Jhoule

Michael Kalil Memorial Fellowship Grant Project Proposal

Project Overview

Jhoule is a modular, self-sufficient and self-reliant system of electrical generation and storage to power off-grid villages in Chhattisgarh, India.

Jhoule, a fusion of the words Jhool (Hindi: "to swing") and Joule (unit of energy), is a portable device which, when hooked or strapped between the body frame and a moving limb (for example the waist and an ankle), harnesses the energy from the swinging action of the leg (for example, while walking) to drive a motor and charge a battery. The energy harvested during the day is stored and used to power LED fixtures installed in homes, providing an additional 3-4 hours of light after the sun sets. I will be designing a lighting element in tandem with the generator to maximise the utilization of the light source using diffraction and reflection.

Statement of Purpose

The communities living within densely forested parts of Chhattisgarh, India tend to be geographically remote and are often targeted by the Naxalite (Maoist) insurgents. The insurgency limits their mobility and also destroys local infrastructure. Power grids are either missing or very unreliable, with frequent power outages for 5-6 days at a stretch. Lodging complaints or paying electricity bills entails a very long walk.

In a place where sunset occurs at 6:30 pm (summers) and 5:30 pm (winters), the days are short. Without any artificial light, life comes to a screeching halt after sundown - food must be cooked beforehand, people must return home before dark (which limits communal activities and socialising) and most importantly, studying hours are limited. Currently, kerosene lamps are the most common source of light; however these pose serious health and safety hazards. Inhaling its fumes is equivalent to smoking two packs of cigarettes a day and is a major cause of lung cancer and cataract. In India alone, approximately 1.5 million people suffer severe burns each year from accidents involving kerosene lamps. Moreover, the lamps' light is grossly inadequate and the typical worker can only afford a fortnight's worth of kerosene.

There has been a push for solar panels; however, on my visits, I learned that the up-take for solar panels has been rather slow. This is due to the high upfront investment as well as ongoing maintenance costs. Further, their efficacy is limited under stormy or cloudy conditions, the most common period for a power outage.

Looking for a universally available source of energy to tap into, I realized that these communities are very physically active. Their geographically dispersed layout means that children walk at least 3-4 miles for school, most adults commute to larger neighbouring villages for work, people walk to the community markets for food and make a daily trip or two to the communal water pumps to draw water for their household needs. During summer, they spend their days gathering forest produce and during the harvest season they work on agricultural fields. On average, every villager walks at least 8-10 miles on a daily basis.

The idea of Jhoule was born to tap into this widely available source of energy - the physically active lifestyle of rural India. Jhoule is a product intervention that will allow the community to gain an additional advantage from the physical activities they already perform.

(An image of the tribe folk of Chhattisgarh)

The population here belongs to old tribes with very strong cultural backgrounds. Jhoule would be a very new product typology for them. Upon my visit to various such villages, I gathered that people seemed especially comfortable with the idea of a one-off purchase and wearing or carrying around Jhoule in return for electricity, especially as they would not have to perform any dedicated actions to power it. They also appreciated that Jhoule is independent of weather conditions and maintenance costs, and is thus more reliable and sustainable.

Jhoule, being a wearable device, shares a very intimate relationship with the user and relies entirely on user engagement. I intend to integrate this unfamiliar item into the language of the users' everyday habits and cultural personal decor. The appearance of the physical prototype, its texture, weight and size, symbolic cultural reference and the ritual for its use are all elements which will be carefully tailored to help people comfortably accept and incorporate Jhoule into their daily life. I am keen to explore this opportunity not only to design Jhoule as a culturally organic product, but to also involve local communities into the product's ecosystem. I am designing the manufacturing process to allow for flexibility in the product's design, to incorporate local interpretation and modification such that it assimilates the skills, techniques and desires of the local communities involved in making and assembling the product. This should create employment opportunities and also give the communities a sense of ownership of the product. This will need a study of the locally available materials, components and fabrication skill levels of the local communities.

Project Proposal

Jhoule taps the basic principle that spinning the shaft of a motor generates a voltage. The speed and duration of such spinning is directly linked to generating a higher intensity of voltage. Jhoule uses easily available DC motors and harnesses human motion to drive them.

These tribes wear elaborate traditional jewelry and Jhoule will be designed to bear a visual cultural reference to their native jewelry; thus adding an aesthetic element to wearing Jhoule.

The first iteration of Jhoule (illustrations later), relied on a swinging motion of the magnet within a copper coil. The current generated was insufficient.

