ABSTRACT

Title of Document:	A study of the benefits of retrofitting cardiovascular exercise equipment of a gym with human energy harvesting technology
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This study seeks to identify the benefits of implementing human energy harvesting technology in gym exercise equipment. The central premise is that work put into fitness equipment by gym members can be used to generate electricity for the gym. This supplemental energy source can reduce the gym's overall need for electricity, therefore enhancing the gym as a green gym similar to the way of other alternative energy sources. The study includes an analysis of consumer preferences using detailed survey questionnaires, as well as an investigation of energy efficiency of gym establishments. Moreover, the feasibility of implementing this technology was evaluated from the standpoint of a business plan. By exploring the issue of a green gym from each of these three perspectives, this research shows that retrofitting a gym with energy harvesting technology can successfully enhance the image of the gym while making its operations more profitable.

A STUDY OF THE BENEFITS OF RETROFITTING CARDIOVASCULAR EXERCISE EQUIPMENT OF A GYM WITH HUMAN ENERGY HARVESTING TECHNOLOGY

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Preface

This thesis has been prepared by Team Human Energy Acquisition Technology (HEAT) as part of the University of Maryland Gemstone Program. Team HEAT was a group of undergraduate students that graduated from the University in May 2009. The team was led and assisted by Dr. Peter Kofinas, Associate Chair of the Fischell Department of Bioengineering.

The thesis opens with a discussion of the development of the project idea, finding the benefits of human energy harvesting technology when implemented into cardiovascular equipment at gym facilities. It follows with two methodologies used to conduct research. The discussion and conclusion chapters analyze the results of our research to help the reader make sense of the hundreds of pieces of data that were collected. The thesis concludes with future recommendations of study. The Final Thesis Presentation was held on March 27, 2009.

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Chapter 1: Introduction

Summary

Current energy generation strategies have focused on large-scale renewable sources of energy such as solar, wind, hydroelectric, and geothermal, but overlook small-scale sources of energy such as human energy. Human energy has been studied in limited roles, mainly as a method to support mobile power needs. Common examples of human energy based technology include hand-crank radios and flashlights, but these applications are limited to a narrow range of situations.

The following document outlines an investigation of the benefits of implementing a human-powered energy harvesting system. Rather than using a system in a mobile setting, the human-powered energy harvesting system will be housed within a gym and used to offset the gym's energy requirements. The Eppley Recreation Center (ERC) at the University of Maryland was examined as a case to determine the local benefits of implementing a system at the University of Maryland. The social acceptance of this system was examined by surveying the University of Maryland population to gauge their interest, and to determine under what circumstances they would be willing to use energy harvesting exercise equipment. Finally, a generic business plan was developed to determine the economic feasibility of such a system. Instead of using the ERC case study as a basis for the business plan, a generic business model was created to account for the differences between the ERC and a commercial establishment, mainly in how membership is handled and the need for competitiveness in a commercial gym.

The energy harvesting system will be based on dynamo technology, which is an energy conversion method which can convert rotational, mechanical motions into electrical energy. Dynamos, more commonly known as generators, can be seen in a wide range of energy generating technology, ranging from turbines to car alternators. The dynamos will be installed onto exercise bikes, to capture the rotational energy expended by the user and convert that energy into electricity. It is important to note that the scope of the research does not include an actual retrofit to exercise equipment, and only studies the potential benefits of such a system.

Background

Energy harvesting has been used throughout history in varying degrees to capture and store energy. Energy harvesting is a unique form of energy generation in that the energy is not generated, per se, but captured from the environment. By capitalizing on potential energy in the environment and converting that energy to usable, electrical energy, rather than actually generating energy through methods such as burning fossil fuels, energy harvesting can be considered a highly environmentally-friendly method of capturing energy.

In recent years, massive strides have been made in the realm of energy harvesting, however the efficiency of such devices is still a point of contention. (Steere, 2008) Energy harvesting, sometimes referred to as power harvesting or energy scavenging is a process that captures and stores energy. The key difference between energy harvesting and energy generation is that the action from which the energy is captured is not performed for the sole purpose of generating energy, but only comes as a secondary objective; one example is the use of hydroelectric energy – the act of placing a water wheel into a river would be considered energy harvesting, while building a hydroelectric dam to power turbines to create power would be considered energy generation. While differences between energy harvesting and energy generation may seem subtle, there is a distinction between the two, though both terms are often used interchangeably.

Typically, energy harvesting is implemented on a significantly larger scale than what was identified for research; capturing large amounts of energy (megawatt range) through systems such as wind turbines, solar cells, wave harvesters, and hydroelectric turbines (Figure 1). However, in recent years due to the increasing trend of mobile, electronic devices, research has also explored using energy harvesting for supplementing mobile power needs (milliwatt range), ranging from consumer electronics such as cell phones and iPods to specialized devices such as nodes within a wireless sensor network.

Figure 1: Examples of energy harvesting methods.
Clockwise from top-left: wind turbines (Microsoft Clip Art Gallery), solar panels (Microsoft Clip Art Gallery), wave harvesting (http://www.oceanharvesting.com/en/technology/index.php), hydroelectric dam (Microsoft Clip Art Gallery).

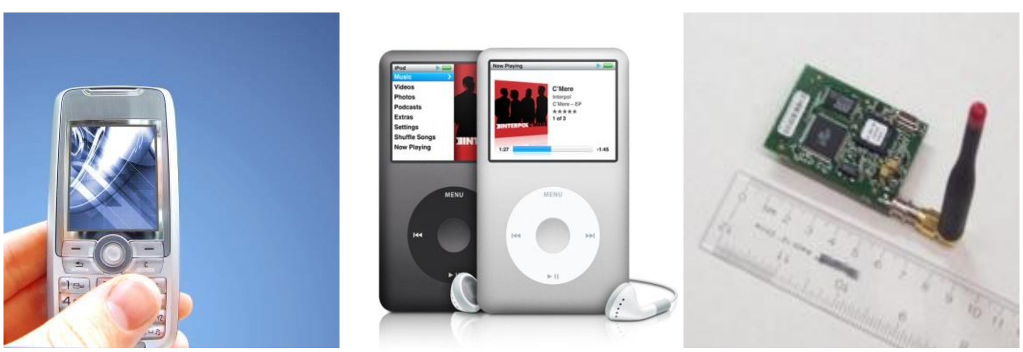


Figure 2: Examples of mobile electronic devices.
From left-to-right: cell phone (Microsoft Clip Art Gallery), iPod (http://www.apple.com/ipodclassic/gallery/), wireless sensor node (http://www.bfrl.nist.gov/863/heat_transfer_group/BESEL_tech.htm).

Energy harvesting technology relies on several classes of devices which can convert latent energy into usable electricity; classes include thermoelectric generators, piezoelectric crystals, electromagnetic collectors (e.g. solar cells), and dynamos/generators. (Paradiso & Starner, 2005) Thermoelectric generators convert heat and/or temperature gradients into a source of electricity; however the amount of energy available is directly related to the magnitude of the temperature gradient. (Jones, 2009)

Piezoelectric crystals convert mechanical stresses into electrical energy via the piezoelectric effect, and are commonly seen in many consumer devices ranging from cigarette lighters to quartz clocks. The piezoelectric effect is observed in materials which are able to generate an electric potential (i.e. a voltage) in response to an applied mechanical load. The piezoelectric effect is used in a cigarette lighter, where the mechanical stress of striking a lighter is converted into an electric potential, mainly a spark, which ignites the gas in the lighter. The piezoelectric effect also works in reverse, where certain materials when exposed to an electric current undergo a mechanical stress. This effect is seen in quartz clocks when a voltage is applied to the quartz crystal, a piezoelectric material – the quartz vibrates in response to the voltage. The major deterrents to piezoelectrics are the relative scale of the power generation and the cost associated with piezoelectric materials. (Inman, Park, & Sodano, 2005)

Electromagnetic (EM) collectors are a class of devices which collect electromagnetic energy and convert it into electricity. The most common example of an electromagnetic collector is a solar cell, which converts light into electricity;

other forms include radio frequency (RF) collectors. RF collectors are similar to solar panels in that energy is gathered from the EM spectrum, but rather than gathering energy from the visible light spectrum, energy is gathered from the RF spectrum.

