# Solarsonics: Patterns of Ecological Praxis in Solar-powered Sound Art

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**Abstract:** Harnessing the sun as an energy source is of great interest in this age of energy crises, and holds our imagination because of its quiet, seemingly magical properties. Photovoltaic technologies have grown quickly over the past 20 years, and more and more applications of solar power are finding use today. In the arts, solar power is often used as energy sources for public artworks, as a practical matter. These systems typically work in conjunction with batteries or other sources of energy in order to ensure a constant voltage and power level. However, an alternate approach is to design the work to use the sun's energy directly, and exclusively, with the sunlight itself as a functional parameter of the material. In this paper, we examine the use of photovoltaics in the direct production of sound as a function of its existence. These solarsonic works are designed to use the sun in the same way that wind-based artworks use the wind: they are activated directly, and are totally dependent on the light available in the moment. We survey solarsonic works by several artists, and discuss a series of works by the author, and conclude with a look at what the future may bring.

## Introduction

What does it mean for something to be "solar powered"? Generally speaking, a solar system assumes that a load (i.e. the power requirements of the device one is intending to power), is met by a stable source, such as a battery (a repository), which contains sufficient power to keep the device operating for however long it is needed. The solar array's job is to provide enough supplemental power to keep those batteries fresh at all times, so that they can provide the clean, regulated power the circuit needs, when it is needed. The extent to which this power is needed continuously, or for fixed durations, is one variable in the equation. So, for a system that provides light during darkness, for example, the idea is that the circuit requires a stable current during dark periods, and is inactive during the day when light is not needed. During this time, the natural light of the sun is captured by the photovoltaic cells and transferred to the batteries, recharging them sufficiently so that they can power the circuit during the dark, night hours. This is how the operation of a typical solar-powered light system works, such as those found in hardware stores for your garden. Therefore, the calculation becomes a matter of determining the power requirement per hour needed, determining a sufficient battery size to accommodate this need, and determining a solar array size that is capable of refreshing that battery enough to create a sustainable situation.

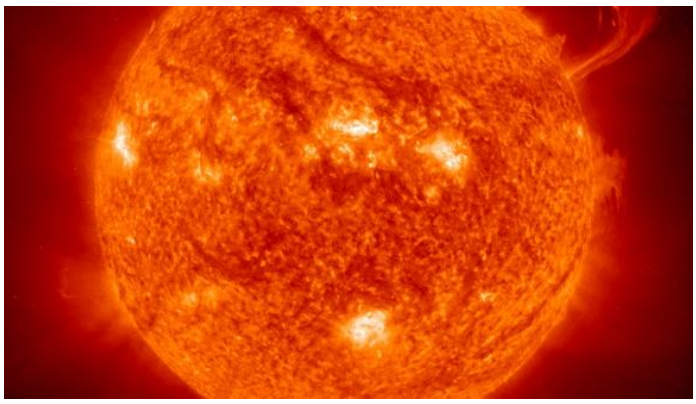
This particular situation works well for situations where (1) a stable source of energy is available and (2) the discrepancy of night vs day can be leveraged into the system such that the period of night and day accommodate the rhythms of the need assessed. If something needs to operate 24 hours a day, however, it becomes simply a matter of vastly increasing the battery size to ensure that the system gets the power it needs, while the so-

lar array can refresh the battery enough *when it can* (i.e. when light is sufficient to do so) to allow the circuit to continue indefinitely. Obviously, this is dependent on weather conditions, among other factors.

But we suspect that there are other ways of looking at this situation. For example: what happens if we eliminate the battery entirely. How could we develop a system that gives us energy *in the moment*, and uses it immediately, to whatever effect is necessary? Is there something interesting about the idea of energy that is there only when the light that is necessary to provide it is present? What kinds of musical systems can we create that are dynamic, in this sense: light is "on" and dark is "off," and the in-between is where the real artistic parameters lie.

