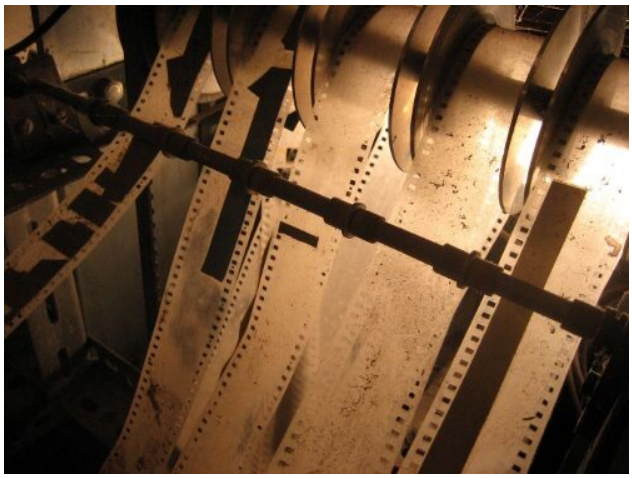


The inner workings of Murzin's ANS synthesizer USSR 1960's (image courtesy of A. Smirnov).

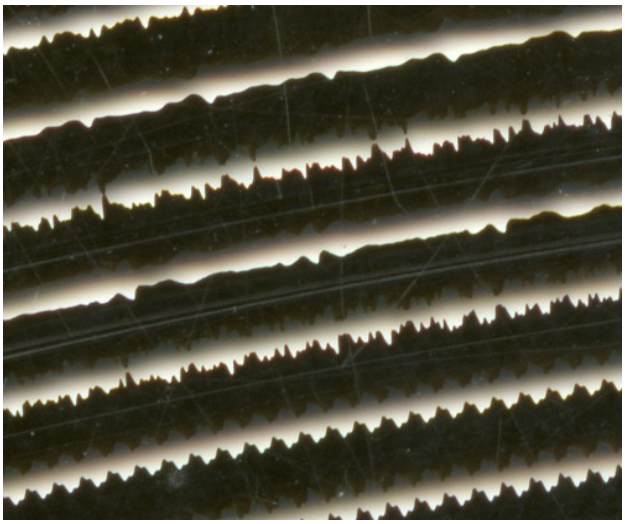
The use of optical synthesis for electronic music creation was largely abandoned after the war. However, the use of light still represented a utopia to two artists working on opposite sides of the Iron Curtain. In Moscow in 1958, **Evgeny Murzin** finished the first version of the *ANS Synthesizer.* This machine used a series of spinning glass discs activated by light shining through lines cut in a sheet of moving glass (the "score") to create up to 720 simultaneous microtones.

Daphne Oram's "Oramics", released by Paradigm Discs, 2007

And in the UK, **Daphne Oram** became the first woman to create and run a sound studio, as well as the first woman to "design and build an entirely new sound recording medium" (**J. Hutton**, "Organized Sound") by developing her *Oramics* machine in 1959. It scanned waveforms hand-drawn on a sheet of glass with a simple cathode ray tube under a photocell to produce unique timbres. The durations and pitches of the sounds where controlled by another optical system using strips of painted 35mm film to notate events over time in the development of the music.

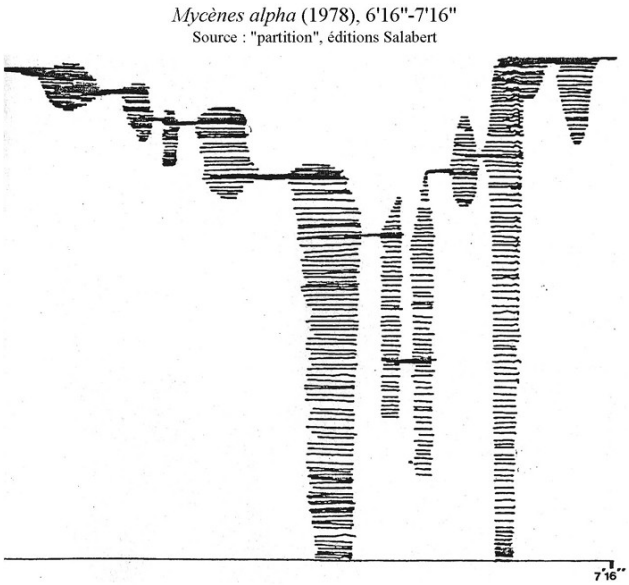

The Oramics machine today, awaiting refurbishment by Goldsmiths University after two decades of storage in a barn (photo: Derek Holzer).

The possibilities of optical or graphical sound were further explored in the 1970's. In 1971, the *Optigan* was released by toy manufacturer the **Mattel Corperation**. The Optigan optically read graphic representations of waveforms from a series of 12" celluloid LP sized discs, hence the name Optigan - 'Optical-Organ'.


Optigan disk close up (photo courtesy of Simon Jenkins).