Dynamos, more commonly known as generators, are the most common technology for energy generation, and convert a rotational motion into electrical energy. Dynamos are used in a wide variety of applications ranging from hydroelectric and wind turbines to hand crank flashlights. They generate energy by rotating a magnet within a loop of wire, or vice-versa. Dynamos are well-suited for a variety of applications because they translate mechanical motion into electrical energy. Most large-scale energy generation systems use some form of a dynamo to generate power, most often a turbine.

Harvesting Human Energy

Human energy harvesting can be accomplished using most of the aforementioned technologies with the exception of electromagnetic harvesting. Researchers and inventors have implemented different methods of energy harvesting in attempts to harvest energy from humans with hopes of offsetting mobile power needs. There are numerous actions that can be targeted for energy harvesting, such as breathing, walking, finger motions (i.e. typing on a keyboard) or even passive items such as blood pressure or body heat. (Starner, 1996)

One example of energy harvesting is the use of piezoelectric materials to harvest energy from walking. Piezoelectric materials have been placed on shoes to harvest energy from the impact of a foot hitting the ground. (Shenck & Paradiso,

2001) An energy harvesting system was designed by researchers at MIT which used a dynamo-based system inside a person's shoe to generate energy resulting in a peak output of 1.61 W and an average of 58.1 mW across the entire gait, well below the desired 250 mW. (Hayashida, 2000)

Walking has been a large focus of energy harvesting due to increasing mobile power requirements. Another area of focus within the walking motion, other than harvesting the energy from a person's foot striking the ground is the bending motion around the knees. A "Biomechanical Energy Harvester" was developed by researchers at Simon Fraser University which capitalizes on the motion around a user's knees. Energy is harvested through two 3.5 lb. devices that a user would wear around their knees, similar to knee braces. In preliminary tests, the device has shown the capacity to generate up to 5 W of power without hampering the user's gait – enough energy to charge ten cell phones. (Caplan, 2008)

Another example of energy harvesting technology, although not used with humans, is the regenerative braking systems of hybrid-electric vehicles. Regenerative braking systems employ dynamos, which take advantage of the momentum of a car when braking. In order to bring a car to a full stop, a torque must be applied to the axles to counteract the forward motion of the car. In a standard vehicle, the torque is applied by the disc brakes, mainly in the form of friction, which dissipates the forward motion of the car in the form of heat and vibration. In hybrid cars, the braking torque results from the electric motor powering the car being run in reverse, and operating as a dynamo. (Rocky

Mountain Institute) The dynamo turns a part of the rotational energy into electricity, leaving the rest of the torque to be applied by a conventional braking system.

Another general energy harvesting example is wave harvesters. Wave harvesters are placed into a large body of water and can harvest energy from the turbulence within the water. The central concept of ocean wave energy harvesting is capturing the undulating motion of a wave by using a buoy anchored to the ocean floor. The waves move the buoy up and down, driving a piston to force water into a turbine to create energy. (Cheung J. T., 2004), (Cheung & Childress, 2007) It was found that this is in fact a feasible method of power generation, and more research is being currently conducted on how much energy could be generated and on what scale. (Von Jouanne, 2006)

Historically, human energy harvesting has extended beyond generating energy, and has been used to perform mechanical actions. Researchers in the nineteenth century studied prisoners in a New York prison as they were made to walk on a rudimentary treadmill – a long rotating wheel with notches for stairs that the prisoners had to operate together in synchronization. (Palmer) Each prisoner generated approximately 100 W of energy, and this manual energy was used to grind the grain for bread at the prison. (Dotinga, 2007) Unlike the aforementioned human energy harvesting examples, the prison treadmill was very large and not portable.

Researchers at MIT developed a stationary energy harvesting device in a piezoelectric floor which generated power when walked on. (Paradiso, Abler, Hsiao, & Reynolds, 1997) The relative success of the piezoelectric floor can be attributed to the fact that it is a stationary device. Stationary devices effectively remove the size and weight constraint on a device, and take advantage of a large group of people as opposed to a single person using the device. In contrast, mobile devices such as a pair of piezoelectric shoes will only harvest energy from one person. An entire floor of piezoelectric material will harvest energy from each step of every person walking across it. Even if the floor proves to be less efficient at harvesting a single person's energy, proper placement will permit it to overcome this challenge through sheer force of numbers. The power generated by one person walking is insignificant in comparison to the thousands that walk across a single surface in a high traffic area.

An example of piezoelectric floor technology can be seen in the Japanese railway system. Researchers implemented a piezoelectric floor into two of Tokyo's busiest train stations hoping to capitalize on the amount of people moving through their gates daily. Their research showed that an average person can generate 0.1 W in the single second it takes to walk across the piezoelectric mat – this energy multiplied by the hundreds of thousands of people who walk through the station daily can significantly reduce the power consumption of the train station. (Ryall, 2008)

One of the most important elements of harvesting human energy is the action targeted for energy harvesting; it must be an action that can be exploited with a minimum detriment to the user. Examining the energy balance of a human action, the maximum energy harvested cannot exceed the amount of energy exerted by the person. The total energy balance can be summed as the minimum energy required to perform the action plus any additional energy exerted, minus the amount of energy harvested. Thus if an excess of energy is harvested, a person would have to exert more effort to perform the same action.

The main impedance to the wide-spread implementation of energy harvesting devices is regarding economy of scale – can an energy harvesting system harvest enough energy to offset the initial cost, and is the cost per kilowatt hour (kWh) comparable to current energy generation methods? Another concern involves the physical scale of the device itself – the amount of electrical energy that can be harvested is limited by the amount of mechanical energy exerted. However, if too much electrical energy is desired, the harvesting device may impede the natural flow of the mechanical motion. One common example of energy harvesting is a self-winding watch – the self-winding mechanism harvests the motion of a person's arm. Yet, if the electrical output of the self-winding mechanism was to be increased to power larger devices, the physical size of the watch would have to be scaled accordingly; quickly reaching the upper limits of what is tolerable in terms of watch size. (Kuo, 2005)

Despite these detractors to energy harvesting, there is a strong urge to develop methods for energy harvesting to improve the life cycle of electronics. Although advancements in technology have spurred the development of smaller, low-power devices, every one of these devices is constrained by its power source. Batteries have not evolved at the same rate as other technology. While technology as a whole has continued to become smaller, batteries are still bulky and heavy. (Lester, 2005)

One organization with a vested interest in energy harvesting technology is the military. The military has funded many projects in the past decade hoping to be able to generate energy on-site through energy harvesting. As the battlefield grows to become highly entrenched in technology, the weight of the batteries necessary to power all of the devices has become increasingly high, spurring funding into energy harvesting. Projects include a Microhydraulic Transducer (MHT) which generates energy when the heel of a shoe strikes the ground by compressing fluid within the shoe and forcing it into a micro-turbine. (Steyn & Hagood IV, 2003) The project originally set out to generate 1 W of power; however the prototype device could only generate 1 mW of power. The researchers concluded that although they came far short of the design goals, they were met with unaccounted design limitations and in future iterations of the device, a 1 W power output could be achieved. (Lester, 2005) Similar attempts have been made to generate energy using piezoelectrics instead of dynamos. The United States Army developed a device that can generate up to approximately 0.1 W per step, but this was well under the 0.5 W target set by the researchers. (Howells)

Another military-backed project carried out by the University of Pennsylvania's Department of Electrical Engineering explored routes of energy generation by using a backpack. The idea behind the project was to harvest the strain in the backpack straps as a source of energy using piezoelectric materials.

