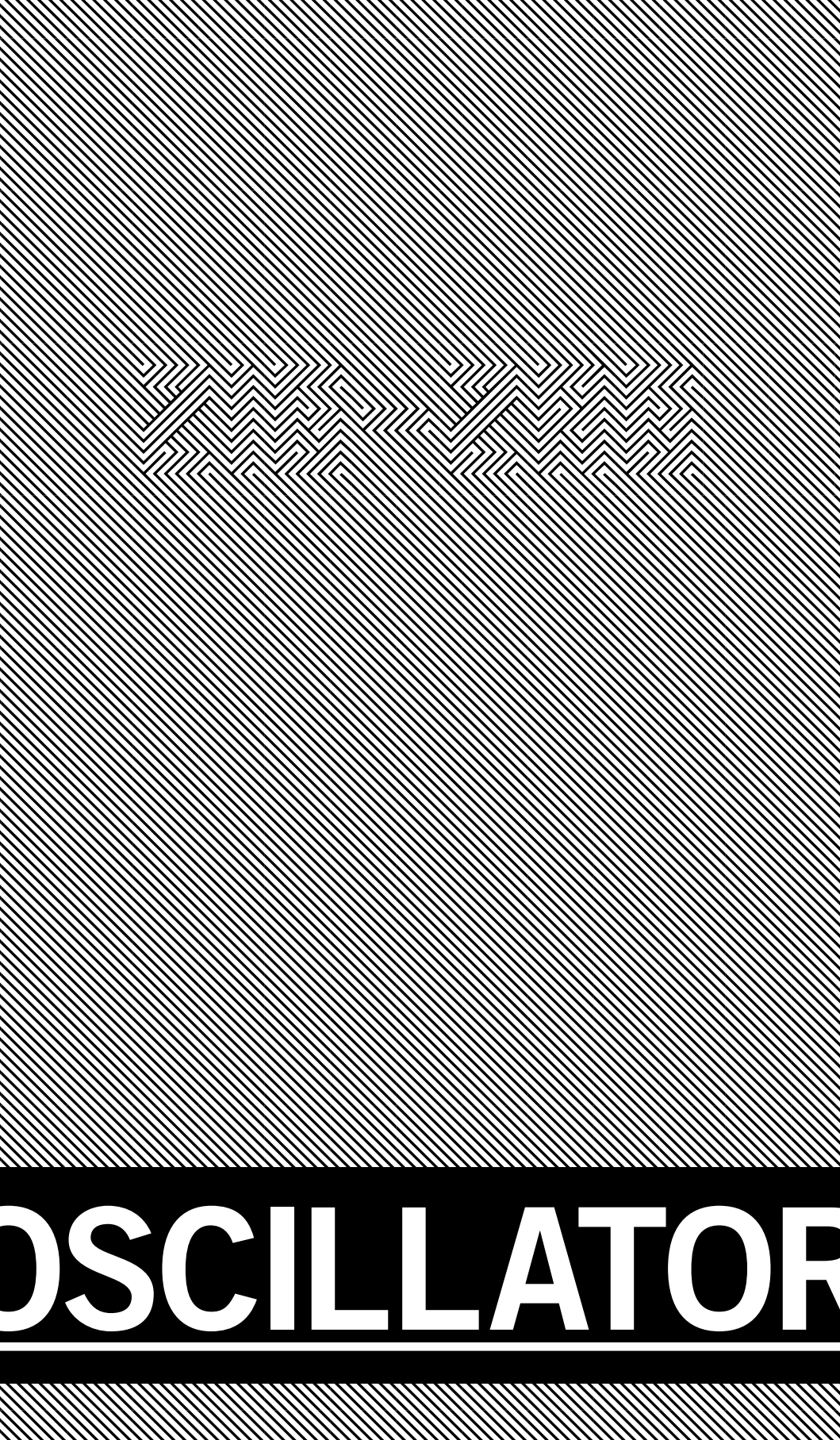
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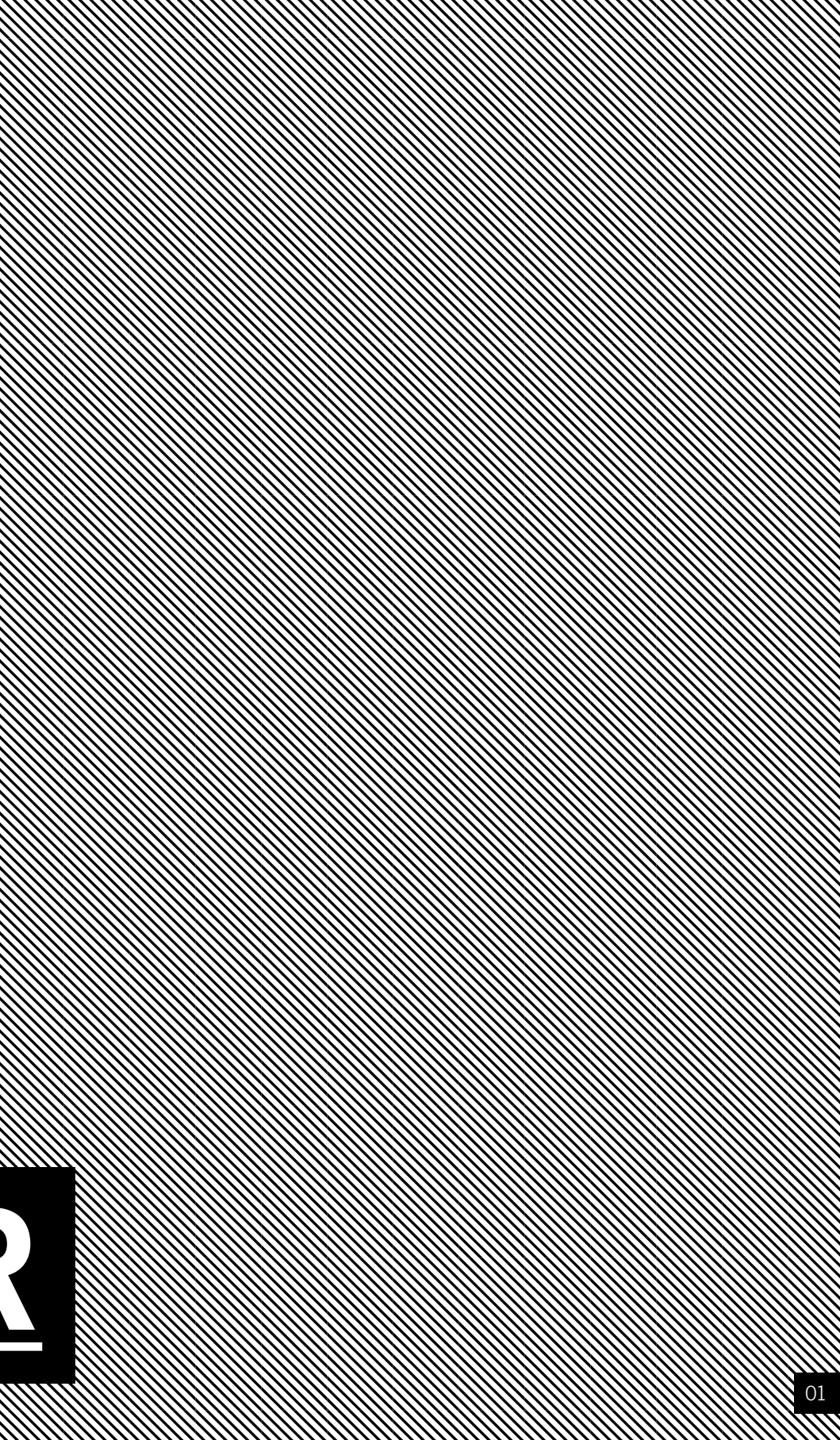

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TRINITY COLLEGE DUBLIN

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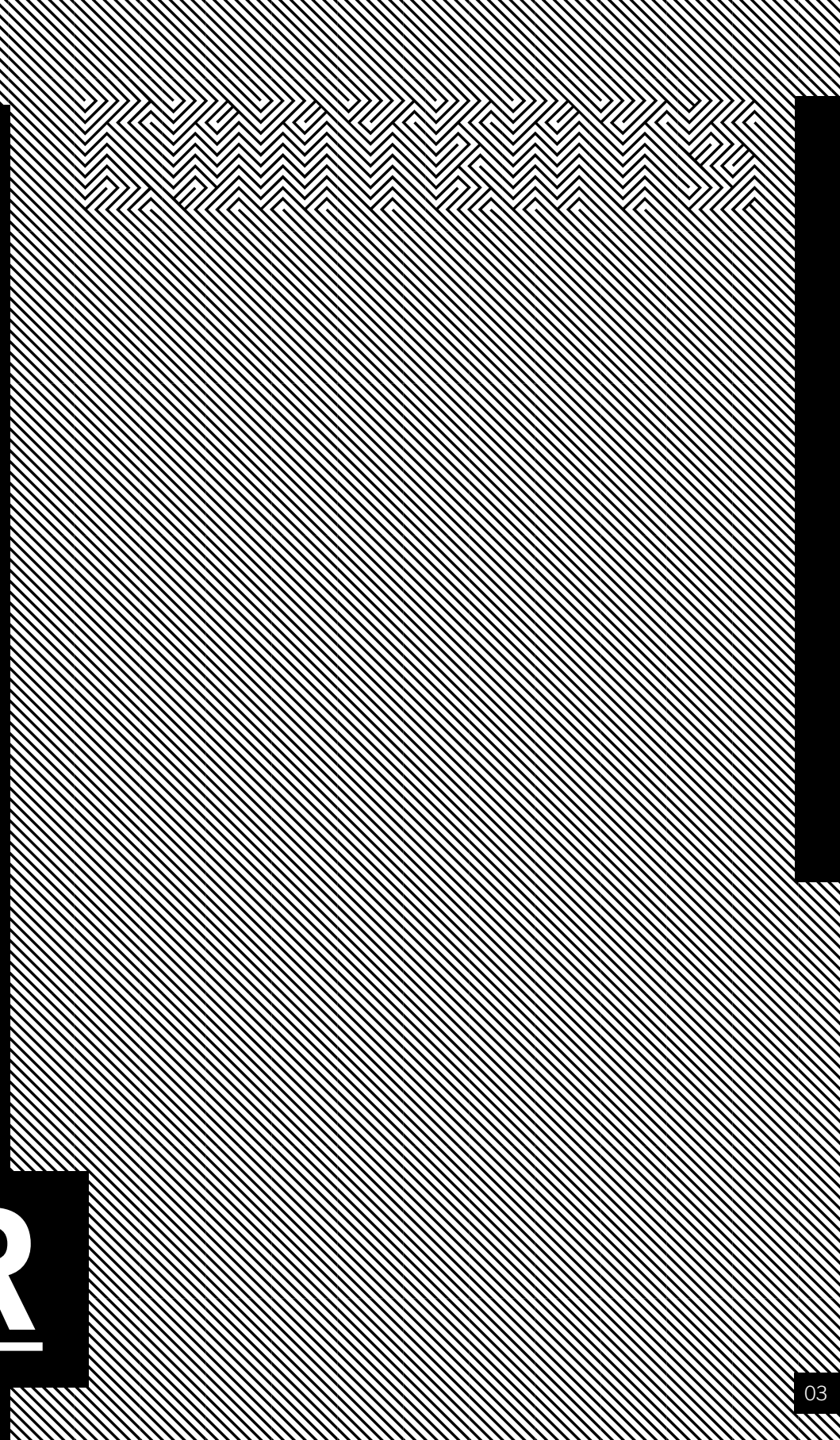
EVERYTHING IN MOTION

