Repurposing the Past: The Phantastron and appropriating history as a DIY approach

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Historical models may often provide some of the greatest inspiration for the creation of new technologies. A DIY approach appropriating older paradigms in technology is discussed, with special attention paid to how old concepts can become relevant within a modern context. The author's electronic instrument, the Phantastron, is introduced as an example of this DIY approach. The Phantastron's creation is detailed in practice and methods such as repurposing, redesigning, hacking and circuit bending upon a historical design are described. A wider angle is then cast upon the concept of repurposing older technologies, and the works of other artists and DIY makers are considered. The concept that antiquated technology is in the common domain and ready to be utilised in the synthesis of new ideas is discussed. Finally, a generalised DIY approach to integrating historical ideas into new creations is posited.

1. SYNTHESISING A NEW DIY APPROACH

By founding DIY methods for the creation of electronic instruments upon historical precedent and research, truly unique instruments can be created which break away from contemporary norms. These instruments exist in a parallel time line; they are contemporary creations, but born of methods that are firmly rooted in the past. They are not historical replicas, but new developments upon technological ideas and idioms of an earlier era. The resulting instrument, created in this style, embodies many of the qualities of historical instruments, but is designed for the world of today and ideally suited to contemporary performance practice. As an illustration of this concept, the author presents his historically inspired instrument, the Phantastron.

The Phantastron is a DIY vacuum tube instrument that produces a broad variety of complex timbres and pitches. It is essentially a vacuum tube oscillator and wave shaper that generates a waveform that is unlike those produced by modern solid-state oscillators. The Phantastron produces an array of sounds which can sound somewhat similar to the ondes martenot or the Trautonium. Due to its vacuum tube topology, though, it sounds different from a solid-state analogue synthesiser.

Unlike early twentieth-century vacuum tube instruments, the Phantastron utilises voltage control of its pitch like a modern analogue synthesiser. It can be manipulated by any controller capable of producing a control voltage or by a MIDI-to-control-voltage converter. This allows the instrument to be manipulated by musical keyboards, ribbon controllers, experimental and alternative controllers, and sequencers. In performance, the player has the flexibility to control the sound of the instrument by many different methods, which allows great freedom for the performer to choose how to interact with the instrument.

1.1. Creating the Phantastron

I first conceived of an instrument like the Phantastron while shopping at a surplus electronics dealer in Los Angeles with my colleague Nicolas Collins. Collins found a dusty old book from 1956, *Analog Computer Techniques* by Clarence L. Johnson, and persuaded me to buy it for my research into analogue sound creation. This book contained many examples of the manipulations of voltage and current to perform mathematical operations, but it also illustrated that one could use the technology of the 1950s to manipulate voltage in complex and interesting ways. After scanning the book I recalled an article I had read by Eric Barbour which detailed how he used vacuum tubes to build vacuum tube synthesisers with voltage control (Barbour 2000). By combining Johnson's and Barbour's concepts, I realised that it was possible, using vacuum tubes, to create a voltage-controllable instrument with a unique and complex waveform. At this point I also realised that research from vintage books and sources could provide a method to create such an instrument.

Although Johnson's *Analog Computer Techniques* provided the germ of an idea, it did not illustrate practical circuits I could use in the creation of an instrument. At this point, I began to seek out electronics books from the 1940s and 1950s to find more inspiration and reference material. Samuel Seely's 1958 book *Electron-Tube Circuits* eventually provided me with the detailed explanation of a circuit that could be adapted for use in an electronic musical instrument. In particular, Seely's chapter on 'Heavily

Biased Relaxation Circuits' illustrated circuits that created many waveforms that could be sonically interesting (Seely 1958: 452–504).

The Phantastron instrument is named for its primary sound-generating and shaping circuit, the phantastron circuit. This circuit was developed by the British and utilised in radar applications during World War II (Seely 1958: 472). The circuit is a Miller integrator built around a single pentode vacuum tube. The pentode takes a sharp pulse as its input, integrates it between its grids, and outputs a more linear ramp-shaped pulse, which can be used in radar applications. The circuit was given its flamboyant name by Frederic Calland Williams, a researcher at the Telecommunications Research Establishment where it was developed (Napper 2000). It is assumed, from its name, that Williams felt that the circuit was in some way 'fantastic'.