Many examples exist, for instance, that make use of light as a "sensor": but what happens when the sensorial aspect is also the source of energy? Imagine a typical wind instrument: such as an oboe or shakuhachi. A person who plays a wind instrument has to blow – and this breath translates into sound directly. If nobody blows through the instrument, it is silent (mostly), unless a gust of wind blows across an opening with sufficient force to cause the body of the instrument to resonate. Certainly we have all heard devices designed to be sounded by the wind: wind chimes or Aeolian harps, for example. These require a kinetic design that can respond to the particular level of turbulence created by natural wind sources, rather than the intentional breaths of a performer of wind instruments. Obviously, this creates a very different kind of "music," but the idea is the same: create enough air, and the device can resonate accordingly. So, translate this to light, and it can be easily understood that the idea of available light, in the moment, could perhaps be a parameter of interest in the production of sound. We suspect that this idea has long roots, and has been considered in a number of ways throughout history. Here are some precedents of such ideas.

**Solarsonics**



There is an intricate connection between sun and sound, a connection whose history far predates current photovoltaic solar sound installations. Our mythologies bear witness to such synthesis, whether found in the ancient Hindu Vedas that attribute the origin of all things to the synthesis of sun and sacred sound, or ancient esoteric Greek philosophies of the logos, combining ideas of sun with spoken word. Even modern science has come to recognize the relevance of the synthesis between light and sound, between energy and vibration. This connection is made real in modern science, exemplified in the recently discovered "signing sun," a phenomenon that allows one to hear the sun's surface oscillations (Scherrer et al 2008). In art, history and science, the exploration of solarsonics bears the inquiry of a world connected by the synthesis of sun and sound.

**Memnonium**

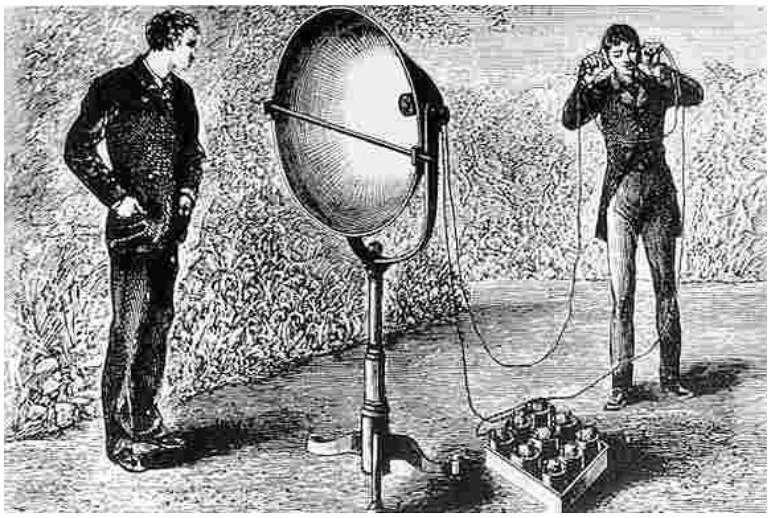
To try to begin to encapsulate the world of solarsonics, we first turn to the famed twin statues, the Colossi of Memnon, as the oldest known source of solar-acoustic intrigue. The eastern colossus suffered damage during an earthquake around the turn of the first century, and for about 200 years afterwards, legend has it, the early passerby could hear Memnon crying out at sunrise. As word and legend spread, this "Vocal Memnon" took on oracular powers, bringing luck to passerby and emperor alike. Sadly, sometime in the first century, repairs were made to fill in the cracks caused by the earthquake, putting an end to the Voice of Memnon. Accounts of the statue emitting sound when warmed by the morning sun are plentiful through out history. Popular theory suggests that it was the changes in temperature and humidity that resulted in producing the Voice of Memnon, since the sound was most commonly heard at sunrise. Fascination with the phenomenon of the statue of remains, standing the test of time, and though the event of the Voice of Memnon has long since been lost to us, its history is often referenced as foundational in philosophical, historical, and scientific literature dealing with the relationship between sun and sound.

