GENARATION OF ELECTRICITY BY PEDAL POWER

by

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Declaration of Candidate

It is hereby declared that this thesis or any part of it has not been submitted elsewhere for the award of any Degree or Diploma.

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Abstract

It is known that the supply of fossil fuels are scarce and their usage as energy source cause environmental degradation ,in addition to this as the world population increases the energy demand is also increasing day by day, so we are in a search of new renewable energy sources. We are trying to generate power at small levels by using bicycle pedal . Generator attached to the cycle pedal can serves as a mechanism for converting mechanical energy from pedal to electrical energy . For running of appliances we need to convert this dc power to ac power by using inverter. Output of the dynamo or generator depends on the speed. .

Chapter 1

Introduction

1.1 Introduction of pedal power

The principal

1.2 History of pedal power

The historical research for pedal powered machine

1.3 Pedal power uses

Appliances of pedal power

WHAT IS PEDAL POWER?

Pedal power is the transfer of energy from a human source through the use of a foot pedal and crank system.

Throughout history human, energy has generally been applied through the use of the arms, hands, and back. With minor exceptions, it was only with the invention of the sliding-seat rowing shell, and particularly of the bicycle, that legs also began to be considered as a "normal" means of developing power from human muscles. A person can generate four times more power (1/4 horsepower(hp)) by pedaling than by hand-cranking. At the rate of 1/4 hp, continuous pedaling can be done for only short periods, about 10 minutes. However,, pedaling at half this power (1/8 hp) can be sustained for around 60 minutes. Pedal power enables a person to drive devices at the same rate as that achieved by handcranking, but with far less effort and fatigue. Pedal power also lets one drive devices at a faster rate than before (e.g. winnower), or operate devices that require too much power for hand-cranking (e.g. thresher). Over the centuries, the treadle has been the most common method of using the legs to produce power. Treadles are still common in the low-power range, especially for sewing machines. Historically, two treadles were used for some tasks, but even then the maximum output would have been quite small, perhaps only 0-15 percent of what an individual using pedal operated cranks can produce under optimum conditions. However, the combination of pedals and cranks, which today seems an obvious way to produce power, was not used for that purpose until quite recently. It was almost 50 years after Karl von Drais invented the steerable foot-propelled bicycle in 1817 that Pierre Michaud added pedals and cranks, and started the enormous wave of enthusiasm for bicycling that has lasted to the present. The main use of pedal power today is still for bicycling, at least in the high-power range (75 watts and above of mechanical power). In the lower-power range there are a number of uses of pedal power--for agriculture, construction, water pumping, and electrical generation--that seem to be potentially advantageous, at least when electrical or internal-combustion engine power is unavailable or very expensive.

1.6 billion people — a quarter of humanity — live without electricity:

Breaking that down further:

Regions without electricity (Millions)

South Asia 706

Sub-Saharan Africa 547

East Asia 224

Other 101

Figure 1.1: Worldwide energy consumption

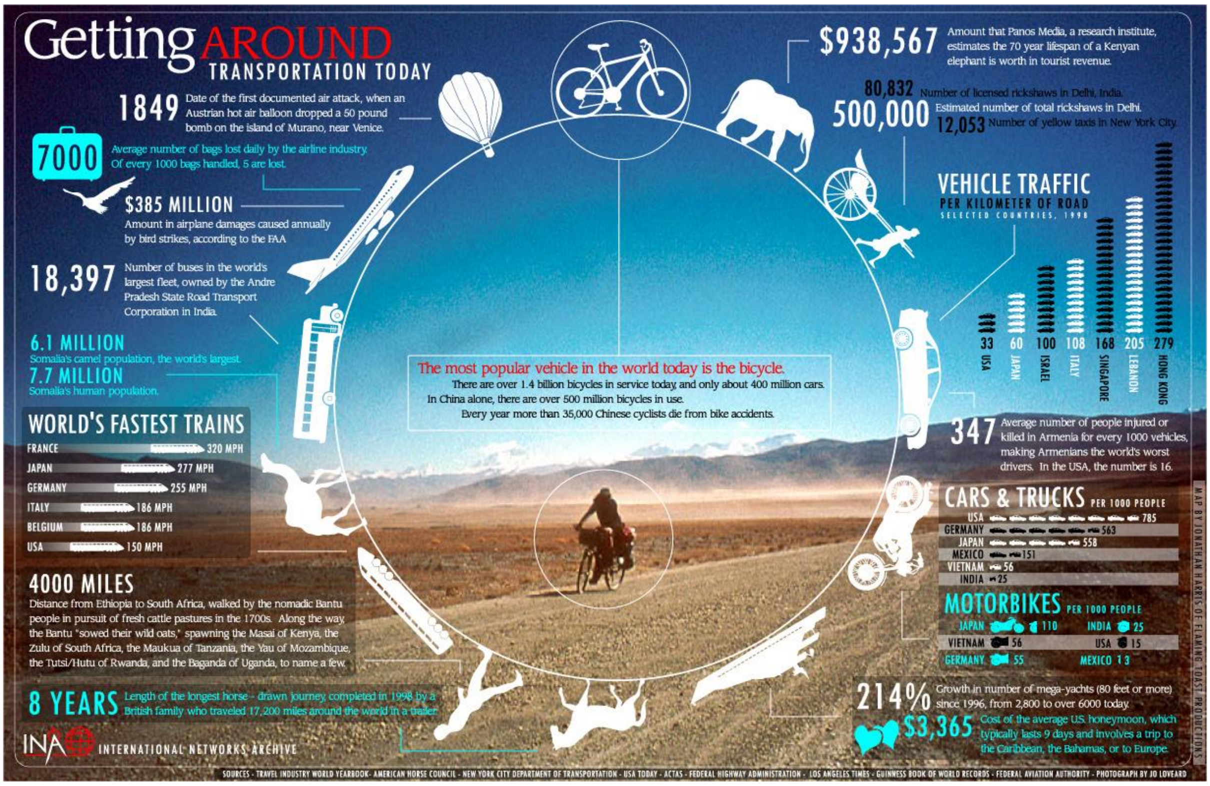


chart made by http://www.princeton.edu/~ina/images/infographics/transportation_big.jpg

Figure:1.2

The rationale behind choosing to use bicycles is bicycles are simple, elegant and available. Bicycles are accessible by most, when you are thinking about global problem solving there are very few places in the world that do not have access to bicycles and also have the knowledge to do the simple mechanics to alter them. We can all be inspired by the story of William Kamkwamba, a remarkable young man from a remote village north of Malawi's capital city. Forced to drop out of school due to lack of funds, William turned to self-education and, after seeing a picture of a windmill in a textbook, decided to build one to power his families home. He built it out of spare bicycle parts because they were easy to manipulate and he did not have to weld anything. (12)

Dan Little of Rochester Community Bikes, Rochester, NY would be the 1st one to admit that you can teach anyone to fix up a bicycle and he has. RCB has already given out 199+ bikes in 2010 and are not stopping anytime soon.

They also host a weekly workshop to instruct anyone interested on how to fix minor problems and give their bikes a tune up.

Bicycles also fit into the category of human powered devices that I have labled "Power on Demand". Power on Demand or POD is any device that you can power at anytimewith out an external source of power. It's the idea that you do not have wait for wind, tides, or fossil fuels to achieve your objective. Its also known when utilizing a bicycle for energy as “Pedal Power.”

Another reason to choose the bicycle generator is that it gives the building blocks for anyone to create electricity, within that you can also develop wind, hydro, and tidal power. If you can show people how simple most of the technology is then they can build of that knowledge and move forward with more innovative ideas.

The history of innovation surrounding the bicycle is also very rich, people are attracted to the simplicity and how easy they can customize the simple mechanics. Orvil and Wilber Wright (also bike mechanics) utilized the bicycle for many prototypes of the first powered human flight machine. There are uncountable internet sites that are just compilations of things that others have built out of bikes, everything from furniture to high end sculpture, not to mention the amount crazy new bikes or “Human Powered Vehicles” that people are creating on a seemingly daily basis from all sorts of materials.

