Pretty Paper Rolls: Experiments in Woven Circuits

Peter Blasser

ABSTRACT

The author presents a history of his efforts to design sustainable and economical circuit construction on paper, which he finds more akin to craft than industry. He focuses on a collection of modules called Rollz-5, which creates organic rhythms out of geometrical forms. A future application of this work will be to create radio devices based on the Platonic solids.

PAPER CIRCUITS

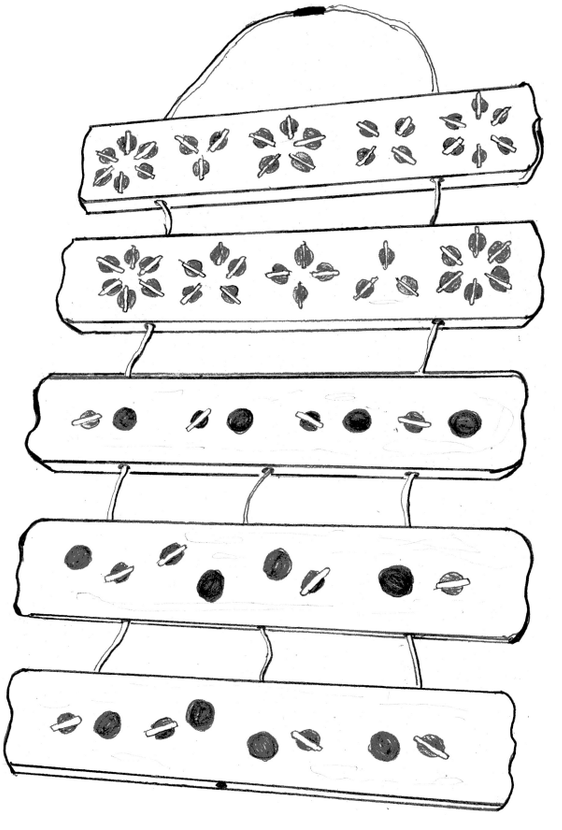
In 2006 I began making circuits on paper. Paper circuits are easier, cheaper and environmentally safer to produce than the alternative: fiberglass circuit boards etched with heavy chemicals at a factory. The idea, which I got from a St. Louis collective known as commonsound <www.commonsound.com>, is to lay out the circuit's front (component) face and back (trace) face adjacently and mirrored on the paper. The pattern is cut out, folded in the middle and then pierced with a needle. The components are inserted and their leads woven and soldered according to the trace pattern. I created several pocket-size paper circuits that explore touch sensitivity and the complexity of circular modulations. I play them by intuitively wiring or touching nodes to each other to create spontaneous re-weavings of the internal circuits. I consider these the most accessible of my designs; anyone can salvage or buy the components after downloading the plans from my web site [1]. Each iteration of a paper circuit is unique, because the time elements vary with the change of component values in key locations. Unlike a schematic, in which electronic ideas are transcribed only symbolically, a paper circuit design suggests a physical placement as well; it is immanent in that the design becomes the manifestation. To ease the assembly process, I arrange leads to flow into each other, often with geometrical repetition. Thus a paper circuit is a geometrical recipe, like a Mandala, that is either read symbolically or constructed physically. This appeals to the alchemist's vision of interplay between physical and spiritual processes; technology is pondered for self-realization, and information is coded to be distributed personally through guilds as well as mnemonically in spell books. The paper-circuit projects attempt to transform the art of electronics from an impersonal, industrial approach to one that is individual and magical. This electronic craft encourages everyone who pursues it to personally reduce waste; creativity leads to resourcefulness and vice versa.

ROLLZ-5

After creating several standalone pieces, I decided to design a group of paper circuits that could be combined in a variety of ways. By this means I intended to call into question the idea of a "drum machine," which implies the sterile regimentation of time, and rethink it as a collection of organic flows generated by geometrical forms. These forms and their accompanying filters can be switched, wired or touched; the final manifestations include a small preset switch-box, a squeezable spike-dome and a traditional modular. My first implementation uses five slim walnut panels connected by heavy cloth-wire, which I hang on the wall to play and fold up to store (Fig. 1). I exposed the nodes on the surface as inlaid brass pegs for alligator clips to grasp.

The top two panels contain the pulse-brain circuitry—the geometrical forms that I call rolls. They are three-, four-, five- and six-noded versions of the same simple transistor circuit (Fig. 2). They cycle impulses, inverting polarity at each node; imagine a pulse oscillator flipping at a set frequency. From this humble base whole montages can be

Fig. 1. A depiction of my first manifestation of the Rollz-5 circuits, encased in five panels of Amish Walnut, tethered together with cloth-wire, 18 in wide, 24 in high and 1 in thick, built in October 2006. (© Peter Blasser) It hangs on a nail; the paper circuits within include 10 geometrical rolls and 12 translators.