It is the distant echo of the Voice of Memnon that influences the work of M. R. Duffey. According to Duffey, who references Memnon as the theoretical basis of his work, the term *memnonium* refers to any self-actuating system that generates music using solar energy. Duffey reviews a few technologies, or prototype designs, of memnonium to date, concluding that an efficient use of such technology would require intense inter-disciplinary work between "physics, music and other disciplines" (Duffey 2007). The experimentation with sound and light that he outlines have continued to evolve since his 2007 review of the field and has in fact become a global phenomenon. Our research into the work of artists creating solarsonic projects has revealed a plethora of varied experiments on an international playing field. Duffey's work immortalized the truth of this research when he stated that, "The story of the statue and its legacy merits a properly researched scholarly account." Duffey himself has explored several solar powered sound initiatives including devices that use shadows to activate music, and he continues to experiment with resonant chambers and shafts of light, as well as prototype flowers with reflective solar sensitive petals.

**To Hear a Shadow**

The first focused, scientifically based attempts at utilizing solar energy to produce sound can be traced back to Alexandre-Edmond Becquerel's original discovery of the photovoltaic effect (Becquerel 1867) which, in turn, influenced Alexander Graham Bell's *photophone*, a concept Bell worked on through much of his life. Steven Connor recounts Bell's efforts to create sound out of light, and how it occurred to Bell that a selenium cell might function similarly to the fluctuating electrical current responsible for creating sound in the telephone (Conner 2011). In numerous lectures during 1880, Bell speculated on the photophone declaring "the construction of apparatus for the production and reproduction of sound by means of light" (Bell 1880).

In one of the most frequently cited biographies on Bell, Robert V. Bruce tells of how Bell wrote his father on the 26 of February in 1880, exclaiming, "I have heard articulate speech by sunlight! I have heard a ray of the sun laugh and cough and sing! I have been able to hear a shadow and I have even perceived by ear the passage of a cloud across the sun's disk" (Bruce 1990, p. 254). The quote in many ways marks the core of all solarsonic research, referenced often, almost scripturally, as in the case of the latest doctoral research in photoacoustics, *Photoacoustic And Photothermal Deflection Studies On Certain Selected Photonic Materials*, by Nibu A George, whose lengthy doctoral thesis and scientific exploration of photo-induced processes demands respect for its scope alone (George 2001).



Volker Straebel, a German musicologist who teaches Sound Studies at the University of Arts (UdK) in Berlin, works with photoelectric technology to produce sound through the action of light. In an article entitled "Klang aus Licht: Eine kleine Geschichte der Photozelle in Musik und Klangkunst" (Sound out of light: A brief history of the photocell in music and the art of sound), Straebel surveys the history of photocell technology in music, highlighting the origins of solarsonics in Bell, through the audiovisual discoveries of Moholy Nagy and Oskar Fischingeras in correlating sound and picture, and concluding with the successful synthesis of sound and light finally achieved by Alvin Lucier and Felix Hess (Straebel 1997).

In the above research, Straebel also highlights Harald Kubiczak's *Singing in the Sun* and Joe Jones' *Solar Music Hot House* as examples of compositions that are played by the sun rather than being direct correspondences between light and sound (i.e. the sun powers mechanical, kinetic sculptures in the same way that wind activates wind chimes or aeolean harps). Created for the 1988 Ars Electronica Festival in Linz, Austria, the Joe Jones piece lived inside a greenhouse structure, with plants, along with several small percussion and

string instruments. The instruments are "played" by motors and actuators, which are driven directly by small solar panels (Jones 1989).

Straebel then reviews Felix Hess' opto-phonetic sound installations as an example of a true transference of light into sound. Hess, a Dutch artist and scientist, works with semi-autonomous sound machines, including his better known *Moving Sound Creatures* (1987) and *How Light is Changed into Sound* (1995), the later piece using solar panels. In his book, *Light as Air*, Hess explains his life's work, including a chapter titled "How Light Is Changed into Sound," which expands on his work with solarsonics and his use of solar panels (Hess 2001). Famous for his electronic frogs, or as he calls them, "cracklers," Hess has demonstrated his sound machines in various installations, including one at the Warsaw Autumn Cultural Festival in 1996. Here he used small solar panels that react to changes in brightness, the sound generator being a combination of piezo elements, stone, and balsa wood, causing the sounding board to vibrate into clicking, or croaking sounds (Ritter 2007).

