Pleech: A Process for Creating and Disseminating a Low-Voltage Wind-Powered Generator

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Questions

1. Can electronics projects that require small amounts of voltage and current, in the range usually provided by a USB cable, be powered by a clean, renewable energy source?

2. Can the energy source be cheap to build, requiring parts and tools that are readily available to the general public?

3. Can the process of creating the energy source be clarified and simplified to the point that it is reproducible by the general public and does not require specialized prototyping skills?

Domains

For this project, five domains were chosen as starting points: Ethics, Culture and Ritual, Decentralized Communication, Co-opting the Means of Production, and Science. The domains are of personal interest to the researcher, but they are fruitful areas to explore in their overlapping regions. Because several of them encompass extremely broad fields of knowledge, it is necessary to define them and subdivide them as they relate to the Pleech project.

Ethics “is the study of values and customs of a person or group” ("Ethics," *Wikipedia: The Free Encyclopedia*). For this project, the sub-discipline of applied ethics is most salient, in that it involves the most practical means by which ethical theories can be applied to real circumstances ("Applied

Ethics," *Wikipedia: The Free Encyclopedia*). Four applications were examined with this in mind: Open Source and Open Content Movements, Non-Violence, Free Culture, Protest and Re-Taking. Of these, the Open Source and Open Content Movements provided the most useful examples for the Pleech project. In particular, the legal application of the GNU Public License by the Free Software Foundation (FSF) exhibits a form of ethical practice based in principle but enacted and enforces by a rigorous and practical process. The GPL will receive further discussion in the precedents sections, as will the work of the FSF's former counsel, Eben Moglen.

One further area of ethics that was originally categorized under Culture and Ritual (and, indeed, is a good example of the overlap with Ethics) is Hacker Ethics. Elucidated in the work of anthropologists, the “hacker ethic,” in its most recent incarnation, demands, among other things, that hackers use what is being wasted by others, exceed unnecessary restrictions, promote peoples' right to communicate, and share data and software (Mizrach 1996). These edicts suggest the ethical stance of the hacker community, a group believed to be likely to use the a power source in illicit installations, as well as describing some of the cultural product of the hacker subculture itself.

Continuing into the Culture and Ritual domain, as well as more overlap of the Ethical, the statements and literature of anarchist groups make a distinction, even an ethical distinction, between violence against humans and so-called violence against property (thr@ll 2001). This sits in opposition to the hacker ethic, which follows a “do no harm” principle. Violence against property, however, does highlight the practice of modifying, violently or otherwise, the material condition of one's environment to suit one's cultural or political ends. While this project does not take the view that installing a

renewable power source, even illicitly, counts as a form of violence, the history of anarchists with regard to this subject provides an ethical precedent for acting upon the property of another in order to serve a common good.

Decentralized Communication, the third domain, connects readily to both the Ethical and Cultural domains. The Eastern European and Russian phenomenon of samizdat illustrates a non-electronic example of this kind of knowledge transfer in which banned authors were able to distribute their works via mimeograph and other means, despite the prohibitions of their governments (Goetz-Stankiewic 1992). More recently, the various practices of Wardriving, Piggybacking, and Wireless Community Networks ("Wireless Community Networks," *Wikipedia: The Free Encyclopedia*) illustrate how popular means may be employed to create methods of communication with and for the public that do not ask for and do not require the permission of a central governmental or corporate authority.

Co-opting the Means of Production, as a domain, borrows the phrase “means of production” from the Marxist literature of the past two centuries (Marx 1887) where the laborer confronts the market with only his or her labor-power as a commodity and does not own the other means by which commodities can be produced (e.g. raw materials, machines, etc.) In examining the current state of the art, there appear to be areas, such as rapid prototyping, where the tools for producing one's own products, with their own use values, comparable to those commodities on the market, is becoming increasingly within the reach of people. While the DIY “movement” is far less self-consciously organized than socialists, there nevertheless exist new cultural and technical resources around which people influenced by DIY as a mode of production can achieve greater proficiency and independence. Magazines such as Make or

Craft and websites such as Instructables.com illustate an admittedly apolitical but no less important avenue by which DIY practioners expand their skills, their tools, and their communities. Other recent innovations, tied to the Open Source and Open Content movements, include the RepRap, which not only can produce small industrial machinery, but is also a social network of people building parts for the RepRap devices themselves using other people's existing RepRap devices ("Home page," *RepRap Project*). The focus on replication, as well as the explicitly social and cooperative nature of what would otherwise seem to be a technical project, make projects such as this interesting and relevant to the work at hand.

