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Geosciences 206: Renewable Resources and the Sustainable Campus
The Fitness Center and the Possibility for Human Power

I. Introduction – The New Fitness Center and Possible Goals

We are always taught to be resourceful, especially when we are trying to be environmentally friendly. When examining the energy output and use of the fitness center it is easy to see that there exists an untapped energy source: human power. The attempts to convert human energy into usable energy for infrastructure are relatively new and very few buildings or companies have attempted to use it. There are however, a few available designs and instructions that show the individual how to put together their own converter using trailer batteries and other scrounged materials; if Williams wanted to look into any immediate installations, this is all they would have to work with. The next best move for Williams College, in the quest of becoming more sustainable and putting more energy back onto the grid, would be to look into making use of the wasted muscle and endurance that already exists within the spaces, for future possibilities of man power manufacturing on the market.

The attempt to use human power in the Fitness Center, which is just one building out of the many at Williams College, is important because of the energy use of the room as compared to the human use of the room. The Fitness Center, lovingly referred to as "The Estrogym" was once located in the Simon Squash Center in a narrow, low-ceiling room with a low balcony overlooking some of the practice squash courts. There were very few lights, very few machines and very little need for high-powered ventilation – a large standing fan was the sole supply of any breeze. This primitive exercise room was not enough supply for the large demand of Williams students, faculty, and other users, so

the Fitness Center relocated into Lasell within the old dance studio in late September. Upon first glance, there are many differences between the new and old centers. The square footage is much greater and the ceilings are much higher; although the space is more aesthetically pleasing and much less stuffy to exercise in, there are greater energy demands that include more lighting as well as added fixtures installed to update the Fitness Center.

II. Exercise Machines and their Possible Uses

With the creation of the new Fitness Center, came brand new endurance and machines. The college invested in six Precor Adaptive Motion Trainers; fourteen Precor 966IES Commercial Treadmills; fourteen Precor 576 EFX with upper body and adjustable cross ramps; six Precor 546 EFX with adjustable cross ramps; four Precor Commercial upright bikes; and four Precor Commercial recumbent bikes. In other words, Williams spent $164,100 on twenty treadmills, $112,900 on twenty ellipticals, and $25,560 on eight bikes; needless to say, the college will probably not be buying too many new fitness machines in the near future, therefore, when examining possibilities for human powering the gym any time soon, we must look at the available equipment.

As there are three kinds of endurance machines available in the Fitness Center, we must examine how each machine runs in order to determine their potential effectiveness of converting human energy into usable energy. The ellipticals and bikes are self powered, meaning the pedal energy is used to rune each machine. When an exerciser presses the “quick start” button, they must then must continue to pedal or run (however, you define the motion of using an elliptical) in order for the machine to work; the energy of an exerciser powers the motion as well as the operating board that displays digital

numbers, such as heart rate, and is used to control the resistance or setting of the machine. If an exerciser stops pedaling or running, the pedals stop moving and eventually the operating board turns off; the latent energy remains in the machine so that the "quick start" button can work the next time an exerciser comes to use it. Treadmills on the other hand, are not self-powered because a runner goes along with the motion of the running band, the runner does not make the treadmill operate; the treadmills, therefore, must be plugged in and electrically powered in order to work.

The ellipticals and bikes will be available for potential human power because their energy is already being harnessed and used, whereas the treadmill expends electrical energy; there is an opportunity to capture and convert the energy that goes into the ellipticals and bikes that is not being used to run the machines and is otherwise being wasted because the machines are not hooked up to any other sources.

Ellipticals

Although Precor does not publish any numbers related to possible human expenditure of their ellipticals or expected Watts produced on their ellipticals, a separate, but similar company, shows that a reasonable average of energy produced on an elliptical is 100 Watts. This is derived from their different programs or settings in which the two average groups were Advanced Beginners and Advanced I who were expected to began and peak at 50-125 Watts and 50-150 Watts[1], respectively. Although there are two different types of Precor ellipticals within the Fitness Center, human expenditure is expected on average to be the same on both. To determine the potential energy produced by the ellipticals weekly, I will utilize the simple equation of

[1] "Smooth CE Elliptical," http://www.smoothfitness.com/ellipticals/smooth-ce_programs.htm.

Number of Ellipticals x Watts x Hours weekly (to be explained later)

Maximum Potential: **20 x 100 x 91.5 = 183 KWH**

Half of the Ellipticals Utilized: **10 x 100 x 91.5 = 91.5 KWH**

This energy output of the exercisers on the ellipticals can be increased if he/she pushes harder or faster, especially on a harder level or higher resistance; if he/she can sustain such a rate, then his or her contribution will be much higher. On a similar note, numbers will decrease if the exerciser is slower or weaker than average.