The project was able to prove that if used correctly, the electromechanical conversion efficiency, a measure of how much mechanical energy can be converted into electrical energy, of this energy harvesting system can be higher than the electroactive material itself. (Zhang & Hofmann, 2005) This research spurred interest since the constraint involved with the use of energy harvesting materials can be overcome by properly implementing the materials into the harvesting system.

Research conducted by the University of Pennsylvania (Lester, 2005) and the University of Michigan (Kuo, 2005) explores energy harvesting with a backpack by using the "bobbing" motion of a person as they walk, translating the whole-body motion into a source of energy. Essentially, both designs allowed the backpack to slide up and down on a frame, harvesting the linear motion as a form of energy. Researchers found that between 4 W (Kuo, 2005) and 7.4 W (Lester, 2005) of power could be generated from an energy harvesting backpack, which is enough to power several devices simultaneously. Another finding of interest, by the University of Michigan team, was that an energy harvesting backpack actually decreased the amount of energy it takes a person to walk Interestingly, the vertical motion of the backpack along the frame actually improved the efficiency of walking, using the momentum of the backpack to "lift" the person up when they are lifting their legs up. (Kuo, 2005)

A similar US Navy project designed a backpack which generated power from the oscillating motion of a person's gait. (Rome, Flynn, Goldman, & Yoo, 2005) This device was designed for the US Navy to supplement power needs of a soldier. Soldiers can carry upwards of 80 lbs. of equipment ranging from night-vision goggles to GPS instruments, and an additional 20 lbs. of batteries to power that equipment. By harvesting the energy from the up-and-down motion of the backpack while walking, up to 7 W of energy can be generated, which is more than enough power to support several mobile devices simultaneously. (Roach, 2005)

Military research has gone so far as to try to modify commercial technologies with energy harvesting technology, including the use of hand-crank generators to generate power for soldiers. (Moyers, Coombe, & Hartman, 2004) Hand crank power has been present for years in commercial devices such as flashlights, radios, and even cell-phone chargers (Merchant, 2008), and although this could be considered to be energy generation as opposed to energy harvesting, the need for onsite power generation is still apparent and small scale energy generating technologies are being considered as energy harvesters.

Commercial level technologies that leverage energy harvesting have focused on a wide variety of places. Projects range from harvesting energy as people walk through a turnstile (Power From the People, 2006) to piezoelectric floors that harvest energy from crowds of people walking across them, (Wright, 2007) with all of these commercial level technologies capitalizing on a large number of people passing through a single area over a short period of time. These technologies remain largely untested, and only a few of them have been brought to prototype levels, such as a piezoelectric dance floor. (SunstainableDanceClub,

2007) All of these technologies rely on the amount of energy a user is willing to exert while performing an action.

Energy Harvesting Gym

A convenient and potentially feasible location for human energy harvesting is a gym. The gym equipment is available to help burn off calories and improve muscle function by performing periodic, repetitive motions with varying degrees of resistance. The mass influx of people at a gym provides the ability to generate power at a viable scale, and the desire for actions with relatively high levels of resistance provides an acceptable amount of mechanical energy that can be harvested and converted to electricity.

Compared to other possible locations for energy harvesting in the general public, a gym is a perfectly suitable location. While the devices would have to be modified to allow for variable physical resistance levels, the need to balance energy generation and user discomfort is eliminated as the users can change the level of physical resistance to suit their needs. In a "public" setting, an entire group of people passing through an energy harvesting device would be subjected to the same resistance level. Thus, to meet the needs of all possible users, the resistance level must be kept to a minimum, thereby minimizing the potential energy generation.

One piece of gym equipment that has been redesigned for energy harvesting is an exercise bike. The Human Dynamo HD-4.2 (Figure 3) bicycle was designed to harness the cyclical motion of an exercise bike generating energy. The device itself capitalizes on the driving forces behind exercising – the desire to burn calories by performing repetitive mechanical motions.

Figure 3: Human Dynamo HD-4.2 Exercise Bike (http://www.humandynamo.net/)

System Feasibility

Before considering the use of human energy as a potential power source, two important considerations must be made: the technical feasibility of harvesting human energy and the economic viability of such a system. The research in this paper aims to find the benefits of implementing human-driven energy harvesting technology into a gym.

People intentionally exert mechanical energy when using exercise equipment. Essentially, they pay for the use of equipment that dissipates the energy stored in the form of calories within the human body through the use of mechanical energy. A balance must be struck between the cost of the device and the estimated amount of energy generation, with specific care taken to ensure that the device is cost-efficient and marketable. An analysis of the economic concerns related to an energy-harvesting system must take into account the initial cost of the machinery and power generation/storage systems, the time before a return can be provided on the initial investment, and how much, in terms of annual energy costs can be offset by an energy harvesting system. This data will then be scaled to represent an entire gym. The cost efficiency of the device will also depend on how often the device will be used, how much energy can be generated by the device in a given time period, and the estimated future costs of energy.

The research includes a mathematical model of energy harvesting fitness equipment at the Eppley Recreation Center (ERC). The aforementioned model will be one component in determining the economic feasibility of an energy harvesting system. A survey of potential gym consumers was also conducted in order to determine if energy harvesting would result in increased gym membership. The survey measured respondents' demographics, exercise habits and their perception of an incentive based exercise program. The final analysis not only considers the predicted energy savings of the gym, but also determines the economic effect of any potential influx of customers at commercial fitness centers.

Sustainability at the University of Maryland

The University of Maryland has made numerous efforts towards increasing its environmental awareness and energy efficiency on campus. As defined in the 2001-2020 Facilities Master Plan for the University of Maryland (University of Maryland, 2002) by former Provost William Destler, an

Environmental Stewardship Committee was established to help direct the University towards the development of an environmentally sustainable and aware campus. An Office of Sustainability was also established by the University to oversee sustainability as it applies to all parts of the campus – not only with respect to the environment.

As the flagship campus of the University of Maryland System, the College Park campus serves as a leader for other institutions in their environmental endeavors. The University of Maryland College Park has an annual energy expenditure of over 50 million dollars, and has undertaken many projects to support its environmental sustainability. The University's Combined Heat and Power plant, completed in 2003, was awarded the EPA's 2005 Energy Star Award; the plant is capable of meeting 90 percent of the energy demands of the campus during the summer, and 50 percent of the energy demands during the winter, while requiring approximately 16 percent less fuel per kilowatt-hour as compared to traditional power plants. (University of Maryland: Office of Sustainability)

Other projects include lighting retrofits to buildings across campus, reducing energy consumption due to lighting by up to 80 percent since the projects began in Spring 2008. (University of Maryland: Office of Sustainability) The Department of Recreation Services at the University of Maryland performed a separate retrofit of its facilities to improve lighting systems at the Eppley Recreation Center West Gym and Ritchie Arena, with savings estimated to be approximately 10,000 annually. (University of Maryland: Office of Sustainability)

Ranging from lighting retrofits to on-campus energy generation, the University has dedicated itself to becoming an energy-efficient institution. In addition to retrofitting systems across the campus with current technologies, the University of Maryland established the University of Maryland Energy Research Center (UMERC) in Fall 2006 to reaffirm its commitment to advancing the frontiers of energy generation and storage technologies. (University of Maryland, 2007)

University of Maryland President C. Daniel Mote Jr. signed the American College & University Presidents Climate Commitment (ACUPCC) in May 2006, affirming the University's commitment to the environment. While the ACUPCC is focused on the pursuit of carbon neutrality, its implications to the University are much more widespread, leading to the formation of the Climate Action Plan Workgroup.