OSCILLATOR



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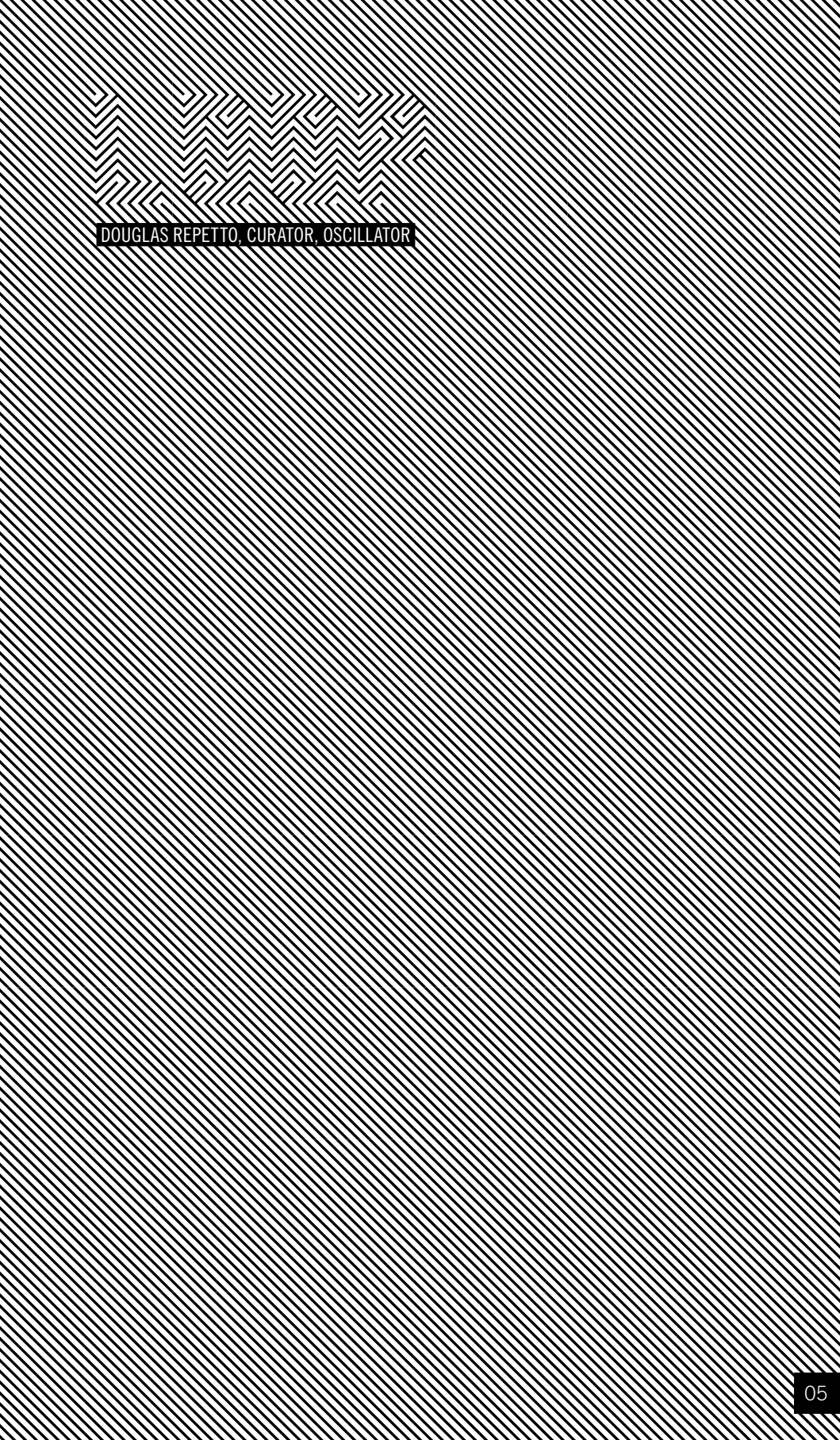
MICHAEL JOHN GORMAN, DIRECTOR, SCIENCE GALLERY
LYNN SCARFF, PROGRAMME MANAGER, SCIENCE GALLERY

What oscillates? From swinging pendulums to throbbing beats and harmonics, oscillations are repetitive variations from one state to another that usually occur over time. Found in human-made systems and in physical, biological, and informational processes, they can arise either by design or by accident. Sometimes they're a critical component, essential to the correct function of a system, other times they might be a curiosity or a nuisance, or even a catastrophic force. Although well-documented there are oscillations that we still can't quite mathematically explain, from the vibrations of Euler's Disk to the peculiar regular and chaotic motion of a Swinging Spring. In short, oscillations are ubiquitous and as such are the perfect fodder for a Science Gallery exhibition!

OSCILLATOR sees us reunite with two previous Science Gallery curators—Douglas Repetto **[ARTBOTS 2008]** and Stefan Hutzler **[BUBBLE 2009]**, to explore a vibratory world of motion and cycles. Like many of our exhibitions, the idea for **OSCILLATOR** came directly from our community. Initially proposed by Douglas just over twelve months ago, the theme lends itself remarkably well to interrogation by a wide audience of artists, designers, chemists, physicists, engineers, geologists, economists, biologists, mathematicians and musicians. We're indebted to Douglas, Stefan and colleagues in the Schools of Physics and Chemistry who have given their time and expertise in bringing the exhibition together. We would also like to thank our exhibition partners, Science Foundation Ireland, whose support has enabled the exhibition development. In any Science Gallery exhibition there is inevitably some weird and wonderful exhibit that requires a number of people to help facilitate it. In this case, we'd like to thank Jim O'Connor at Rosderra Irish Meats Group and Áine Kelly in School of Physiology for enabling us to reanimate two pig hearts.

You will find a range of diverse exhibits, experiments and events at **OSCILLATOR** exploring electricity, economics, pulsars, brainwaves, tectonic plates, musical harmonies, pendulums, chemical reactions, algorithms, heartbeats and feedback. Whether you're marvelling at the synchronicity of a pendulum wave or intrigued by your own brain activity, we've put together an interactive exhibition that should have something for everyone's tastes and interests. And hopefully, at the same time, expose the sometimes unseen motion, cycles and vibrations of our oscillatory world.


DOUGLAS REPETTO, CURATOR, OSCILLATOR

As a child I was constantly getting stuck in loops—working a palindrome back and forth and back and forth, humming variations on the last two big chords in a symphony *ad infinitum*, fretting over language puzzles ["this sentence is false"] and tautologies, drawing endless stars and loops and grids. I was obsessed by systems and cycles that seemed somehow eternal, with no clear beginning or end, and with no particular reason to ever stop [or start, for that matter].

As that early fascination matured, my attention turned to more complex systems, like music theory with its many messy, intertwined traditions and half-hearted 'rules', and computer programming, with its doomed promises of purity and logic. Today my obsession with cyclical systems continues unabated, and I find myself constantly parsing the world into feedback loops and interference patterns, digging for the cycles and logic that occasionally pop out of the chaos.

Because of its looping nature, an oscillator is a bit of a time machine: If you know something of where it's been, you have a notion of where it's going. And if it doesn't end up where you thought it would, you know that something about the world has changed. Subtle changes in oscillators drive both the squeals of the theremin and the sensors on the most distant spacecraft. Complex feedback systems drive the price of oil in the Middle East and weather in the North Atlantic. Both brains and beats encode meaning as rhythm, although neither is particularly anxious to give up the key.

OSCILLATOR was conceived as a place to bring together physical and conceptual cyclical systems from as many domains as possible. Art, music, physics, chemistry, biology, seismology, neurology, and computer science are just a few of the fields represented. The show includes artworks and experiments from an international group of artists, scientists, researchers, and inventors, all with some—possibly remote or strange—connection to the idea of an oscillator. Kelly Heaton's paintings in *The Parallel Series* use simple, hand-wired electronic oscillators as stand-ins for the cries of living creatures. Helen Pynor and Peta Clancy's *The Body is a Big Place* embeds living hearts in a throbbing machine. Meanwhile, in the LAB, a pool of mercury beats out its own mysterious rhythm.

Waves by Daniel Palacios gives us a stunning view of the paths taken by an oscillating string. Clay Lacefield, Greg Wayne, and Drew Baughman's *Central Pattern Generator* maps the daily paths and routines of a lab mouse. Nurit Bar-Shai uses audio waveforms captured in agar as a growth medium for bacteria.

These, like all the works in **OSCILLATOR**, provide a glimpse into the many intimate, clinical, funny, and even melancholy ways creative minds engage with cyclical systems.

As a complement to the artworks, we've created the **OSCILLATOR LAB**, a hands-on space full of demos, games and [thought] experiments to help get your own ideas about oscillators cranking along, and talks and special events with topics ranging from the boom and bust cycles of finance to the function of nostalgia in fashion and design.

As you wander through the show our hope is that you will not only marvel at the ingenuity and insight of the many creative people involved, but that you will also begin to tune in to the oscillations that quite literally create our world, from the tiniest electromagnetic wiggles to the cosmic cycles [or not] of the big bang.

STEFAN HUTZLER, CURATOR, OSCILLATOR

"I'm picking up good vibrations", [The Beach Boys, 1966]

We are all immersed in a sea of vibrations and the waves that they emit. It is the job of the physicist to make sense of them.

Sound waves shake air molecules and are picked up by our eardrums—or indeed the whole body, when in a Dublin nightclub. Our eyes detect electromagnetic waves, variations of electric and magnetic fields in empty space. When these light waves have longer wavelengths we feel them as heat on our skin. Not only do we absorb these waves, but we also emit them. Quantum physics tells us that ultimately all matter is wave-like. Advances in research mean that in the nanoscience labs above you, CRANN researchers can now visualise these matter waves.

The simple pendulum is the icon of oscillation, however a not-so-simple execution is the Newton's Cradle. Featured in the exhibition, this executive toy consists of five balls in contact, suspended from strings. Grab one ball, move it away from the others and let go. As it hits the remaining stationary balls, the ball at the far end will temporarily be ejected, before in turn colliding with the other balls and ejecting the first released ball. You might remember this experiment from your school physics when discussing conservation of energy and momentum. Like most things in physics, it has a simple explanation, but if you look more closely there are very interesting complications. Isaac Newton compared himself to a boy playing on the seashore [a beach boy picking up the good vibrations?], every now and then finding a smoother pebble than ordinary "whilst the great ocean of truth lay all undiscovered before me".

Closer to home, our own local hero, the 19th century TCD physicist George Francis Fitzgerald was the first to suggest that an oscillation in an electrical circuit could generate what we now call radio waves.

Oscillations and waves remain at the forefront of research, with physicists nowadays also investigating their occurrence in society, such as in economic cycles or Mexican waves.

This exhibition offers oscillations in many varieties. Tune in and resonate!

THIS SENTENCE IS FALSE.

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IN DEVELOPING OSCILLATOR
WE HAVE TAKEN SOME OF THE MOST COMPELLING, WEIRD AND WONDERFUL OSCILLATORY PHENOMENA FROM CHEMISTRY AND PHYSICS LABS AND RECREATED THEM FOR YOUR INTRIGUE AND ENTERTAINMENT. THANKS TO MICK KELLY OF SPIDERFISH AND COLLEAGUES IN SCHOOL OF CHEMISTRY AND SCHOOL OF PHYSICS IN TRINITY COLLEGE DUBLIN FOR ASSISTING US IN CREATING THESE ODD OSCILLATORY OCCURRENCES.

LAB

MERCURY BEATING HEART

A combination of a mercury pool with just enough sulphuric acid to cover the surface of the mercury and an iron nail positioned so that it is immersed in the sulphuric acid with its tip just touching the mercury. This set up results in a weird and wonderful throbbing of the mercury pool. The contraction and relaxation of the mercury is due to changes in the surface tension of, and charge on, the mercury drop. When the mercury is not in contact with the iron nail, its surface becomes oxidised and the positive mercury ions repel each other, causing the mercury pool to relax [i.e. lower its surface tension]. The relaxation causes the mercury to come into contact with the iron nail, which has a sufficiently negative electrochemical potential to reduce the mercury ions to mercury metal. The surface tension of the mercury increases and the pool contracts, causing the contact with the nail to be broken. The mercury surface reacts with the acid and becomes oxidised again, thereby, completing one cycle of the oscillation.