The revised prototype can be worn between any two moving body parts (for instance, the lower back and an ankle or the waist and a wrist) such that the main device is attached to the user's body frame and the retractable string is pulled out and hooked onto a bangle or an anklet worn on the user's limb. If attached to the waist and ankle, the bending of the knee (whilst walking) extends and retracts the string, setting the connected gears into motion. The gears help translate a single rotation caused by a small tug of the string into approximately 15-20 quick rotations of the motor shaft, generating a current between 3 to 10 Volts - sufficient to charge a battery.

The motor generates an alternating positive and negative voltage upon the extension and retraction of the string. This voltage is directed into a circuit which consists of full-wave rectifier diodes (which convert the input wave-form to one of constant polarity i.e.positive or negative), a capacitor (temporarily stores the current), a regulator (maximises use of the current) and two diodes that act as a charging unit to recharge the 9 volt rechargeable battery. The LED indicator shows the charging status but also provides guiding light on the users' commute after dark. An intuitive press-down button switches on the battery when an output device (an LED or cell phone) is plugged into Jhoule.

The 12V battery can power a bright 2 watt LED lamp for around 14 hours. The community's current need for 3-4 hours of light will only partially drain the battery. The current prototype of Jhoule employs slow charging to recharge the battery, and therefore the users' daily motion suffices to recharge the partially drained battery. The re-charge time will depend upon the orientation in which Jhoule is worn and the frequency and duration of motion. Longer swinging actions and more frequent tugs will recharge the battery faster. I am refining the prototype such that 30-60 minutes of motion recharges the battery. This will expand expand the ability to use Jhoule to accommodate any growth in the electricity needs of the community (for example, laptops or TVs).

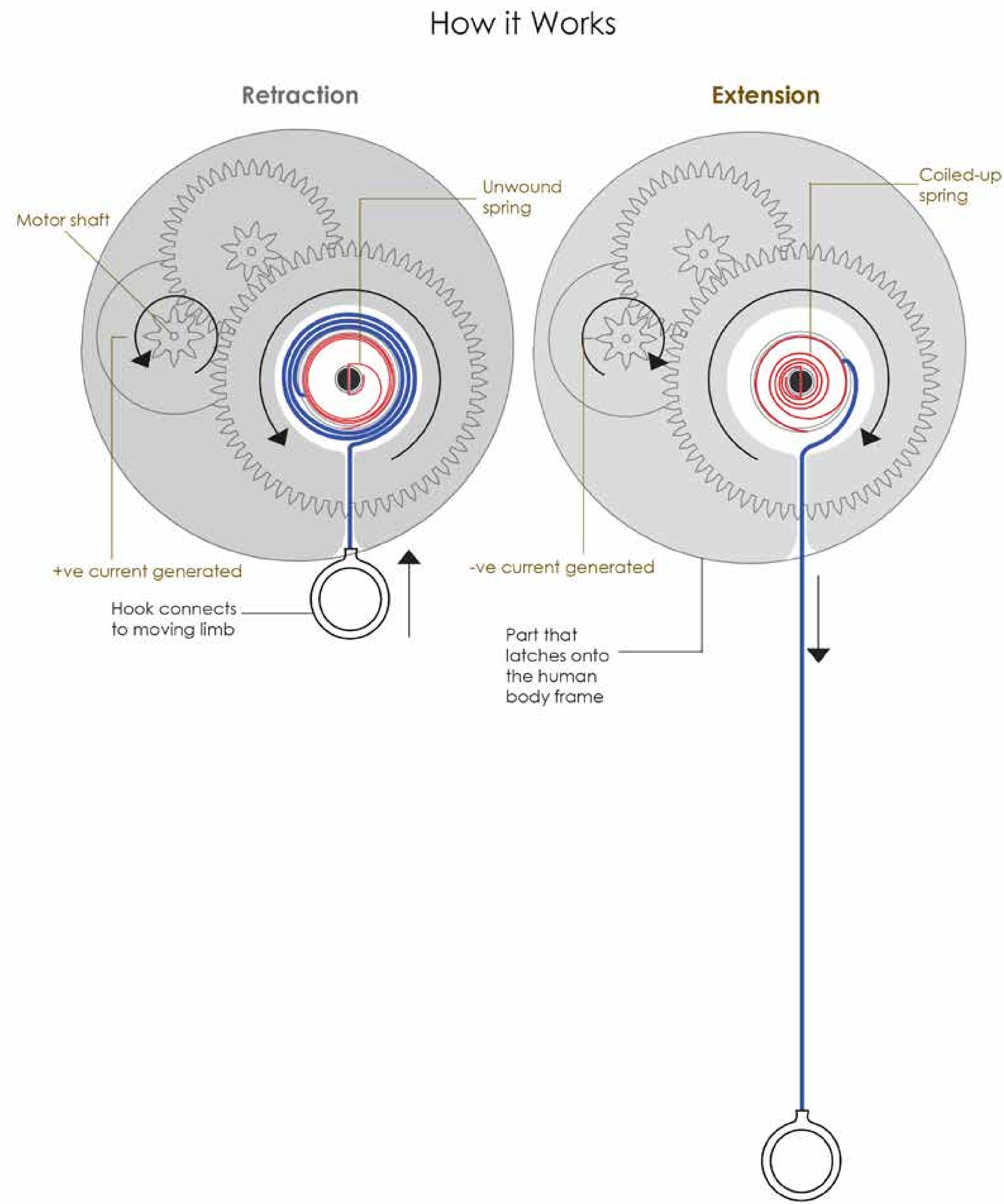
The second part of the project is devising a simple and cost effective method of diffracting and reflecting the light from the LED light-source such that the small light source can effectively light up large spaces. This may be achieved by using a reflective material or a simple method of diffraction like the one employed in the "Litre of light" project (which fixes a plastic bottle filled with water and bleach through a hole in the roof and uses it to diffract the sun's light into the gloomy slums in the Philippines).