Prior to the creation of the Phantastron instrument, it was unprecedented to use the phantastron circuit to create audio. Audio waveforms are synthesised at much lower frequencies than the pulses used in radar applications, and the phantastron circuit required adaptation and retuning to run at audio frequency. For audio application, it was necessary to change many of the component values within the classic radar circuit, causing it to oscillate at audible frequencies.

Figure 1 shows the phantastron circuit used in the Phantastron instrument and the associated component values. The circuit generates a unique pulse or oscillation through the Miller feedback created by C1, a capacitor connecting the anode of the tube with the grid. When a triggering pulse is applied to the suppressor through the pulse input, the anode begins conducting. As the anode conducts, it drops in voltage and transfers its charge to the grid through C1. This, in turn, causes a gradual rise in the voltage of the grid resulting in a linear drop of the anode voltage. Initially, the anode voltage drops suddenly, but the effect of the rising grid then slows the drop to a linear ramp down as the grid rises proportionally. This linear ramp down in the waveform is clearly seen in Figure 2 just after the initial drop from the wave's peak point. The ramp down is termed the 'Miller rundown' and its length is determined largely by C1 and the resistance of R4 and R5, which hold the grid at a lower voltage than the anode and the screen (Royal Air Force 1962). Increasing C1 results in a longer Miller rundown time and lengthens the period of the waveform. Once the grid voltage has risen sufficiently to cut off the flow of current between the anode and cathode, conduction stops and the wave drops precipitously to its lowest point. When this happens, C1 can recharge and the anode and grid can return to their starting point to start another cycle. This recharge period is seen in Figure 2, where the wave rises in two distinct, exponential arcs back to the peak point.

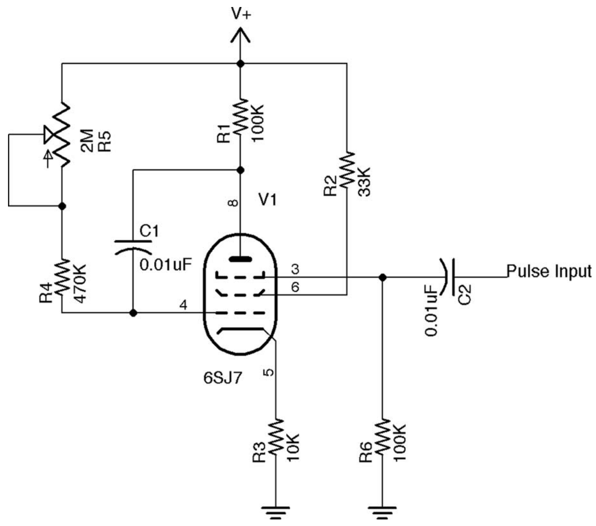

Figure 1. The phantastron circuit used within the Phantastron instrument.

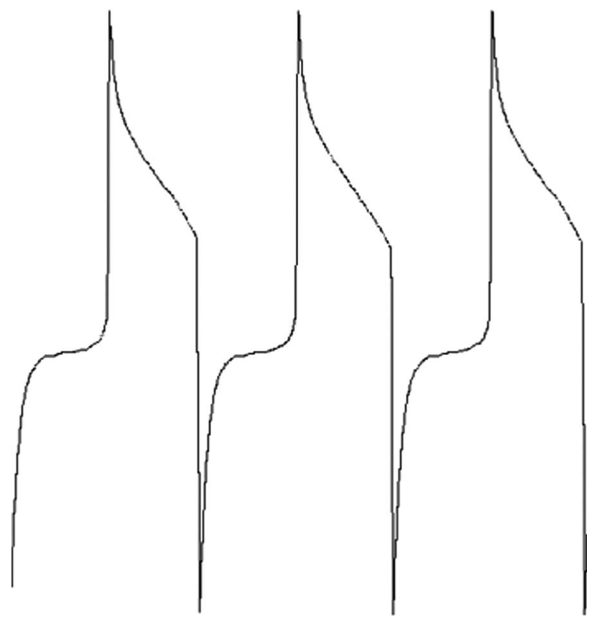

Figure 2. A typical waveform generated by the Phantastron instrument.

