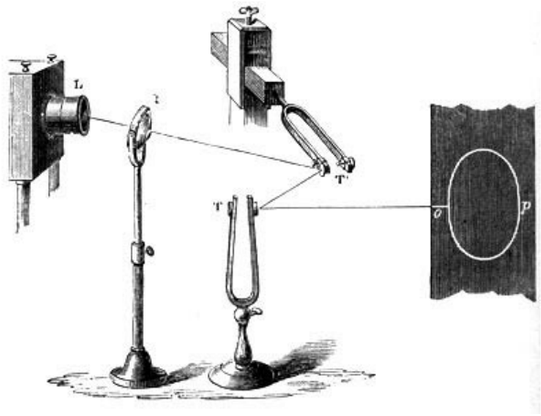
I am sitting in a room with Jules Antoine Lissajous. It's 1855 in his Paris workshop and he is showing me his "beautiful machine." Devised to draw a picture of two systems superimposed, it is constructed of a pair of tuning forks placed facing at right angles, each with a mirror attached. The light source is focused through a lens, bouncing off the first onto the second and projecting to a large screen a few feet away. As the tuning forks are struck and tones are produced, simple vibrations begin to move the mirrors in a regular oscillating pattern. The projected image begins to form the strange and beautiful curves of a Lissajous Figure.

Easily mistaken for the infinity sign, a circle or any number of more complex pretzels and knots, the Lissajous Figure is a picture of compound harmonic motion named for French physicist and mathematician Jules Antoine Lissajous (1822–1880). The shape is drawn by plotting a two-variable parametric equation as it iterates itself over time — the resulting figure is the picture of two systems falling into and out of phase.



Schematic drawing of Lissajous' machine

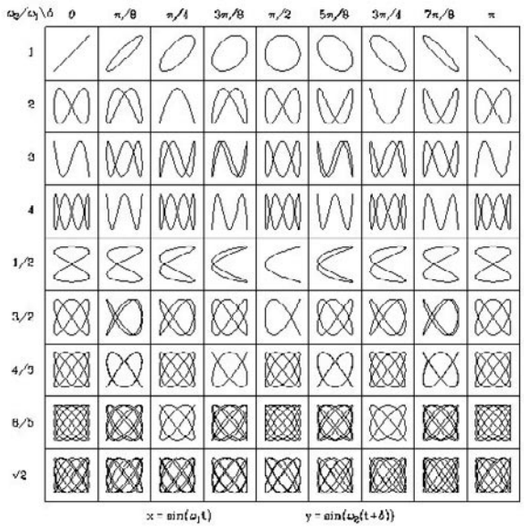
For his machine Lissajous was awarded the Lacaze Prize in 1873 and was exhibited at the Paris Universal Exhibition in 1867. He did not otherwise distinguish himself as a scientist or mathematician. In fact, almost fifty years earlier American Nathaniel Bowditch had already produced similar figures with his harmonograph.

The simple harmonic motion which Lissajous was measuring is easily described by the motion of a clock's swinging pendulum. As the pendulum swings its speed isn't constant, but rather it accelerates and decelerates following a precisely predictable curve. If plotted over time, as the clock ticks the motion of its pendulum draws a sine wave — the so-called "pure wave" or zero-picture of a simple moving system. Ocean waves, sound waves, light waves, even average daily temperatures all produce this same oscillating sine wave pattern.

Compound harmonic motion, then, is simply the superimposition of two sine waves as they register, interfere and produce a series of overlapping waves. When juxtaposed at right angles, two sine waves recording simple harmonic motion produce the surprisingly complex figures that Jules Antoine Lissajous identified.

Lissajous Figures can be easily found today in computer graphics, in science museums, in laser light shows and, perhaps most precisely, burned into the green phosphor screen of a cathode-ray oscilloscope. A standard piece of electronic test equipment, the oscilloscope allows signal voltages to be viewed as a two-dimensional graph of potential differences, plotted as a function of time. When testing an electronic system, the phase differences between two signals form opposing sine waves on the screen of the oscilloscope connected together, constantly drawing and redrawing themselves in a precise and regular pattern.

These two varying signals produce a perpetual infinity (figuratively and literally as it will actually construct itself in the shape of the infinity sign given the right initial values). The Lissajous Figure becomes a picture of timing and sequence, registration and resonance, sound and music.



A subset of possible Lissajous Figures by harmonic interval

Specific shapes are produced corresponding to the resonating harmonic intervals familiar from western music (major fifth, minor third, major sixth, etc.) Any figure may be transformed into any figure and an infinite number of in-betweens as the oscillating sine waves pass in and out of harmonic resonance.