Finally, the Science domain ties many of the other domains together, as far as their technical realization is concerned. While this domain is extraordinarily broad—seemingly too broad—it does have specific overlaps with the other domains. The useful application of scientific principles in popular projects is both an opportunity to teach the public more about the functioning of the natural world and a chance to apply these functions to technologies in the public interest. Take, for example, the engineering and medical principles involved in works like the Open Prosthetics Project, which enjoins participants in work to build prosthetic devices, regardless of expertise within either the engineering or medical fields ("Home," *Open Prosthetics Project*). Or take the work of artists and designers in creating sensing and other telemetry devices in the public spaces without permissions, a field that could well be called "sentiti," which is borrowed from the Italian and stands in counterpoint, as a form of "reading," to graffiti, a form of "writing." Using computer science and electrical engineering is a "guerrilla" mode seats the practice of science within the other domains identified in this project.

Summary

Based on the preceding domains, this project is called Pleech, which is a portmanteau of Power Leech and describes the kind of practice in which it is involved. It is a device that generates power, via magnetic induction, from mechanical moving parts, similar to how commercial wind turbines function. It is designed for activists, hackers, graffiti artists, amateur scientists, campers, hikers, and others interested in installing low-power electrical work in areas without access to grid power or easy change of batteries. The Pleech will be left in place for as long as it is allowed to exist, and the public is welcome to plug in their own work into it once it is encountered.

The Pleech is designed to generate electricity by rotating magnets placed on a Savonius wind turbine ("Savonious Wind Turbine," *Wikipedia: The Free Encyclopedia*) that will induce current in a copper coil. It is based, electronically, on an alternator, one of the simplest means for producing alternating current available. The alternating current will then be fed into a bridge rectifier, which converts it into direct current and makes is available for simple electronic devices.

This project will explore the basics of energy generation, but with a different source of power involved. More importantly, this is an experiment with "parasitic" technology, one that allows the public to draw more resources out of the infrastructure around them, especially if the airflow source does not benefit people directly or is generally wasteful of energy. For example, a steel cooling fan that runs regardless of whether there is anyone to cool could supply power to a guerrilla pollution sensor that broadcasts with the ZigBee or Bluetooth protocols.

People should respond to the environmental impact or reusing and re-purposing raw energy to serve an

improved or entirely new purpose. Beyond making a single product more efficient, it makes the perhaps inherently inefficient systems work in ways that harvest their energy into something more sustainable.

People might see this work appear on fans in the subway, HVAC fan outlets, inside the wheels of cars (think of a Pleech-powered lojack,) or in playground or amusement park equipment. It is further useful for people who live in areas that have no access to grid power but nevertheless require small amounts of power to charge communication devices or other instruments. This group may include campers and hikers, but also identifies users in developing countries where local power generation is unreliable.

Pleechs should be simple to construct with simple and widely available parts. Instructions should be posted on the Internet for how to create them quickly and cheaply, so they should hopefully appear in many locations spontaneously or as needs arise. Pleechs should also be simple and hearty enough to survive as devices so long as they go unnoticed and unmolested by authorities or property owners.

Hopefully, these devices could run useful or beautiful low-power devices without additional environmental impact. It could make a big difference in the work of artists who design for interactive architecture, locative media, etc., as well as activists who may need electronics in place for protests, demonstrations, interventions, or other public performances. It could potential even be the only source of power in regions without electrical infrastructure or where power generation is unreliable or overly expensive.

Precedents

paraSite

Designer

Michael Rakowitz

Description

The paraSites are plastic tent-like structures that attach to heat sources like dryer vents or HVAC outlets. They are built for homeless people, allowing them to stay warm using vents that are not located on the ground.

Relevance

This fits almost literally into the idea of "parasitic" tech. Using excess energy and resources for alternative, unplanned, and potentially unauthorized purposes is something that greatly informs the current project. Given that the heat from these units would go unused and benefit no one, it makes sense, logically and morally, it channel it into a better goal. Similar tactics could be employed to pull heat or even electrical power off of otherwise untapped public sources.