I am currently prototyping with different locally available materials and simple fabrication techniques, such that almost all of the manufacturing and assembly is viable locally - leading to a self-reliant mechanism for creating this self-reliant source of energy.

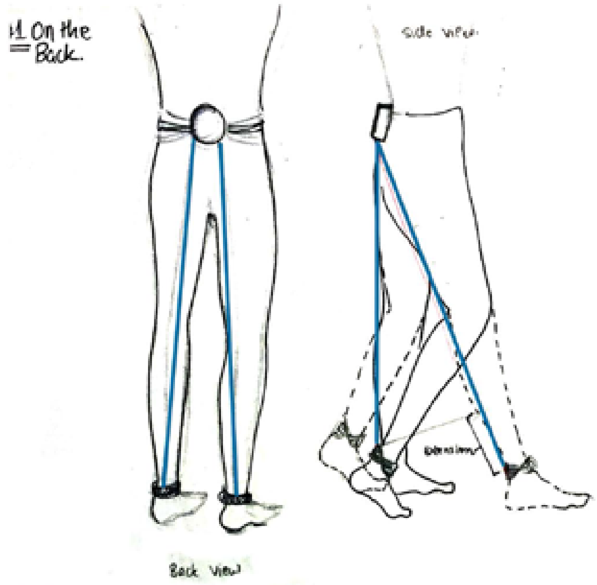
<u>The first iteration of Jhoule</u>

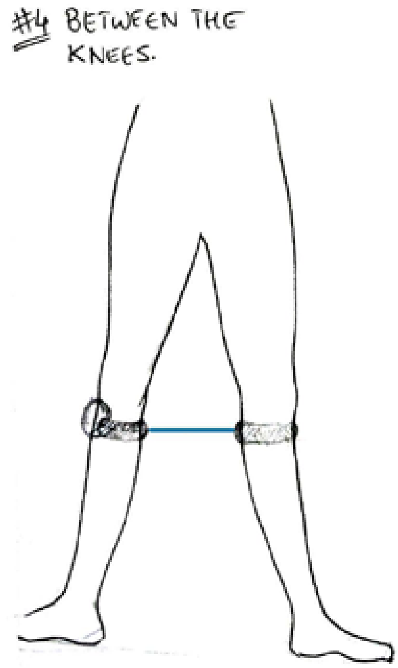
How it Works

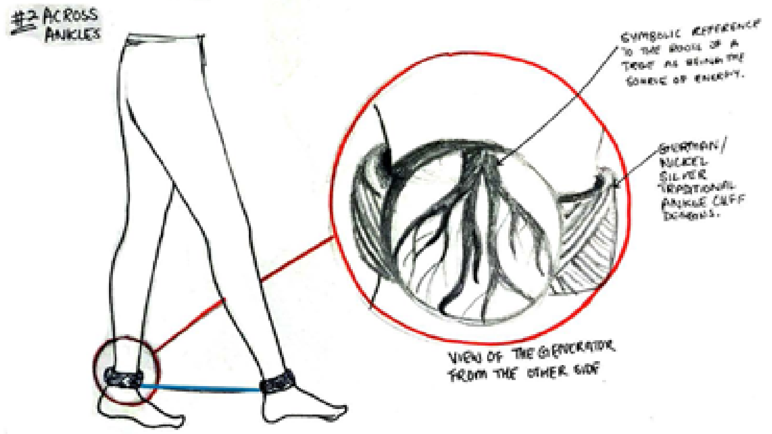
Diagram of the current iteration

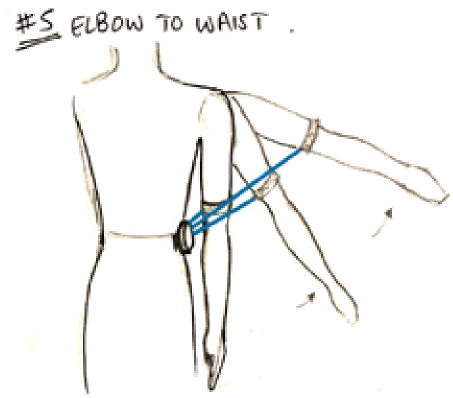


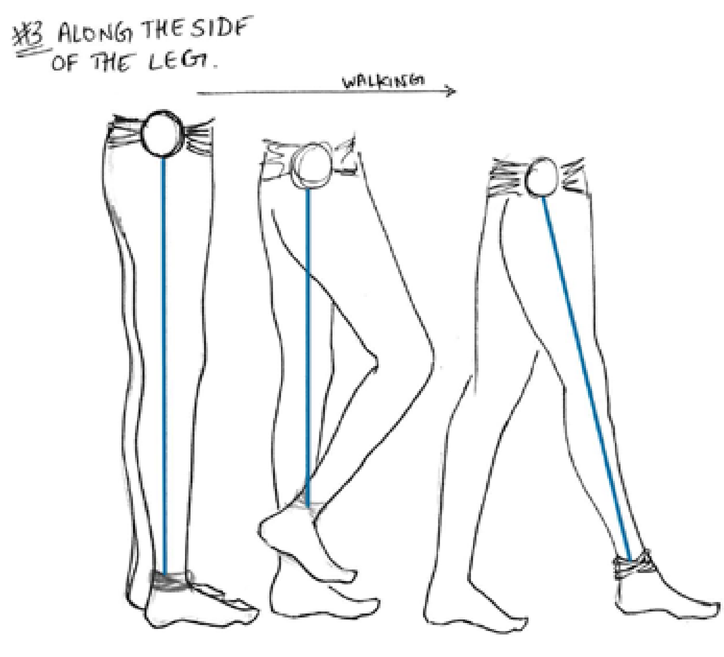
Different ways of configuring Jhoule (The retractable mechanism)

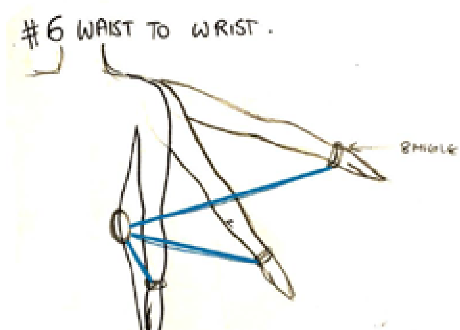


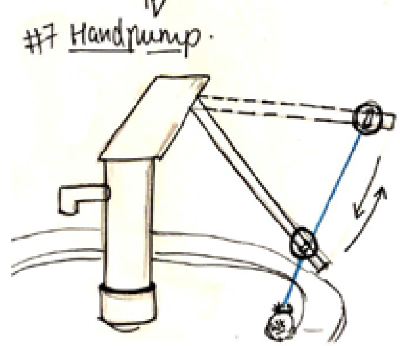












<u>Budget Outline</u>

Prototyping Budget

Material Sampling and testing...$300-400
(Wood, plastics, bamboo, sheet metal, reflective fabrics)

Magnet wire spools...$100
Neodymium Magnets...$100-200
Electrical components...$100-150
(Rectifier, Capacitor, circuit boards)
Rapid Prototyping..$600-700
(3D printing, Laser-cutting, CNC)
Other equipment...$300
(Multimeter, Portable digital oscilloscope, Soldering iron)
Battery/cell sampling...$300-400
LED light bulbs sampling..$100
Hiring the services of experts...$800-1000
(Electronics Engineer)
Travel Expenses... ....$800-1000
(Flight, train and car hire to reach the villages for field study)

Estimated Total: $3500-4350