There is also a health factor for the people that would consider taking this to extremes. Three hours of bicycling a week can reduce your risk of heart disease by 50%(10) Caloric intake was also thought about when thinking about POD’s . If you use the calorie calculator on creatingcurrent.blogspot.com, you will quickly see that losing too many calories for people in developing countries will not be a problem.

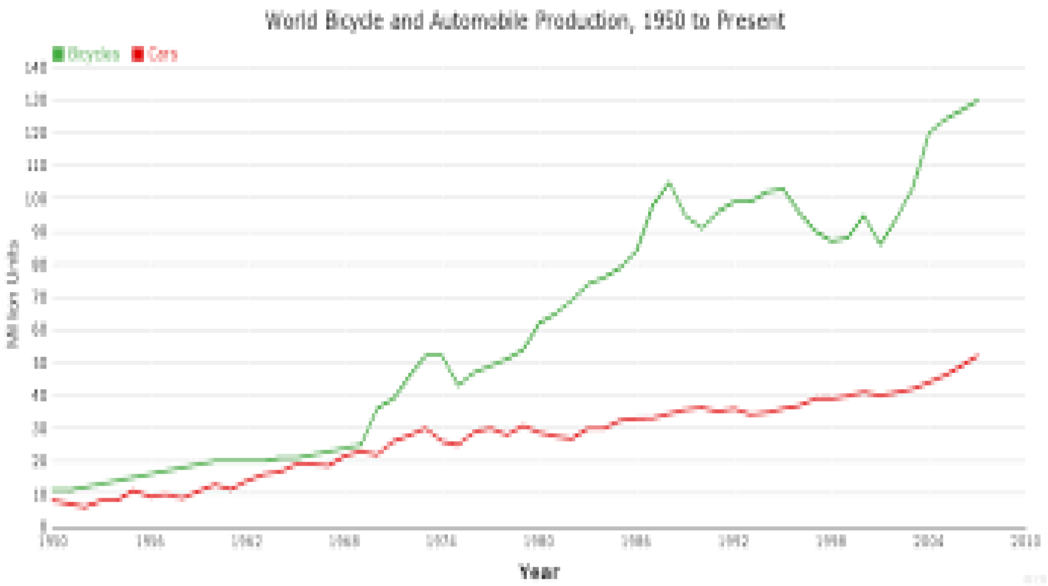
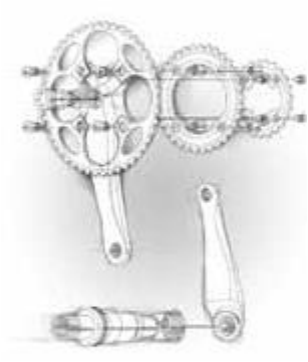
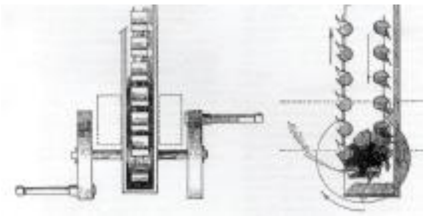


Figure:1.3: World Bicycle and Automobile Production

Organizations like Maya pedal (13) have taken the bicycle and started creating devices along with costumers like waterpumps, grinders, threshers, tile makers, nut shellers, blenders (for making soaps and shampoos as well as food products), trikes, trailers and more. Maya Pedal is a Guatemalan NGO based in San Andrés Itzapa. They accept bikes donated from the USA and Canada which they either recondition to sell, or use the components to build a range of "Bicimaquinas", (pedal powered machines).
Pedal power can be harnessed for countless applications which would otherwise require electricity (which may not be available) or hand power (which is far more e_ort). Bicimaquinas are easy and enjoyable to use. They can be built using locally available materials and can be easily adapted to suit the needs of local people. They free the user from rising energy costs, can be used anywhere, are easy to maintain, produce no pollution and provide healthy exercise.

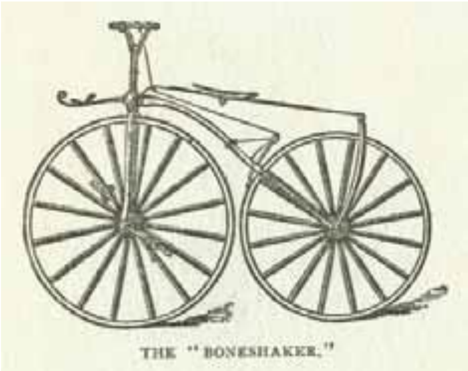
Pedal Power History(brief)





Roman Empire-Bilge Pump

1418 -Giovanni Fontana built the _rst human powered land vehicle -- it had four wheels and used an endless rope connected via gears to the wheels.



1863- Bone Shaker or Velocipede Bone Shaker or Velocipede: Made of sti_ materials, straight angles and steel wheels make this bike literally a bone shaker to ride over the cobblestone roads of the day.

 **1872 -**Hand Crank air pump

1890 -W. F. & John Barnes- Grinding and Polishing Machine

1908- Hurley Machine Company of Chicago

1929 Mrs. Gertrude Rothery of Augustus Downs, operates the first pedal radio.

1938- Bike powered gas pump

Oct. 6, 1977- EMMAUS, Pa. - A manufacturer here has come up with two multi-purpose pedal- powered machines to save fuel energy indoors and out.Fringe benefit they can also help trim your waistline.

Dec. 13, 2009 -A Danish hotel is pioneering a pedal-power electricity generation scheme it hopes will catch on in other countries.

Applications of pedal power

* Pedal powered charging system for portable "Jump Start" systems. Thesedevices feature lights, air compressors,battery chargers, power meters, 12 Volt DCoutlets, and of course jumper cables.

* Pedal powered backup generator forsolar electric systems or other off grid power systems.

* Pedal powered biodiesel circulation pump or bio diesel transfer pump.

* Pedal powered washing machine.

* Pedal powered clothes dryer.

* Pedal powered whole-house ventilationfan.

* Pedal powered pump and wateringsystem.

* Pedal powered emergency sump pump.

* Pedal powered energy source to power astronomy equipment.

* Pedal powered whole-house (central) vacuum cleaner.

* Pedal powered backup circulation pump and backup air pump for tropical fish.

* Pedal powered generator, emergency bilge pump

* Pedal powered air compressor.

* Pedal powered offset printing press, sewing machine (an ancient idea), hand tools (grinder, ,disk sander, buffer, drill, reciprocating saw, lathe), mulch grinder.

* Pedal powered public address systems, projectors, or amplifiers for music -Basically, any device that was hand cranked, foot-powered, or powered by a fractional horsepower electric motor could potentially be converted to pedal power.

Pedal One Laptop Per Child
Pedal powered concert at Coachella

Pedal power water pumpPedal power sculpture

Pedal power mobile charger

Pedal power washing machine

Pedal apple grinderPedal washing machine for the developing world

Pedal mower

Chapter 2

Generation of electricity by pedal power

Bangladesh is the eight most populous country in the world. With on growing population the needs of people and their usage is also growing ,in such cases demand of electricity is very high here. Biomass and other non – commercial fuels constitute around of energy requirements in Bangladesh. Around 62% of the population are getting electricity , but many of the remote villages are still without electricity. People in villages mainly use bicycle as their means of transport for small distances, in such places our system is of great use. Energy produced by pedalling can be used for driving small appliances. Charging of batteries can be done easily by connecting battery to the output of dynamo which is connected to pedal of bicycle. This project is meant to allow anybody to interact with a power producing mechanism, and ultimately to see how simple steps can be taken to lower our carbon footprints in environment and also helps in lowering their energy bills. World is a store house of energy ,also energy can neither be created nor be destroyed but can be transformed from one form to another .But we are not using resources effectively as if they are limited. Humans are able to generate around 100 watts of power while bicycle riding. However this power is wasting without our knowledge, but if we make use of this we can able to power many electronic gadgets. A dynamo or alternator can be used for harvesting the energy generated by a cycler while riding. Small devices, laptops, mobiles can be charged with this power. This mechanism can also be used with bikes, cars and exercise vehicles also. In cities exercise bikes are used for health purpose,if we adopt this mechanism to such bikes it will have double advantage.Riding bicycle is a good exercise as well as good source of power. The user will be helping to stay fit too. The typical adult will burn around 300 to 700 calories for a 30 minute workout. Plus the amount of energy created over the time is surprising. In recent times this idea was being used by students in London universities, where the distance between hostel and class rooms was up to 5kms.Some students go to classes by bicycle using this mechanism to power their laptops , mobiles without going it waste

II. WHY PEDAL POWER:

Electricity was the basic need of all people, the consumption rate was increasing at 10 % every year but there has been no sufficient growth in production rate which leads to load shedding and increase in price levels . While pedal power is not a new concept but it has not been successfully used on a wider scale. A pedal power generator with a lighting system was developed for residential schools in India and tested, it is giving 40 minutes of lighting for 10 minute of pedalling, this will be of a great use in populous country like India. Currently about 10 such lighting systems are in all over India and more are being undertaken. In such huge demand it will be of great help to use this technology to fed small loads.