DOUBLE PENDULUM

The double pendulum consists of one pendulum attached to another. Double pendulums are a good example of a simple physical system which can exhibit chaotic behaviour and a study of the complexities of the double pendulums can lead to understandings of chaos in general and coupled/dependent oscillations where the behaviour of one mass influences the behaviour of another.

CHLADNI PATTERNS

A Chladni Plate consists of a metal plate secured at one point to a stand and a bow. When you vibrate the metal plate at one of its natural frequencies with the bow, salt scattered across the plate illustrates a variety of standing wave patterns. These patterns are dependent on where the plate is secured [node] and where the bow creates the vibration [antinode]. Different configurations of node and antinode produce different patterns.

CHEMICAL CLOCKS

A chemical clock refers to a mixture of chemical compounds that react with each other in concentrations where one or more of the components exhibit periodic changes or there is a sudden change after a set or predicted time. The reactions are referred to as a non-equilibrium thermodynamics and they result in a non-linear oscillation. The three chemical clock reactions exhibited here are the Briggs-Rauscher reaction, the Bray-Liebhafsky reaction and the iodine clock reaction. The oscillations in these reactions can clearly be seen due to the accompanying colour change that occurs. These are oxidation-reduction reactions with a catalyst. The oscillation is a result of the cycle of loss and gain of electrons. Oxidation refers to the loss of electrons, while reduction refers to the gain of electrons.

SWINGING SPRING

The Swinging Spring or elastic pendulum is a simple mechanical system that exhibits complex dynamics. It consists of a heavy mass suspended from a fixed point by a light spring which can stretch but not bend, moving under gravity. It can oscillate in two fundamentally different ways: Vertically, with the elasticity of the spring acting as a restoring force or [quasi-] horizontally like a pendulum, with gravity as the restoring force and exhibits a mixture of regular and chaotic motion.

PENDULUM WAVE

In the pendulum wave, fifteen uncoupled pendulums of increasing lengths, when set in motion together, produce visual traveling waves, standing waves, beating, and random motion. The period of one complete cycle is 60 seconds. The length of the longest pendulum is such that it executes 51 oscillations in a 60 second period. The length of each successive shorter pendulum is carefully adjusted so that it executes one additional oscillation in this period. Thus, the 15th pendulum [shortest] undergoes 65 oscillations. When all 15 pendulums are started together, they quickly fall out of sync—their relative phases continuously change because of their different periods of oscillation. However, after 60 seconds they will all have executed an integral number of oscillations and be back in sync again at that specific instant, ready to repeat the oscillations again.

NEVER ODD

OR EVEN

OSCILLATOR ACKNOWLEDGMENTS

CRADLE-EULER'S DISK -RATTLEBACK

Thanks to Gary Delaney and Denis Weaire for their collaboration on the original scientific project concerning Newton's Cradle. Thanks also to the School of Physics, Trinity College Dublin.

EQUILIBRIUM VARIANT

Thanks to Galerie Mario Mazzoli, Berlin.

MAGICICADA

Thanks to St Martins Press and Animal Planet.

MOUTH TANK

Special thanks to Rik Hart, David Arnold, advancedacoustics-uk.com, Balmoral Tanks, Ryan Moffett and Dennis O'Keefe.

OTAUTAHI

Earthquake data was supplied by GeoNet, New Zealand [geonet.co.nz].

PHASE RING

The original concept was developed in collaboration with Björk for her Biophilia project.

SOUND TO SHAPE

The project was made possible with the support and guidance of Professor Eshel Ben-Jacob and his team at Tel Aviv University. Special thanks to Inna Brains, Dr. Alin Finkelshtein, Ella Sieradzki, Lital Bachar, Mark Polikovsky and Conor Courtney.

THE BODY IS A BIG PLACE

Sound: Gail Priest Heart Perfusion System—
Scientific and clinical consultants:
Professor John Headrick and Dr Jason Peart, Heart Foundation Research Centre, Griffith University, Queensland, Australia.
Dr Kumud Dhital and Dr Arjun Iyer, St Vincent's Hospital, St Vincent's Clinical School [University of New South Wales], and the Victor Chang Cardiac Research Institute, Sydney.
Professor Michael Shattock, Cardiovascular Division, King's College London.
Underwater Video Footage Team:
Director of Photography: Rob Hunter
Videographer: Pete West
Performers: Members of the organ transplant community, Melbourne
— Adrian Brown, Stuart Campbell, Tracy Campbell, Peter Miller, Felicity Nolan, Mill Repse, Glen Teague
Transplant Australia liaison: Karen Knuckey
The Body is a Big Place was funded by:
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The Australia Council for the Arts
Besen Family Foundation, Australia
Monash Art Design & Architecture, Melbourne
The Editors, Sydney
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Performance Space, Sydney
Monash Art Design & Architecture, Melbourne
Sydney College of the Arts, The University of Sydney
The Lung Transplant Service, The Alfred Hospital, Melbourne
Heart Foundation Research Centre, Griffith University, Queensland, Australia
St Vincent's Hospital, St Vincent's Clinical School [University of New South Wales], and the Victor Chang Cardiac Research Institute, Sydney
Cardiovascular Division, King's College London.
With special thanks to:
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Transplant Australia — Victoria Branch
Leonardo Electronic Almanac and Vince Dziekan

THE NEG-GUITAR

Sincere and wholehearted thanks to Greg McMullen for his technical prowess with woodworking and electronics.

THE PARALLEL SERIES

Kelly Heaton is represented by Ronald Feldman Fine Arts, NYC.

WAVE MACHINE

Thank you to Anthony Deen; mentor throughout this, and other projects.

WAVES

Awarded by VIDA 9.0 Fundacion Telefonica

OSCILLATOR CURATORS

MICHAEL JOHN GORMAN

Michael John Gorman is the Founding Director of Science Gallery. Currently, through a gift of €1M from Google.org, he is developing an international network of Science Galleries in partnership with leading universities in urban centres worldwide. Michael John is also Adjunct Professor of Creative Technologies at Trinity College Dublin, Director of the Idea Translation Lab [in partnership with Harvard University] and PI of the European StudioLab project. Prior to coming to Trinity College Dublin, he worked at Stanford University where he lectured in science, technology and society, and has held postdoctoral fellowships in Harvard University and MIT. He has authored numerous publications and articles on aspects of the relationship between art and science and history of science. He holds a PhD in seventeenth century history of science from the European University Institute in Florence.

STEFAN HUTZLER

Stefan Hutzler is Associate Professor in the School of Physics, Trinity College Dublin, a Fellow of the College, and a member of Science Gallery's Leonardo Group. His research interests are the physics of foams and complex systems, and he has co-authored over 100 publications in these areas. He is stimulated by the interface between science and art [which he sometimes traverses as a music performer] and in 2009 was co-curator of Science Gallery's **BUBBLE: DON'T BURST IT** exhibition, which explored the world of soap bubbles and foams.

DOUGLAS REPETTO

Douglas Irving Repetto is an artist and teacher. His work, including sculpture, installation, performance, recordings, and software, is presented internationally. He is the founder of a number of art/community-oriented groups including dorkbot: people doing strange things with electricity, **ARTBOTS: THE ROBOT TALENT SHOW**, organism: making art with living systems, and the music-dsp mailing list and website. Douglas is Director of Research at the Columbia University Computer Music Center and lives in New York City with his wife, writer Amy Benson, and their young son Beals; two cute/bad cats, Pokey and Sneezy; and many plants.

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SCIENCE GALLERY IS AN INITIATIVE OF TRINITY COLLEGE DUBLIN

Science Gallery at Trinity College Dublin is a dynamic and vibrant cultural space where science and art collide, ideas meet and curious minds connect. Featuring work by both national and international scientists, artists, engineers, designers and technologists, Science Gallery explores broad themes that can be interrogated from a variety of disciplines and perspectives. With a primary audience of young adults from 15 to 25 years old and a strong community that visits regularly, Science Gallery provides a lively social space for public engagement with science. Through an ever-changing programme of exhibitions, events and workshops, the space serves as a porous membrane for ideas and connections between the university and the city around it.

Thanks to the generous support of its partners, Science Gallery develops four ground-breaking exhibitions in Dublin every year. Being a partner allows companies, foundations and individuals to enjoy year-round association with Science Gallery and its work to ignite passion and creativity.

If you're interested in joining Science Gallery to inspire the next generation of innovators and build a fresh start for Ireland's future, visit www.sciencegallery.com/support.

HOW MUCH WOOD WOULD A WOODCHUCK CHUCK IF A WOODCHUCK COULD CHUCK WOOD?

1BIT 1HZ CPU

SLOW SIMPLE COMPUTER, 2011

TAYLOR LEVY [CA]

1Bit 1Hz CPU is a diagrammatic wall sculpture of a very simple, slow computer. By flicking a regular light switch, a single bit is processed at a rate of one cycle per second to turn on and off a standard fluorescent tube light.

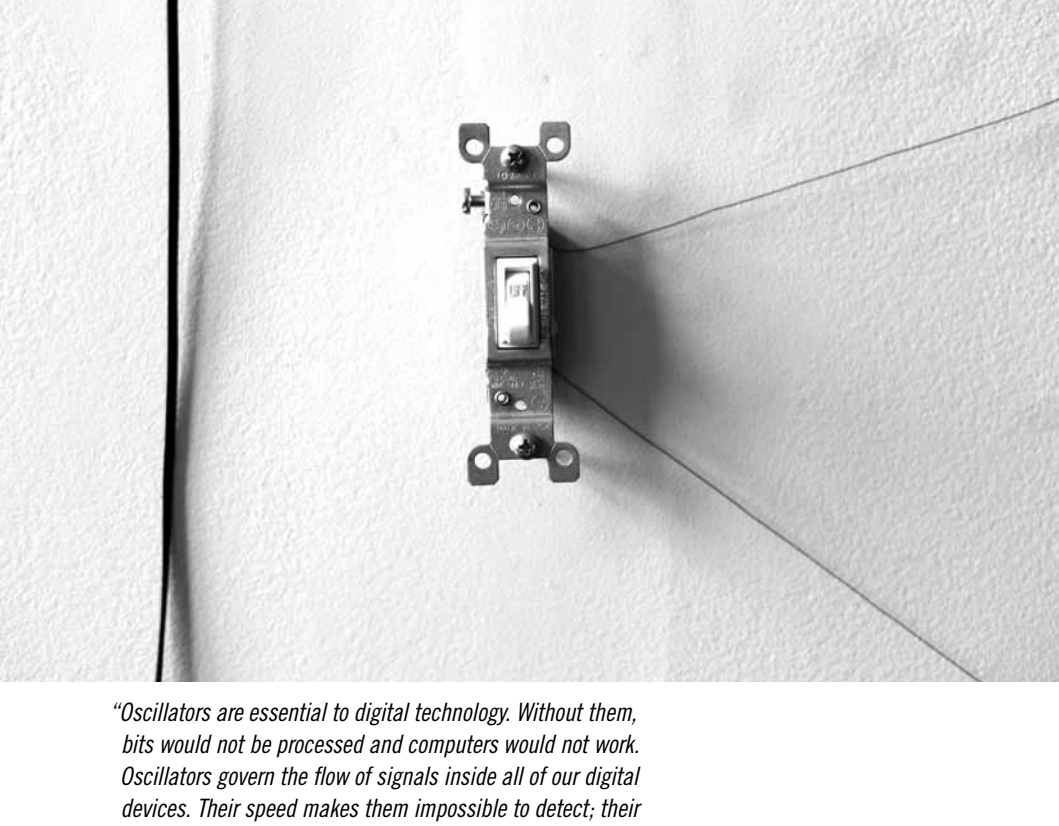
Normally, when you switch on and off a light it responds immediately; the relationship between input and output is analogue. Here, that relationship is digital and requires an oscillator to function. Like inside a computer, bits are processed and sampled by an oscillator, a clock that regulates the transmission of digital signals. In ordinary computers, this clock operates at a sample rate of around 2.4 Ghz; that is 2.4 billion cycles per second. An oscillator at this frequency is so fast that it makes the flow of signals from input to output seem immediate, and obscures what is actually going on.