**Solar Sound as Philosophy of Nature**

Such creations as those highlighted above certainly intrigue and fascinate, and perhaps that is the goal of their creators. Often the goal of solarsonics is more pragmatic than mere fascination, with artists using photovoltaic technologies for practical reasons in environments where power is simply not available. However, many artists seem interesting in working towards the general good of the future of human endeavor. Even further than this is a philosophical drive that strives for an ideological connection, or reconnection to the grandeur of nature itself.

From Bell forward, research in solar sound finds Alvin Lucier, one of the original pioneers in the field of experimental music and the use of electronics. In 1979 he created *Solar Sounder I*, a sound installation that was designed to change its sonic character throughout the year, as the sun rose and set, but also as its angle relative to the earth changed with the seasons. His primary concern in this piece was not in creating an instrument that could be played by people passing their hands in front of it, rather, he wanted the piece to represent the position of the rotation and revolution of the earth around the sun. Lucier's "phenomenon of light and shadow" was highly philosophical in nature, and Lucier went to great lengths to clarify his objective in a conversation with Arthur Margolin. He explained that the function of sound changing in response to light was not about the technology or human interaction. "Once you've passed your hands in front of the panels, you've learned pretty much what the panels can do. That is, you've demonstrated a rather gross manifestation of the phenomena of light and shadow" (Lucier and Margolin 1982). His intension with the work was rather more cosmic than the actual function of the device. Lucier centered the magnitude of his concept on the function of the ancient sundial, his vision being to bring awareness to the onlooker of the grandeur of the movements of the earth through the cosmos, the device changing in pitch and tone to the differences in day and season.

Solarsonics and ideology brings us next to digital artist Morgan Barnard's personal electronic device, *CONNECT*, a photovoltaic device that generates audio towards the purpose of performance or relaxation (Barnard 2005). Using photovoltaic technology, Barnard's goal was to present his device as a solar powered personal listening device that takes its audio cues from the surrounding environment. Like Lucier, Barnard hoped to create a sonic experience that reflected the environmental factors of light energy in a kind of

"environmental synthesis," but designed for a personal, individual experience. What would have initially been a standalone device placed in the environment evolved into something much more intimate, as Barnard realized that the device could be contained in a small enough unit to make it highly portable. By connecting headphones to the device, the user could experience a solarsonic connection with the various elements of light in his or her surroundings.


Craig Colorusso is an artist and musician known most recently for his outdoors *Sun Boxes* (2010) project. In this travelling installation, Colorusso has created twenty independent loudspeakers, all operating on raw solar energy using photovoltaic panels. Each box contains additional electronics which playback an audio loop, based on a sampled electric guitar note, which when heard as a collective make an undulating ambient texture.

He then spreads the speakers out in an outdoor setting where the listener is exposed to a soothing soundscape environment. Colorusso's objective with *Sun Boxes* is the creation and appreciation of the subtleties within the soundscape through the gradual evolution of sound based on variations formed by the different loop lengths, which change their distribution based on available sunlight. The idea is for these subtleties to focus the listener on the surrounding natural environment and its own subtleties. He likens the experience to that of meditation; calling upon the listener to slow down, to escape the busyness of the world and notice the sonic environment in which the speakers are positioned (Colorusso 2010). Izalia Roncallo notes that part of the awareness of the subtleties of Colorusso's *Sun Boxes* comes with the understanding of the loop's reliance on nature itself for its existence (Roncallo 2012). This awareness brings the observer face to face with the power of nature. Similar to Barnard's *CONNECT*, Colorusso's *Sun Boxes* presents a way to utilize technology, so often considered an antithesis to nature, to help create a strong connection to it. The piece has been exhibited in numerous outdoor environments, and recently a short film has been created about the project (Belli 2012).