The Climate Action Plan Workgroup will devise strategies to minimize greenhouse gas emissions. The greenhouse gas inventory, as measured by the Center for Integrative Environmental Research (CIER) in the School of Public Policy, concluded that the majority of campus emissions come from purchased electricity, on-campus steam and electricity generation, and transportation including commuting and air travel. These metrics of greenhouse gas emissions will serve as a key consideration for future planning on campus. (University of Maryland - Office of the President, 2008)

Student involvement in environmental stewardship has increased in recent years, culminating in several campus-wide programs and initiatives. One such program is Recyclemania, which is a nationwide competition between colleges and universities to promote waste reduction activities on campuses. (RecycleMania, 2009) The University also instituted the "Feed the Turtle" program in 2008, with goals to increase the recycling at home football games by 65 percent, and compost an additional fifteen tons of material during the 2008 football season compared to the previous year. (UM Newsdesk, 2008)

As part of its ongoing green dining focus, University Dining Services and partner Freshens opened the "Energy Zone" on September 29, 2008 in the Eppley Recreation Center, where they debuted the "ecotainer® cup - the first renewable, compostable paper cold cup in the United States." (Freshens, 2008) Additionally, Dining Services has replaced all of its polystyrene containers with the biodegradable alternatives including Bagasse, a sugarcane-based polystyrene alternative. (University of Maryland: Office of Sustainability)

The University's actions in environmental stewardship have not gone unnoticed, being ranked among the top fifteen "Green Colleges and Universities," worldwide, in 2007 by environmental magazine Grist. The publication was particularly impressed by "91 percent of undergrads [voting] to raise student fees in order to pay for clean energy, when tuition and fees are already at record highs." (15 Green Colleges and Universities, 2008) Partnering with the United States Environmental Protection Agency, the University of Maryland also hosted the second Smart and Sustainable Campuses Conference in April of 2007 -

making it the host of three such major sustainability conferences since 2003. (Society for College and University Planning, 2007)

Project Evolution

Team HEAT formed in spring 2006 with the original goal of designing a human-energy harvesting device. A literature review revealed many projects that sought to convert mechanical energy generated by human beings into electrical energy. One simple example is a flashlight that generates electricity when shaken. It uses a dynamo to convert the mechanical "shaking" motion into electrical energy which powers the flashlight. Another example involves a backpack that charges batteries from the oscillating motion the backpack experiences due to the carrier walking. (Rome, 2005) More complex projects involve the use of piezoelectric technology, another form of mechanical-to-electric energy conversion. Examples of these types of technology are piezoelectric dance floors and sidewalks that can generate electricity as people step on them. (Paradiso & Starner, 2005)

During the first six months of the research, many possible projects were evaluated. One consideration was a device that would harness electricity from the rotational energy of turnstiles pushed as people walked through. However, it was difficult to define an appropriate amount of energy that a user would be willing to exert to generate a maximum amount of energy. Additionally, it was unclear if a significant amount of energy could be generated by such a system, due to the non-continual use of turnstiles. The feasibility of building such a device was considered, but it was ultimately found that the energy generation would not suffice because of the limited use of turnstiles. A similar idea involved using a revolving door as a generator, generating electricity as it was pushed – however most revolving doors researched are independently powered, making energy generation from a powered device a fruitless concept. In spring 2007 it was decided that gym equipment, specifically cardiovascular exercise equipment that utilizes rotational energy, would be a good medium to conduct the project, since people are willing to exert energy at gyms. Using a gym eliminated the constraint of finding an "appropriate" amount of energy to try to harvest, due to the fact that people would be able to set that level on their own, as resistance levels on exercise equipment are set.

After Team HEAT's decision to focus on gyms, several different types of cardiovascular equipment were considered before the exercise bike emerged as the most promising. The exercise bike was favored over other equipment such as the treadmill because it required little to no electricity during operation. Moreover, compared to similar rotational equipment such as the elliptical or the rowing machine, an exercise bike is typically operated at a continual rate. Rowing machines suffer from being operated in "pulses" as the user pulls back, which may adversely affect energy generation. Likewise, the configuration of elliptical machines may make it harder to retrofit. It was decided that the research would initially focus on one device, and spread to other machines given appropriate time and resources.

The initial intention was to conduct a survey of both gyms and users, in addition to designing an actual device that would attach to a stationary bicycle and convert a user's mechanical energy into electrical power, culminating in a working prototype. As the project progressed it became more apparent that the team was ill-equipped to design a complete energy harvesting system, due to a lack of engineering expertise and resources. This realization resulted in a dramatic shift of focus – rather than developing an energy harvesting device, the team would instead analyze the benefits of such a device based on proposed specifications. Additionally, rather than surveying multiple gyms about their equipment usage patterns, it was decided that the Eppley Recreation Center would become the focus of the study due to its proximity and accessibility.

The Eppley Recreation Center

The new project direction required a significant amount of data in order to perform the necessary calculations to determine the potential impact of an energy harvesting device. Based on this, the project's scope was modified to examine the Eppley Recreation Center as a case study example. The Eppley Recreation Center (ERC) is located on the north side of the University of Maryland, College Park campus. It is the largest recreation center on campus with four levels and a diverse array of facilities. The ERC's size and popularity makes it suitable for this study. By sampling the ERC across an entire year, data can be averaged to account for any anomalies.

The ERC houses several facilities, including a track, fitness room, weight room, martial arts room, table tennis facility, aerobics room, racquetball and squash courts, instructional and deep-water pools, saunas, locker/shower facilities, an equipment issue service, Pro Shop, the Center for Health and Wellbeing, Sneakers Café and lounge, as well as the Campus Recreation Service (CRS) Member Services Desk and staff offices.

The bottom level is made up primarily of an Olympic size pool equipped with audience bleachers, diving boards, and segmented swimming lanes for competition. This level is also the site for equipment rentals, locker rooms and a sauna. The first floor contains basketball, racquetball, and squash courts as well as a weight room. Most of this floor is comprised of the four full sized basketball courts. Occasionally, these courts are converted into volleyball courts. In addition, this floor contains an equipped aerobics room, food and beverage café, and a Pro Shop.

The second level is the main entry level and as such does not contain much exercise equipment. However, the weight room from the first floor extends into the second floor, though access is limited from the second floor. It also is the site of several member services staff desks. The third floor consists of a running track over the lower level basketball courts as well as cardiovascular exercise equipment such as treadmills, exercise bikes, and ellipticals. It also contains private exercise rooms used for martial arts, aerobics, and other activities.

Focusing on a single gym allowed the group to obtain very specific statistics, but would not prevent the team from standardizing the information so that it may be applied to other gyms. With the help of the ERC staff and the University of Maryland facilities management, the team was able to obtain very useful information such as the gym's energy expenses, complete inventory, and usage numbers.