1Bit 1Hz CPU is a simplified model of how input bits are actually sampled inside a computer and processed to produce an output. The input here is a light switch, the output is a light and the oscillator is a 60Hz [1 cycle per second] AC sync motor. Visitors might be surprised when they have to wait up to a second for the light to respond to the switch. However, by re-imagining the everyday act of switching on and off a light we start to unravel, experience and learn about the elegant mechanism that is behind how computers really work.

Taylor Levy is a Canadian artist based in New York. She holds a master's degree from the Interactive Telecommunications Program at NYU's Tisch School of the Arts and a B.A. from Vassar College. Levy is one half of CW&T, an art and design studio based in Brooklyn, New York, whose client list has included Saatchi & Saatchi, The Bronx Museum of Art, Acconci Studio, Johnson & Johnson, and The Huffington Post. Inspired by technology, her work simplifies complex or opaque systems by breaking them apart, exposing their inner workings and re-organising them into self-explanatory structures.

@cwandt
cwandt.com

Photo: "Light switch detail"
Taylor Levy



"Oscillators are essential to digital technology. Without them, bits would not be processed and computers would not work. Oscillators govern the flow of signals inside all of our digital devices. Their speed makes them impossible to detect; their ubiquity makes them easy to take for granted. However, once you notice the oscillator, you immediately recognise its ingenuity. You want to observe it and reveal it to others. ***1Bit 1Hz CPU*** *brings this integral part of computer architecture to the surface and presents it in a way that is simple and beautiful; it provides an entry point to appreciate the elegant mechanisms upon which all our devices rely."—Taylor Levy*

CENTRAL PATTERN GENERATOR

MOUSE BEHAVIOURAL RHYTHMS, 2012

CLAY LACEFIELD,
GREG WAYNE
& DREW BAUGHMAN [US]

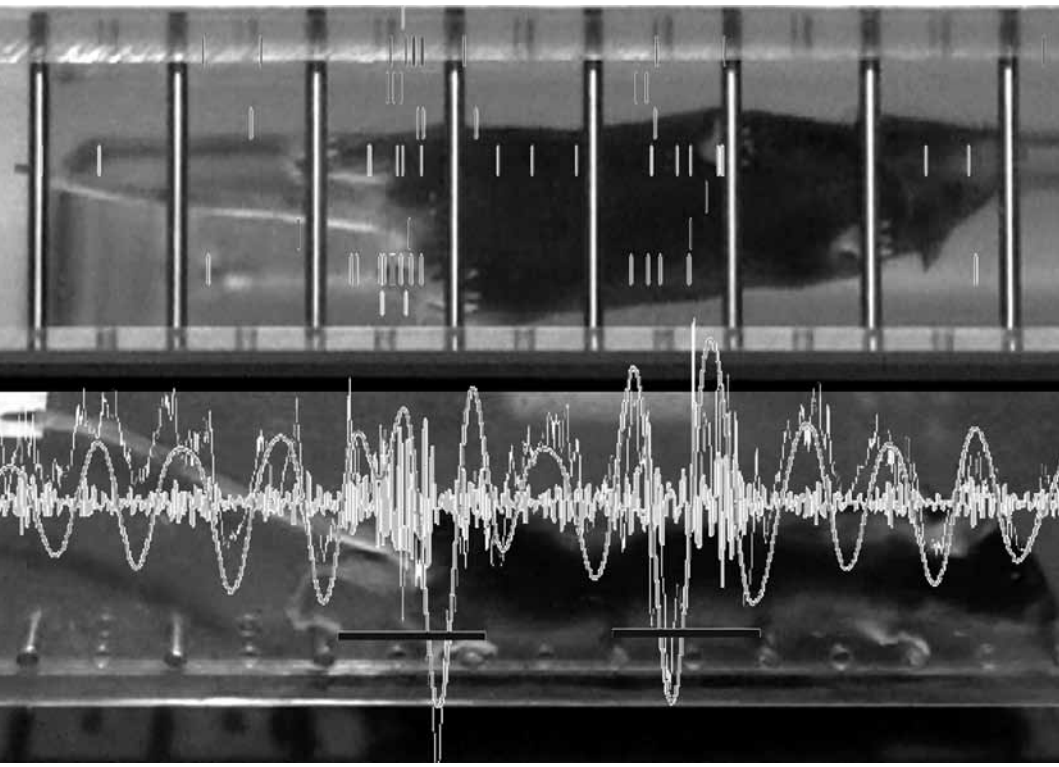
Among the variety of forms that oscillations take in nature, living organisms make frequent use of rhythms and feedback to coordinate their internal state, as well as to respond to periodic changes in the world around them. Animals have developed complex nervous systems to organise such feedback loops and couple them with their environments. Rhythms and loops in the vertebrate nervous system exist at every scale of structure. At the level of molecules, a neuron's membrane is re-polarised by ion channels after it fires; at the level of neural circuits, neurons feed back into the spinal 'central pattern generator' that produces oscillatory muscle movements for locomotion. Cycles continue to proliferate on macroscopic scales of behaviour. At each level, these recurrent systems have their own characteristic durations and frequencies, with rhythms at one time scale nested inside the cycles of another.

In this installation a microcosm of the behavioural patterns present in our lives is created by observing an animal as it goes through its daily cycles. This paradigm consists of a mouse in a living space containing a variety of modules, each housing an activity that the animal periodically performs either by necessity [sleeping, drinking water, or reaching for pellets of food], or by choice ['games' of interactive visual enrichment]. The location and activities of the mouse, tracked through motion capture and with a variety of sensors, will modulate sets of tones and be visualised graphically to show how the rhythms interact at different time scales. By measuring and transforming these oscillations, a symphony of continuously interacting voices is presented, making tangible the different rhythms and cycles of which we are composed, produced by our own central pattern generator, our nervous system.

This work is via a live feed from a US laboratory. Unfortunately, Science Gallery was unable to secure permission to keep a live mouse for the exhibition duration due to animal care legislation.

The creators of *Central Pattern Generator* study how different patterns of neural activity in the brain coordinate diverse senses and behaviours in mice in the Neuroscience Department at Columbia University in New York. Clay Lacefield is a postdoctoral scientist studying neural mechanisms of selective attention in rodents and has collaborated in projects shown at ArtBots and in Make magazine. Greg Wayne is a graduate student whose work focuses on using neural networks as artificial intelligence control systems for real world devices. Drew Baughman has master's degrees in Creative Writing and Biotechnology and experiments with multimedia installations.

Photo: "Video frame characterising patterns of mouse locomotion, overlayed with neural signals showing rhythmic neural activity in the animal's brain" Clay Lacefield, Andrew Fink



"In neuroscience, the central pattern generator is a network of neurons in the spinal cord whose oscillatory activity is the basis for oppositional limb movement during walking. Using this as inspiration, we wanted to create a work that illustrated some of the diverse rhythms organised by the nervous system and how rhythms interact at drastically different timescales. Our entire lives are nested loops of these rhythms; brain waves, breaths, heartbeats, the waxing and waning of drives like hunger and tiredness. In this experiment we will create a microcosm of the oscillations present in our own lives by observing an animal as it goes through its daily cycles."—Clay Lacefield

CRADLE-EULER'S DISK-RATTLEBACK

STEFAN HUTZLER [IE]

DEMONSTRATIONS OF NON-TRIVIAL MOTION, 2013

Cradle-Euler's Disk-Rattleback presents three mechanical experiments that the audience thinks it is familiar with. However, at closer inspection, what happens it not what one thinks should happen. All three experiments continue to attract the attention of physicists and mathematicians and are regularly discussed in the specialist literature.

A Newton's Cradle is a line of touching balls suspended from a rail by pairs of inelastic strings. In textbook illustrations it is generally claimed that displacing one ball will result in a collision that leads to another ball being ejected from the line, with all other balls remaining static. However, if one does the experiment one sees that already the first collision breaks up the line of balls. Eventually all balls move in phase. This effect is very striking if one uses large balls with a diameter exceeding 10–20cm.

If a coin is spun, it first rotates and then settles rapidly. If this coin or Euler's Disk is made large enough, for example 20cm in diameter, it will spin for over a minute. Furthermore, it is very noticeable that the sound created during the spinning increases in pitch as time progresses. The frequency rises very rapidly, just before the disk suddenly comes to a halt by dropping flat on the ground.

A Rattleback is a semi-ellipsoidal object that can be made to spin on its back, but only in one direction due to a slight inbuilt asymmetry of the object. This toy has been around for hundreds if not thousands of years in different cultures, and under different names, like a 'celt'. The theoretical investigation into the details of the mechanism is ongoing.

Stefan Hutzler is an Associate Professor in the School of Physics at Trinity College Dublin. As a Science Gallery Leonardo he is interested in the connections between science and art. He has worked on numerous projects and exhibitions at Science Gallery, including curating **OSCILLATOR** and co-curating the **BUBBLE** exhibition in 2009 which explored the physics behind soap bubbles and foams.

tcd.ie/physics/foams

Photo: Freddie Stevens

*"Oscillations play a most prominent role in the physical world, so as a physicist I see **OSCILLATOR** as a great opportunity to tell the public more about this. The three pieces we're displaying are not original [although we did original work on one of them], in fact they all date back hundreds of years. All are hands-on demonstration experiments, and have in common that they attract the attention of both three-year-old toddlers, as well as that of professors of physics and mathematics. I am also particularly excited about the possibility of up-scaling the demonstrations in size, as this will add to both their visual and aural aesthetics."—Stefan Hutzler*

EQUILIBRIUM VARIANT

KINETIC SOUND SCULPTURE, 2011

ROBERTO PUGLIESE [IT]

Feedback is the distinctive shrill screech that develops when a sound loop exists between an audio input, like a microphone, and an audio output, like a speaker, with sound from the output returning to be picked up by the input. The phenomenon is usually triggered when the microphone is too close to the speaker and picks up a frequency emitted by the latter. The microphone amplifies and reproduces the speaker's frequency with gradually increasing amplitude, to the point where it saturates the amplifier and creates a signal with more power than its power supply can produce and causes the physical breakdown of the system.

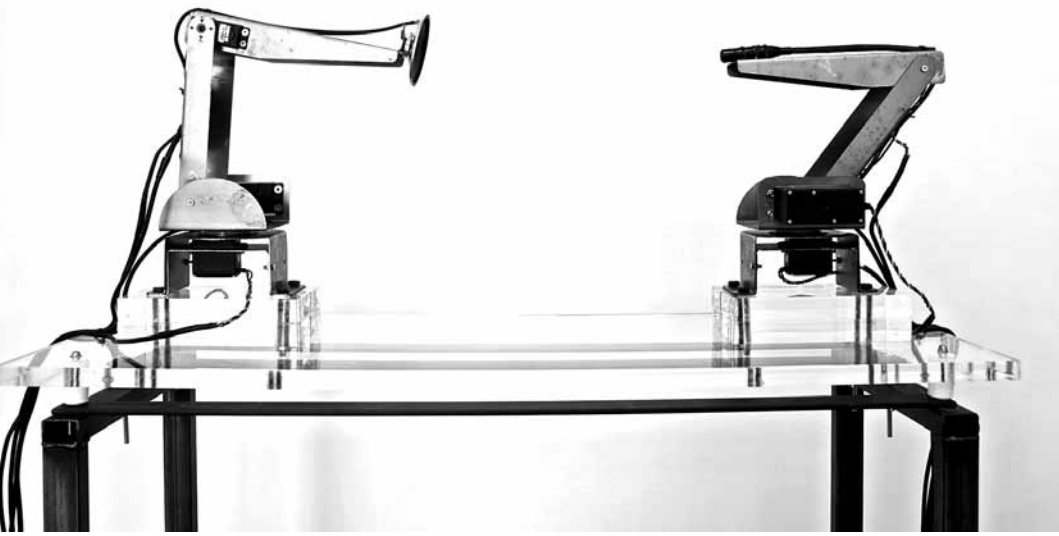
Equilibrium Variant is a kinetic sound sculpture consisting of two robotic arms, with a microphone placed on the end of one and a speaker on the end of the other. Software, created specifically for this purpose, dynamically manages the position of the robotic arms in space and maintains the distance between the microphone and the speaker, preventing the system from going into saturation. This way, the system tends to reach an equilibrium that is otherwise physically impossible to attain. This struggle for balance creates an acoustic and visual dimension that is never the same: the frequency of the feedback and the movements of the mechanical arms are always different and change in real time.