**To Hear the Light**

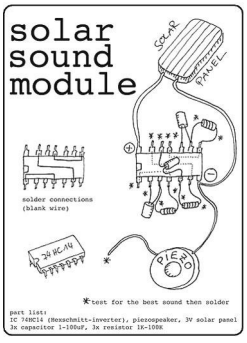
Christina Kubisch is a musician and a sound installation artist who combines elements of sound and light, using solar installations as well as magnetic induction, ultraviolet light, and solar energy to demonstrate the 'synthesis of the arts'. Kubisch is well known for her solar-acoustics work, most notably for her *Clocktower Project* (1996), an artistically synthetic restoration of a deserted clock tower in North Adams, Massachusetts. Surrounding the tower with solar panels, relaying the position and intensity of the sun to a computer software program of pre recorded bell sounds, the clock tower bells once again lives, allowing

the listener to "hear the light" (Kubisch 2012). The compositions are as varied as the day, each prerecorded bell sound a recording of the original tower bells, that differ depending on cloud cover and intensity of the exposure of the sun, outputting sharper tones during the heat of day, fading to slower, softer tones in the evening, and finally sleeping with the dark of night. It was on visiting MASS MoCA (Massachusetts Museum of Contemporary Art) for the first time that Kubisch became acutely aware of the silence of the bells. Seemingly neglected and forsaken, the clock tower represented not so much a silence, but rather a vivid antithesis to its natural state, that of sound.

The clock tower, as perceived by Kubisch the observer, enveloped an artistic metaphor, and it was this vision that drove her to the project of restoring it to sound. Sound being a spatial entity, Kubisch veiwed the clock tower as a metaphorical symbol for MASS MoCA and the town of North Adams, where the clock tower directly represents the life and history of its community. Kubisch saw opportunity where others saw silence and neglect, and she spent the next several years bringing the bells back to life. Her vision paid off, as the restored clock tower did restore life to North Adams, as MASS MoCA itself put North Adams on the map as one of the most significant art centers in North America.

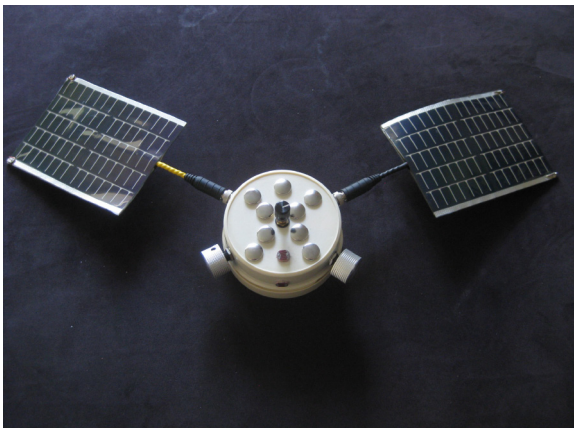
Nigel Helyer brings the symbolic nature of solar sound full circle in a philosophical hats-off to the ancient Vedas and the Hindu creator god Vishnu with his creation of the lotus-like *Padme* (2010), a solar powered wetland installation that interacts with the movement of nature and local wildlife to produce various insect soundscapes. Before *Padme*, Heyler experimented with a number projects that use mechanically created solar powered devices in a wetland setting. His vision is to emulate the relationship between the soundscape of an environment and its changing structure. He likens the affect of wave movement on his Padme to the impact of a flood on the changing sounds of an environment (Helyer 2010).

Ralf Schreiber arrived on the solarsonics scene in 1996 with his *solarsoundmodules*, a small sound-making circuit that utilizes piezo speakers, CMOS logic chips, and small solar cells to produce sound sequences similar to that of birds and insects. The sequences are continuously unique in that they are determined by the amount of light touching the surface of the module at any given time and change with the time of day, forming any unique sound creations from the first light of day to the setting of the sun at night. The *solarsoundmodules* have been used to create several installations, including one in collaboration with Canadian artist Mark Tilden, inventor of BEAM robotics, whose *suneater* module, a solar-powered robotic circuit, combines with the *solarsoundmodule* to become chattering, moving creatures, or "living particles." The circuits work independently of each other, thus producing numerous sound textures alongside randomly varying movements. Schreiber contends that the aesthetic achieved in the installment is found not within the individual robots but rather in the space created as a product of the interactions between the robots. Schreiber has beautifully documented the design of the *solarsoundmodule*, even creating tutorial PDF for those who may want to make their own (Schreiber 1996).



