NOTIONS OF EXPENDITURE:
REQUEST FOR SPECULATIVE PROPOSALS...

… to re-design exercise equipment to generate and store energy; and/or to retrofit gyms to function as local power sources linked to the grid.

Notions of Expenditure invites participation from individuals and groups to address the problem of converting the volume of human energy that is voluntarily expended in the pursuit of health, fitness, vanity, distraction, discipline, and/or dates to electrical energy, that can be used or stored as a collective resource.

(text excerpts from website, 2005, A. Laurie Palmer)

histories and precedents

Harnessing human powered energy is associated for some with harnessing the animal in us—our inner horse (plows, old mills, water pumps), or inner dog (sleds...), or with other humiliations. Certainly dogs, horses, and sheep have been put to work on early muscle-powered machines, including early versions of the treadmill, to grind corn, saw wood, thresh grain, drive piles, lift stone, fan fires, and turn roasting spits, possibly as early as 4000 years ago (Steven Vogel, "A short history of muscle-powered machines," *Natural History*, March 2002). But humans have also tread the mill to generate power since at least Roman times. Typically, though, it has been certain types of humans—slaves, epileptics, women, prisoners, children, or laborers in the mines.

Georgius Agricola's *De Re Metallica*, 1556, includes descriptions of mining machines fueled by foot-treading as well as by arm-cranking. (The latter, involving body parts closer to the head, suggests more intentional, directed, and refined labor than the brutishness of using the lower body, which is associated with sex and base instinct and, again, our animal natures). It is unclear from Agricola's elegant illustrations what conditions these workers treaded under. In Roman mines around 100 CE, it was slaves who tread the mill both to pump water and to raise ore.

The hospital of Bicêtre, France boasts a prodigiously deep well underneath, dating from 1735. The horizontal wheel that pumped the water was turned initially by twelve horses, then, starting in 1781, by 72 men, taking shifts on a 24 hr day. These workers were eventually replaced by epileptic patients and "madmen" in residence at the hospital (free, I guess).

A description of women working a treadmill in China, written at the beginning of the 20th century by an American company that made educational image sets for children, uses the barbaric implications of the treadmill to attack Chinese culture altogether:

" Rice is the chief food of the Chinese and as there are over 400,000,000 of them it requires enormous quantities of rice to feed all those hungry people. ... In this view you see a crude but common method of raising water from a stream to the field. ... In our country we would probably have a small gasoline engine to turn the wheels or pump the water. In China they do not want machinery as it would deprive men, women, and children of the work. Here the women are hired for a few cents a day to stand on this log and keep it turning by stepping upon each one of those projecting arms that look like croquet mallets. Three women can work at a time on this treadmill. In China women work in the fields just as the men do. In fact they are often required to perform much harder and more disagreeable tasks than women in our country are allowed to do. Why is this?" ("Women Pumping Water by Treadmill for Irrigation Near Hankou, China", from Jim Zwick's edited web collection "Stereoscopic Views of War and Empire," www.boondocksnet.com/stereo/sv230f.html)

A treadmill for use in prisons was invented in England in 1817 by Sir William Cubit, who observed prisoners lying around in idleness and put himself to the task of "reforming offenders by teaching them habits of industry." (Oliver P. Hubbard, *The Treadmill in America*, 1887, pamphlet) Forty-four prisons in England adopted it as a form of hard labor that could also grind grain.

The punitive treadmill was implemented in America for two long years, between 1822 and 1824, at Bellevue penitentiary outside New York. Prisoners stepped on the mill for 10 hours a day (with 20 minute breaks per hour), grinding grain, often with a large audience of jeering onlookers housed in a specially built viewing house.