Project Goals

The goal of the research was to determine the benefits of an energy harvesting system when implemented into gym equipment. The harvested energy would be used as a supplemental power source that could contribute to the energy demands of the ERC. The intended outcome was to provide the ERC with a supplemental energy source that would be both cost and energy efficient. It was determined that equipment which employed a simple, circular motion, mainly exercise bikes, is the most efficient and easily adaptable piece of equipment that could be used to generate power. The effectiveness of any energy harvesting technique is dependent upon the existing clientele that uses exercise bikes at the ERC, with the amount of energy harvested being directly proportional to the number of hours and the resistance level at which the exercise bikes are used. In addition, it was necessary to determine if the increased demand for energy harvesting exercise equipment would boost equipment use, thereby increasing the total energy-harvesting output that would be available to the gym. An increased customer base would also increase the membership dues that a commercially operating gym would collect.

To perform a thorough analysis of the feasibility of energy harvesting at the ERC, various statistics were used. One of the primary variables that need to be determined was how much energy could be generated from exercise bikes. This information is based on several factors, including the total number of hours a bike is in use and the total number of bikes used. The project aims to determine how much energy could be harvested and stored from bicycle use, and how much it would contribute to the overall energy supply necessary to power the building. Various other statistics, as outlined in the methodology section, were used to answer more specific questions concerning the effectiveness of energy harvesting. Additionally, the feasibility of such a system was examined with respect to the current and potential gym users to gauge the potential interest in such a system.

Chapter 2: Methodology

Survey Methodology

The first research method adopted by the team was to conduct a survey in order to determine trends within gym users attending the University of Maryland in College Park. A descriptive survey was used to allow for the collection of data that can be quantified and used to find patterns in public opinion. (Burns, 2000) These patterns would help gym owners predict whether or not their consumer base would be accepting of energy harvesting. Without consumer acceptance, it would be pointless for a gym to incorporate the dynamo technology into their exercise equipment; before adopting an environmentally friendly means of energy harvesting, gym owners need to ensure that they would be able to retain and attract consumers. The driving force behind a business is to turn a profit, and gyms are no exception. Without gym users paying to use the facilities, there is no way for a gym to maintain its equipment, pay its employees, or generate a profit.

Creating the Survey

The generation of a survey that would be both user-friendly and provide comprehensive results was the essential component of the survey methodology portion of research. Before writing the survey, a list of important questions was brainstormed to help guide the focus of the survey:

- How long and how often does a typical person exercise?
- Would people be more or less likely to join a gym using energy harvesting technology?

- Would people be more or less likely to join a gym using energy harvesting technology if their gym membership rates increased? Decreased?
- Would gym users be more willing to join a gym using energy harvesting technology if incentives were offered?
- What demographics are likely to support energy harvesting technology?

Pinpointing the ideal information that would have to be collected to assist in the research process was the first step in drafting a survey. It is important for the survey to have the capacity to generate meaningful results that will assist the research. At the same time, the survey should be concise and easy to understand in order to get participants to take it seriously and answer truthfully, according to their own opinions. A survey with too many questions can look daunting, and thus, lose the interest of the survey-taker before the process even begins. At the same time, the questions need to be thorough enough to provide sufficient data to analyze. Considerable effort was used in writing each question, ensuring that the questions were relevant, easy to understand, and concise. The entire survey can be found in Appendix A, however, an explanation of the survey, given in a question-by-question justification is provided below.

The survey started with a broad question to determine if the survey participant works out in a gym. This simple yes or no question was designed to divide results into two groups: people who actively work out in a gym and people who do not. Both groups were surveyed to determine if there was a difference in perception about energy harvesting exercise equipment based on students' current exercise habits. People who do work out in a gym are expected to have differing opinions about the potential energy harvesting technology than people who are not as familiar with gyms.

For those that answer 'yes' indicating that they work out at a gym, three additional questions are provided to determine the extent to which each individual uses a gym. These questions include the number of days per week the student attends a gym, the amount of time spent on cardiovascular workout equipment, and whether or not the student belongs to a gym at home when school is not in session. The purpose of determining how many days a week the student attends a gym and how much time is spent on cardiovascular equipment provides an indicator of how much usage this equipment will receive. If most people work out five days a week, for an average of one hour per day, energy harvesting technology will receive much more use than a similar scenario where people only work out once a week for twenty minutes.

These results will provide information on the amount of energy that could be harvested from current gym patrons. The third follow up question regarding whether or not the individual belongs to a gym outside of the University of Maryland ascertains how many of the gym users only exercise at school. This can help put the ERC into a frame of reference; do people only work out because the ERC is viewed as "free" and easily accessible? A higher percentage of people that work out at home will lead to favorable results, because the commitment to working out is carried throughout an entire year, as opposed to only the time that a student is on campus.

The next two questions are follow-up questions for people that answered 'yes' to whether they belong to a gym at home. This sub-group is asked to answer similar questions as before, such as the number of days per week the student attends a gym and the amount of time spent on cardiovascular workout equipment. The main reason for the preceding questions is to gain a background on survey participants. These two questions provide information on whether or not most college-aged individuals that work out at school also work out at home by paying a membership fee to another gym facility. All of the aforementioned questions ask about the past or present exercise routines of the survey-taker. The second half of the survey revolves around the survey-taker's workout expectations and how the potential presence of energy harvesting fitness equipment will impact gym membership preference.

The following section begins by asking the survey-taker about their post-graduation exercise habits, and if they are planning on joining a gym near their home, workplace, or school. This is a yes or no question that will help divide the survey participants in order to estimate future gym attendance. For people that answer 'yes,' four additional questions are asked and participants respond by circling a number on a scale from 1-10 to illustrate their degree of willingness. A '1' would indicate the participant is not likely to use energy harvesting gym equipment, whereas a '10' indicates the participant is very likely to use energy harvesting gym equipment. Choosing '5' or '6' represents relative neutrality where the participant is more or less indifferent to the idea. The first of the final four questions provides a description of energy harvesting technology and is incorporated in the survey to see if there would be a willingness to use such equipment if it were stated that the equipment would not affect their workout experience. This question determines if gym users are interested in this technology and if gym owners should implement energy harvesting technology into their gym equipment. The next question has a broader scope and asks about the likelihood of joining a gym with this technology over a traditional gym that uses regular equipment. Rather than determining if the individual would use the equipment, this question investigates whether they would choose a gym that integrates energy harvesting equipment over one that does not, assuming that there are no cost differences in membership prices. Depending on the results, this data could be used to persuade gyms to implement an energy harvesting system.

The last two questions in this section deal with monetary factors to determine if reduced fees or extra costs would change the decision regarding which gym a person joins. The first question explicitly asks whether the person would be more willing to choose a gym that offers equipment that could generate electrical energy while at the same time being offered a reduction in their membership rates over a gym that uses regular equipment. Results from this question show whether survey participants would be strongly against harvesting technology even if it leads to cheaper gym membership rates. This question seeks to confirm the common belief that given two options to save money or not save money, most people would choose the former. Therefore, it is also assumed that someone choosing a value of 1-3 on this question would be against the entire concept of energy harvesting. Similarly, the last question seeks to determine whether or not a person would be willing to pay higher membership rates at a gym if it offers equipment that could generate electrical energy. Again, one would expect that a traditional consumer would choose the least costly version. It is assumed that a person that gives an answer greater than '6' to this question has a serious interest in energy harvesting fitness equipment. They may believe it is worth the extra money to use equipment that is environmentally friendly. All four of these questions will determine whether there is enough support from gym users to implement energy harvesting devices in fitness centers and how much do monetary factors influence their decision.