In nature, the phenomenon of feedback is the capacity of a system to regulate itself, taking into account the effects of certain modifications to its features. All living beings experience this condition. This project introduces this phenomenon into the world of cybernetics, through the use of sound. Sound makes all the movements extremely harmonic and natural, and the mechanical arms show a movement pattern that is similar to the behavior of living beings, such as two animals fighting or courting. The system changes into a biomechanical organism that has its own life and reacts to external solicitations.

Roberto Pugliese was born in Naples in 1982, where he lives and works. Following his master's degree in Electronic Music at the Conservatorio San Pietro a Majella in Naples, with Agostino di Scipio, he divides his time between teaching at the same institution [Musical Systems and Electroacoustic, Informatic Laboratory and Sound Art], playing music and realising sound installations. His works have been exhibited in different institutions such as the Ballroom Marfa in Texas, US, the Museum ZKM in Karlsruhe, Germany, the Volta Art Fair in New York, Galerie Mario Mazzoli in Berlin, the Pixxelpoint Festival of Nova Gorica, Slovenia, and have won honorable mentions in competitions such as Vida Prize in Madrid.

robertopugliese.com

Photo: "Equilibrium variant"
Marco Gargiulo



"My research draws its energy mainly from two tendencies in art; sound art and that of the kinetic and programmed art. I examine the phenomena attached to sound; the processes that use the human psyche structures to differentiate natural from artificial, both aurally and visually; the relationship between man and technology; the relationship between art and technology, giving a role no less important to the visual aspect. The idea of creating an active relationship between the work and the user drives me to create dimensions in which the sound is moving, creating different perspectives of sound for the listener."—Roberto Pugliese

MAGICICADA

INSTALLATION WITH INSECTS AND SOUND, 2013

TESSA FARMER [UK]
& DAVID ROTHENBERG [US]

The seventeen year cicada, *Magicicada septendecim*, is a most unusual insect. They appear in great outbreaks only once every seventeen years, after spending sixteen years slowly growing underground. Once they emerge, the trees are full of their loud, swirling music. Though at first it all sounds like one huge wash of noise, it turns out the insects are making three separate sounds that are each part of a complex mating ritual, the most complicated of any insect we know. This was only discovered seventeen years ago, the last time they came out in the New York area. This phenomenon only happens in the Eastern US. Why it happens is still not known. This installation reveals how at first it all sounds like noise but when you learn what to listen for, a whole range of intricate sounds can be heard. In fact there are three related species of *Magicicada* that all look the same, but need to make a series of different sounds during the mating process. Tessa Farmer, an artist who has made wonderful installations out of real insect parts, and who has also collaborated previously with other musicians, most notably Amon Tobin, will visualise this complex mating ritual, and a sound piece will evoke the ritual in sound and words.

Tessa Farmer received a Master of Fine Arts from the Ruskin School of Drawing and Fine Art in Oxford, and has shown at Saatchi Gallery, The Tatton Park Biennial, Museum Villa Rot, Germany and 'ISAM: Control Over Nature', a collaboration with DJ/ Producer Amon Tobin at Spencer Brownstone Gallery, New York. In 2011 she was awarded a Kindle Project 'Maker's Muse' Award. David Rothenberg has performed and recorded with Jan Bang, Scanner, Glen Velez, Karl Berger, Peter Gabriel, Ray Phiri, and the Karnataka College of Percussion. His album, One Dark Night I Left My Silent House, a duet with pianist Marilyn Crispell, came out on ECM in 2010. Rothenberg's next book, Bug Music, comes out from St. Martins Press in April 2013, along with an album of the same name.

@whybirdssing
tessafarmer.com
davidrothenberg.net

Photo: "David Rothenberg playing live with Magicicadas" Charles Lindsay

"David and I had wanted to collaborate for a while. ***OSCILLATOR*** *provided the perfect opportunity to develop a project that related to David's ongoing 'bug music' work and to expand my knowledge of the insect world and the narratives inherent to my sculptural installations. I've worked with musicians before, but never from a scientific perspective and was excited to explore the mysterious minutiae of the life cycle of Magicicada septendecim, and create an immersive installation to explore the dramas that unfurl."—Tessa Farmer*

"Now that I've just finished writing a book, Bug Music, about insects and music that will come out next spring in time for the next big emergence, I know that the sounds they make are much more complex and intricate than I ever before realised, so wanted to reveal that fact in a mix of sound and sculpture. Tessa Farmer is the most celebrated artist in the world whose main material is entomological in origin, so I'm happy we have the chance to present this work, to remind everyone of this longest and strangest population oscillation in the animal world."—David Rothenberg

MOUTH TANK

ACOUSTIC INSTALLATION, 2009

MICHAEL HANNA [UK]

The International Phonetic Alphabet [IPA] provides symbols representing all the sounds that can be produced by the human vocal tract. Each of these symbols is associated with a specific mouth position used to create the sound and these are combined to create words. IPA was chosen for this work as it is an international 'language' that does not in itself enable international communication, only analysis.

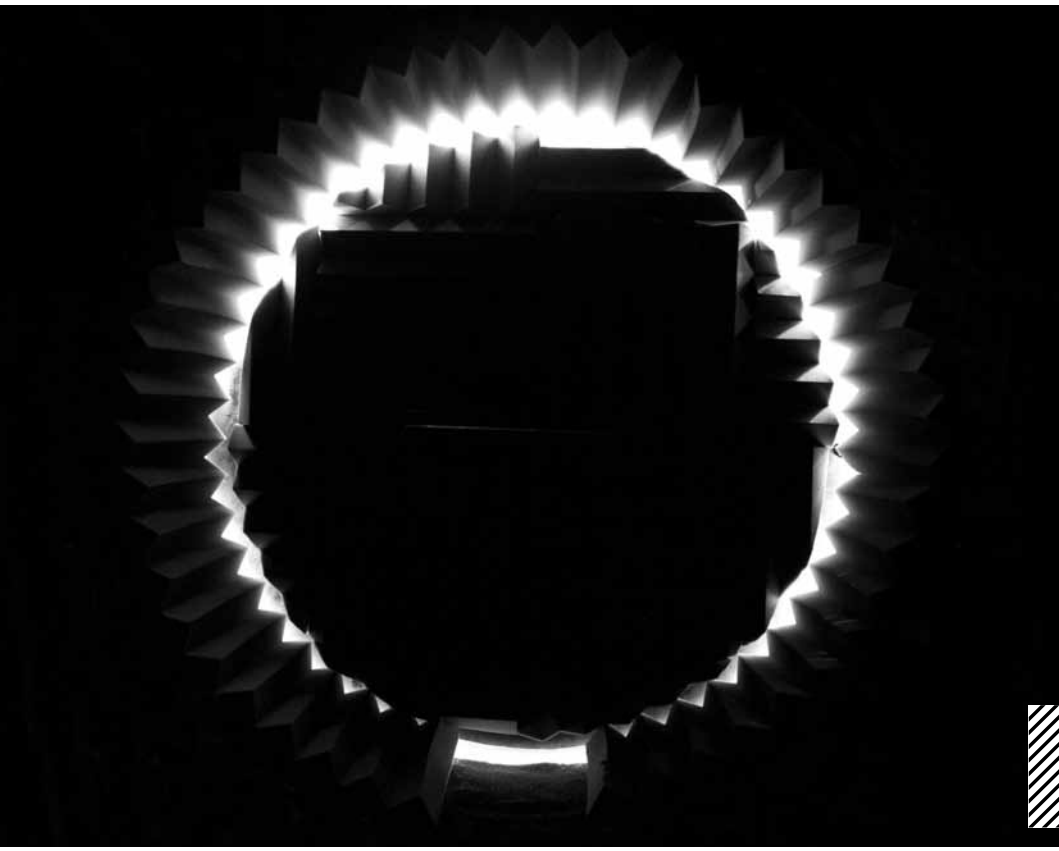
Mouth Tank is developed from research into practical phonetics, looking at what is physically required from the body to create individual speech sounds. Each sculptural element alludes to key physical components involved in speech—pressure, lubrication, vibration and flesh, and materials are chosen based on these components. This has developed into an interactive acoustic installation which explores the vibratory element of speech through physical experience.

The installation is built from a 6000 litre septic tank lined with acoustic foam. Four speakers are embedded in the walls of the tank with one subwoofer incorporated in the chair inside. Viewers enter the tank individually and experience a vocal performance exploring the vibratory aspect of speech played across the speakers. The vocals are mapped across the speakers based on where each individual speech sound is produced in the mouth. There is a sense of entering something which appears alien but experiencing something entirely personal and physical, with the wetness of mouth being replaced by the dark dryness of the foam-lined chamber.

Over the past two years, Michael Hanna has graduated from the Master of Fine Art course at the University of Ulster and completed a residency at Belfast's Digital Art Studios. Michael has been involved in numerous group exhibitions both locally and internationally including gallery shows in Los Angeles and Taiwan. His first solo exhibition, Calculated Error, opened at the Golden Thread Gallery, Belfast in early 2012. His second solo exhibition is due to take place at the Millennium Court Arts Centre, Portadown in 2013. His recent work has taken a range of forms including acoustic and video installation, photography and sculpture.

michaelhanna.org

Photo: "Mouth Tank"
Michael Hanna



*"**Mouth Tank** is the culmination of a research project on speech, where I collaborated with artists, sound engineers and linguists. The research aspect of the project dealt with linguistic transcription, the physicality of speech, onomatopoeia and transposition. The practice consisted of a scientific and cultural mapping of the mouth. This involved the production of words based on where sounds are produced in the mouth rather than on meaning. The creation of words based on the predictable journey they would take through the mouth led to the 'logical chants' that make up the vocal performance in **Mouth Tank**."—Michael Hanna*

ŌTAUTAHI

SOUND INSTALLATION, 2012

ARRAN POOLE [UK]

Ōtautahi is an experimental music composition drawing upon the extreme oscillatory phenomenon of an earthquake. The piece was inspired by composer Arran Poole's experience of a string of over five thousand earthquakes in the New Zealand city of Christchurch, which decimated the city and lead to the deaths of almost two hundred people in February, 2011.

The piece attempts to engage with this phenomenon on a uniquely personal level, depicting the trauma, the panic, and the existential fear that Arran considers to be embodied not simply in the physical experience of an earthquake, but in the sonic profile as well. Referring to his own vivid memories—and taking further cues from scientific readings made by New Zealand's seismologist community—this piece will recreate the sounds that accompanied a selection of the quakes Arran experienced in Christchurch.

Varying in intensity and scale, the work will present impressions of barely audible, subterranean shudders, and large cacophonous bursts of energy that momentarily flood and overwhelm the space. Part artistic recreation, part sonic documentary, the piece aims to evoke the myth of an impending seismic event, and provide an insight into the trauma, terror, and fear that experiencing such an event entails.

Arran Poole is a composer and sound artist. He studied as an undergraduate under British Systems composer Christopher Hobbs, and as a postgraduate researcher under classical pianist, Julian Hellaby. With an interest in twentieth-century avant-garde music, sample culture, soundscape studies, and musical instrument design, Arran's creative output focuses upon ambient and drone music, often produced by unusual and experimental means. Projects that Arran has been involved with have been screened throughout Europe, the US, and further afield. Recently, Arran was part of the production team responsible for the quirky short film, Wind, which won Encounter Film Festival's 0117 Challenge, and was included in Shetland Art's '*Hansel of Film'* relay from Lerwick to Southampton. Arran has a particular interest in experimental instrument design, and performs regularly using a resonant sound-sculpture called a 'bow chime'.