Jules Antoine Lissajous created a way to see sound (using mirrors, light and vibrating tuning forks.) But the most radical possibility of his mathematics might be in the commitment it asks of its audience. The image that Lissajous produces forms slowly right in front of your eyes — imperceptibly changing, forming, adjusting and re-aligning over time.

With a significant debt of gratitude to the assembled thoughts in http://www.gardenvariety.org/projects/lucier/booklet.html and a tip of the hat to Paul Morley's Words and Music: a history of pop in the shape of a city.

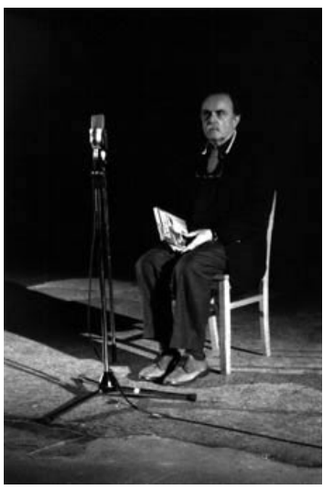
Dexter Sinister
6 September 2007

I am sitting in a room with Alvin Lucier. It's 1969 and we are on the campus of Brandeis University. Alvin is about to begin the recording of his soon-to-be-seminal electroacoustic composition *I Am Sitting in a Room*. In the space sits a microphone, a reel-to-reel tape recorder and a pair of amplified speakers. The recording begins. He speaks simply and clearly with an occasional stutter:

> I am sitting in a room different from the one you are in now. I am recording the sound of my speaking voice and I am going to play it back into the room again and again until the resonant frequencies of the room reinforce themselves so that any semblance of my speech with perhaps the exception of rhythm, is destroyed. What you will hear, then, are the natural resonant frequencies of the room articulated by speech. I regard this activity not so much as a demonstration of a physical fact, but more as a way to smooth out any irregularities my speech might have.
>
> Alvin Lucier, *I Am Sitting in a Room*, 1969

Alvin Lucier produces installations and compositions that explore the psycho-acoustic qualities of music in space and its perception. As a member of the Sonic Arts Union with Robert Ashley, David Behrman and Gordon Mumma, Lucier has been at the front of contemporary experimental music since the 1960s. His work is concerned with natural resonances, closely tuned pitches, harmonics and phase interference.

In 1969, while director of the University Chamber Chorus at Brandeis University, Lucier recorded *I Am Sitting in a Room* by speaking the text above in a room and recording it. The recording of his speech is then played back again in the space and the results recorded. The recording of this recording was again played and recorded — the process continues for more than 45 minutes as Lucier's spoken voice is slowly morphed into an abstracted progression of resonant harmonic tones resulting from the particular physical and acoustic properties of the room in which it was recorded (and recorded.)



Alvin Lucier, sitting in a room sometime after 1969

The completed piece is a picture of two systems (his voice and the room) coming into and out of phase, eventually settling into a pattern of harmonic resonance. Each recording amplifies the acoustic qualities of the room and abstracts his speech further. The result is a specific sonic blur — abstract and precise at the same time, it is the image of compound harmonic motion in that room.

Further, Lucier specified that *I Am Sitting in a Room* may be recorded in any room. The piece has been performed in and produced sound portraits of spaces as varied as the Guggenheim Museum and his living room in Middletown, Connecticut.

Guggenheim Museum, New York

I Am Sitting in a Room requires a time commitment in order to hear it take shape. After five minutes, the voice is no longer legible; after ten minutes the rhythm asserts itself and by the end, the formless tones take on a concrete urgency. In *Words and Music: a history of pop in the shape of a city*, British music writer Paul Morley describes what he likes about the piece:

> It represents the side of me that loves music for the way it constantly surprises, changes what it is, moves with the times, moves through time, creates space within itself, reacts against the past and finds new ways of saying the same thing. What this "same thing" actually is, and why the variety of the "same thing" is constantly stimulating, makes listening to music just as challenging an idea as the making of it — and can make listening a musical act, so that the listener can, in ways, be described as a musician, participating in the making of the music.

Alvin Lucier created a way to hear space (using serial recordings and harmonic resonance.) But the most radical possibility of his music might be in the commitment it asks of its audience. The sonic image that Lucier produces forms slowly right in front of your ears — imperceptibly changing, forming, adjusting and re-aligning over time.

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