Bikes

Finding exact or accurate expenditures for the Precor models created a similar issue that the ellipticals did. The average number recorded for stationary bikes, in general, is around 50 Watts[2]; although there are two different kinds of bikes, human energy expenditure is expected to be the same on both. I will use the same equation as utilized with the ellipticals, so as to keep the results constant,

Number of Bikes x Watts x Hours weekly

Maximum Potential Expenditure on bikes: **8 x 50 x 91.5 = 36.6 KWH**

Half of the Bikes Utilized: **4 x 50 x 91.5 = 18.3 KWH**

As with the ellipticals, the energy output of the exercisers can be increased on the bikes if he/she pushes harder or faster, and will decrease if he/she pushes less or slower. In general for the gym, if only a few machines are adapted to convert human energy, perhaps there is a way to encourage more fit exercisers to go on these machines.

Difficulties with harness power from the machines

[2] Tylene Levesque, "Human-Powered Gyms in Hong Kong," Inhabitat, http://www.inhabitat.com/2007/03/08/human-powered-gyms-in-hong-kong/.

The previous results display the total power that can be produced by the given examples. However, the energy harnessed would not nearly be as high for a couple of simple reasons. First and foremost, much of the energy produced goes into running the machines and their display boards. Precor has not recorded this number, but most likely, the number is not negligible because the size of the ellipticals is not negligible. In addition, the converter would use some of the energy to run itself and would not be 100% efficient.

III. Energy Outputs of Electrical Appliances within the Fitness Center

First and foremost, it is important to keep in mind the usage and popularity of the Fitness Center. None of the energy expenditures for the following appliances are going to be abnormally high or uncharacteristic for the room the size of the Fitness Center; however, the energy expenditures may be considered a bit high for the use of the area. Exercisers can use the Fitness Center for a total of 91.5 hours throughout the entire week. The Fitness Center is open from 6-9am and 10am-9pm on Mondays, Wednesdays, and Fridays; from 6-9am and 11-10.30 pm on Tuesdays and Thursdays; from 10am-9pm on Saturdays; and from 1-10.30 pm on Sundays. The hour breaks on the weekdays are used for cleaning so the lights, TVs and computer remain on. The only time that anything is turned off is at night when the Fitness Center is closed at night.

Once again, the hours are not that long if compared to buildings such as the Paresky Center or Schow that open early and stay open until 3:00am. The real problem that exists, is that the energy use remains constant for however many people reside in the Fitness Center. The number of attendees is usually low in the morning, the early afternoon, and later at night, while numbers are a bit higher in the late morning and peak

in the late afternoon. It is possible that at times there is nobody using the Fitness Center, but usually at off-hours there are at least two or three exercisers. On the other hand, peak hours could host over fifty people at once; there are times when all of the machines are taken as Joanna Hoffman can attest, “Around 4 the Fitness Center is packed. If I get there at 4, I usually get one of the last treadmills.”

Televisions

There were six 46” Sony Bravias added with the new Fitness Center, four of which hang from the rafters and two of which are mounted on the wall at the front of the room. During the hours of the room, including the five weekly for clean up, these TVs are always on, despite the number of exercisers. This is unneeded, especially during the times when there is low usage of the Fitness Center; it seems ridiculous that the two attendees at 6:00am, for example, each need three TVs to watch. There is a master remote with which to change the channels, which is not always out and accessible, nor do people really think about going out of their way to change it. Apparently, this creates the need to have six televisions on from which people can choose what to watch. Perhaps instead of using the opt-out method, the TVs could start off only to then be turned on by necessity or want.

The energy-conscious do not understand why the TVs have a place in the Fitness Center and wonder why they cannot just be removed and either recycled or perhaps reused on another part of campus. Firstly and more trivially, the college would most likely not be willing to do this because they just paid $15,000 for the TVs. On user-friendly note, they have become a part of the Fitness Center and most people say that since they were already there, they would be missed if they were taken out, whereas they

wouldn't have missed them if they hadn't been there in the first place. Joanna Hoffman believes that we need the same amount of TVs and offered that **"**Everything I need is right there and you can entertain yourself with other things, like the TVs," in reference to the place that she likes to exercise and how the TVs have become a part of her daily workout routine.

Most importantly, the TVs are ENERGY STAR® rated and therefore not actually that energy abusive. When the TVs are on, they each expend 260 Watts and when they are on standby it is reduced to .4Watts. This is very low, especially because it is only 5.3 Watts/square inch.