SHELLHOUSE

Designer

Carolina Pino

Description

SHELLHOUSE is a collapsible and portable shelter for the homeless. It can hold one person and has embedded in it an RF beacon (using the ZigBee protocol) that can be read by the benevolent agency distributing the shelters. Plans for the structures were posted to instructables.com and the public was asked to contribute what shelters they built to the project.

Relevance

While fitting into the same “parasitic” mode as paraSITE, Pino also makes explicit that the process by which the structures are made is as much a part of the project as the end results themselves. The Pleech project has a similar goal as far as reproducibility is concerned.

SW Radio Africa -- SMS Reporting

Designer

Gerry Jackson

Description

Forced to flee Zimbabwe after crackdowns on press freedom by President Mugabe, Jackson and his reporters continued to get news out of the country via text message, 160 characters at a time.

Relevance

Rapidly adapting to political and technical challenges is a major interest of this project. In an era when large portions of the major communications networks can be shut down or disrupted by governments (in this case, Zimbabwean radio being jammed using Chinese equipment,) it is necessary for reporters and activists to stay flexible. Deploying or extending alternative technological networks is part of the Pleech ethos.

Open Prosthetics -- Pimp My Arm

Designer

Jesse Crossen

Description

The Open Prosthetics Project (OPP) is great in so many ways. For one, all their designs go into the public domain. They have partnered with instructables to distribute the work. And they are big fans of rapid manufacturing. All of this is in the service of making prosthetics better, cheaper, and more widely available.

Specifically, OPP's Pimp My Arm project is a call out to all technicians and developers to try and create novel, real prosthetics that do interesting things (or just do things better.)

Relevance

Pimp My Arm seems to be OPP's most direct call to the community for contributions. Making prosthetics available to the people who need them the most and can afford them the least is a noble goal and worth pursuing. Finally, if the devices can be built at home or in a low-cost community location, this makes their process similar to that of the Pleech.

GNU Public License

Designer

Richard Stallman, Eben Moglen, et al.

Description

The GNU Public License was among the first and arguably the most important Free Software license. It, too, is “parasitic,” in a way, in that it takes the mechanism of a copyright license, which had prior to the GPL been a tool of repression, and transformed it into a means for ensuring freedom and engineering a social movement of greater

importance, perhaps, than the technical achievements that were licensed under it.

Relevance

The use of a technology, in this case a legalistic "technology," that pursues social change relates directly to the purposes of the Pleech project. The GPL demonstrates the ability of a seemingly technical procedure to influence and, indeed, revolutionize social practice. It is hardly an overstatement to say that without the GPL, projects such as the Pleech, instructables, Creative Commons, and even Free Software itself would have been delayed by decaded or would never have arrived.

Of further importance is the moral stance of the documents authors, particularly Eben Moglen. In a recent lecture at NYU, Moglen stated that the new cultural interest in sharing information necessary for the growth of all people has achieved what revolutionaries of previous generations could not—the mean by which society can become more equitable for all of its members while pursuing this goal through strictly non-violent, cooperative means (Moglen 2007). The Pleech project finds common cause with this ethical stance.

Process

There are, in fact, two processes associated with this project. The first is the final and public process, the process that has been formalized into a set of easily readable instructions and posted to the internet (see http://www.instructables.com/id/ERTAINQF18DW99A/). The second is the subject of the current discussion. It is the means by which the Pleech prototypes and the public instructions were created.

The following description relies on knowledge of the public instructions, as it will be laid out in terms of their differences, rather than repeat publicly available information that is beyond the scope and purpose of this paper.

The design process consisted of the construction of two Pleech prototypes. The first step was to research existing DIY builds of wind turbine fans. Three designs in particular provided the foundation for the Pleech. The first is the PicoTurbine, an educational kit that uses similarly simple parts for the purpose of school projects in energy generation ("Alternative Energy, Windmill and Solar Project List," *PicoTurbine*). While a helpful reference, this model would not be able to provide the amount of electricity need to meet the design goals.

The second is a design by bhunter736 on the Instructables website. The design of the electronics for the Pleech, particularly the use of a Y-circuit three-phase alternator for increased voltage, owes a debt to this design ("Build a Savonius Wind Turbine or VAWT to make electricity", *instructables*). Although a highly powerful working model, the parts and tools required far exceeded the design constraints, and the wiring diagrams, though instructive, were flawed at certain points and unclear in others.