To retune the phantastron for musical and audio applications, the Miller rundown period was increased by enlarging C1. This lengthened the period of the waveform and brought the frequency of oscillation down into the audio range. Choosing a large resistor for R4 also contributed to a longer period by keeping the grid voltage low. In order to allow the performer to tune the frequency of oscillation somewhat with the turn of a knob, the log taper potentiometer R5 was added. When R5 is turned to a greater resistance, the cycle length increases and the frequency drops. With C1 at 0.01 microfarads and R4 at 470 kiloohms, the phantastron

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circuit used in the instrument oscillates at about 200 Hz when no synchronising input pulse train is present to change the frequency.

The phantastron circuit used in the instrument also uses a different value of R3. In the classic radar circuit, this cathode resistor is a higher value, which keeps the circuit in monostable operation. A monostable phantastron does not oscillate freely. Instead, it returns to a resting state after generating each pulse. It was experimentally determined that the phantastron circuit sounds better when configured in astable operation, wherein the phantastron immediately starts generating another pulse after it has completed a cycle. With R3 at 10 kiloohms, the phantastron oscillates freely in an astable mode of operation. Despite the fact that the astable phantastron oscillates on its own, it will still synchronise its own pulses to incoming pulses presented at the suppressor. Thus, the phantastron circuit used in the instrument will synchronise its frequency to another waveform fed to it through the pulse input. This facility allows the Phantastron instrument to have voltage-controlled frequency via another circuit that converts control voltages into pulses.

As a result of retuning the circuit, the pulses generated vary from their radar counterparts. The wave generated at the anode, as a whole, is less linear and more exponential in shape than the waves shown in radar texts. Also, waveform shape varies slightly depending upon frequency, the shape of the input pulse and which grid of the pentode vacuum tube is being used for output (output can be obtained from the anode, the screen or the grid). However, most waveforms produced by the Phantastron instrument exhibit sharp pulses connected by exponential ramps similar to those shown in Figure 2. Although these waveforms are notably less linear than those produced by the classic radar circuit, they add a great deal of sonic interest to the instrument as the shapes generate many rich harmonics.

After the fundamental circuit was retuned, much of the tone and operation of the Phantastron instrument was perfected during the prototyping phase. To prototype the instrument, rather than calculating and drafting the circuits strictly according to texts and research, I chose to take a much more DIY approach. I built the circuits by constructing the basic circuit and then hacking or circuit bending it until it produced interesting sonic results. I replaced and added components experimentally to shape the circuits into what I wanted. To make the instrument more adjustable, I also experimented with replacing various fixed resistors with potentiometers that could provide knobs to control facets of the instrument. This process was slow going and unpredictable, and resulted in more failures than successes, but allowed the instrument to develop uniquely and organically. Although the finalised instrument still contains a circuit with the phantastron circuit topology, the experimental method of construction changed the nuance of its operation greatly from the textbook circuit. At this point, the Phantastron instrument's waveforms are rather unlike the more linear waveforms of the phantastron circuit illustrated in Seely's text (Seely 1958: 473).

Through adapting the phantastron circuit to audio frequency and adjusting its components I also discovered that the circuit was reactive at its input to much more than simple pulses and oscillators. I discovered that the circuit I built would shape almost any stable audio input. Furthermore, the circuit would match its output pitch to the pitch of the input audio. While prototyping, I was able to sing into a high-impedance microphone plugged into the Phantastron and the instrument would match pitch perfectly with the singing while reshaping the audio into its characteristic pulses. I capitalised on this feature by adding an audio or 'sync' input to the Phantastron.

To add stability to the instrument and provide voltage control of the frequency, a gas thyratron tube oscillator was added in front of the Phantastron's actual phantastron circuit. This feeds the phantastron circuit with the steady, controllable pulses that are to be shaped into more complex waves. The circuit was influenced by 'an improved trautonium circuit arrangement' illustrated and described in S.K. Lewer's 1948 monograph *Electronic Musical Instruments* (Lewer 1948: 27). Eric Barbour's synthesis article then provided insight on how to adapt this circuit to make it voltage controllable (Barbour 2000). The final oscillator, also prototyped in the manner of the phantastron circuit, adds its own colour to the instrument and, perhaps, increases its resemblance to the Trautonium.