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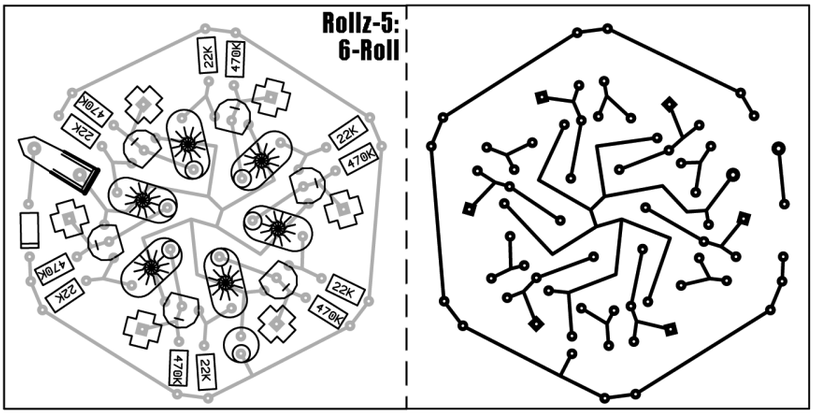


Fig. 2. The actual paper circuit for a six-noded geometrical roll, describing the circuit as well as housing it. (© Peter Blasser)

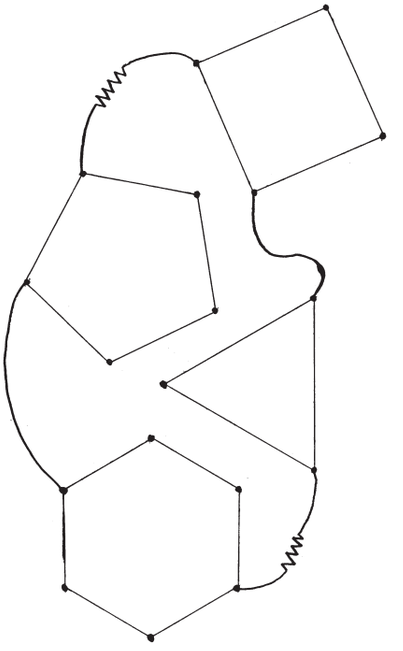
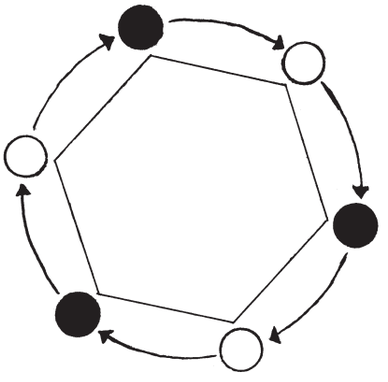


Fig. 3. An abstracted montage of geometrical rolls. (© Peter Blasser) Some connections incorporate resistance, some do not.

built by connecting nodes to nodes on other rolls (Fig. 3). A connection with a resistance allows individuality for its two endpoints; a connection without resistance welds both into a new monadic node. During experiments with the rolls, I found an interesting difference between even and odd ones. Take a 6-roll (Fig. 4). The lozenges surrounding it represent the temporary state of each node, where white is the inverse of black. Start on a black node and follow the arrows; the impulse ends as it started. The even rolls are stable and alone they maintain a certain periodicity. Now observe the 5-roll (Fig. 5). Start on the star and follow the impulse around—upon arrival at the start node it has become inverted. Odd rolls exhibit a "paradox spiral": In attempting to resolve their states, they transcend periodicity and go into a sort of high-frequency chaotic trance. The combination of even and odd lead to rich experiments in pulse and periodic fuzzburst.

Fig. 4. An even roll, such as this six-noder, perpetuates a stable alternation of verso and inverso. (© Peter Blasser)



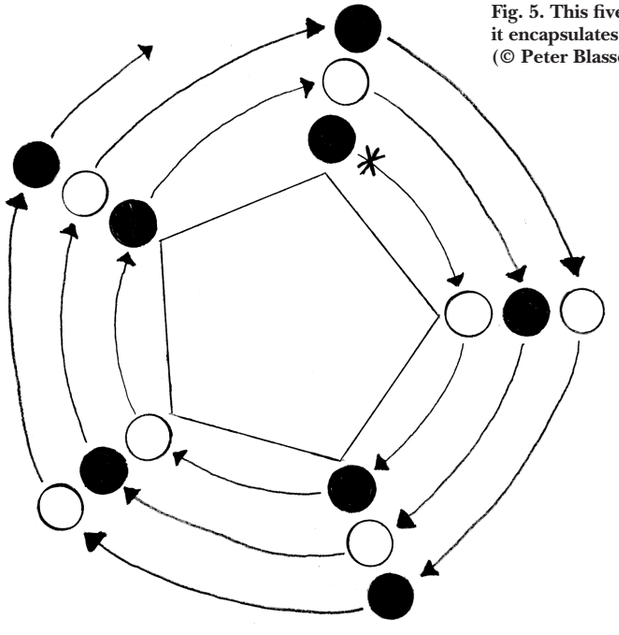


Fig. 5. This five-noded roll is odd; it encapsulates unresolved paradox. (© Peter Blasser)

Meditating on the oscillographs of chaotic regions between pulses, I was inspired to design a translator to bring the ultrasonic bubbles into audible range. I happened upon a switched capacitor filter, which uses a reference tone at ultrasound frequency to set the cutoff of a low pass filter. It has the (happy) side effect of heterodyning frequencies near its reference—which is exactly how radio is converted to audible sound by difference tones. The ultrasound filter reveals sounds hidden in the shrill as well as processing the timbre of the pulses.