Jacques Dudon's photosonic synthesizer (from artwork of his "Lumieres Audibles" LP, 1996 Mondes Harmoniques).

And in 1972, French composer and instrument builder **Jacques Dudon** began his work with photosonic synthesis. His system, developed more extensively between the years 1984-2002, used stationary, spinning disks printed with optical patterns drawn in just-intonation scales, plus a series of moveable light sources and optical "comb filters" to produce microtonal music which Dudon associated with the Chakras of Indian spirituality.



A section of Iannis Xenakis' UPIC score for "Mycènes Alpha" (1978).

Finally, in 1977, Greek-born composer **Iannis Xenakis** completed his *UPIC* system at the *Centre d'Etudes de Mathématique et Automatique Musicales* in Paris. Although a computer-based system, the UPIC interface was essentially the same as in Murzin's ANS: the composer drew lines on the screen with a light-pen representing pitches which changed over time depending on the direction of the line. With the UPIC, the long-explored direct relationships between image to sound finally entered the digital era.

Xenakis imagined his UPIC system would open up the possibilities of composition to those with no formal musical training, allowing them to create music in a direct, intuitive way.

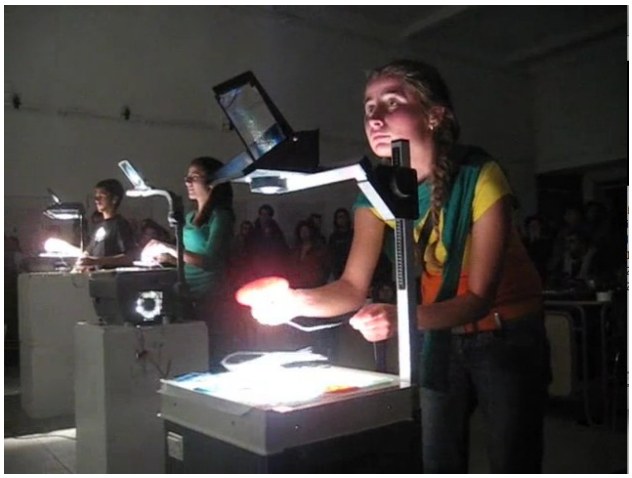
HISTORY of the TONEWHEELS PERFORMANCE

Derek Holzer has performed live audiovisual sets using laptops and the Pure Data programming language since 2001. During this time, he became frustrated with the performance limitations of the computer and began new experiments with all-analog systems designed to overcome the twin dystopias of electronic music: the apparent lack of both performer and sound source.

These experiments came together during the *Art of the Overhead* workshop in Cologne in August 2007. Inspired by some of the pioneering 20th Century electronic music instruments such as the *ANS Synthesizer,* the *Variophone* and the *Oramics* system, as well as the research of **Andrei Smirnov** of the *Theremin Institute* Moscow, Holzer developed electronic and graphical systems for playing light on the overhead projector.

TONEWHEELS live performance, Warsaw 2007 (photo by Patrycja Stefanek).

The project was developed further for the *Passengers International Festival of Public Art,* which took place in Warsaw during October 2007. There, the piece was premiered in its most elaborate form--a duo using one projector for sound generation and another for visual manipulation. Holzer continued to develop the sonic aspects of TONEWHEELS for a 3 month residency at *Tesla,* Berlin DE during the months of Oct-Dec 2007, as well as in residence at *STEIM,* Amsterdam NL during February 2008.



TONEWHEELS workshop participants present their work, Sofia 2009 (photo: Derek Holzer).

A workshop on analog sound and light techniques was developed for the *WAVES* exhibition in Dortmund DE during June 2008, and was later held at the *DA Festival* in Sofia BG in 2009 and the *Bent Festival* in New York City in 2010. A lecture on the history of optical synthesis and drawn sound is also available. Experiments for a TONEWHEELS installation, which visitors and audience members can play with light or design graphical scores for, were made at *Access Space,* Sheffield UK during July 2008. And currently, an audience-playable TONEWHEELS instrument inspired by the *Welte Light-Tone Organ* is under construction for premiere at the *Aces-s Festival* in Pau FR during October 2012.

LINKS TO FURTHER INFORMATION

TONEWHEELS performance:
http://macumbista.net/?page_id=476

TONEWHEELS historical research:
http://www.umatic.nl/tonewheels_historical.html

TONEWHEELS technical information:
http://macumbista.net/?page_id=539

TONEWHEELS workshop:
http://macumbista.net/?page_id=493

TONEWHEELS events documentation:
http://macumbista.net/?tag=tonewheels

ABOUT THE ARTIST

Derek Holzer (1972) is an American sound artist based in Berlin DE, whose current interests include DIY analog electronics, sound art, field recording and the meeting points of electroacoustic, noise, improv and extreme music. He has played live experimental sound, as well as taught workshops in noise art technology, across Europe, North America, Brazil and New Zealand.

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TONEWHEELS live at AS22, Providence Rhode Island (photo by Amy Hope Dermot).