Lastly, for people that previously answered that they do not have plans to join a gym after graduation, three follow up questions were presented. The three questions are very similar to the ones asked to the survey participants that indicated that they plan to attend gyms after college. The first question asks if the person would be willing to join a gym after graduation if it offers equipment that could generate electrical energy. The second question probes the extent to which one would be willing to accept higher membership rates at a gym if it offers equipment that could generate electrical energy. Lastly, the third question examines the willingness of the survey participant to receive incentives at a gym to use equipment that could generate electrical energy. These questions are included to see if this new technology could sway the opinions of people who originally did not plan to activate a gym membership upon graduation. Again, positive responses to these questions would demonstrate that energy harvesting technology has commercial appeal along with an environmentally friendly appeal.

Companies are always looking for ways to expand their customer base and persuade new customers into the market. The installation of energy harvesting technology would be a possible way of accomplishing that goal.

Although the questions were drafted before the collection of data from the ERC at the University of Maryland, the responses remain just as beneficial in determining how a population would respond upon learning energy can be harvested through human-mechanical movement. After drafting the original survey, a sample group of approximately forty individuals was surveyed to check for understanding and comprehension of the questions. These survey responses are not included in the final survey results. Following feedback and edits to the original survey, a final copy was submitted to the University of Maryland Institutional Review Board (IRB). Approval was needed in order to use information gathered from human subjects for research purposes. (Appendix B) As part of this process, each survey participant was required to sign and initial a consent form. This signified that filling out the survey was completely voluntary, and no personally identifiable information would be recorded. Upon receiving approval, approximately five months were spent distributing surveys and tabulating data.

Surveys were distributed throughout the campus community with a focus on undergraduate students. Participants were allowed to complete the survey in privacy. Moreover, the consent form (Appendix C) was separated from the survey questions when they were collected. This helped to enforce the anonymity of the research data. Each survey was assigned an identification number for verification purposes. All of the survey information was entered in a common web-based spreadsheet document. This allowed team members administering the surveys to concurrently enter information into the same document, in real time.

ERC Methodology

In order to evaluate the effectiveness of a human-driven energy harvesting system, the workings of a gym lacking this technology must first be understood. To determine whether or not energy harvesting technology is beneficial, it is necessary to know the difference between a gym that harvests human energy and one that does not. Therefore, it was decided that using the ERC at the University of Maryland as a case study would be the best course of action. The ERC was selected because as part of the University, it would be possible for the team to obtain more detailed information than would be possible from an unaffiliated gym. It would be much easier to obtain data on items such as inventory, electricity usage, and attendance figures; competitive information less likely to be shared by a commercial gym.

While performing the case study to examine the feasibility of energy harvesting fitness centers, many questions must be addressed. The goals of the modeling portion of this research aim to answer the following:

- What are the ERC's annual energy costs, and how do these costs vary throughout the year?
- How much energy is likely to be harvested with the proposed technology?
- How much money could energy harvesting save the ERC over a given time period?

- What would the initial cost be to implement energy harvesting technology?
- Does a correlation exist between energy usage and gym attendance?
- Do enough people currently visit the ERC to make the implementation of energy harvesting worthwhile?

Identifying Power Usage

To identify the impact of energy harvesting at the ERC, it is necessary to analyze the gym's current energy consumption. Once the current energy usage is known, it becomes possible to calculate how much of a contribution human energy harvesting technology will make as a percentage of the total used by the facility. The data employed to analyze energy use at the ERC was exported from energy analysis software developed by Itron Incorporated, "the world's leading provider of solid-state meters—electricity, water, gas and heat—and data collection/communication systems, including automated meter reading (AMR) and advanced metering infrastructure (AMI) technology." (Itron, Inc., 2009) On July 28, 2005, Itron Inc. announced "a contract with the University of Maryland … to provide the university with Itron's Enterprise Energy Management (EEM) software solutions to help reduce energy costs and improve conservation on campus." (Itron Inc., 2005) The University of Maryland is not unique in its employment of Itron's EEM software; other contracted universities include Clemson University, Stanford University, San Diego State University, and the University of California-Irvine.

Itron's EEM software has a proven track record of saving organizations money by providing data to predict energy trends accurately, in order to manage power consumption and save money. According to a case study conducted by Itron Incorporated, California State University at Long Beach (CSULB) was able to save more than 2.5 million during the 2001-2002 academic year by taking advantage of the data and analysis techniques embedded in Itron's EEM suite. Employing the EEM suite as part of an overarching energy strategy, CSULB has been able to maintain consistent energy usage of approximately 77,000 British thermal units per square foot (BTU/sq. ft.) compared to 'the national average for similar institutions,' 175,000 BTU/sq. ft. (Itron Inc., 2006) The meter tracking data provided by the software suite proved especially helpful when analyzing the power usage at the ERC and the potential effects of energy harvesting fitness equipment.

It is worth noting that despite the vast capabilities of the Itron software, only few of the available tools were relevant to the research. Although much of the information was initially graphed and examined, it eventually became apparent that a majority of the trends noticed have no real bearing on the implementation of energy harvesting. A certain amount of power will be generated based on how much time the energy harvesting bikes are in use, and it does not matter during which months energy usage spikes or precisely what time of day it peaks; the total energy used over specific time periods are the most important figures to focus on since these can be compared to the energy harvested over the same timeframe.

The electricity usage of the ERC, measured in kWh, is monitored by two separate meters whose values can be summed to analyze the consumption of the building as a whole. Itron provides a variety of power meters that typically have the capability to record consumption in five-minute intervals. These measurements can be transmitted in a variety of ways to a 'collector unit' that then would transfer the data to a central data storage device. While not significant to this research project, Itron's metering technology also records natural gas and water activity. Once the data is stored on a central server, Itron's EEM suite can be used to view and analyze consumption trends. In addition to being viewed online, the data can be downloaded, allowing for further analysis without certain restrictions inherent to the Itron software. For this investigation, both options were utilized in analyzing energy summaries for the ERC.

Downloading the numerical values for energy usage is required because although the charts produced by the Itron software are helpful, the user has a very limited amount of freedom in how they are displayed. For example, there is no option allowing the selection of which values are used on certain graph axes making direct comparisons difficult, and it is impossible to get the charts produced by the software to exclude zero values, which are errors in detection. Once downloaded, the data can be broken down into various time periods of interest and from this, general trends can be observed concerning energy use throughout the academic year.

ERC Attendance and Usage

The ERC at the University of Maryland serves a client-base of over 30,000 unique users, which provides an excellent site for implementing energy harvesting technology. A large population of gym users will ensure that the exercise equipment with energy harvesting technology will be in constant use. To understand the benefits of implementing such technology, its overall impact must be assessed on several key factors. These factors include the ERC's average daily attendance, equipment usage patterns, types of equipment that could be adapted for energy harvesting, and the energy generating potential of a single person.

To begin the analysis, data was collected from the ERC regarding average daily attendance. The ERC regularly collects attendance data on an hourly basis for each exercise area. Due to the scope of the project and analysis of data across an entire year, hourly data was deemed too specific and daily attendance was used instead. The attendance data provided by the ERC was specifically for the "Fitness Center," the upper level of the ERC which holds a majority of the aerobic exercising equipment, including exercise bikes. This data is collected by the ERC staff for internal purposes, and consists of "head counts" of the Fitness Center Area (FCA). The ERC provided daily counts of the FCA, from September 1, 2007 through September 1, 2008 for a total of 354 days; the ERC was closed for business for a total of 11 days: on September 29, 2007, November 22, 2007, and December 22, 2007 through January 1, 2008.