It is important to note that the vacuum tubes used in the Phantastron are not currently manufactured. During design and prototyping I had to choose vintage vacuum tubes that are cheap and plentiful on the surplus market. Eventually, I settled on the common and cheap 2D21 thyratron tube and the 6SJ7 pentode. The availability of parts was especially important since I was considering selling the instrument as a DIY kit.

The final prototype and later instruments were constructed in the style of 1950s circuits upon turret boards using point-to-point wiring. I chose this method of construction over modern printed circuit-board construction for a number of reasons. Firstly, I believed that there would be a small chance that point-to-point construction could affect the overall sound of the instrument and reduce the possibility of 'cross talk' common to circuit boards. Indeed, with vacuum tube circuits powered at 90+ volts, there is a greater potential for such hot signals to cross wires on the circuit board and create unwanted noise. Secondly, turret-board construction results in a larger circuit layout and makes the construction convenient when using large vacuum tubes. Finally, I felt that constructing the instrument in a historical manner would add aesthetic appeal by making the instrument appear more like an artefact than a brand new device.

2. PRECEDENTS AND OTHER ARTISTS APPROPRIATING VINTAGE TECHNOLOGY

The method and approach applied in creating the Phantastron are not unprecedented. There are many technological artists and DIY makers that have applied historical appropriations in their creation of a new object.

In his 2004 installation *Firebirds*, Paul DeMarinis creates a space inhabited by flames that are modulated to reproduce speech. The flames themselves replace the role of a loudspeaker and create all sound in the environment, speaking famous speeches by Hitler, Mussolini and Stalin. DeMarinis drew upon an old technology developed in 1967 by military researchers at United Technologies Corporation to turn the acetylene burning flames into sound transducers (DeMarinis 2004). DeMarinis comments on his exploration of a series of old, lost technologies to modulate flames in his artist's statement: 'The speaking flames of *Firebirds* follow in this succession of orphaned technologies – devices that actually work but failed to enter the dominant discourse' (2004). Historical research and re-invention of old technologies and designs are common in much of DeMarinis' installation art. In *Firebirds* and his other work, the old is re-invented and made new again as it is brought into a completely new context within the installation.

Sound artist and author Nicolas Collins appropriates the venerable transistor radio and turns it into a synthesiser through circuit bending in his demonstrations, performances and lectures. He writes about it in a chapter in his book *Handmade Electronic Music: The Art of Hardware Hacking* entitled 'Laying of Hands: Transforming a Portable Radio into a Synthesizer by Making Your Skin Part of the Circuit' (Collins 2009: 73). Collins introduces the human hand as a resistor to facilitate feedback in the radio's circuits, causing oscillation at audio frequencies. He shows that simply touching a circuit can transform a mundane consumer technology into a new electronic instrument. Much of Collins' work demonstrates that methods of hacking and circuit bending old technologies can render them into new instruments for the performance of electronic music and performance art. Collins has also done much to promote the legitimacy of these DIY methods through publishing his popular book and lecturing at colleges and community workshops.

British artist Daniel Wilson is largely known for his 'Miraculous Agitations', in which he electromagnetically vibrates assemblages of objects, which evoke the historical experimentations of Nicola Tesla and other pioneers of electromagnetism (Wilson 2012). However, in a new work in progress, he is going even further back in history to appropriate concepts posited by Francis Bacon in the seventeenth century. On his webpage he writes about creating dollhouse realisations of 'sound houses', a concept proposed by Bacon in his 1627 work *New Atlantis* (Wilson 2013). In Bacon's utopian vision, he describes edifices in which various natural and artificial sounds are created, resonated and explored (Bacon 1627). Wilson's appropriation of material this antiquated for his work is largely unprecedented for a contemporary sound artist, and raises the question of whether a Baconian 'sound house' can even be termed a technology in the modern sense. Furthermore, Bacon's 'sound houses' were originally realised through imagination alone, and only leave hints about their construction unlike the schematics and detailed plans that more modern technology has left behind. Regardless, Wilson's 'sound houses' do represent a novel and interesting appropriation of a historical idea and should prove interesting as they are realised.