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2.1 Operating principles:

Power level: The power levels that a human being can produce through pedalling depend on how strong the pedaler is and on how long he or she needs to pedal. If the task to be powered will continue for hours at a time, 75 watts mechanical power is generally considered the limit for a larger, healthy non-athlete. A healthy athletic person of the same build might produce up to twice this amount.

A person who is smaller and less well nourished, but not ill, would produce less; the estimate for such a person should probably be 50 watts for the same kind of power production over an extended period. The graph in Figure 1 shows various record limits for pedalling under optimum conditions. The meaning of these curves is that any point on a curve indicates the maximum time that the appropriate class of person could maintain the given average power level. Power levels are also directly related to the environment of the person doing the pedalling. To be able to continue pedalling over an extended period, a person must be able to keep cool.

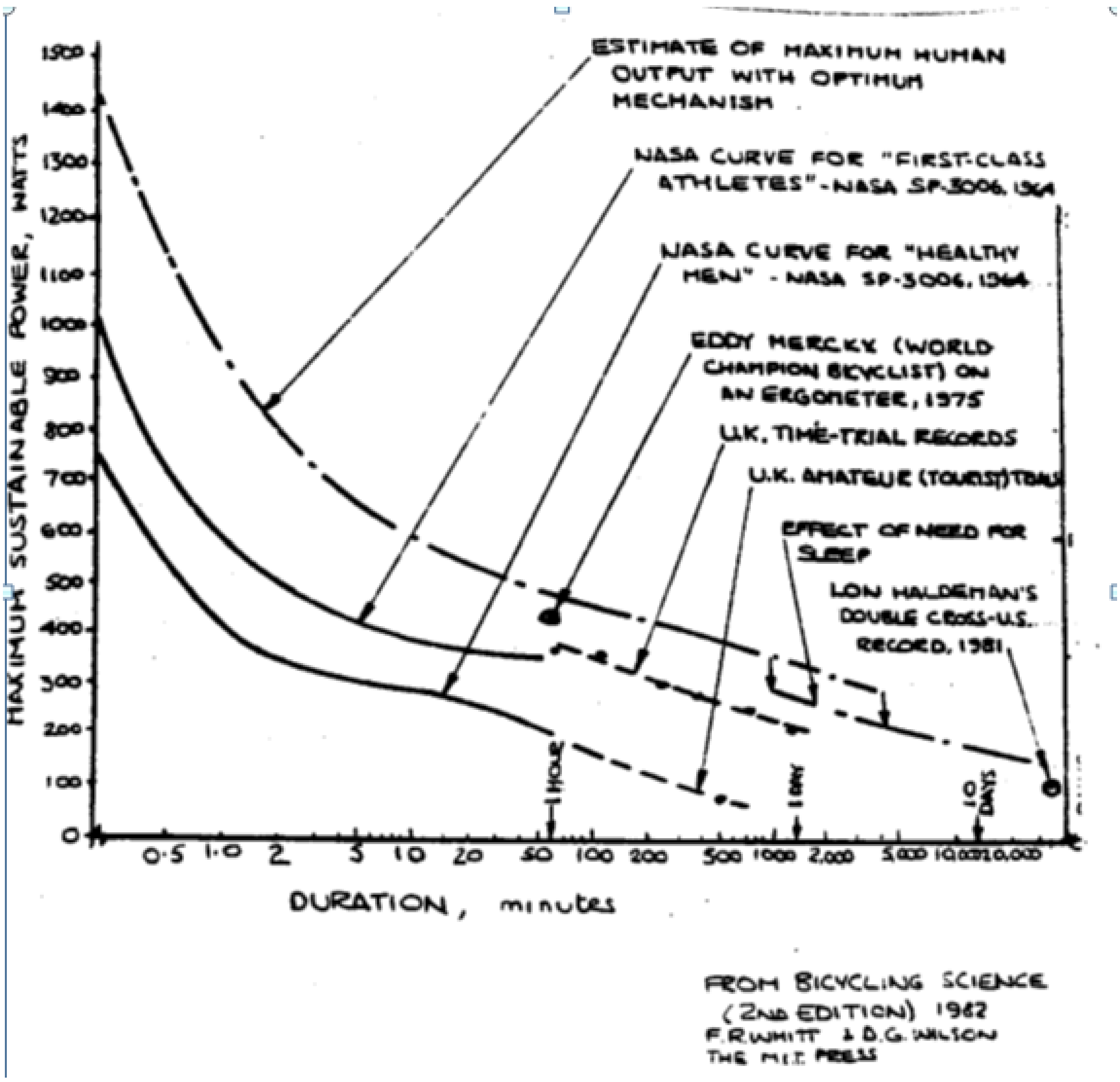

Figure 2.1 Power duration cycle

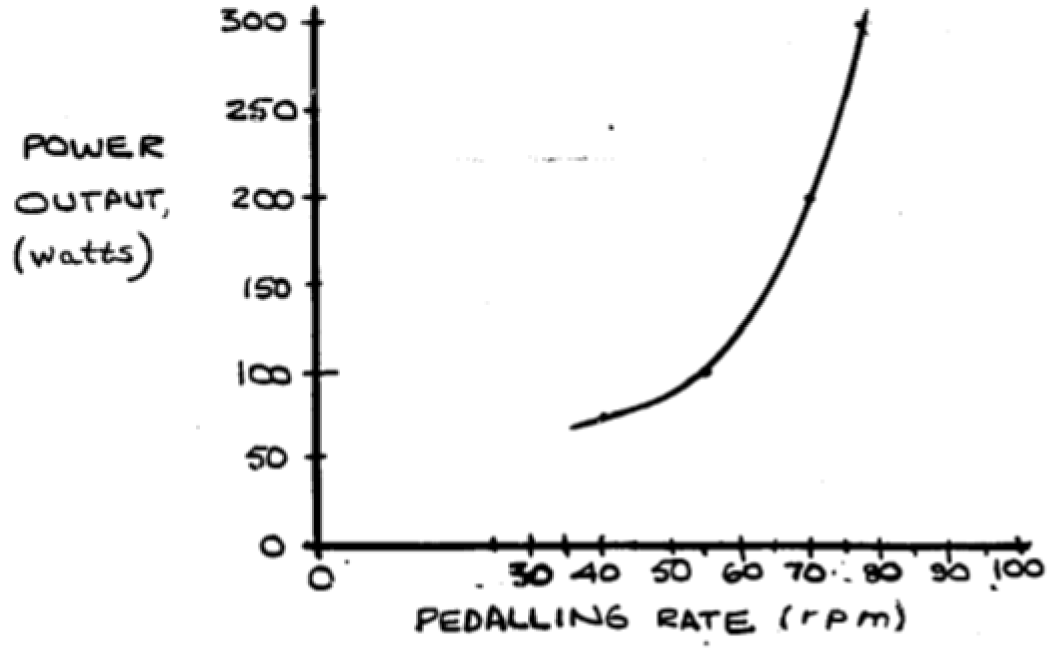

Figure 2.2.Power vs rpm graph

-whether because the ambient temperature is low enough, or because there is adequate breeze.
There is a vital difference between pedalling a stationary device and pedalling a bicycle at the same power output. On a bicycle, much of the pedalling energy goes into overcoming wind resistance; This wind resistance, however, provides an important benefit: cooling. Because of the wind, even in hot, humid climates, so long as the bicyclist drinks enough liquids, dehydration and heat stroke are unlikely to occur.
On the other hand, when pedalling a stationary device on a hot or humid day at more than about half the maximum possible power output, there is a considerable danger of the pedaler's collapsing because of an excessive rise in body temperature. Therefore, it is essential that an individual pedalling such a stationary device in hot or humid conditions be provided with shade from the sun, plenty of water, and preferably some sort of fan.
A portion of the power that the pedaller is producing can be used to drive this fan; this is an efficient

use for the power, since it will help prevent damageto the pedaler's health.