I designed the Gongs translator to ignore ultrasound and measure only pulses; it waits a period set by knob and then allows one pulse into a resonant filter preset to a certain pitch and damping. Normally I would desire movable pitches, but I accepted set pitches because this is a drum machine. The tones mark phrases around which melodies develop externally, and I would rather control the phrase length than the tone of the gong. A creative hacker could easily modify these circuits to make the pitches movable. The sonic effect is anything from a short woodblock tone to a deep resonant gong that punctuates the pulse.

A third translator, Auto VDog, uses the same resonant filter as Gongs, but at a very low frequency, to transform pulses into a slow undulation. This undulation controls the amplitude of a simple drone tone, forming a ghostly complement to the pulse material. I created this translator to balance the plucked and pulsed sounds. It is like sending pulses through a watery wave-tank that speaks a simple tone, a complement to the more abrupt rhythms of the other translators, yet it relates periodically because it is based on the same raw material.

Practice, Futures

On a recent tour of the U.S., the Rollz-5 served as the organic ostinato on top of which we humans gestured with voice, trombone, flutes and strings. The drum machine marched onward with a certain limp, or *pleng*, to keep the rhythm interesting. Pleng is a Javanese Gamelan term describing tones an octave apart but slightly detuned, to create shimmering difference tones. This term is appropriate to any analog circuit because of minute variations in components. For example, if two oscillators are truly analog, they can never be tuned to the exact same pitch, because their frequency has infinite fineness of scale. As they approach unity their interface creates longer and longer difference tones. These difference tones add variety and an organic feel to the phrases.

In Sarasota, Florida, a student named Marcus Aurelius noticed the geometry of the Rollz-5 and enthusiastically introduced us to sacred geometry. He gave us a book by Drunvalo Melchizedek about the history of the "Flower of Life" [2]. This hexagonal arrangement of circles or spheres leads to a perfect diagram of all five of the Platonic solids—the tetrahedron, octahedron, icosahedron, cube and dodecahedron. These forms interest me as a basis for circuits. Take a paper pentagon, create a spiral of wire in it (coil or inductor) and excite it into radio resonation. A dodecahedron is 12 of these active pentagons joined into a ball (Fig. 6). Dangle it near a radio and tune to its sounds, which are spread over the airwaves; it is convoluted so it transmits a wide range of frequencies. The coils on each polygon make radio, which is very sensitive to any change in capacitance, so hand gestures are enough to manipulate their fields and transform the overall pattern, somewhat as with a theremin.

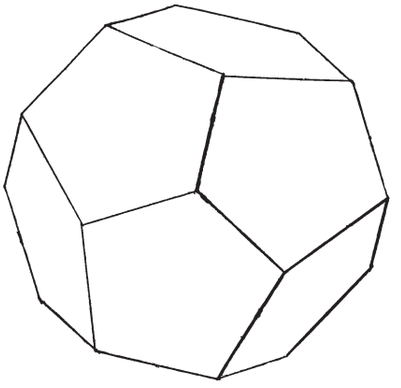


Fig. 6. A dodecahedron, which provides form and function for paper circuits. (© Peter Blasser)

The Egyptologist Schwaller de Lubicz defined magic as "the manipulation of harmonic forces which may lie outside sensory perception and are therefore beyond the pale of possible measurement" [3]. Radio is outside our direct perception, and it does not occur solely in the static stations we listen to by habit; it is much more pliant than the industry reveals it to be. As I write this, in March 2007, I am informed that Don Buchla is designing a voltage-controlled radio; the tuner itself has become a medium for composition. Coincidentally, Moog is releasing a radio/audio device—evidently there is a coming shift of expression into the radio realm. Compared to traditional audio synthesis with mechanistic components, radio is intrinsic to the most discrete electronic components; it is nearer to the primordial frequencies of electrical vibration within space. Because radio vibrates at such a great speed, it reacts to the space it inhabits and the forces within it. It is a lie that radios are receivers and the towers are transmitters; this is only unequal distribution of power, for in fact all radio devices blur the arbitrary line between reception and transmission. To experience this by physically manipulating radio fields is to ponder the mystery of universal source—that to give is the same as to receive. Clearly radio offers a soul more than hypnotism by programming.

Discography

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2. Drunvalo Melchizedek, The Ancient Secret of the Flower of Life, Vol. 1 (Flagstaff, AZ: Light Technology Publishing, 1990).

3. John Anthony West, Serpent in the Sky: The High Wisdom of Ancient Egypt (New York: Harper & Row, 1979).

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Peter Blasser lives in Baltimore, MD, where he designs and builds electronic sound devices as a hobby and for profit. He also does landscaping, low brass and cooking.

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