A small book (James Hardie, *The History of the Treadmill*, 1824), written by a self-avowed former drunk who found god, quit ardent spirits and took a job as gatekeeper in the prison adjacent to the almshouse where the ardent spirits had led him, outlines the many advantages of the treadmill at Bellevue: no skill is required to work it (women are as useful as men because it is only the weight of the prisoner that pushes the wheel); prisoners can't neglect their task because all must work equally and synchronize their steps (8 or 10 on the wheel at one time); the power it generates can grind grain to offset the cost of providing food for the prisoners; it is constant and sufficiently severe – but, "its monotonous steadiness, not its severity, breaks down the obstinate criminal spirit." Hardie also points out that the architecture of this mill is such that if the supply of grain were to run out, the prisoners wouldn't know it, so they could still be employed in hard labor even if nothing was produced. Hardie's emphasis on this important detail underscores the fact that the prison treadmill was not simply an economic but of course an ideological machine– intended, as he states repeatedly, to reform moral character.

The one aspect of this punishment that Hardie, the reformed sinner, deplored as unnecessarily humiliating was the public spectacle—1000 visitors at a time came to watch on holidays like Easter. The treadmill was discontinued altogether as too cruel, and erased from most American histories as if it never existed here.

Jeremy Bentham's famous Panopticon (1787) envisioned an economically self-sufficient prison on the model of a slave labor camp that supported itself through internal factories worked by the inmates. Those inmates included children; the factories would be powered by mechanisms attached to the children's seesaws, swings, and merry-go-rounds, translating play into work. A recent invention in 2003 by Raj Pandian, engineer at Tulane University, transforms the energy from children's seesaws, swings, and merry-go-rounds into electricity. Pandian's project is intended to contribute a partial solution to affordable and sustainable energy in places that have none. Clearly his humanitarian invention comes at a different time, for a different purpose, and from a different mindset altogether than Bentham's utilitarian one, though both designs attempt to translate play into work.

The present initiative, which translates voluntarily expended exercise energy (a kind of adult "play") into power, shares a similar structure. But it's not quite the same, as working out for some adults is truly hard work, and not especially fun. But we still sign up and pay the monthly membership. One might think that we had internalized punishment, and transformed it into a form of pleasure. The monotonous repetition that was considered worse than pain but useful for squashing the spirit of resistance is now enjoyed, or at least tolerated for the sake of other priorities, like health, beauty, energy, vanity, or offsetting boredom. "Notions of Expenditure" acknowledges a cultural moment when individual interests are elevated above the collective, but can't this coincide with collectively contributing to a sustainable future?

The first private health club in the U.S. was started by Professor Louis Attila in 1894. Cardio workout machines entered the clubs much later and were developed initially for the hospital. The first medical treadmill designed to diagnose heart and lung disease was invented by Dr. Robert Bruce and Wayne Quinton at the University of Washington in 1952. Dr. Kenneth Cooper's research on the benefits of aerobic exercise, published in 1968 (*Aerobics*), provided a medical argument to support the commercial development of the home treadmill and exercise bike. Tunturi, Schwinn, and LifeCycle produced stationary bikes in the mid and late 60s; Aerobics, Inc produced a home treadmill in 1968. (The Jetsons' treadmill (1962) was designed for Astro the dog, and pre-figured home treadmills for humans by about 6 years.) Meanwhile NASA was developing stationary exercise systems for long space missions because, in Zero-G, astronauts' muscles atrophy quickly. Early versions included a velcro mat and wooly socks; in 1973, Skylab went into orbit with a stationary bike and a treadmill made of a slippery teflon plate to which the astronaut was attached by bungee cords. Membership in health clubs in the US grew to 36 million in 2002.

In his essay on the history of the treadmill, biologist Steven Vogel estimates an average healthy male body can sustain production of about 100 watts over an eight hour day of treadmill labor. He also estimates that a body would need 350 calories per hour to produce this much electricity, given that a body also uses food energy for basic metabolic processes and that we are only partly efficient at digestion. Shorter bursts of activity can of course generate higher numbers.