PEDALING RATE:

How fast should a person pedal? Human beings are very adaptable and can produce power over a wide range of pedalling speeds. However, people can produce more power--or the same amount of power for a longer time--if they pedal at a certain rate. This rate varies from person to person depending on their physical condition, but for each individual there is a pedalling speed somewhere between straining and flailing that is the most comfortable, and the most efficient in terms of power production. (For centuries, this fact was apparently not recognized. The predominant method of human power production was to strain with maximum strength against a slowly yielding resistance. This is neither comfortable nor efficient.

Neither is the opposite extreme of flailing at full speed against a very small resistance.

A simple rule is that most people engaged in delivering power continuously for an hour or more will be most efficient when pedalling in the range of 50 to 70 revolutions per minute (rpm). - See Figure 2. For simplicity's sake, we will use 60 rpm, or one revolution of the pedal cranks per second, as an easy reference value for estimates of the gear ratios required to drive a given load.

GEAR RATIOS:

The relationship between the rotating speed of whatever is being driven and the pedalling rate (both expressed in revolutions per minute) is called the gear ratio. Most practical applications of pedal power will use bicycle-chain drives, which on bicycles range from 1:1 (the rear wheel turns at the same speed as the crank) - to 1:5 (the rear wheel turns at five times the speed of the cranks) for high gears.

III. DESIGN VARIATIONS:

CRANK LENGTH:

The crank length is the distance between the center of the pedal-spindle and the crank axis; that is, it is the radius of the circle defined by each pedal as it turns. The normal crank on an adult's bicycle is 165 to 170 millimeters (mm) long. However, people remain able to produce near maximum power output at any crank length from between 165 and 180 mm, so long as they have a period to practice pedalling at the new length.

SHAPE OF CHAINWHEEL:

Evidence from tests suggests that elliptical chain wheels with a relatively small degree of elongation--that is, with a ratioof major to minor axis of the chain wheel ellipse of no more than 1.1:1--do allow most pedallers to produce a little more power. No subject tested showed a reduction in power. It is therefore recommended that, when elliptical chain wheels are available at a reasonable price, they be used. However, the gain in power output is small, and this must be considered when comparing costs and benefits.

PEDALLING POSITIONS:

There are three common pedalling positions:

1. The first is the upright position used by the majority of cyclists around the world. In this position, the seat, or saddle, is located slightly behind where it would be if it were a seat, or vertically above the crank axis; the hand grips are placed so that the rider leans

forward just slightly when pedalling. Tests have shown that subjects using this position are able to produce the most pedalling power when the top of the saddle is fixed at a distance 1.1 times the leg length to the pedal spindle at the pedal's lowest point.

2. The second position is the position used by riders of racing bicycles with dropped handlebars, when they are holding the upper parts of the bars. Their back is then at a forward lean of about 40 degrees from the vertical. Their saddle height requirements are similar to those of cyclists in the first position. (The position of the racing bicyclist who is trying to achieve maximum speed is not suitable for power production on a stationary device. Even racing bicyclists sometimes experience great pain after a long time in this position, and the position is unnecessary on a stationary device because there is no wind resistance to overcome.

3. The third position is the position used in modern semi-recumbent bicycles. The placement of the centre of the pedalling circle relative to the seat. In this seating position, the pedalling forces are countered by the lower back pushing into the seat (which is similar in construction to a lawn chair made of tubes and canvas). The arms and hands do not need to remain on the handlebars to perform this function, the way they usually do in the first two positions. They can remain relaxed, and free to guide the work that the pedaler is powering. The upper body too can remain relaxed, and the chest is in a position that makes breathing easier than when the pedaler bends forward. The major disadvantage of this position is that, since the pedaler's legs move forward from the body, it may be hard to position large, deep equipment like a lathe or saw so that it is in reach without being in the way. In almost all other respects, the semi-recumbent position is highly desirable, though not essential.

Chapter 3

Basic design of pedal powered bicycle generator

In the wake of energy crisis efficient and commercial use of renewable energy resources to meet power demands is in vogue. Various renewable energy sources like solar energy, wind power, geothermal energy, and tidal wave energy have gained popularity in last decade and are being commercialised on large scale. The various limitations like per unit cost, non-availability of sources, and lack of development of infrastructure facilities contribute as hindrance factors in development of non-conventional sources of energy. Pedal power generation uses a simple concept of harnessing energy generated in rotation of tyres because of the force applied on the pedals of cycle. This is easily accessible and available system because battery charging can be done by layman. It is advantageous over typical generation infrastructure facility which requires use of expensive technology for generation, transmission and distribution. Pedal power generation does not require raw materials, fuel supply chain connecting suppliers to users. It also eliminates long term variable costs. The whole of the pedal power system developed in this project was constructed using simple and cheap engineering processes and the system does not use complex circuits and specialised tools or equipment for providing services. This system can be easily implemented in un electrified villages that can help to encounter the global problems which are rooted in rural population because of lack of access to energy and education and can increase the productivity and lead to progress.

Figure1 below shows the block diagram of the entire pedal power system used in this project.:

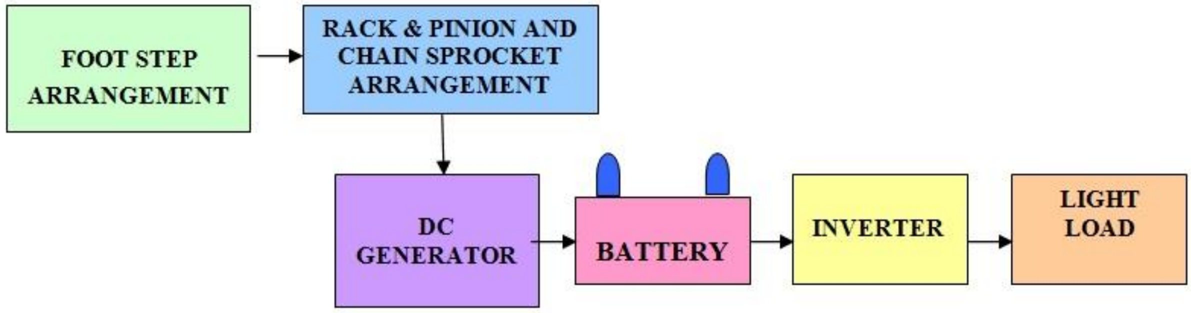

Figure 3.1: Block Diagram of Overall Project Design

The project's main goal is simply to charge a battery array with a produced 12VDC fromthe bicycle design; however, for this project design to be considered successful, a list ofprimary and secondary objectives has been determined.