Photo Detail: "Broken windows in Christchurch, following September 2010 earthquake" Arran Poole

"Experiencing oscillation in its perhaps most extreme and deadly form, as an earthquake, left a lasting impression on me. Not only was the experience violent and powerful in a physical sense, but it was also accompanied by an extreme soundtrack: subterranean rumbles flooding through space, inundating the body with immersive, vibratory energy, accompanied by the wounding sound of cascading masonry, of buildings being shaken to breaking point. This sound is the trigger of existential fear, I thought: the fear of destruction, the fear of annihilation. ***Ōtautahi****—a Māori term referring to the land on which the city of Christchurch sits—is a musical work recreating and exploring the sound of an earthquake."—Arran Poole*

PHASE RING

RING OF HANGING MUSICAL PENDULUMS, 2013

ANDREW CAVATORTA [US]

All natural oscillators work by converting one form of energy into another and back again: the kinetic and spring-potential energy in a plucked string, the wave energies and spongy compression and rarefaction of air in organ pipes, the electric charges and magnetic fluxes of an LC circuit in an analogue synthesiser.

Pendulums are natural oscillators. They convert gravitational potential energy into kinetic energy and back again. Their natural steady periods would make them ideal for producing tones, except for the fact that the periods of all practically-sized pendulums are far below the human hearing range. Indeed, to produce a tone as high as 500Hz, a pendulum would need to be about one micron in length, or 1/20 the width of a human cell. So in this experiment with music and pendulums, we use the pendulums for another aspect of music: rhythm.

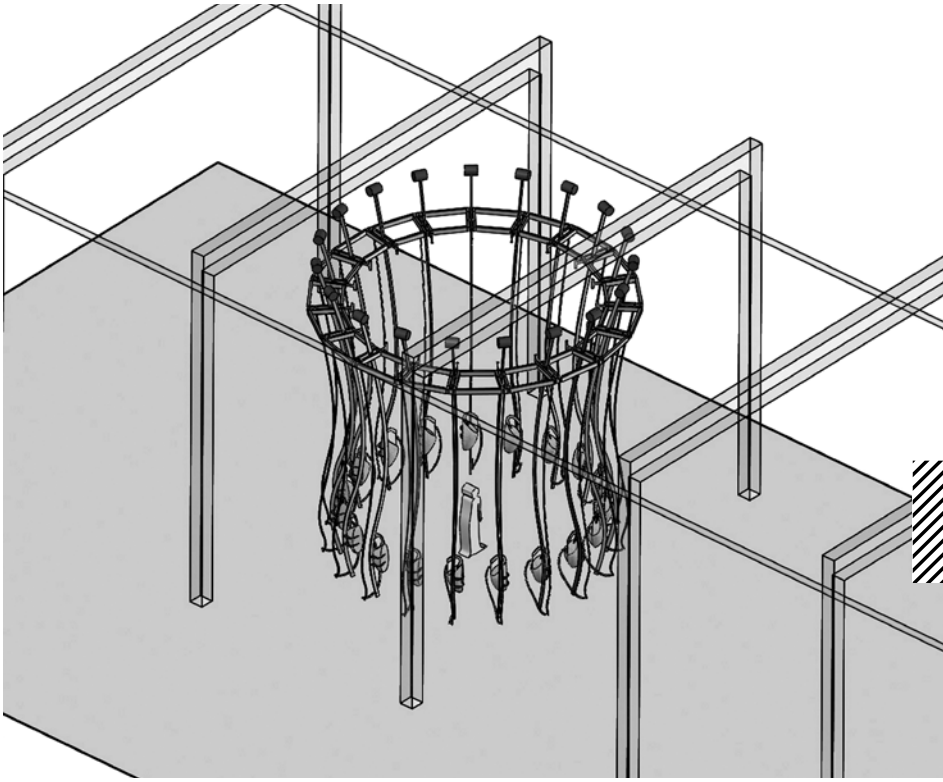
The *Phase Ring* is a very physical interactive music installation and a hypnotic exploration of the infinite within the finite. It is comprised of a large circle of free-swinging pendulums, which each play a note as they swing through the bottoms of their slow arcs. A viewer sets the pendulums moving by hand. The notes and periods are predetermined. But an infinite number of simple songs can be discovered by changing the order and timing of the swings.

How much feeling and meaning can we discover in music when the oscillations are so simple that only the phase of the notes can change? Phase Ring will allow us to find out.

Andrew Cavatorta grew up largely unsupervised in the pine-covered Northeastern United States. He moved to New York City at the age of 17, where he encountered great pressure to acquire entirely new manners, hygienic habits, and an outward persona. He found this process was much easier if he secretly pretended to be a robot. This left him with a lifelong interest in how we use robots and the idea of robots as a lens through which to see ourselves. He now creates robots, experimental musical machinery, museum exhibits, big ideas and lots of software. He is the former Director of Engineering for Ensemble Robot and holds a master's degree from the MIT Media Lab.

Twitter: @andycavatorta
andycavatorta.com

Photo: "Rendering of tall, circular version. Perhaps suitable for installation under train arch" Bill Washabaugh



"Most recent experimentation with music and technology focuses on the input side: new ways to control synthesisers and samplers. I take my inspiration from the output side: new ways of creating physical sound. I explore the often-ignored natural oscillators latent in the objects around us: fields of crickets, chairs dragging across floors, the rich harmonics of helicopters. I develop new technologies to articulate those sounds, at their point of creation, into music. I developed the original prototypes of the ***Phase Ring*** *during a yearlong collaboration with Björk. It was the first fruit of a long and complex design evolution. With the* ***Phase Ring****, I give a fully-realised life to the surprise, fascination and delight we discovered in that first prototype."—Andrew Cavatorta*

SOUND TO SHAPE

SOUND-GENERATED BACTERIUM PATTERN FORMING, 2013

NURIT BAR-SHAI [US]

Sound to Shape is a site-specific installation that features live microorganisms, sound and stripped back speakers. It looks into the social life of bacteria using sound waves to visualise the 'chemical tweets' of microorganisms as exceptionally beautiful and rare image patterns.

From the Soundscape series, and part of the body of work Objectivity [tentative], *Sound to Shape* explores the intersection of art, science and technology while looking into biological systems of self-organisation. The work examines the immense complexity within seemingly simple structures and the formation of shapes, patterns and network systems in nature, and the process of achieving dramatically varied results with slight alterations in initial settings.

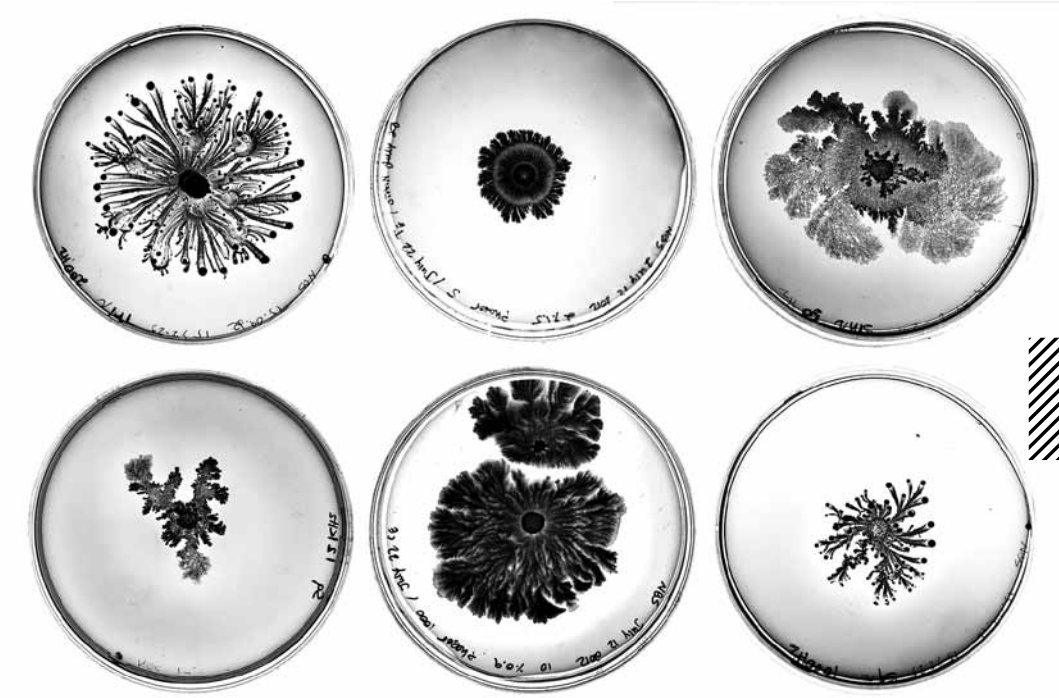
The protagonist, a 'smart' microorganism bacterium, performs complex social behaviour with rich communication patterns, each with an exceptional and unique imagery outcome. *Sound to Shape* examines morphogenesis and the complex networks and decision making of microorganisms that 'grow images' based on various applied sound frequencies.

Audio waves are transmitted through liquid agar-medium as it solidifies and forms sound-generated topographies for the bacterium to grow on throughout the entire exhibition. These surface shape arrangements created through sound experiments affect the bacterium's growth and its unique pattern forming.

Nurit Bar-Shai is a multimedia artist working at the interface between art, science and technology. She has exhibited at the Bloomfield Science Museum Jerusalem, the OK-Center in Linz, The National Art Center Tokyo, SESI Gallery in Sao Paulo, Science Gallery in Dublin, The State Museum of Contemporary Art Thessaloniki and The Center for Digital Art in Israel. Bar-Shai received a Prix Ars Electronica 2007 Honorary Mention, the 11th Japan Media Arts Festival Jury Award, ETC Finishing Funds award, funded by NYSCA, ARTIS—Contemporary Israeli Art Fund Grant, and was commissioned by Turbulence.org, with funds from The Greenwall Foundation and with funds from The Jerome Foundation. Bar-Shai is the co-founder and the Art and Culture Director at Genspace NYC, Inc., a community bio-tech lab in Brooklyn NY.

nuritbarshai.com

Photo: "Objectivity soundscapes":
The Soundscape series 2012"
Nurit Bar-Shai



*"**Sound to Shape** examines how sound shapes and forms patterns in bacteria growth. This body of work is the outgrowth of the research of Professor Eshel Ben-Jacob at Tel-Aviv University, who studies bacterial self-organisation or 'the social life of bacteria'. In this work, acoustic vibrations are used to affect and determine forms and shapes in bacteria growth as it designs and structures complex network systems to socialise and communicate. The audience is invited to witness the process from its start at the opening night, where the artist transmits sounds to the bacterium habitat, and follow its growth during the entire exhibition." — Nurit Bar-Shai*

TELEPHONE REWIRED

AUDIO-VISUAL BRAIN OSCILLATION SYNCHRONISATION, 2013

LOVID
& SEAN MONTGOMERY [US]

Telephone Rewired is an immersive audiovisual art installation and scientific experiment examining the role of oscillations in the brain and the future of human cognition. As viewers enter the exhibit, the surrounding oscillations of light and sound begin to dominate their perception. Using previously documented techniques to manipulate the viewer's dominant electroencephalography [EEG] frequencies with light and sound, the viewers' brain oscillations synchronise with the installation's frequencies, stimulating the brain's endogenous waveforms, including beta [focused attention], theta [deep relaxation] and alpha [calm awareness].

Viewers don an EEG monitor to create a neurofeedback loop and the experiment begins. Flashing images appear, and the resulting event-related potentials [ERPs] are captured and written to disk for subsequent analysis. Images continue to appear, some immediately seen and others hardly noticed. As the frequencies of the flickering and beating installation modulate brain oscillations, they affect the viewer's consciousness. After experiencing a cycle of frequencies, viewers exit to complete memory testing and a subjective report. Oscillations from the previous viewer influence the progression of frequencies experienced by the following viewer, and this carry-over connects each individual's personal experience with those of other participants. This direct sharing of brain oscillations provides a model for novel communication methods as human consciousness transforms into more distributed networks.