The Matrix (the movie) might seem an unfortunate precedent for a collective harvest of body energy to run machines. Another unfortunate lower-tech precedent is *Les Triplettes de Belleville*, in which the energy of the captured bike riders powers the projected movie that holds them in thrall. (Many up to date exercise machines have similar built in entertainment systems). But both of these invented precedents, as well as most of the historic ones, used bodies without their consent, and gyms supply more-than-eager volunteers.

Soldiers, however, constitute one category of potential participant that is arguably indentured, given that, for many U.S. soldiers, military service often seems to be the only option for employment. Research attempting to harvest a soldier's autonomic body energy to support military operations in the field has become increasingly realistic, paired with research into the use of drugs and genetic engineering to design and insure a soldier's peak performance. (https://safe.sysplan.com/scihelpamerica/SOTO.pdf) While squeeze-powered flashlights and power generators built into the heel of a boot may seem benign, or quaint, or just a good idea, the overall military project is to design an increasingly invulnerable and task-oriented body, professionally fit to kill, and not to think twice about it. Since access to limited resources has traditionally been a major cause for war, next to the need to avenge a family member (still occasionally a cause), wouldn't it be better not to be so dependent on those resources to begin with? We could all give just a small amount of our life energy, energy that would otherwise coagulate as fat, or be wasted in unharnessed exercise like grain left to rot in the field.

moment of doubt

Is the idea of producing a product from our exercise antithetical to the incentive to work out? Do we have a need to lose, to spend more than we make, to waste what we have? Is the gym one of the few places we get to go to spend ourselves without producing something? Sure, most of us think we are honing and building our bodies, but maybe that is a by-product of a bigger need to spend without tangible return? Is there something inherently asymmetrical about our lives, tilting as they are towards death and entropy, that requires an asymmetry in our expenditures? Why not glory in that extravagant expenditure, why put it to work?

The upstairs cardio gallery at the University gym pulses with the inaudible vibrations of competing headset tunes and the frenetic energies of 40 bodies pumping up and down on machines. We are working, in a way that used to signify labor, but generating nothing for all that work. Each of us may be healthier, but collectively our work contributes nothing beyond increasing isolation (one person, one machine) and narcissism (better butts).

In the meantime, the Bush administration is waging a war to control the fossil fuel resources of Iraq, lowering emission standards of US power companies to allow more pollutants to enter our air and water, continuing to generate nuclear waste without safe storage, neglecting to develop renewable power sources on any convincingly committed scale, planning to drill, by hook or by crook, in the Alaska wilderness, and otherwise committing egregious acts of violence and injustice in order to profit from perceived scarcities of energy.

This project is not intended to contribute to or condone the new anti-obesity measures being directed toward poor children, especially in the south–making them feel individually responsible for living in a culture that provides neither nutritious foods nor adequate education nor living wage jobs, resulting in diets that are cheap and compensatory. But it is intended to stimulate thinking about every day activities in relation to larger systems and public policies, as well as to generate collective solutions.

energy units

selected from:
http://www.physics.uci.edu/~silverma/units.html, and http://www.phy.syr.edu/courses/modules/ENERGY/ENERGY_POLICY/tables.html

Energy (the ability to do work) is measured in joules or calories
1 joule (J) is equal to the force of one newton acting through one meter
1 calorie (cal) of heat is the amount needed to raise 1 gram of water 1 degree centigrade
1 calorie = 4.184 J
(But, the calories in food ratings are actually kilocalories, so 1 (kilo)calorie = 4184 J

Power is measured in watts
1 watt is the power from a current of 1 ampere flowing through 1 volt
Power = Current x Voltage
Energy = power x time
1 kilowatt is a thousand watts.
1 kilowatt-hour is the energy of one kilowatt power flowing for one hour (E = P t).
1 kilowatt-hour (kwh) = 3.6 x 10^6 J = 3.6 million joules
1 megawatt = a million watts

approximate energy content of fuels:
AA battery = 10^3 J
candy bar = 10^6 J
pound of coal = 1.6 x 10^7 J
pound of uranium 235 = 3.7 x 10^{13} J

90 lbs coal = 1.1 day energy consumption per capita in U.S.