Examining the attendance data might reveal certain trends about when students exercise throughout the year, which can inform the ERC about peak equipment usage times. Additionally, knowing the number of people who use the FCA is necessary in order to calculate how much energy the facility could potentially generate over a given time period. The attendance data can be combined with energy usage data, making it possible to determine if the two are correlated. This is important for estimating any secondary consequences that may arise from new users hoping to use energy harvesting equipment.

Chapter 3: Results and Discussion

Survey Results

With an online database of all survey responses, numerous statistics were calculated. Calculating an arithmetic mean gave the average response for each question. Since all questions were answered by circling a number value, determining if any outliers occurred was not necessary. Although there was a set range for every question, calculating the standard deviation quantified the spread of answers. Since survey-takers could not give open-ended responses, these values were straightforward for further calculations.

After calculating the statistical measurements for the entire group of surveys, the surveys were categorized for correlation purposes. The data was mainly categorized by gender and race. By separating the surveys based on demographic information, statistics for various groups can be compared. For example, it may be of interest to determine if males or females have a more favorable view of energy harvesting technology. This would be necessary information if a commercial fitness center decided to implement certain equipment. For example, if women have a more positive response than men, a female gym such as "Curves" may be more interested in the technology than a recreation facility that draws from both genders such as "Gold's Gym." Once the survey results were analyzed, it became possible to draw certain conclusions regarding workout behavior and potential marketing ideas.

Of the 600 people that were surveyed, 298 identified themselves as males while 297 responded to be females. A few subjects chose not to specify their gender. Additionally the majority of the people surveyed were between the ages of 18 and 21. Figure 4 shows the breakdown by state, with the overwhelming majority coming from Maryland. New York, New Jersey, and Pennsylvania also comprised a good portion of the total. On average, the males claimed to work out 3.07 days a week, while the females responded with a slightly lower value of 2.70 days per week.

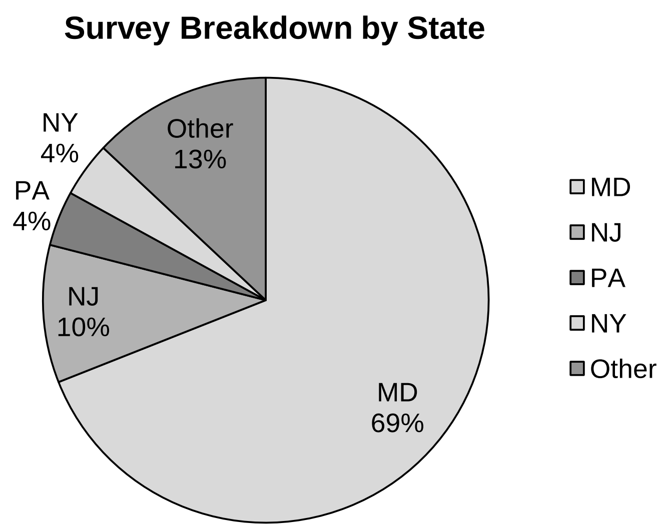


Figure 4: Survey demographics - home state.

One of the primary goals of the survey was to find out the current workout habits of the campus community. Of the 600 participants, 443 people already work out at an average of 2.9 days a week, for an average of 30-35 minutes at a time. Of the 443 current gym users, the results show that 139 of those surveyed display workout habits that meet or exceed this recommended thirty minutes per workout, four workouts per week routine. Those that do not meet the healthy guidelines by working out less than four days per week indicated that they also exercise less than thirty minutes each day.

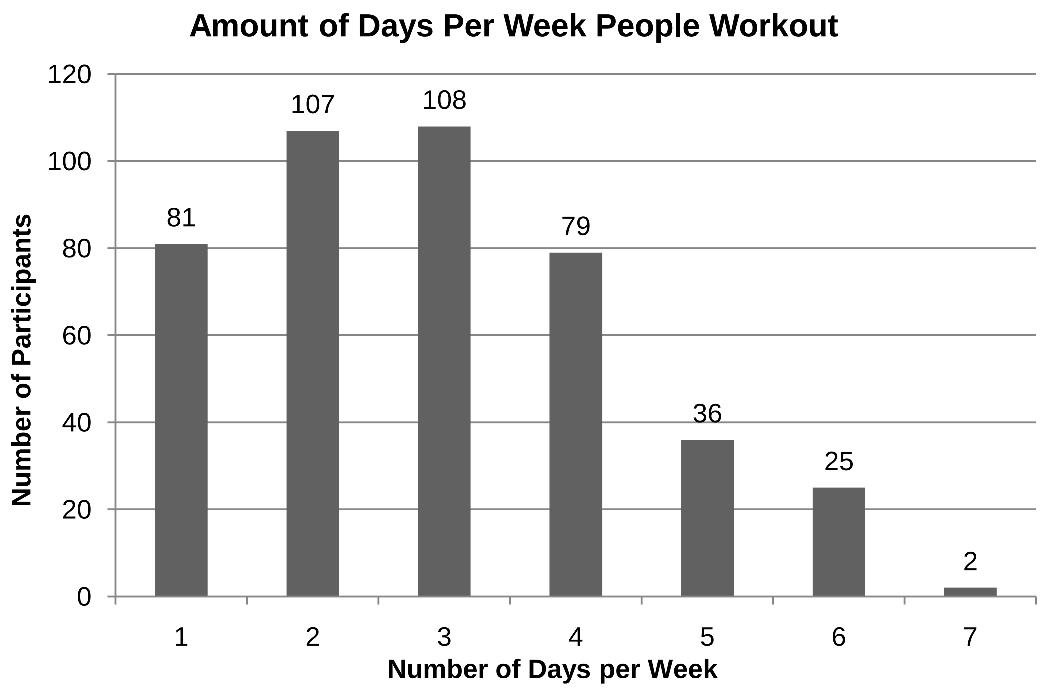


Figure 5: Number of days a person exercises, per week.

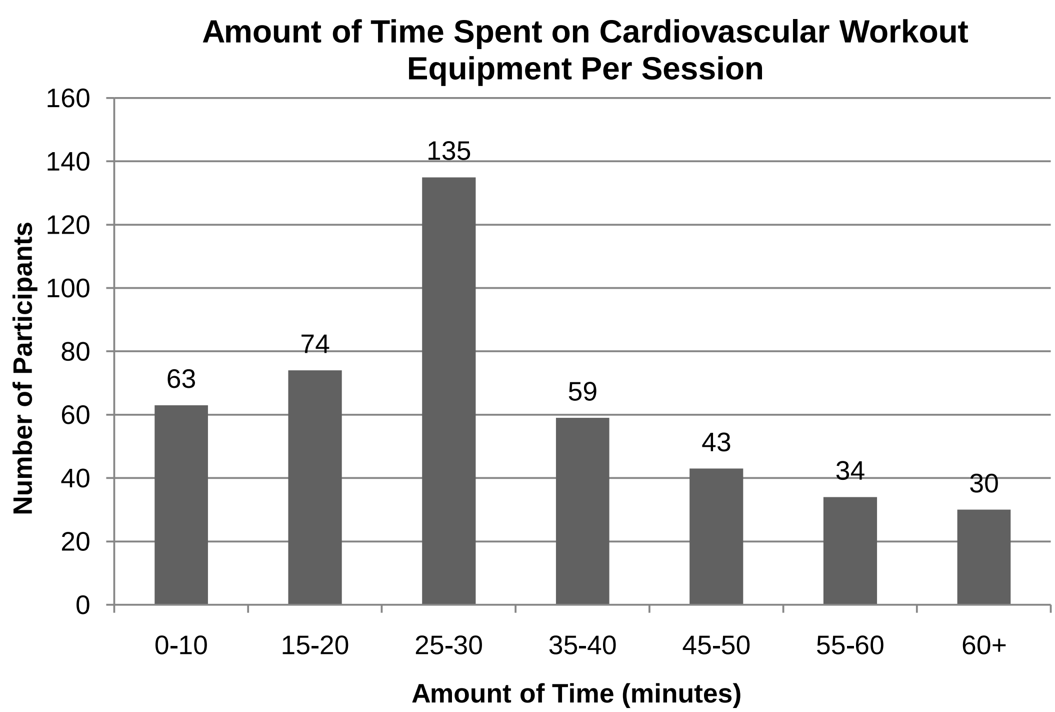


Figure 6: Amount of time spent on cardiovascular equipment per workout session.