Willful alteration of physiological and cognitive processes will become increasingly important as humanity progresses and will become increasingly possible as we develop greater neuroscientific understanding. Existing at the intersection of art, science, and technology, *Telephone Rewired* gives viewers a visceral experience that demonstrates the role of brain oscillations in cognition, while concurrently engaging viewers in scientific research about these oscillations. The work invites viewers to consider the potential of neurofeedback and the future of augmented collaborative cognition.

LoVid [the interdisciplinary art duo of Tali Hinkis and Kyle Lapidus] and Sean Montgomery are New York-based collaborators, interested in the human body and its relationship with technology. LoVid has performed and exhibited their DIY audiovisual works around the world including at Science Museum Jerusalem, Museum of Moving Image, Eyebeam, Netherlands Media Art Institute, The New Museum, and MoMA, and has received support from rhizome.org, Franklin Furnace, and Experimental Television Center for a collaboration with Sean Montgomery. Sean Montgomery is an artist, inventor, scientist, and engineer. Sean is particularly interested in using emerging technologies to create new ways for people to interact with one another and the objects around them. He has numerous peer-reviewed publications in the field of neuroscience and presently directs an engineering shop in New York City. His recent art works have been shown in museums around the world including ISEA 2012.

@lovidlovid
lovid.org
labs.sensorstar.com

Photo: "Performance Documentation from Hack Your Face" LoVid

"The brain is an oscillator. More specifically, each of the brain's 100 billion neurons is an oscillator. These neurons communicate by synchronising their individual oscillations into coherent rhythms that range from small coalition 'chat groups' to large-scale synchronous activity involving nearly all regions of the brain. Neuronal oscillations modulate every aspect of consciousness, from perception to memories, from changing emotions and mood to the circadian rhythms that regulate sleep and wakefulness. In ***Telephone Rewired****, viewers get a personal experience of the role of brain oscillations and how changing these patterns can affect their own perception, attention, memories, and mood. The work examines external synchronisation of brain activity and implications of neurofeedback at the level of the individual, society, and the changing nature of human consciousness." —Kyle Lapidus [for LoVid]*

THE BODY IS A BIG PLACE

BIO-ART INSTALLATION AND PIG-HEARTS PERFORMANCE, 2011

HELEN PYNOR
& PETA CLANCY [AU]

The Body is a Big Place is a large-scale, immersive installation developed through collaboration between artists, scientists and clinicians. The work explores organ transplantation and the ambiguous thresholds between life and death, revealing the process of death as an extended durational process, rather than an event that occurs in a single moment in time. The work's title refers to the capacity for parts of the body to traverse vast geographic, temporal and interpersonal distances during organ transplantation processes. The project was underscored by risk and uncertainty, mirroring the uncertainties lying at the heart of organ transplantation itself.

As part of the installation a fully functioning heart perfusion system is used to reanimate to a beating state a pair of fresh pig hearts during a live performance. Rather than sensationalising this performative event, the artists hope to encourage empathic responses from viewers, appealing to their somatic senses and fostering their identification with the hearts they are watching. This opens up the possibility of a deeper awareness and connection with viewers' own interiors.

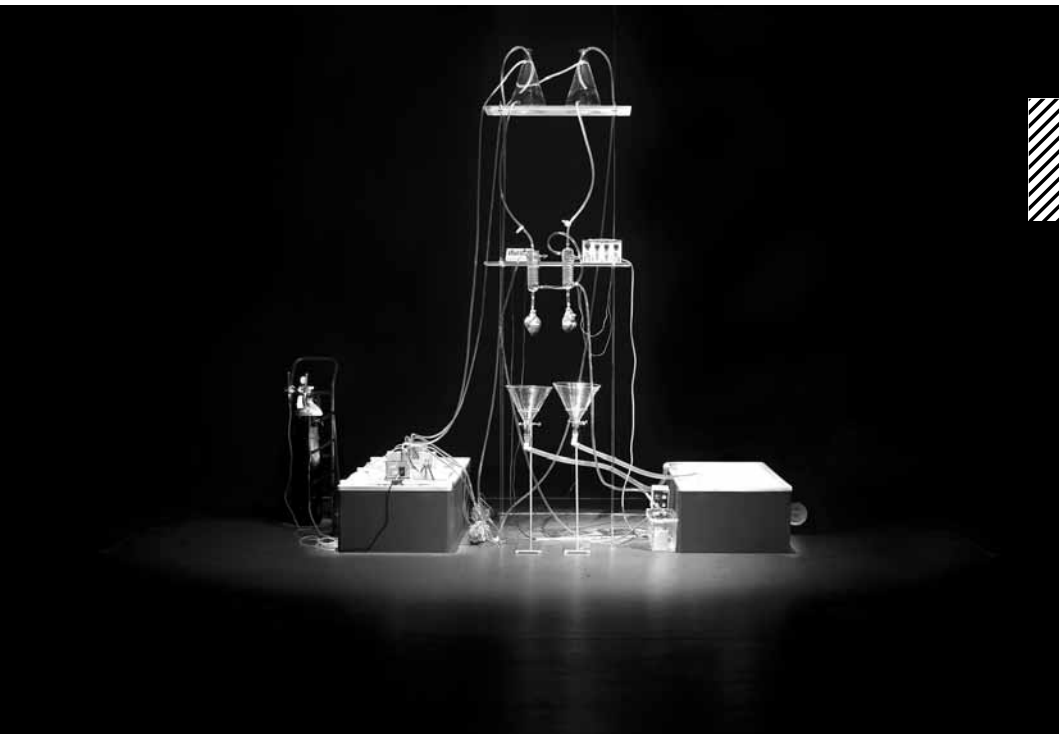
The performance makes apparent the heart's status as a highly contractile and unusual oscillator. The heart has its own 'mini' oscillator; a bundle of nerve cells called the sinus node, which can initiate the heart's muscular contractions independently of the central nervous system. This trait allows transplanted hearts to continue to beat for years without connection to the central nervous system, and the hearts in this performance to beat without external mechanical or electrical stimulation.

The heart perfusion performance is accompanied by an underwater video sequence. Performers in this work are members of the organ transplant community in Melbourne, individuals who have traversed extraordinary experiences in the form of receiving, donating, or standing closely by loved ones as they receive or posthumously donate human organs.

Peta Clancy and Helen Pynor have been independently exploring the intersections between art and the life sciences for more than a decade and have been collaborating since 2010, working across installation, media art, video, sculpture, performance and photography. Their work has been exhibited extensively in museums, institutions and private galleries in Australia, Asia and Europe, and developed during residencies in scientific and cultural institutions such as SymbioticA at the University of Western Australia, Murdoch Children's Research Institute in Melbourne, Performance Space, The Children's Hospital at Westmead in Sydney, and École Nationale Supérieure des Beaux-Arts in Paris. In 2012, their collaborative work *The Body is a Big Place* received an Honorary Mention in the Hybrid Arts category of Ars Electronica and was included in the 'CyberArts' exhibition in Linz, Austria. They are currently undertaking an extended residency in the Heart and Lung Transplant Unit at St. Vincent's Hospital, Sydney, researching their new work.

thebodyisabigplace.com
helenpynor.com
petaclancy.com

Photo: Still from live pig hearts performance, 21 Nov, 2011, Performance Space, Sydney
Helen Pynor and Peta Clancy 2011
Geordie Cargill



"What's startling is the mood of respect and reverence in the room as we watch the rhythmic contractions of this tiny piece of flesh, obtained only a couple of hours earlier from the killing floor of an abattoir. This resilient heart, suspended from tubing and seemingly floating, an organism fighting for survival miraculously clinging to its strange semblance of life. It's like watching a birth or a death... we're confronted by the absolute fragility of life, its visceral nakedness. We're reminded that we have a heart that's beating inside our own chests and that our lives depend on it. It's humbling, awakening a reverence for the unknown forces that keep our lives pulsing and palpitating decade after decade, each moment of life dependent upon contractions and relaxations just like the ones we're watching now in this disembodied pig heart."—Helen Pynor and Peta Clancy

THE NEG-GUITAR

PLAYABLE MICROTONAL GUITAR, 2012

NEG-FI [US]

Neg-Fi's sound is based upon acoustic beating. This phenomenon is created when two tones of close, but not quite identical, frequencies interact. As the sound waves alternately reinforce or cancel each other out, an effect similar to tremolo can be heard. As the frequencies drift apart from each other, the rate of this observed oscillation will increase, and as they approach unison the speed will decrease—until eventually stopping altogether as the tones reach unison.

Neg-Fi harnesses these oscillations in their sound by purposefully tuning to notes in-between the standard Western twelve-tone temperament. This adds a unique texture and density to the sound, and makes it possible to play three tones within a single half-step of each other on two strings. The purpose of this work is to create a simplified representation of the foundation of Neg-Fi's music in an easily accessible and interactive presentation.

A simple piece of wood, with only a few alterations, has been outfitted with spare parts—tuning pegs, nuts, a pick-up, a bridge constructed out of a piece of pipe, and an input jack—to create a very simple two-stringed guitar. The strings are tuned specifically to slightly above and slightly below the standard low-E on a guitar. Metal 'frets' placed at intervals up and down the instrument provides the ability to create a few other notes. The intent is that by playing the instrument, the audience will be able to experience oscillations through microtonal music. Distortion and octave effects pedals have been added to further enhance the exploration of these sounds, in addition to a tuner and a small headphone amplifier with volume control.

Neg-Fi made their debut as a band in December 2003 with a series of home-recorded cassettes and art objects for the annual DIY holiday event La Superette. Using dissonant and percussive sounds from detuned guitars and bass as building blocks, Neg-Fi create short, metallic compositions, which sometimes also feature walkie-talkies and handmade devices. Releases include 2007's Listen-OK!, a split EP with noise artist Eiliyas; 2010's mid-side; and Unmergency, a new LP due in 2013. Neg-Fi have performed in a dozen countries at venues ranging from museums to DIY spaces, including Issue Project Room, NY; City Museum, St. Louis; BIGZ, Belgrade; Ateliers Mommen, Brussels; Babel Teatro, Argentina; and Universidad de Valparaiso, Chile. Their composition Neg-Lagoon was featured in Nancy Garcia's installation *Lover's Alarm Clock* at the Bas Fisher Invitational in Miami in 2011. Both members are former members of the Glenn Branca Ensemble, and appear on Branca's 2010 release *The Ascension: The Sequel*.

neg-fi.bandcamp.com

Photo: Neg-Fi live in Valpariso, Chile" Luis Toto Alvarez

"We were instantly interested in the theme because our sound is built on a specific kind of oscillation—the acoustic 'beating' that results when two notes that are close, but not quite the same, are played simultaneously. ***The Neg-Guitar*** *is an attempt at recreating this phenomenon as a stand-alone, interactive object. It is a two-stringed instrument intended to be played with additional octave and distortion effects to create the dark, mysterious low-frequency oscillations that we find so fascinating. The idea is to give the audience a hands-on chance to play with these sounds on their own. Be your own Neg-Fi!"—Ryan Walsh and Evelyne Buhler [Neg-Fi]*

THE PARALLEL SERIES

ANALOGUE ELECTRONIC PAINTINGS, 2012

KELLY HEATON [US]

Kelly Heaton's images literally come to life with the pulsing, chirping, and breathing of the natural world that surrounds her in rural Virginia: a simmering fire, a rainy spring forest, insects on a summer night, a beating heart, the cry of a lonesome bird. None of the effects are recordings. The sounds of crickets, cicadas, and birds are electrical phenomena crafted by Heaton. Analogue electronic circuits, designed by Heaton to generate this audio-visual show, adhere to the paintings' surfaces. The light and sound effects are two consequent oscillating circuit design elements: one is the analogue astable multivibrator; and the other is the popular 555 timer chip. Heaton's subtle modification of oscillating waveforms creates a strikingly realistic and wide variety of natural effects.