**for more rough values of power of various processes, and energy comparisons, see the great website at:
http://www.phy.syr.edu/courses/modules/ENERGY/ENERGY_POLICY/tables.html

energy storage

selected from: http://www.nrel.gov/analysis/power_databook

battery

> "Electrode plates of chemically reactive materials sit in a bath of electrolyte, which facilitates the transfer of electrically charged ions. The negative electrode gives up electrons during the discharge cycle, this supplies a flow of electricity to any system attached to it. During the charging cycle, the flow of electrons is reversed as energy is sent into the battery. Batteries only store direct current, so a transformer is necessary to convert battery power into AC power."

Lead acid is the most common and reliable; other types: nickel-cadmium, lithium ion, nickel metal hydride, zinc bromine, sodium bromine, lithium polymer, sodium sulfur are under development; largest system to date for lead acid is 20 mw.

Lead acid batteries give off hydrogen gas when charging, and have to be ventilated; lead acid batteries can be recycled.

flywheel

Flywheels store kinetic energy in a rotating mass.
Low speed flywheels are less expensive, metallic; high speed flywheels spin at very high speeds inside vacuum chambers. Their composite rotors are made of carbon-fiber materials; they can fly apart, and have to be encased in heavy protection; superconducting electromagnetic bearings can virtually eliminate energy losses through friction

superconducting magnets

> "SMES systems store energy in a magnetic field created by the flow of direct current in a coil of superconducting material that has been cryogenically cooled. SMES systems provide rapid response to either charge or discharge, and their available energy is independent of their discharge rate. SMES systems have a high cycle life and, as a result, are suitable for applications that require constant, full cycling and a continuous mode of operation. Micro-SMES devices in the range of 1 to 10 MW are available commercially for power quality applications."

pumped hydropower

> "Pumped hydro facilities use off-peak electricity to pump water from a lower reservoir into one at a higher elevation. When the water stored in the upper reservoir is released, it is passed through hydraulic turbines to generate electricity."

supercapacitors

> "With characteristics of both batteries and capacitors, supercapacitors (also called electrochemical capacitors or ultracapacitors) could be used by utilities to regulate power quality... charge is stored electrostatically in polarized liquid layers between an ionically conducting electrolyte and a conducting electrode. No chemical reactions occur, charge and discharge based entirely on physical properties."

direct to the grid

No need for storage! But who benefits? Either the health club gets compensated, or the utility gets free power, or? – something to think about.

human energy

To utilize human energy to create power, you have to fuel the human. Food is the fuel—how much fuel is necessary for basic human functioning, and how much extra fuel is necessary to create energy "to burn"? The following excerpts describe how cellular energy works, and approximately how much power humans can produce.
Note: Clearly, nutritious food is critical to a human-powered energy production system. Policy initiatives emphasizing good nutrition will be a critical component of any system-wide, human-powered energy plan, as will re-thinking how food is produced. Contemporary large-scale agriculture consumes a good deal of energy, as well as engaging in unhealthy if not immoral practices. Re-thinking this link—how our food is produced—will also contribute to the viability of a systemic plan for people-powered energy.

sign in kansas: *1 Kansas farmer feeds 128 people for a year*
another sign in Kansas: *God Bless America/ 20 oz sirloin*

Adenosine Triphosphate
from : http://hyperphysics.phy-astr.gsu.edu/hbase/biology/atp.html