Artists from South Korea associated with the collective Balloon & Needle (Balloon & Needle 2013) are approaching historical appropriation through hacking, circuit bending, and repurposing older technologies. Balloon & Needle member Ryu Hankil coordinates his assemblages of motors, contact microphones and tiny speakers from a repurposed Swiss typewriter (Meanwell 2011). Other group members Choi Joonyong, Hong Chulki and Jin Sangtae use technology including discarded hard drives, obsolete PDAs, hacked CD players and turntables spinning a variety of materials other than vinyl records (Meanwell 2011). Unlike DeMarinis and Wilson, the artists of Balloon & Needle are not creating new elaborations of older technology, but repurposing discarded technological artefacts. Despite the fact that the technologies used are hacked rather than redesigned does not detract from the novelty of their application. The sounds the artists coax out of their homemade instruments are new and unique, and represent entirely different applications of older technology.

Eric Barbour's synthesiser designs also draw from historical precedent, but are completely novel in themselves. He produces an entire line of commercial vacuum tube synthesiser modules for modular synthesis under the brand name Metasonix. He also describes some of his earlier DIY designs in his article 'Audio Synthesis Via Vacuum Tubes', in which he discusses the many inspirational historical instruments and precedents that may have inspired his own designs, including the Trautonium (1928), the Novachord (1939) and the Clavioline (1941) (Barbour 2000). His current instruments are unique among commercial analogue synthesisers in that they create sounds that are inimitable by solid-state technologies. Also, they are completely compatible with the popular 'eurorack' synthesisers. These new instruments incorporating old technology exhibit the very important characteristic of being completely interactive with current technology and designs.

2.1. DIY subcultures reproducing older technologies

There are thriving DIY subcultures engaged in the building and repurposing of older technologies. In audio, there is a strong community dedicated to building and experimenting with vacuum tube designs, especially guitar amplifiers. The AX84 Cooperative Tube Guitar Amp Project on the Internet is especially thriving, where members share ideas and build vacuum tube guitar amplifiers (AX84 2013). The AX84 project is especially notable because it seeks to make vintage-styled DIY amplifiers accessible to a large group of makers, and uses uniquely designed vacuum tube circuits rather than verbatim reproductions of classic designs. *Make Magazine* also dedicates an entire section of its issue 17 to 'The Lost Knowledge', in which DIY makers of obsolete and old technology are featured. Within that issue articles give hobbyists instructions on building a Wimshurst influence machine and a teacup-sized Stirling engine, both technologies from the nineteenth century (*Make* 2009).

A large subculture of DIY creation has developed around building analogue synthesisers from historical designs and commercial kits. Many analogue synthesiser meet-up groups have sprung up around the USA and the UK, where synthesiser hobbyists share their instruments and ideas with each other. A multitude of discussion groups exist on the Internet, dedicated to synthesiser DIY builders, as well as many sites with free schematics, lessons and theory. A number of synthesiser kit companies such as PAiA and Synthesis Technology (also known as MOTM) sell a variety of kits to the synthesiser DIY community. The author's Phantastron kit has been embraced by this community and has sold to customers in North America, South America, Europe, Asia and Australia. This subculture's particular interest in exploring historical designs is also proven by the continued reprinting of *Electronotes*, a circular assembled by Bernie Hutchins in Ithaca, NY, beginning in 1972. Within the pages of *Electronotes* are illustrations, schematics and explanations of classic analogue synthesiser designs (Electronotes 2013). *Electronotes* was one of the original sources for synthesiser builders during the 1970s when analogue synthesis was still a burgeoning technology. Today, synthesiser DIY builders reproduce many of the old *Electronotes* designs from reprinted copies of the newsletter. Likewise, many reengineered copies of Moog, Buchla, ARP and Serge instruments continue to be built by resourceful individuals.

These subcultures of makers reproducing older technologies believe that there is an intrinsic value in early technology despite the fact that commercial technology has moved on. Builders of vacuum tube guitar amplifiers enjoy the sound qualities, distortion and character of the amplifiers that they build. They also find value in the experience of building an amplifier oneself that does not require as many parts as solid state amplifiers do, and is therefore more accessible and understandable to the novice builder. Some also simply value the elegance of the older designs and the aesthetics of vacuum tubes and vintage looks. Vintage synthesiser builders believe that their analogue synthesisers possess admirable tone qualities that cannot be reproduced by digital instruments. They also value the process of 'patching' analogue modules together to produce unique modulation and mixtures, a method of operation that is not used commonly in digital instruments. Both amplifier and synthesiser builders also express themselves very creatively in the creation of ornate cabinets, panels and visual embellishments for their often bulky creations.