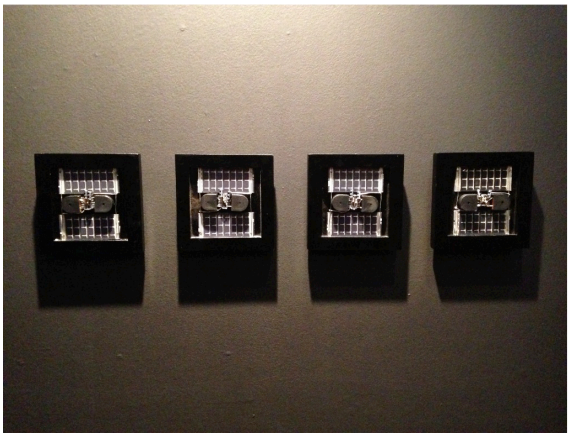
**Recent Work by Smallwood**

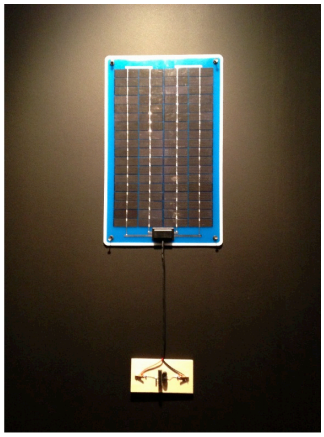
Much of this work has been inspirational in my own quest to create solarsonic experiences. In particular, Schreiber's work above, along with the more general sound work of the hardware hacking community and artists such as Alvin Lucier, Nicolas Collins, David Tudor and others. However, some of the initial forays into solarsonics came from a more general interest in portability and site-specific modalities that came out of my research with laptop orchestras (Cook and Smallwood 2009). This research led to an interest in custom hardware and portable, experimental handheld instruments, and simultaneously branched into sound installation concepts (Smallwood 2011).



Most recently, the Radio Flyers project began with the idea of creating a series of instruments based on an AVR RISC-based microprocessor and networking capabilities over a wireless radio network. This series of instruments uses the Atmel ATmega328 8-bit chip, programmed in the Arduino environment, to create a simple two-voice synthesizer that can play tones and melodic patterns. These chips can be powered with very small amounts of energy, and coupled with a simple LM386-based amplifier, can generate sounds with 1 milliwatt or less of power. The networking capabilities happen over a local X-Bee network, giving the instruments the capability of group synthesis. This project is still in progress, but so far has resulted in promising results. Shown here is the first working prototype, which also is able to broadcast its sound over a low-power FM transmitter. The hope is to create several of these for group synthesis performance scenarios in outdoor locations.

Sound installation projects have also resulted from this research, but recently I became interested in the idea of creating solarsonic pieces that could live in a conventional gallery environment, on walls or pedestals with normal gallery lighting providing all necessary energy for sound production. *Hideout* was a recent sound installation, featured at the SeedSpace Gallery in Nashville, TN, USA during March and April of 2013 (Bubis and Baker 2013). This piece consisted of several wall pieces hung as visual art, but which contained raw circuits and solar panels, generating small sounds using the gallery lighting. The concept was to





create a kind of sonic "hideout," mimicking the forest soundscapes of an urban, Albertan river valley, but without referencing any specific place directly. The irony of these works is that they require light, but are designed for indoor environments.

## Conclusions

Solarsonics, in many ways, is a new frontier in the exploration of not only light and sound, but also in the general idea of environmentally activated arts. This paper is only a brief survey of the field, but we hope to have shown that real potential exists in this area. The implications and possibilities inherent in the above noted works are endless. One wonders what it is that drives us to explore the connection between light and sound? And while the many inventors, artists, musicians, and scientists who have delved into the field have certainly produced some amazing concepts and devices, it is the meaning the artists give to their work that is intriguing. Many of the above noted solar sound artists have found an intricate connection between their work and nature, while others have founded new philosophical inquiry. A seemingly overarching theme in solarsonics presents itself as an awareness of technology as nature rather than antithesis to it. If a truly direct transformation of light into sound is actualized, will it be at the hands of nature, such as the phenomenon of the "singing sun," or will it be through some synthesis of technology and nature? Such questions push the boundaries of thought, just as the artists themselves do through their effortless work, pushing the boundaries of possibility.

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