> "Adenosine triphosphate (ATP) is considered by biologists to be the energy currency of life. It is the high-energy molecule that stores the energy we need to do just about everything we do. It is present in the cytoplasm and nucleoplasm of every cell, and essentially all the physiological mechanisms that require energy for operation obtain it directly from the stored ATP. As food in the cells is gradually oxidized, the released energy is used to re-form the ATP so that the cell always maintains a supply of this essential molecule. ...In animal systems, the ATP is synthesized in the tiny energy factories called mitochondria.
>
> The structure of ATP has an ordered carbon compound as a backbone, but the part that is really critical is the phosphorous part - the triphosphate. Three phosphorous groups are connected by oxygens to each other, and there are also side oxygens connected to the phosphorous atoms. Under the normal conditions in the body, each of these oxygens has a negative charge, and as you know, electrons want to be with protons - the negative charges repel each other. These bunched up negative charges want to escape - to get away from each other, so there is a lot of potential energy here.
>
> If you remove just one of these phosphate groups from the end, so that there are just two phosphate groups, the molecule is much happier. This conversion from ATP to ADP is an extremely crucial reaction for the supplying of energy for life processes. Just the cutting of one bond with the accompanying rearrangement is sufficient to liberate about 7.3 kilocalories per mole = 30.6 kJ/mol. This is about the same as the energy in a single peanut.
>
> Living things can use ATP like a battery. The ATP can power needed reactions by losing one of its phosphorous groups to form ADP, but you can use food energy in the mitochondria to convert the ADP back to ATP so that the energy is again available to do needed work. In plants, sunlight energy can be used to convert the less active compound back to the highly energetic form. For animals, you use the energy from your high energy storage molecules to do what you need to do to keep yourself alive, and then you "recharge" them to put them back in the high energy state. The oxidation of glucose operates in a cycle called the Krebs cycle in animal cells to provide energy for the conversion of ADP to ATP."

...humans need food energy to cover the basal metabolic rate; the metabolic response to food; the energy cost of physical activities; and accretion of new tissue during growth and pregnancy, as well as the production of milk during lactation. Energy balance is achieved when input (or dietary energy intake) is equal to output (or energy expenditure), plus the energy cost of growth in childhood and pregnancy, or the energy cost to produce milk during lactation.

Not all combustible energy is available to the human for maintaining energy balance (constant weight) and meeting the needs of growth, pregnancy and lactation. First, foods are not completely digested and absorbed, and consequently food energy is lost in the faeces. The degree of incomplete absorption is a function of the food itself (its matrix and the amounts and types of protein, fat and carbohydrate), how the food has been prepared, and - in some instances (e.g. infancy, illness) - the physiological state of the individual consuming the food. Second, compounds derived from incomplete catabolism of protein are lost in the urine. Third, the capture of energy (conversion to adenosine triphosphate [ATP]) from food is less than completely efficient in intermediary metabolism (Flatt and Tremblay, 1997). Conceptually, food energy conversion factors should reflect the amount of energy in food components ... that can ultimately be utilized by the human organism, thereby representing the input factor in the energy balance equation....The energy that remains after accounting for the important losses is known as "metabolizable energy."

Not all metabolizable energy is available for the production of ATP. Some energy is utilized during the metabolic processes associated with digestion, absorption and intermediary metabolism of food and can be measured as heat production; this is referred to as dietary-induced thermogenesis (DIT), or thermic effect of food, and varies with the type of food ingested. This can be considered an obligatory energy expenditure and, theoretically, it can be related to the energy factors assigned to foods. When the energy lost to microbial fermentation and obligatory thermogenesis are subtracted from ME, the result is an expression of the energy content of food, which is referred to as net metabolizable energy (NME)."

Output in watts
from: A short history of muscle-powered machines: what goes around comes around—and does useful work
by Steven Vogel, Natural History, March, 2002

"Where humans worked against gravity, as they did inside cage wheels and upon treadmills, we can calculate the power outputs. As a benchmark, we might use data, first obtained in the eighteenth century by British scientists Jean Desaguliers and John Smeaton, of the power a human laborer could produce if working steadily all day: 90 to 100 watts. In contemporary terms, this means that if you attach a generator to an exercise machine, you can watch TV as long as you climb, pedal, or row.