Many of these older technologies possess intrinsic and unique qualities worth continuing alongside current technology following their own technological trajectories. The Phantastron, homemade analogue modular synthesisers, DIY tube amplifiers, 'sound houses' and other DIY creations appropriated from history not only exist as throwbacks, but can become new evolutions in their respective lineages. Their creation not only contributes a commentary on contemporary technology, but often becomes a living, breathing, growing part of contemporary technology itself. The Phantastron, for instance, is the evolution of an antiquated radar circuit into an electronic musical instrument that is unique and new. It also continues to evolve and grow through the ongoing contributions of the DIY community elaborating, evolving and building upon their own Phantastrons (either built as kits supplied by the author or from scratch). The DIY community thus propels technological growth along other diverging corollaries, independent from the cutting edge of commercial technology. Likewise, artists appropriating history in their work also create divergent lines of technological growth and inspire further exploration by the larger DIY community.

Historical exploration in the arts is also discussed in great detail within the field of media archaeology, a relatively new branch of media studies. Media archaeology examines past technologies to better understand present media and technological culture. Media archaeology often examines creative work dealing with historical technologies and its implications to our contemporary culture. Jussi Parikka summarises how media archaeology artwork is defined by its meaning, 'We know it deals with engaging with the past and learning from the past media cultures in order to understand present mediated, globalized network culture through artworks executed in various media' (Parikka 2012: Chapter 7, Paragraph 5). Although Parikka advocates the use of historical technologies in creative work he does not account for the phenomenon of old technology becoming a new, reborn paradigm in the present. In fact, he goes on to say: 'Media archaeology is always in danger of veering towards excavations of curious instruments and odd gadgets just for their own sake and hence losing the wider political contexts in which technology takes part in governing bodies, affording perceptions and building platforms for social relations, work, entertainment and identity' (Parikka 2012: Chapter 7, Section 3, Paragraph 1). Thus, much of the work discussed here both fits within media archaeology for its value to culture and DIY culture. However, media archaeology does not account for the intrinsic value of an appropriated technology when stripped of its social implications. Through the lens of media archaeology it is sometimes difficult to see the relevance of appropriated technologies such as the Phantastron or a DIY synthesiser as new branches of technological progress or valid creative works because their social implications are not as obvious at first glance.

The article 'Zombie Media: Circuit Bending Media Archaeology into an Art Method' by Garnet Hertz and Jussi Parikka expands media archaeology to include circuit bending as relevant media archaeology artwork. Here, Hertz and Parikka suggest that circuit-bent obsolete commercial electronics become 'zombie media', carrying commentary on technological waste, planned obsolescence and black-box technology (Hertz and Parikka 2012). According to the authors, a circuit-bent object becomes a new technological divergence that is neither dead nor alive, a 'zombie media'. They state that 'Zombie media is concerned with media that is not only out of use, but resurrected to new uses, contexts and adaptations' (Hertz and Parikka 2012: 429). Thus, the expansion of media archaeology to include zombie media as relevant creative work opens up more room for the inclusion of a wider array of DIY projects as well. Many historically appropriated DIY projects, like circuit-bent works, are technologies adapted to new uses, contexts and adaptations. However, such DIY endeavours may deserve the status of being fully alive; they carry on a new technological lineage from an outgrowth of historical technology, rather than existing like the undead in a state of limited interaction between life and death.

Some DIY makers are resurrecting dead consumer technologies into new creations that Hertz and Parikka would term 'zombie media' through the integration of microcontrollers for MIDI implementation. Many makers have successfully integrated MIDI implementation kits, like Highly Liquid's retrofit kits, to add new, modern MIDI functionality to old and obsolete consumer electronics such as the Casio SK-1, the Atari 2600 and the Texas Instruments Speak and Spell (Highly Liquid 2013). This type of modification not only resurrects an obsolete consumer technology, like circuit bending does, but also greatly enhances its functionality and introduces the possibility of networked communication with computers and contemporary technologies. Thus, such a DIY retrofit transforms a dead technology into much more than just a zombie; it becomes a new media with the capability to interact with and influence other technology in a network-mediated dialogue. As a further benefit to the DIY community, Highly Liquid's designs for MIDI implementation on the Atari 2600 and the Speak and Spell have been made open source with a Creative Commons licence. Thus, the DIY community can easily develop and evolve these retrofits into even more advanced reincarnations.