Primary objectives include:
• Low Production Cost
• High Safety

Secondary objectives include:
• High Energy Efficiency
• Low Upkeep
• High Product Durability

The first two major objectives were identified for their obvious necessities. Withthe majority of people without energy being at or below the poverty line, and with minimal expected financing and donation, it is imperative that the product design be at its absolute minimum cost to any users.These systems are built with expensive steel stand, DC motors, and regulators. Our system will look to use more common items such as wood for the stand, and reused motors from other products. These items will be engineered to afford the most power output for the least amount of money.
Safety is another major factor, because the safety of the consumers, no matter who orwhere, is always of the utmost importance.For the aspects of safety, nothing will be overlooked and the product will be held to standards equivalent to any national electrical product. These include following mandates:

• Conform to the National Electrical Code (NEC)
• Conform to IEEE code 1547

These regulations required the obvious safety precautions. These precautions include noexposed wires or components in order to prevent electrocution, and rated electricalequipment to protect the system and users for electrical shorts and overloads.
Once these two objectives have been sufficiently met, the focus can be turned to thesecondary objectives.We want our bicycle generator to be able
to power the most utilities for the longest possible time. For this objective, we constructed multiple designs to verify the most efficient setup. These various designs areexplained in the design section.We want our bicycle generator to be ableto power the most utilities for the longest possible time. For this objective, weconstructed multiple designs to verify the most efficient setup. These various designs areexplained in the design section.Just as it
must be low the product must last for a long
period of time, as the inhabitants may not be able to afford the necessary

equipment orlabor to maintain or fix the product if something should fail. We hope to do this bykeeping the components of the product simple and commonly available. This includes astandard, stand-alone bicycle, a simply constructed bicycle stand, and standard electricalcomponents for any energy conversation. Secondary components such as DC-DCconverters could add more cost and complexity, but should be designed as purelyoptional. If all of these objectives can be met, we can consider the Bicycle PoweredGenerator Design to be a success and usable for any consumers.

3.1 Project Methods:

This project has various different design paths to complete our product while meeting the majority objectives. This means we will have to implement and compare ourdifferent designs to insure the best product based on our set of objectives. These pathshave changed as we progressed through our project, and there were a few foreseenmethods that we expand upon in the design section. The basic design for the bicycle powered generator is to have a bicycle on a fixedstand, and then when the bicycle is pedaled, the spinning motion of the rear tire is used toproduce mechanical energy directly into a DC voltage. If an AC voltage is produced, afull bridge rectifier will be necessary to produce the DC voltage. This DC voltage canthen be used immediately or stored via a battery array. If a constant DC voltage isrequired by the user a DC-DC converter may be necessary to change the varying DCvoltages produced from the varying bike speed to a constant DC voltage for certainutilities or battery array. The first decision is selecting a bill of materials for each design path. This will help determine the ultimate product affordability. We must decide whetherto use an alternator or dynamo to convert the bicycles mechanical energy to AC or DC,respectively. While an alternator is easier to find and purchase with many functioningunits available in scrap yards, they also tend to be less efficient in the output of DC powercompared to a dynamo. Another design factor that must be implemented and compared isthe coupling of the bicycle wheel to either the alternator or dynamo rotor. One option is to use two contacting wheels to connect the two components. This option is a bit simplerto implement and take very little upkeep to maintain; however, the efficiency of thecontact is relatively low due to slippage losses and frictional losses. A more efficient yetexpensive design would be to have the wheel and the alternator/dynamo be connected viaa rotary belt, similar to a car belt system.

3.2 Design:

The Bike:
A bicycle is designed to convert human energy into mechanical energy for transportation purposes. The mechanical energy is then translated into electrical energythrough the use of a drivetrain turning a motor. To maximize the efficiency of bothconversions is essential to obtaining the maximum power output. The first conversion isfrom human energy or muscle energy into mechanical energy. The bicycle is an efficientand robust method to convert between the two types of energy. It is an efficient designthat provides seating for the user as well as pedals and drive train that are easilyactivated. There are few moving parts and the simplicity of design is proven. Alan Cotewrote in Bicycling Magazine in 2005, that most of the forces acting again a rider are due to off bike force such as wind, gravity, and rolling resistance. He explains, these three off-bike forces make up about 95 percent of the force against you, which means the bike itself is about 95 percent efficient‖ . The bicycle is one of the mostefficient uses of the human body's existing musculature and the ergonomic positionallows for nearly everyone to utilize. As published in the International Journal ofIndustrial Ergonomics, ―Pedaling is the most efficient way of utilizing power fromhuman muscles. Pedal power enables a person to drive devices at the same or higher rateas that achieved by hand cranking, but with far less effort and fatigue‖ . The humanmusculature is concentrated in our legs and the bicycle set-up allows for harnessing themaximum output. The article also explains that stationary power generation on bicycleshas been skipped over in past research but with the rising cost of other power generation,
reliance on human power generation will become more important; furthermore, thebicycle is a universal symbol of transportation in all types of countries especiallydeveloping ones. We can find bicycles everywhere and the robustness of the simplemechanical system makes the learning curve essentially zero.
The rotational nature of the bicycle drive train or more specifically the pedals is a steadystyle of movement. The constant driving of the pedals become more constant whenreaching the drivetrain since there is rotational inertia to smooth out any subtle changes inthe speed. The rear wheel therefore becomes an ideal prime mover for electricalgeneration; we would need to connect an alternator and rear wheel though either directcontact or a belt system. Modern bikes have gears that can adjust the range of RPMs andmakes initial pedaling easier. The user is able to start softly and increase the resistance asmomentum is gained. The user can also adjust the speed and perceived resistance to theircomfort levels. When the bicycle stabilizes and gains more speed, then the user downshift thereby increasing perceived resistance and outputs more power. The sameapproach can be used by the user of our stationary power generation set-up.

This factorcomes into play further when developing the motor for the bicycle design.In developing countries, people use bicycles more often than motor vehicles. Theidea of electricity generation through stationary bicycling has been introduced in selectarea, but more as recreation focus in the United States. An elementary school in NewJersey uses a pedal-a-watt system that requires children in gym class to pedal for at leastfive minutes. These stationary bicycles generate electricity to power the gym’s soundsystem as well as charge batteries in the school’s laptop computers.

While a bike is the ideal tool to harness human power, there are a few difficultieswhen trying to use a bicycle. A bicycle is only stable when in movement; it will fall overif not moving forward or braced. A stand or brace has to be built in order to remain stationary when trying to generate power. This bracing, if done haphazardly, could result in injury to the user or the bicycle. These injuries would not be more catastrophic than crashing on a traditional bicycle. A bicycle is not design to be braced easily. It is a streamlined structure that is not readily drilled, glued, or clamped down upon. Modern materials are making bike lighter, but less suited for being braced or placed on a stand for example carbon fiber or aluminum alloys. These materials are not meant to be stressed in all directions; a brace often adds shear or torsion stress which may damage the bicycle’s frame.

There is limited adjustability for different sizes of users. The position of a single frame of a bike does not allow for all of the population to be accommodated. The seat post adjustment only accounts for one dimension of accommodation and there needs to be more dimensions. Standard bicycle frames also come in various sizes thus indicatinglack of accommodation for all of the population.

3.3 Bike Stand:

The first step in designing a bicycle generator is building the stand for the bicycle.A bicycle being an important transportation device, we tried to design a stand that wouldnot damage the original intention of the bicycle. Our stand’s design could not render thebicycle useless for traditional transportation. A permanent attachment to the stand wouldalso void transportation. Welding and other permanent methods were thus eliminatedfrom design choices. For the stand, we opted to construct it using wood, instead of buyingor constructing a stand from metal. This was an easy choice to make as wood is much

cheaper than steel in most locations around the world. The negative aspect of a woodframe is the issues of breakability and corrosion from the user or the environment or both.

These factors can be reduced with a proper stand design and protective coatings. For thestand to be able to handle the vertical and lateral motions of the users, a wide and solidbase is necessary. The bike to be mounted on the frame is intended to have pegs on theback wheel. If the bike does not have pegs, a pair can be found or purchased.