By the same token, a Roman cage wheel sixteen feet in diameter and eight feet across accommodated six to eight men, who could, forty times per hour, jointly lift one ton a distance of twenty-seven feet--which equals a power output of 600 foot-pounds per second. Dividing that among eight workers, we calculate a power output per person of just over 100 watts. That figure attests both to respectable efficiency for the machine and to considerable effort for the workers (who may have worked in relays).

On the Bellevue Penitentiary treadmill, prisoners climbed on treads protruding from a wheel that was slightly over five feet in diameter and turned three times each minute. If one assumes that a typical prisoner weighed 132 pounds, then the prisoner must have worked at a power of almost 140 watts. Since the normal duty cycle allowed each prisoner to rest one-third of the time, the sustained output would have been a little over 90 watts--sustained, according to the report, for up to ten hours a day. That figure of 90 watts confirms the reported unpleasantness of the task. A similar output was demanded of nineteenth-century Australian convicts, who worked up to twelve hours per day; some said they'd rather hang than work their mill.

We can view that 90 watts in yet another context. At best, only about one-fourth of the energy in food emerges as useful mechanical work. Thus, laboring on the treadmill--sustaining 90 watts for ten hours--itself requires more than 3,000 Calories. So Bellevue's inmates worked hard enough and long enough to require *double* the food intake of a normally active adult male.

A worker doing hard physical labor all day long--or a felon turning a treadmill--can put out about 100 watts of power. That's the output, in the form of a little light and a lot of heat, of the familiar light-bulb. It's a little more than the rate at which an inactive human heats a room. But to understand 100 watts of muscle power, one needs to turn to a quantifiable everyday task that humans do with reasonable efficiency. Climbing stairs fits that bill.

When you climb a flight of stairs, what's your power output? Just multiply your weight in pounds by the height of each step in inches and by your climbing rate in steps per second, and then divide by 9. The last number takes care of gravity and converts the figure into watts. I weigh 140 pounds. When climbing seven-inch steps at two per second, I put out about 220 watts--a rate that I, an age-challenged man, can sustain only briefly. Ascending a down escalator, I work at 140 watts.

But what climbing rate corresponds to an output of 100 watts? Divide 900 by your weight in pounds and by the step height in inches; the resulting figure is how many steps per second you would have to climb. On seven-inch stairs, I'd have to ascend them at a little less than one step per second--trivial for the first couple of flights but a tiring regimen to keep UP for even an hour.

What about fuel? We're at best only about 25 per cent efficient, so an output of 100 watts requires a minimum input of 400 watts, which translates (when we multiply by 0.86) into about 350 Calories per hour. Burning a tenth of a pound of good fuel--fat--yields 350 Calories, so working at 100 watts for eight hours costs less than a pound of body fat--still nearly double a human male's normal energy use.

> For a difficult task of only a few seconds' duration, a person can put out thousands of watts--many times the 746 watts in one official horsepower. For tasks lasting a few minutes, a fit human can generate perhaps 1,000 watts. For an activity that must be sustained for an hour, output drops to around 300; for an activity kept up all day, 150 watts is about the maximum."

"A child spending three minutes during its school break time on a teeter-totter provides enough energy to power a 20W lamp for one to two minutes," Dr Raj Pandian said to *edie*.
http://www.bikewalk.org/technical_assistance/resources_information/publications/centerlines/centerlines2003/cl_issue_66.htm

pedal power

selections from: Understanding Pedal Power, by David Gordon Wilson
http://thinkcycle.media.mit.edu/thinkcycle/main/human_power_generation/pedal_power_generation/Upp.txt

Published by Volunteers in Technical Assistance: "VITA is a private, nonprofit organization that supports people working on technical problems in developing countries. VITA offers information and assistance aimed at helping individuals and groups to select and implement technologies appropriate to their situations. VITA maintains an international Inquiry Service, a specialized documentation center, and a computerized roster of volunteer technical consultants; manages long-term field projects; and publishes a variety of technical manuals and papers."