Builders of older technologies benefit greatly from the availability of a wealth of open source material. Many of the classic designs they emulate are detailed in books, magazines and manuals that are free from copyright. Thus, sources of information on old designs, methods, service manuals and schematics can be found on websites such as www.archive.org. Open source information is a powerful catalyst in the DIY movement at large and enables makers of such devices to complete their projects successfully. A large quantity of the open source material available to DIY makers is historical in nature.

These builders of seemingly obsolete technology find an innate value in older technologies, regardless of whether they are building reproductions or variations upon the original. To many, the older technology represents a more durable object, conceived before the concept and practice of planned obsolescence. These technologies are sturdy and hard wearing, and can be fixed indefinitely, unlike the delicate commercial technology of today. Also, older technology does not possess miniaturised components or require automated construction techniques; these devices were often meant to be assembled by hand.

It is important to note that the DIY culture of building electronics also has a historical precedent. In the 1950s and 1960s especially, it was common for hobbyists to build their own electronics. This was the era of the Heathkit, when electronics enthusiasts built their own oscilloscopes, stereos, amateur radio equipment and many other projects. Indeed, magazines such as *Popular Electronics* and *Radio and Television News* were dedicated, at that time, to providing plans for electronic projects and knowledge about the home assembly of electronics. These original sources of instructions, designs and information serve as references for the DIY community today.

Unfortunately, the DIY culture of the past died down during the 1980s as technology became more miniature, complex and difficult for the hobbyist to reproduce. Also, in the West, the introduction of more foreign-made technology made the cost of building one's own technology more expensive than purchasing new devices. Interestingly, in South Korea, where some of the new consumer technology was beginning to be produced, the emerging consumer electronics boom of the 1980s planted the seed for the generation of DIY artists such as the members of Balloon & Needle (Meanwell 2011).

However, in the USA, miniaturisation and a shift to foreign manufacturing led to the decline of the electronics hobbyist of the 1950s and 1960s. Heathkits began to incorporate preassembled components, and magazines such as *Popular Mechanics* shifted their focus away from projects towards articles on consumer technology. During this era, the concept of planned obsolescence was also being widely introduced. However, at the same time electronics as a hobby was diminishing, the rise of the present DIY culture began. A new breed of DIY culture showed up in the form of hackers, builders and makers who wanted to maintain propriety over their technology. Standing in opposition to planned obsolescence, these makers were interested in creating novel devices not available from commercial manufacturers.

2.2. Old becomes new

As seen with the Phantastron, current methods and approaches to DIY can be used to transform old concepts into new creations. The greatest value in exploring older avenues of DIY culture and information lies not in the re-creation of archaic technology, but in the integration of these ideas into current paradigms. Despite the fact that commercial technology may have left many designs behind, rendering them obsolete in the marketplace, these models are not necessarily dead ends. Rather, like Paul DeMarinis, we can look upon these obsolete technologies as orphans waiting to be adopted into a modern context.

Our technological past is accessible to anyone. An abundance of information exists in the form of historical designs, many of them open source, to provide inspiration to the DIY community at large. However, to appropriate this knowledge properly it is necessary to create a variation on the original theory that is unique and brings it into a contemporary framework. Many DIY makers perform this appropriation through hacking, circuit bending, modifying and other means in order to re-contextualise the technology into a new work. This modification is an important part of the DIY process and is especially crucial when the builder does not want simply to re-create an object.

There are myriad possibilities for hybridising digital technology with antique concepts in electronics. Other newer approaches in DIY culture, such as community DIY and the application of microcontrollers, could also provide very creative results when combined with historical models. These projects could develop in an open source environment, without conflicting with commercial interests. They could also interface with contemporary electronics to expand the scope and capability of current technologies. The synthesis of old and new modalities creates novel possibilities for artistic expression, and the ingenuity of the DIY community can realise this unique fusion of past and present.

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