Figure:3.1

In order to build a stand with acceptable stability, a wide and strong base must beconstructed for the design. Two of the four 2x4 wooden beams are used for the base. Onebeam is cut into two equal 4 foot pieces. The other wooden beam is cut twice. Once thepiece is cut into two 4’ sections, use one of the sections and cut it in half again to formtwo 2’ sections. This gives us three 4’ sections, and two 2’ sections of wood. The two 2’sections are laid down parallel to each other 4 feet apart, and one 4’ section is placedparallel between the two pieces, with the piece about 1 foot away from the front 2’section and 3 feet away from the back 2’ section. Then the two remaining 4’ sections arelaid on top of the three wooden boards perpendicularly across the two 2’ sections spaced about the distance mid-peg to mid-peg of the bike to be mounted as depicted in

Figure 3.2

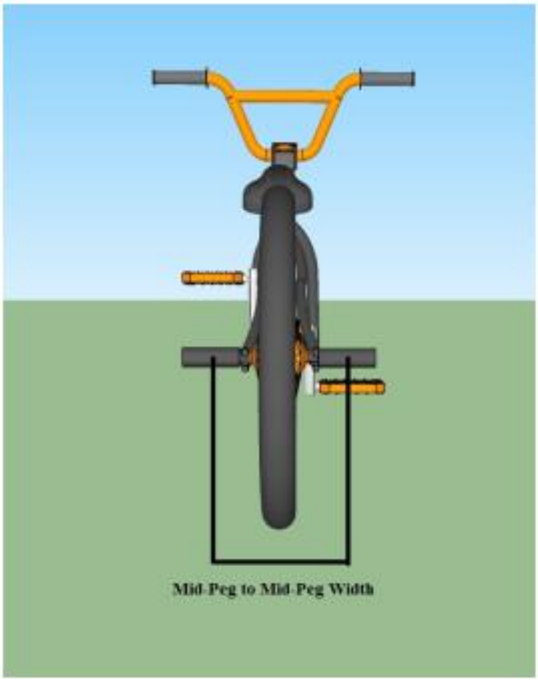

Figure: 3.2:Mid-Peg to Mid-Peg Distance Defined

These pieces of wood are fastened together with 6 angle ties at each connecting point,giving a base with the form shown in Figure3.3.

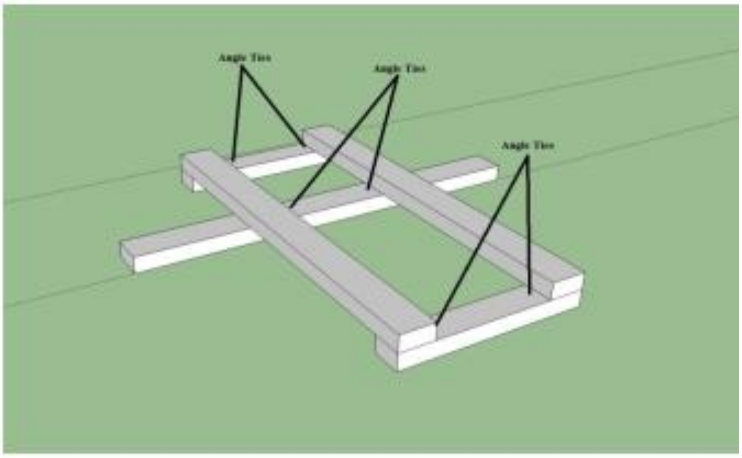

Figure 3.3: Visual of the Bike Stand Base

Once the base is made, the vertical stands for holding the bike can be added to the frame. These vertical pieces are two 2’ wooden sections cut from one of the remaining 2x4 wood beams. These two 2’ sections are mounted vertically over the cross section of the two 4’ sections, and face each other, wide side out, perpendicularly. Two holes slightly bigger than the peg’s diameter need to be drilled in the two wood sections, in order to hold the bike in the stand. These holes need to be high enough to avoid the back wheel from contacting the lower 4’ wooden section of the frame’s base. The two rigid ties are used to connect the two vertical beams to the base of the frame. Figure 3.4 clarifies this layout.

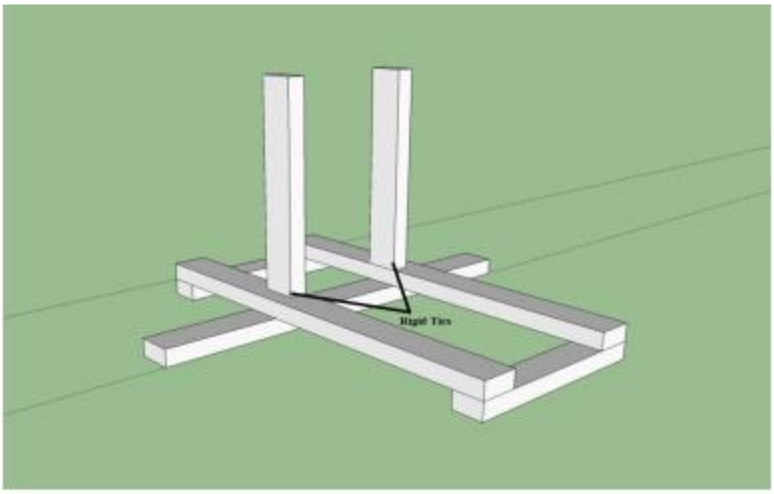

Figure 3.4: Vertical beam placement on the bike stand base

Side stabilizers are imperative for the final frame design, as there is a greatamount of force put on the stand, from twisting and push-pull forces, when the userpedals the bike. These side stabilizers are made from the remaining 2x4 wood. A 45°angle needs to be cut at each end of the six stabilizing beams, to connect the stabilizersfrom the base to the vertical posts. The angle ties are used to connect the stabilizingbeams from the base to the vertical posts. Figure 3.5 depicts the final frame designshowing the locations of the six stabilizing beams, as well as the approximate locations ofthe peg holes and angle ties.

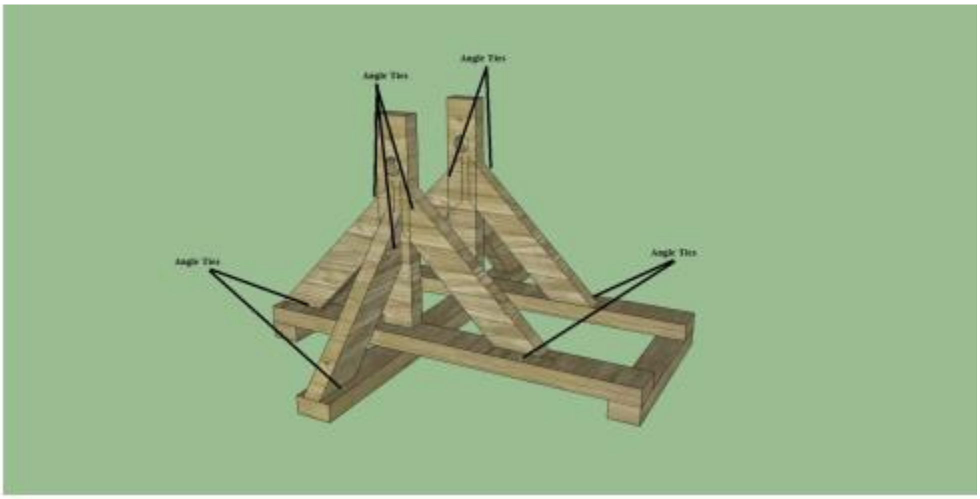

Figure 3.5: Completed back half of the bike stand

The main frame for the bike stand is now complete; however, a front wheel holder must be constructed to hold the front tire in place. This will keep the user from turning the tire and possibly shifting too much weight to one side of the stand. The front tire holder is much easier to construct. Simply cut the 2x3 wooden beam into two 2’ sections, and two 1’ sections. Place the two 1’ sections parallel to one another approximately 2 feet apart. Lay the two 2’ sections on top of the 1’ sections perpendicular to the 1’ sections and parallel to one another. The space between the two 2’ sections should be just a bit wider than the width of the bikes front tire, in order to hold it tightly in place. Angle ties are used to connect the pieces of wood together as Figure 3.6 demonstrates