> "The power levels that a human being can produce through pedaling 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.
>
> A simple rule is that most people engaged in delivering power continuously for an hour or more will be most efficient when pedaling in the range of 50 to 70 revolutions per minute (rpm). 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.
>
> Broadly speaking, applications of pedal power are possible when the power level required is below a quarter of a horsepower (that is, below about 200 watts). Common applications of stationary pedal power include pumping water, grinding grains or metals, shredding, or threshing.
>
> Pedal power can also be used to generate electricity for individual uses--to operate room lights, a television set, or a projector, for example. Surplus power could be diverted to a battery-charging circuit. The easiest way to do this is simply to drive either a DC generator or an AC alternator through a circuit feeding a battery in parallel with the load. The same circuit could be used for an alternator of higher power, chain-driven from the cranks, through an appropriate gear ratio.
>
> Other pedal power applications include:
> o Cassava graters
> o Coffee pulpers
> o Coffee/grain hullers
> o Cracking of oil palm nuts
> o Fiber decorticaters--sisal, manila, hemp, etc.
> o Winches or hoists
> o Balers
> o Potter's wheels
> o Flexible shaft drive for portable grinders, saws, etc.
> o Tire pumps
> o Sewing machines
>
> The Dynapod
>
> Bicycles can sometimes be adapted to drive the devices mentioned above, but the result is often inefficient. It is frequently cheaper in initial and maintenance costs to use a properly designed and constructed dynapod.
>
> There are three kinds of dynapods: 1) A one-person dynapod that utilizes belt drive. It can be built either with or without chain drive. 2) A two-person dynapod that can be pedaled either by one person at a time, or by two people together. It is also possible to fit a special adaptor so that a direct shaft drive leads off the unit and powers a flour mill or other machine. (When this is done, only one person can pedal at a time.) 3) A one-person dynapod that has belt drive, chain drive, and direct drive. It is very similar to the two-person dynapod.

> The two-person dynapod ... has been attached to a grain mill, but the unit can be adapted to a wide variety of uses. The dynapod frame can be made of wood or welded steel, depending on cost and availability of materials.A heavily weighted flywheel provides extra power and smoothes out the pedal stroke, reducing operator fatigue.
>
> A similar device, designed to draw irrigation water from shallow wells in Bangladesh, consists of a welded steel frame with a drive wheel attached to the plunger of a handpump."

health club numbers

(from various private health club websites)

Bally Total Fitness – 4 million members, 420 facilities, 150,000,000 member visits / year
Gold's Gym – 2.5 million members, 550 facilities, members run 556,800 miles/day
24 Hour Fitness – 2.7 million members, 300 facilities
Goodlife Fitness – 200,000 members, 1,500,000 member visits / year
Wellbridge – 200,000 members, 40 facilities
Town Sports International – 350,000 members, 130 facilities
Lifetime Fitness – 35 facilities
World Gym – over 200 facilities
Lady of America/Ladies Workout Express – 1000 facilities
Equinox – 20 facilities
Dolphin – 20 facilities
LAFitness – 100 facilities
Curves for Women – no cardio machines

38 million Americans by the end of 2003 were members of health clubs.
If each member worked out only 37 days/yr, less than 1x/week, for one hour, this would equal 1,406,000,000 hours. (This doesn't include hotel, university, YMCA, or corporate facilities, or home users.)

(There are more than 2400 YMCAs in the U.S.)

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...to Tom and Connie Merriman, whose presentation at the Monangahela Conference in Pittsburgh in Fall 2003 included this observation from a Cree Elder whose lands had been destroyed and poisoned by Hydropower Quebec: "If you want to help (speaking to a white person from the US who had traveled to Quebec to offer assistance), go home. Just remember to turn off your lights when you leave the room."