Since it is known that the TVs are on throughout the hours of Fitness Center, it is possible to find a relatively accurate weekly energy expenditure for the lot:

6 (TVs) x 260 Watts x 96.5 (+ 5 hours for cleaning) **= 150.5 KWH**

Treadmills

While treadmills are clearly an integral part of any gym, it is still easy to look down upon their energy usage in comparison to their counterparts, the ellipticals and bikes, who have the potential to create energy, instead of using it. As previously stated, the treadmills need to be plugged in at all times. Again, it is a rare occasion that all of the treadmills will be used at once, but they are still on standby, equipped with a "quick start" button when they are not in use. It is estimated that in full use the average treadmill consumes 1,500 Watts[3]. However, it is estimated that on standby, the energy expenditure

[3] "Saving Energy in Exercise Form: Treadmill or Trail?" http://savingenergy.wordpress.com/2007/03/10/saving-energy-in-exercise-habits-treadmill-or-trail/

is reduced to 3 Watts[4], a small number, yet one that can easily add up. Weekly, if all of the treadmills were on, they would expend:

20 treadmills x 1500 Watts x 91.5 Hours = 2,745 KWH

(Mean and More likely): If half of them were on and half of them on standby:

((10 x 1500) + (10 x 3)) x 91.5 Hours = 1,375.2 KWH

(Already a reduction by 1369.8 KWH)

Lighting

Lighting is the anomaly of the appliances when looking at human usage of the gym and expected usage of the lights. Clearly a certain amount of light is expected for a gym, regardless of the amount of people; everybody uses light and if one person is in the gym or if fifty people are in the gym, the same amount of light is needed. However, the light is one facet of the building that can be supplemented by an outside source: the sun. There are windows surrounding the room, with the largest one in the back of the room; turning the equipment around so that the light faces the exercisers instead of creating shadows from their backs can already increase natural light.

Most importantly, increasing natural light would mean the ability to decrease the fluorescent lighting. Clearly the natural lighting is not consistent during all hours or all times of the year; daylight is shorter and darker during the winter months and nighttime still happens during all seasons, so an adjustable system is needed. When the Fitness Center was installed the attempt to balance the two kinds of light was made with the use of a sensor and the dimmer. The sensor is supposed to register the amount of light

[4] Tony Tighe, "Hidden Standby Power Costs," Global TV, http://www.canada.com/globaltv/calgary/features/consumer_advocate/story.html?id=7a342063-e292-49b2-9617-e75cb820a3fc

coming in from outside and adjust the lights accordingly; if done correctly, during times when the sun is strong and is entering the room effectively, the fluorescent lights would be dimmed, therefore, lessening the energy expenditure. However, the sensor was placed at the back of the room with the large window and registers too much light; the light would shine directly on the sensor and therefore it would think of the room as brighter than it actually is so the lights would be turned down too low.

The dimmer is never turned on because the Fitness Center becomes too dark when it is, so much so that it is not considered conducive to working out. People like to work out in brighter light because it makes them less tired, it is more uplifting or positive, and it is easier to read if they have brought such materials to the Fitness Center. Therefore, high-powered fluorescent lights are always on in the fitness center despite the outdoor lighting or the amount of people inside of the room.

Currently the lights have an output of 40 Watts

38 banks x 40 Watts x 96.5 Hours = 146.7 KWH

Computer

Although the computer's energy expenditure is minimal in comparison to the previously mentioned machines, it is still important to mention the lack of necessity for such an appliance, while discussing the superfluous expenditures of the lights, TVs, and treadmills. Apparently, somebody believes that the computer has a place in the Fitness Center and as a Dell Pentium 4, its energy use ranges from 80 Watts to 163 Watts. Giving it the benefit of the doubt, since it is not usually being used, the minimum weekly energy use would amount to:

80 Watts x 96.6 hours = 7.7 KWH

IV. What can we Power?

It is clear that the potential for human energy production is relatively low, given our current equipment, numbers of equipment, and numbers of visitors; however, this power, if made available could be used to help power certain appliances in the Fitness Center, while decreasing the demand for electrical energy, therefore, making the room more sustainable and the power source more renewable.

Total Maximum Available Human Power Weekly:

183 KWH (Ellipticals) + 36.6 KWH (Bikes) = 219.6 KWH

- 7.7 KWH (Computer) = 211.9 KWH

- 150.5 KWH (TVs) = 61.4 KWH

- 61.4 (of the mean Treadmills) = 0.0 KWH

Leaving 1313.8 KWH for the Treadmill and 146.7 KWH for the Lights

Knowing that the maximum availability will probably not be reached, using half of the power, a more likely calculation, the following can be powered:

109.8 KWH - 7.7 KWH (Computer) = 102.1 KWH

- 102.1 KWH (TVs) = 0.0 KWH

Leaving 48.4 KWH for the TVs, along with the Treadmill and 146.7 KWH Lights

- Without the Computer, the Human Energy would only leave 40.7 KWH of the TVs to power

V. Conclusion/Discussion: How feasible is this idea?

The human energy potential of the gym may seem low in comparison to expectations. While proposing this idea to the school, the numbers may also seem very low to actually consider investing in this undeveloped idea; however, what it stands for should be just as important as costs if we can help make the Fitness Center more eco-friendly. There are several problems with the current model that need pointing out and examining further if there is anyway to hope for any beneficial changes in the future.