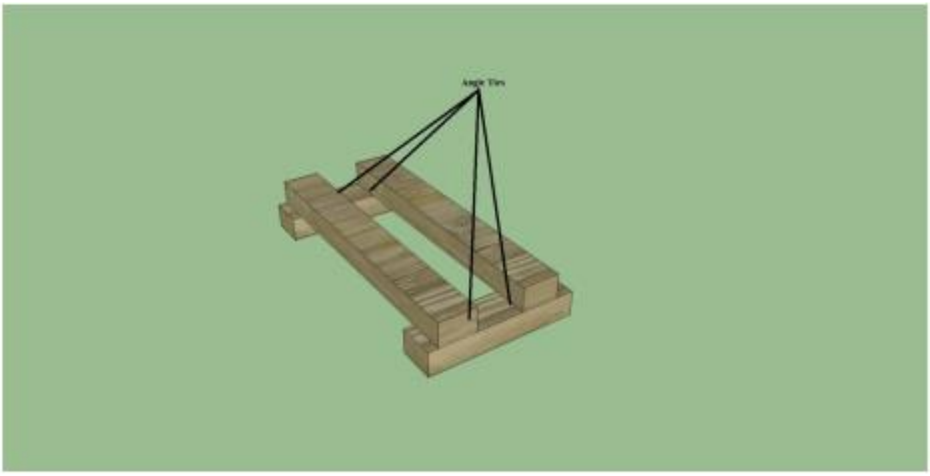

Figure 3.6: Front Tire Holder

Once the two sections of the bike stand are completed we can mount the bike and other hardware such as a motor or alternator on the frame. A concept of the bike frame with a bike is shown in Figure 3.7

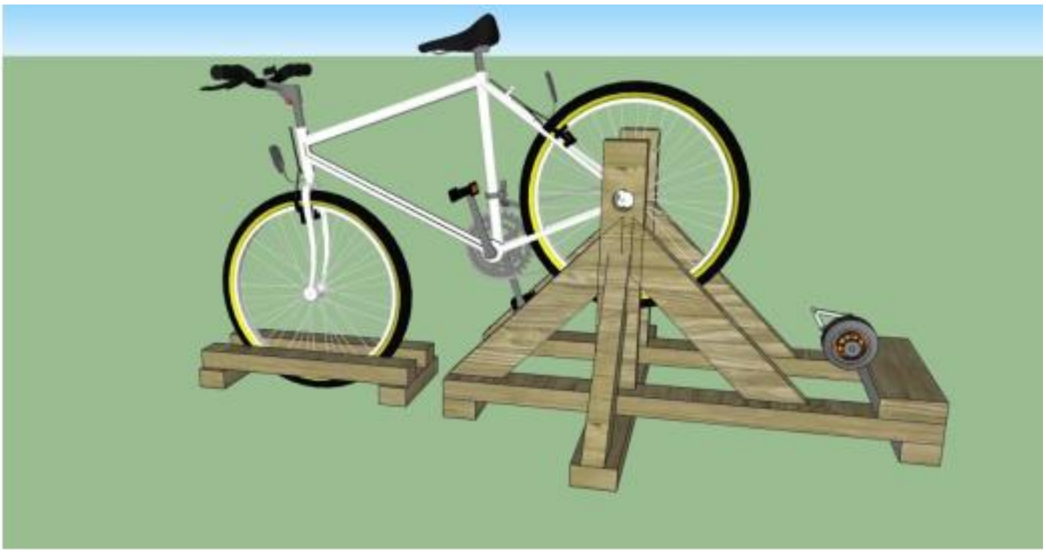

Figure 3.7: Final bike stand design with bike and alternator in place

The bike stand frame design was made to withstand a great amount of force from the user and still maintain its performance and form. This is necessary in the bike to allow the user to pedal much faster if more energy is required in a shorter amount of time. While the stand does not have the strength of a steel stand, we believe the stand is more than adequately meets the strain requirements from a user of average weight and size. Another factor that needs to be addressed is the issue of corrosion. This bike is intended to be used by people in developing and third world countries, so it is safe to assume the entire system will be outside in the elements for the majority of its working lifetime. Wood corrodes when left unprotected in the environment for an extended period of time; however, there are many protective coatings for wood on the market that are reasonably priced. A coat of lacquer and fresh paint should be more than enough to help significantly increase the lifetime of the stand for outdoor use. If cost is too much of a factor, the stand should still hold up quite well in an exposed environment if it is kept out of direct contact with rain, water and other liquids.

While we believe our stand has high durability and stability for its given cost, there are more than likely many improvements that can be made to the stand in order to improve its quality to cost ratio. This would require extensive testing in a controlled environment as well as extensive testing in an exposed environment; however, the scope and limited time of our project did not permit us this opportunity.

3.4 Motor:

With a solid stand in place, a motor must be selected in order to create the DC power to supply the DC House's battery array. There are many options for the motor set up for the system. These include a DC motor, a Generator, and an Alternator. We will look to connect the spinning back wheel directly to the axel of motor's rotor. The two options are to either have direct contact between the back wheel and motor axel or to have a belt connect the two elements. It was decided early on to use a belt to connect the two elements together. While a belt adds more complexity to the set up and makes the bike more difficult to remove from the stand, it gives much more grip between the wheel and axel, reducing the slippage losses between the two parts. If a direct connection was made the slippage losses could increase dramatically depending on how the user was pedaling the bike and the external conditions at the time, such as the stand being in a wet environment.

To connect the wheel to the motors axel, the bicycle tire and tube was removed. A belt that fit nicely on the wheel rim was chosen and an axel head for the motor needed to fit the belt as well. The next step was to determine the best motor to connect to the bike. A simple DC motor was initially thought to be the best choice as the DC output of the motor was the desired electrical output for the battery array. That meant components would not need to be created or maintained to convert AC to DC and the losses from AC to DC could also be avoided in the system. We searched for DC motors in common household appliances such as vacuums and ceiling fans, but found no motors at the size we wanted for the scale of the bicycle system. The sizes were too small and did not create enough voltage or current to output a substantial amount of power. While looking into buying a DC motor at a decent size and rating, it was found that the cost for such a motor would be too expensive, and finding such motors in third world and developing countries, much less buying them, would be out of the question for the scope of cost for this project.

Another motor option was using a car generator to produce the output DC voltage for our system. Car generators are parts found on older models of cars before the 1960's. They are similar to alternators, but produce DC voltage directly without a use of a converter like an alternator. This seemed a valid choice as once again the losses from AC to DC conversion could be avoid; therefore, improving the efficiency of the bicycle system. We looked for a car generator from an old car in order to test the part; however, it soon became obvious that the part is very difficult to locate. There are very few cars left that use car generators as opposed to car alternators and the ones that still exist are usually very expensive or hard to find. When looking for a car generator from Los Angeles to as far north as Bakersfield, we found no working car generators. The few that were located were rusted beyond the repair we could provide. This was unfortunate because we were not able to compare a car alternator to a car generator. It may have been in vein nevertheless, if it was that difficult to find a car generator in California where supplies are very abundant, it could be even more difficult to locate internationally in poorer areas. The cost of a car generator could also pose a problem as older car generators tend to cost more due to their rarity and the components they utilize. Car generators use a component called a commutator to rotate the motors fields, which makes the generators more costly and heavier. Due to the increased expense and less availability compared to alternators, the car generator was ruled out for the system design.

3.5 Alternator:

The last practical option to implement for the bicycle system was to use a standard car alternator. This seems to be the most reasonable motor for the design, as car alternators are widely available worldwide for relatively low costs when purchased as a used part. Finding donated alternators would also be an easier task to reduce the projects overall cost. There are some difficulties however with an alternator as opposed to other motor options. The first issue is the power loss due to conversion from AC to DC voltage. Most alternators automatically convert AC to DC in the regulator of the part; however, there is still the power loss in the alternator that will reduce the efficiency of the product and waste some of the energy exerted by the user. Another major issue when using an alternator occurs at the speed at which the part is operated. When a car is idling, the rpm of the motor can be seen in the odometer. This value is usually around 600-700 rmps. Alternators usually run at a 3:1 rpm ratio due to the diameter difference in the motor and alternator head. This means an alternator is more efficient at speeds of 2000 rpms and higher[3]. We could never hope to achieve this speed even with a bike tire being somewhere around a 10:1 ratio of the alternator's head diameter. If a user was to pedal around a reasonable 100 rpms the alternator would only be rotating around 1000 rpms; which is around half the speed of an idling car.