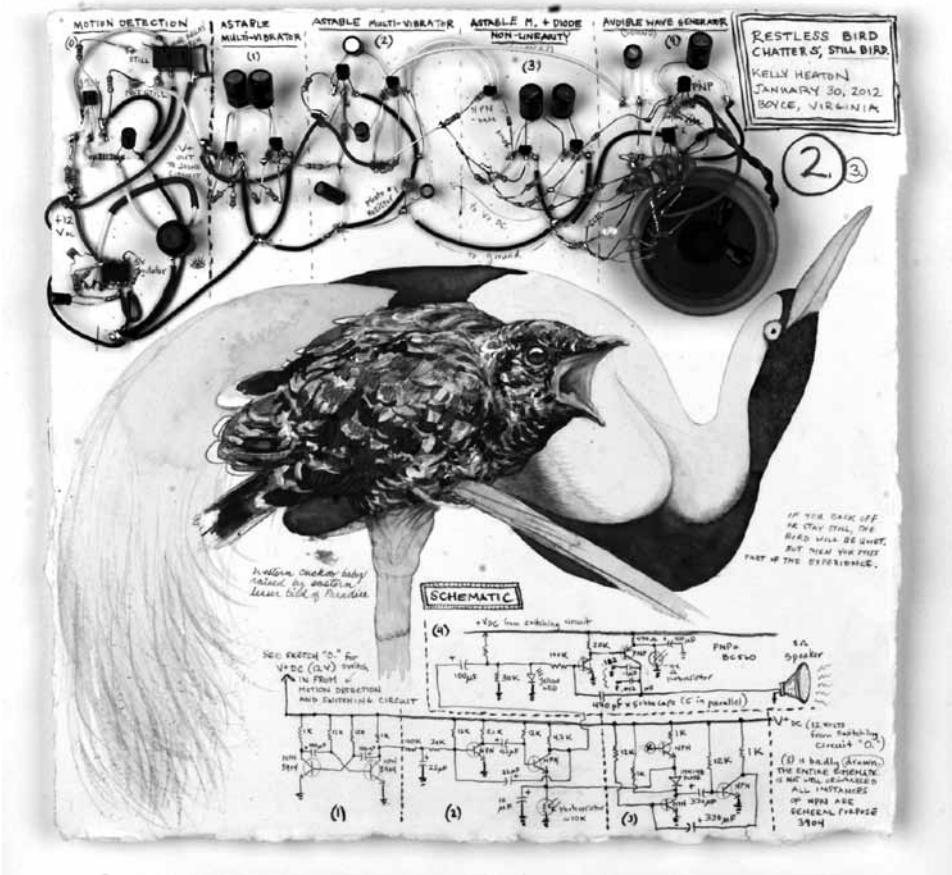
When the paintings are 'turned off', their dormant surfaces continue to sparkle with shiny plastic parts, the glint of lead solder, and the lively interplay of seemingly infinite, miniature electronic components: resistors, capacitors, and transistors; transformers, sensors, and timers; and yards of wires on spools. As with any technology, the electronic components in these artworks are not engineered to work forever, inviting a comparison to the impermanent sand mandalas of Tibetan Buddhism. Through the intersection of nature, energy, and spirituality, Heaton asks what does one gain when a painting is imbued with electronics, and what does one lose when the electricity is gone?

Trained in art and science, Kelly Heaton received her Bachelor of Art from Yale University in 1994, her Master of Science from the Massachusetts Institute of Technology in 2000, and was awarded a residency at the Duke University Department of Computer Science in 2002. She is represented by Ronald Feldman Fine Arts in New York, where *The Parallel Series* premiered in the fall of 2012. Critic Jerry Saltz wrote in New York magazine: "Sculptor, seer, scientist, spiritualist Kelly Heaton allows us to glimpse the ghost in the machine." The Feldman Gallery exhibited Heaton's last solo show, Live Pelt in 2003, described by the critic Kim Levin "as conceptually perfect" in The Village Voice. An avid nature lover and gardener, Heaton lives in rural Virginia with her husband and stepchildren.

@kelly_heaton
feldmangallery.com/pages/exhsolo/exhhea12.html

Art Work: Kelly Heaton
Restless Bird Chatters, Still Bird, 2012
electronics, gouache, and coloured pencil on paper
18 x 18 x 3 1/2 inches
Photo: Varvara Mikushkina

Courtesy Ronald Feldman Fine Arts, New York
www.feldmangallery.com



*"I am interested in **OSCILLATOR** because I am an artist of oscillation. My work is a hybrid of traditional media and analogue electronics, where the electronic component is intended to introduce life into my art. Life moves continuously and with a signature vibratory pattern that creates all the dynamic effects we perceive in this world. In order to render life-like effects in my electronic design, I must craft the oscillating patterns of electricity that jiggle a speaker, excite a lamp element or drive a motor. It is principally the quality of oscillation that makes or breaks the success of my electronic art, and the process to achieve the desired oscillation builds layers of traditional, physical texture into my work."—Kelly Heaton*

WAVE MACHINE

PROCEDURAL ANIMATION OF WAVE FUNCTIONS, 2012

MICHELLE KIRBY [US]

Wave Machine is a procedural animation inspired by wave functions—the fundamental formulas that permeate quantifiable definitions of the formation of the natural world. In recreating the diverse multiplicity of constructions generated from these oscillating functions upon a digital canvas, *Wave Machine* marries the natural and the digital—coexisting at the intersection, with zeroes and ones running like parallel backbones. Where the digital jumps between two points, waves flow and each next step is an as-yet to be determined destination.

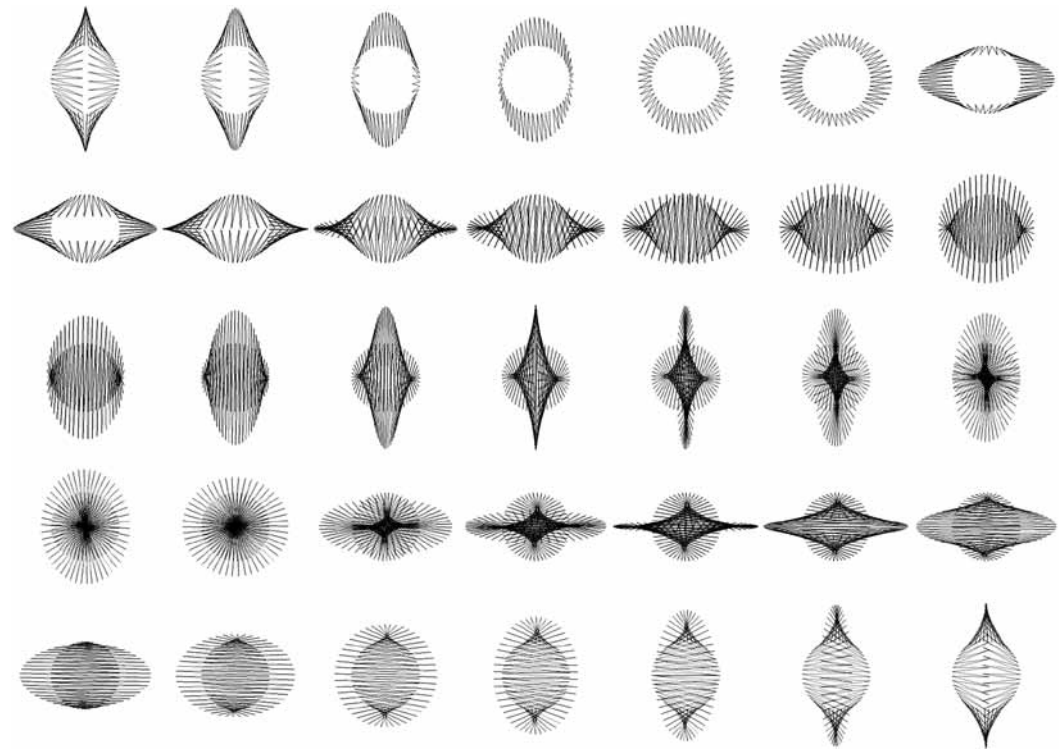
The screen surface is divided into a symmetrical grid. Each unit of the grid contains a creatively applied wave function, defined and coded with the trigonometric functions sine and cosine. The speed with which the functions cycle fluctuates, adding another layer of complexity. A standard Cartesian grid houses the units, containing the unknown within the house of the known. Infinity in boxes.

*S*een without beginning or end, the movement extends infinitely forward and backward in time. Focus dissolves and time suspends. A window is made into a secret world that is ever-present and presently changing. *Wave Machine* pulls up a curtain, revealing a world science has defined, but that remains elusive to the naked eye. What has been explained is now transformed into experience. For a moment, you can step into that place where scale distorts and the invisible comes into focus. What is real is only what you know and how you come to know it. *Wave Machine* adds another facet to the facts, adding poetry and giving them back their groove.

Michelle Kirby is an ambient artist and creative coder. A nature lover, and science enthusiast, Michelle became curious about patterns of growth. After reading The Power of Limits: Proportional Harmonies in Nature, Art, and Architecture by Gyorgy Doczi, she became fascinated by laws of concentric and proportional growth. Drawing inspiration from scientifically-defined micro and macro perspectives, she creates work that explores these invisible realities that are perpetually in motion. Transforming captured facts into personified moving particles, the focus shifts from the known destination into the space between. What if, instead of events, there was only motion? Originally from Cleveland Ohio, Michelle now lives and works in Brooklyn, NY.

melladay.com

Photo: "Wave over time"
Michelle Kirby



"Wave functions are oscillations around a central point over time, of which sine and cosine are the drivers of this oscillation. I first dusted off the sine and cosine functions when I was exploring electronic tones and how they can be created via defined frequencies. By chance, I happened to be researching universally shared natural growth patterns, which can also be fundamentally broken down and defined with sine and cosine functions. I became curious about how two functions can generate so many different things. ***Wave Machine*** *came out of this curiosity and experimentation with the two fundamental oscillating functions."—Michelle Kirby*

WAVES

INTERACTIVE SOUND INSTALLATION, 2007

DANIEL PALACIOS [ES]

How does sound move? A long piece of rope generates 3D waves floating in space by the physical action of its movement: the rope which creates the visual waves also simultaneously creates the sound by cutting through the air, making up a single element.

The installation is affected by those who watch it. When the audience moves around it they influence the movements of the rope, generating visual and acoustic sound waves from harmonic patterns to complex ones. Depending on how we may act in front of it, according to the number of observers and their movements, it will pass from a steady line without sound to chaotic shapes of irregular sounds [the more movement there is around the installation] through the different phases of sinusoidal waves and harmonic sounds; examining the action-reaction principle applied to sound and space.

Due to its particular features, a space has a way of relating with sound, as sound is a series of compressions and decompressions which move through the air. The geometry of the space itself and the elements in it will influence the movements of the sound and finally our perception of it. This adds to the entire stationary system a chaos of infinite variables from the most minimal movement on our part, examining how we interpret our own position in a sonic landscape.

But even though this could seem like a mere representation of what we can't see by ourselves, beyond the persistence of vision, it connects with our most visceral side, combining the intangible beauty of the represented graphic with the brutality of the sound it produces.

Daniel Palacios creates machines that can scan and visualise the flow of visitors, or objects that communicate with their viewers by means of artificial intelligence. Viewed in terms of form alone, they are interactive artworks consisting of complexly functioning machinery with scarcely comprehensible software components. Beyond such technical aspects, however, the artist's works are stirring inasmuch as they are concerned with extremely human, philosophical questions, about perception, memory, time and space. His works can be found in museums, festivals and art fairs of Europe, Asia and America, as well as edited in several specialised books and publications. Besides his artistic practice, he gives workshops and conferences on the combined use of technology and plastic arts.

danielpalacios.info

Photo: “Audience and standing waves”
Daniel Palacios

“My work is deeply based on technology, but technology is just a tool. I always try to keep all the technical stuff as hidden as possible, as it’s not about the tool itself but how it can help to expand our perception; so although I make different kind of works, you could put all of them under that premise. I work with information, capturing people’s movements or any other kind of external behaviour and translating that to the behaviour of the piece, not showing you the raw information that I’m managing, but an emotive representation of it to make you perceive something that you were not perceiving, to invite you to establish new relations between elements that you previously understood to be isolated.” — Daniel Palacios

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