The Fitness Center is run on electrical energy, which is extremely cheap at $0.129; for example, it would cost just short of $1.00 to power the computer per week. Clearly any investment in machines or equipment to convert human energy to usable would take tens of years to pay back in the reduction of electricity costs; the California Fitness Center in Hong Kong estimates that it will take upwards of eighty years to pay back their initial investment in which bicycling power runs the lights[5]. However, they also estimate that a bike run one hour every day can reduce CO2 emissions by 4,380 liters per year[6].

In addition to the waning use of the Fitness Center throughout the day, the room has different peaks seasonally; of course more people are going to use the Fitness Center in the colder months because there are fewer options of places to work out, whereas during warmer months, many people would prefer to exercise outside or using other methods. The use of Chandler and Lassell clearly drop during the warmer months, whether it's due to fewer students around Williams or just fewer users of the gym, as with vacations; regardless it means that there is less available manpower.

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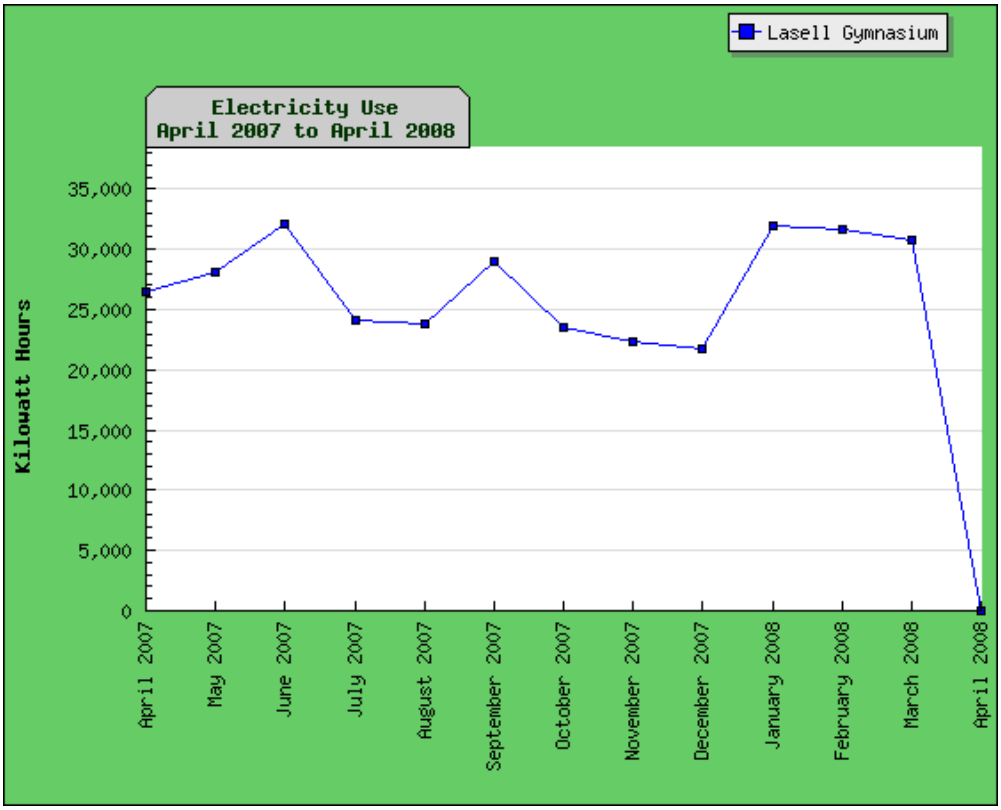
[5] Tylene Levesque, "Human-Powered Gyms in Hong Kong," Inhabitat, http://www.inhabitat.com/2007/03/08/human-powered-gyms-in-hong-kong/.
[6] Ibid., "Human-Powered Gyms in Hong Kong."



Most important, however, is that if any of the above energy conversion were to actually take place, it would have to be with the "bootleg". In order to use these, we would need somebody to put them together and install the makeshift machines and wire them into the wall using a protective covering to ensure safety. This would be expensive, time-consuming, and uncertain; therefore, it would be unlikely for Williams College to invest in any such equipment. Therefore, the only real hope for man-power would be for manufacturers to build machines that could easily hook up to a battery or to a source that can put the power back onto the grid. Until this can happen, the task at hand is relatively unfeasible; the strongest possibility, therefore, would be to approach companies, such as Precor, and pressure them into to starting to look into these machines since no company

is currently experimenting with converting human power using ellipticals or stationary bicycles.