The third design worth mention is a horizontal axis wind turbine (HAWT) that used a Pringles potato chip can for its vanes ("The Pringles can windmill," *Persistent Realities*). Despite being very different mechanically from the Pleech, the turbine's use of the can provided inspiration for how to construct the Pleech using recycled products (a design goal) as well as being ideally suited for the size envisioned for the project.

The next step was to acquire the necessary parts and tools. These were obtained at local hardware

stores in the neighborhood of Parsons in New York City, as well as local Radio Shack outlets for the electronics and magnet wire (30 gauge). This was an essential part of the project—being able to rely on easily obtained materials.

For the initial prototype, the parts differed from the final version in the following ways:

- A wooden dowel was used to connect the two compact discs that comprise the top and bottom of the Pleech turbine. This was exchanged for the cork pieces on the assumption that the dowel obstructed airflow.
- The bridge rectifier, obtained at Radio Shack, was replaced with a circuit wired from scratch using diodes that produced a lower voltage drop. This resulted in greater voltage generation, but required the design of a wiring template that is now provided with the Pleech instructable site.
- The initial magnets were ceramic and low power. Stronger rare-earth magnets were obtained from a friend of the project, though their provenance is more exotic than the hardware store.
- A larger spool of magnet write (28 gauge) was used in the final version. The high cost of buying small spools at Radio Shack outweighed the difficulty in tracking down a bigger supply.
- Aluminum bobbins replaced coils wound on the dowel by hand. The result was a tighter set of coils, greater in number (12 instead of eight), that could be would using a variable speed hand drill, with the trade off that the bobbins are difficult to obtain outside of specific industrial sewing machine repair shops. These shops are present in New York City, but are not common elsewhere.

Numerous tests of both the mechanical and electrical components followed every build. The turbine was subjected to tests by blowing, by taking the device outside into the wind, by placing it (for 24 hours) against an air conditioning vent, and, most dramatically, by placing it in the way of a Shop Vac blower. Electronically, a voltmeter was attached to the circuit and run in testing sessions as soon as the coils were complete and wired. After each test, the position of coils and magnets, the lubrication of the main bearings, and the schematic of the circuit were examined to determine the most beneficial improvement for the next round.

Every step of the process was exhaustively photographed and recorded. When the time came to promote the final design to the instructables website, the most representative shots were taken and uploaded in order. Furthermore, to as great a degree as possible, construction diagrams were produced for the turbine, the wiring, and the rectifier circuit. The diagrams described can, magnet, and coil placement, wiring order for the coils, and a schematic that could be overlain on a soldered project board, similar to that created by Mouna Andraos for her Shakelight project ("Shakelight," *Electronic Crafts*).

After posting, the researcher took an active role in answering comments as they began to appear. This was done to answer questions that the posted procedure left ambigous, to solicit advice from more knowledgeable users on how to improve the design, and to attract more viewers interested in learning more about the project. The link was also sent to several blogs and websites, including several of those that had provided the original inspiration for the design. This was an explicit community-building step and vital to the longer-term success of the project.

Evaluation

There are three main criteria for the success of this project: producing adequate enough power to be able to replace a USB cable; built using easily obtained parts and tools; and disseminated to the public in such a way as to be reproduced on a larger scale.

The first criterion was not met under normal wind conditions, though a voltage as high as 5.8 volts was obtained under extreme conditions using the Shop Vac. This suggests the possibility that increased efficiency, better constructed coils, and tighter tolerances between the spinning magnets and stationary coils could result in voltages in the appropriate range.

The second criterion was met in part. The use of rare-earth magnets, bulk quantities of magnet wire, and aluminum bobbins restrict how easily the Pleech may be built from local supplies. The parts can be ordered with little extra expense over the Internet, however, so serious builders should not find the parts list a major issue. The tools used were all conventional and easily acquired or borrowed.

The third criterion appears to have been met. Respondents on the instructables site have been overwhelmingly complimentary, as have other builders. The site was picked up by several other DIY and alternative energy news sources, including MAKE magazine's blog, which is a very popular news source in the community. In addition, at the time of writing, the instructable is the 16th most popular page on the whole site, presumably over the past week, surpassing even longer standing projects such as the LED Throwies.

Overall, there is much room for growth and improvement, but initial tests and public response seem to indicate that there exists both a need and an appreciation for an easily reproducible energy source, if

only as a hobby for the moment. Research into better prototypes will continue in the near future and more versions of the Pleech will be produced for the public once the feedback is digested and new parts arrive.

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