3.6 DC Permanent Magnet Motor:

The first idea for deciding how to mitigate the EMF issue was to attach a DC motor into the belt system between the back tire of the bike and the alternator head to produce a DC voltage to apply to the stator. An alternator will not produce any current unless the stator has a sufficient voltage and current to induce the EMF required to interact with the rotor. The greater the voltage on the stator, the greater the EMF and resistance the user will encounter. If a large voltage was applied to the stator via a battery or voltage supply, the EMF could be strong enough to keep some users from even starting to pedal the bike, inhibiting them from producing any power. The DC motor hooked up to the same belt as the alternator would be a good way to regulate the stators EMF depending on the pedaling speed of the user. When the user is not pedaling, no DC voltage is being produced or provided to the stator of the alternator. This means there will be no EMF resisting the user from starting the bike. As the user begins to pedal more rapidly the DC motor will begin to produce a strong voltage to charge the EMF of the stator. This means the strength of the field and resulting power output of the alternator would be completely depend on the strength and speed of the user. This would allow smaller, less capable individuals to still produce some small amount of power from the alternator opposed to none, and stronger individuals would be able to avoid the initial EMF field and build pedaling momentum to charge the EMF of the stator to its maximum strength and allow for a higher amount of power output from the alternator for a longer amount of time. We received a small DC motor from a previous power generating bike stand to try implementing the process on our design. In order for the DC motor to be viable for our system, the motor would have to supply enough voltage to the stator in order to start the charging of the alternator. The DC motor was tested individually in a motors lab to determine the output power of the part. The motor was connected to an induction motor that was controlled by a Variable Frequency Drive. With this VFD, the DC motor was tested at various RPMs to determine the output current and voltage. We would want a maximum voltage of around 12V and a maximum current around 1A to charge the stator and produce a strong EMF for the alternator. Once the motor data was collected, it was clear that the DC motor we were using would not provide a strong enough DC voltage to stator to induce the EMF at the operating RPMs of our system. Basically, the user would have to pedal so quickly to induce the EMF of the alternator from the DC motor, that the use of the motor to power the stator field is unreasonable.

Figure 3.8: Output Voltage vs. RPM of DC Motor

The method of using a DC motor as a field generator on the design is stillfeasible; however, it would take a bigger and more expensive DC permanent magnetmotor to implement, and the main goal of this project is to keep the costs as low aspossible.

3.7 Mounting & Wiring:

In order for the alternator to produce power, it must be securely fastened to the stand and connected correctly to the bike and all other components. Alternators are very durable when connected correctly, but if connected incorrectly the alternator can be destroyed very quickly and pose a serious injury threat to everyone around the system. To mount the alternator on the bike frame, two pieces of remaining 2‖x3‖ wood can be used to secure the alternator. The Ford 3G alternator has three mounting holes; two on one side and one on the other. The alternator can be laid on top of the two cross sections of wood across the back of the bike stand. The holes can then be marked and drilled with a 3/8‖ bit. Three 3/8‖ 3‖ bolts and screws can be used to then thread and secure the alternator to the pieces of mounting wood. These cross pieces of wood can now be attached to the back of the stand with remaining angle ties from the construction of the bike stand. It is recommended to first attach the pulley belt from the back tire to the alternator head. Once they are connected, pull the alternator and attached pieces of wood back until no slack is left in the belt. The belt must be tight between the two mediums in order to reduce any belt slippage and slippage losses when the user pedals. Once the belt is tight, mark the angle tie locations to connect the mounting wood pieces to the bike stand firmly. A rough view of the mounting position can be viewed in Figure 3.9 and a view of the connection between the alternator shaft and bicycle rim in Figure 3.10.

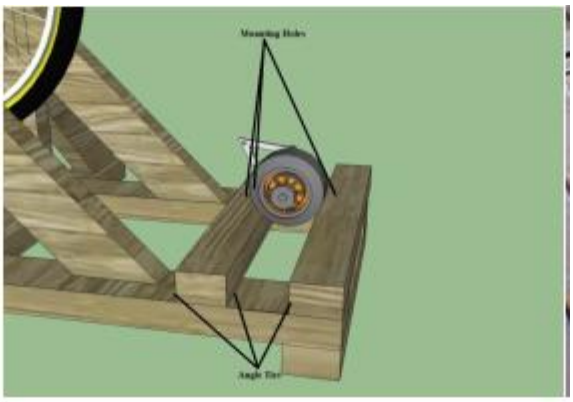

Figure 3.9: Mounting Alternator to Stand Figure

Figure 3.10: Pulley Connection Between Alternator and rim

The overall configuration when integrated looks like below:

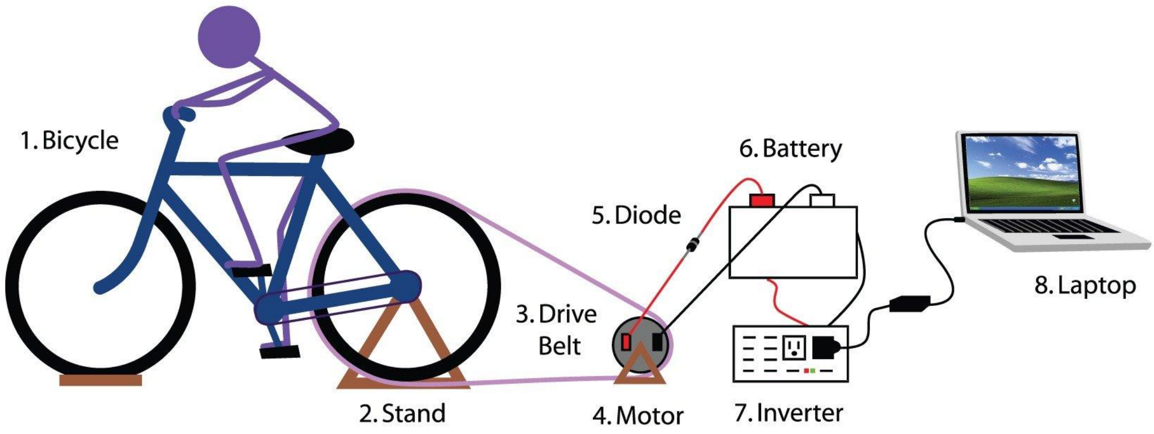

Figure 3.11: Pedal powered generator setup

3.8 Batteries/Super capacitors

Batteries store charge chemically, where as capacitors store them electro-statically. Ultra capacitors are costlier than therechargeable batteries. Ultra-capacitors will discharge suddenlyif short circuited.Rechargeable battery is used to store the energy produced by pedaling. Rechargeable batteries are made up of one ormore electrochemical cell used to store energy in the form ofelectrical energy. The only reason why batteries are preferred over capacitor is its easy usage i.e. the batteries after rechargingcan be easily removed from the charging case and can be usedfor desired purpose like for lighting up torch, etc. On the otherhand, super-capacitors cannot be taken out from the circuitafter recharging and be used boost a device. Also, ‘case’ forplacing the super-capacitors are not available.
At first NiCd (Nickel Cadmium),batteries were used butlater were changed to NiMH (Nickel Metal Hydride). NiMHhas got many advantages over NiCd battery:

- More charge capacity (about twice as that of NiCd)
- Has no hazardous effect on the environment
- Has no memory effect (generally occurs due to overcharging or due to full drainage of battery)

3.9 Inverter:

We used a 12V DC-220V DC 500 Watt inverter for ac appliances.

Chapter 4

Conclusion

At a time when there is energy crisis casting its shadow all over the world, one has to look into alternate renewable energy resources. One such alternate way to generate power is presented in this paper. The rotational energy of the tires in the bicycle, generated by pedaling can be used to operate small powered devices. Both dynamo and alternator can be used and various options and situations where a dynamo or alternator can be used are provided. The various applications where this power could be used are also discussed in this paper. Villagers who use bicycles are going to be benefitted the most.

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