Of the people that do work out, 200 responded by saying they work out at a gym at home, as well. This is an important number, as it shows that around half the students who work out on campus are motivated and committed enough to belong to a gym outside of the school year. The survey showed that these people average 3.76 days of exercise per week at home. The higher average can be attributed to the fact that students have more discretionary time when they are at home than when they are away at school. Additionally, this number may be higher as the 200 surveyed students who work out at home could be more committed to exercise than those who do not work out while at home. The average workout time per session, however, stayed very similar to the amount of time spent working out at school. Perhaps students have a routine that they prefer, and will keep as close to that routine as possible regardless of gym location.

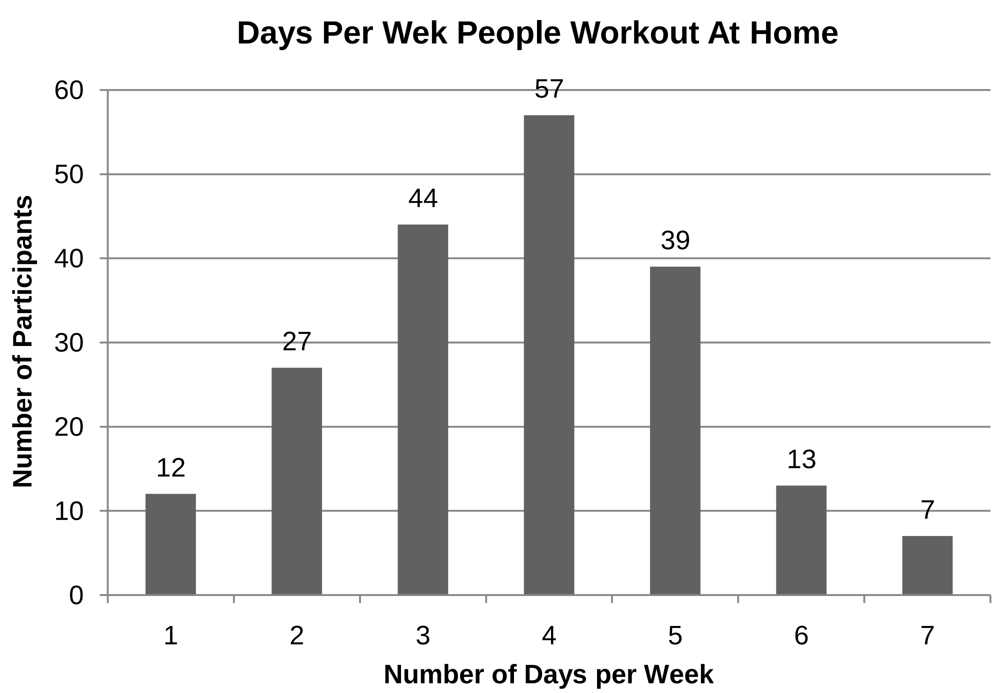


Figure 7: Number of days per week people workout when not at the University of Maryland.

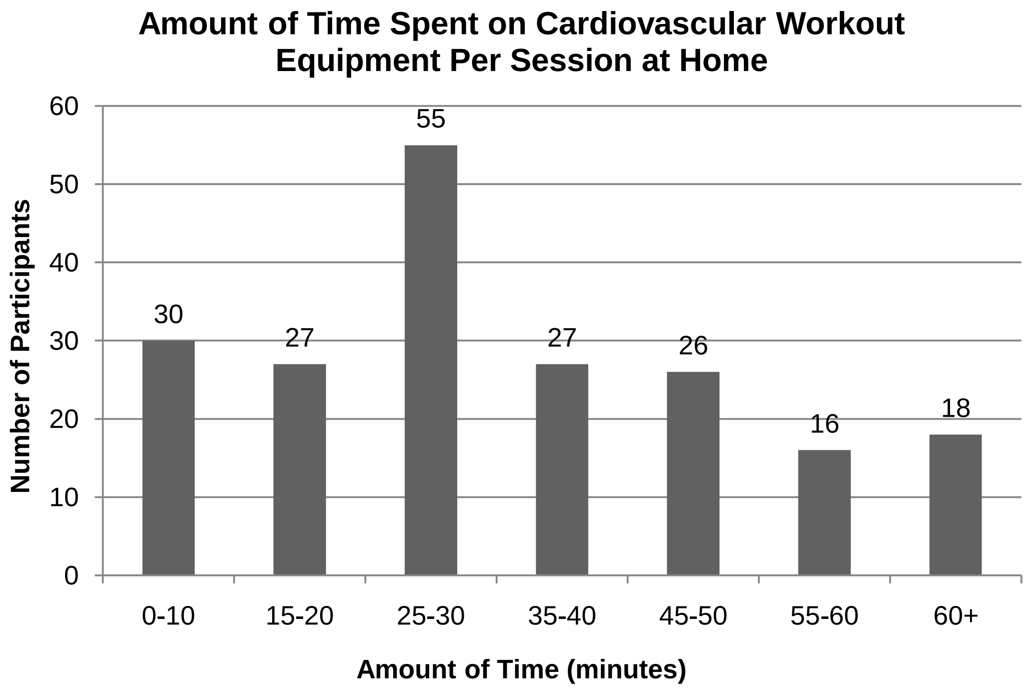


Figure 8: Amount of time people spend on cardiovascular equipment per workout, when not at the University of Maryland.

When asked whether a gym membership was part of post graduation plans, 450 students replied yes. 379 of these students already work out at a gym, which means 64 students, or approximately 10 percent, said they currently do not work out but are planning to in the future. To give some perspective, this means that at a University of 30,000 students, about 3,000 students that do not already frequent a gym are planning to start upon graduation. Only 85 students indicated that they do not work out now, nor do they plan to in the future. These numbers could greatly assist a marketing plan for any type of gym. 75 percent of all people surveyed plan to use a gym post graduation and almost half the people that do not work out now plan to start at some point. This shows a potential increase in the amount of memberships a gym could get in the next few years.

The second half of the survey focused on consumer willingness and likelihood of using a gym with energy harvesting technology versus using a gym without it, with a focus on which factors would affect a willingness to change. A large majority indicated that they would be willing to use gym equipment that harvested human energy, as long as it did not affect their workout. 48 percent of students that plan to join a gym after graduation responded with a score of 10 meaning it is very likely they would be willing to use energy harvesting gym equipment. 75 percent replied with a score of at least an 8 out of 10. Only 4.5 percent claimed that they would not be willing to use gym equipment that generated electrical energy from your exercising.

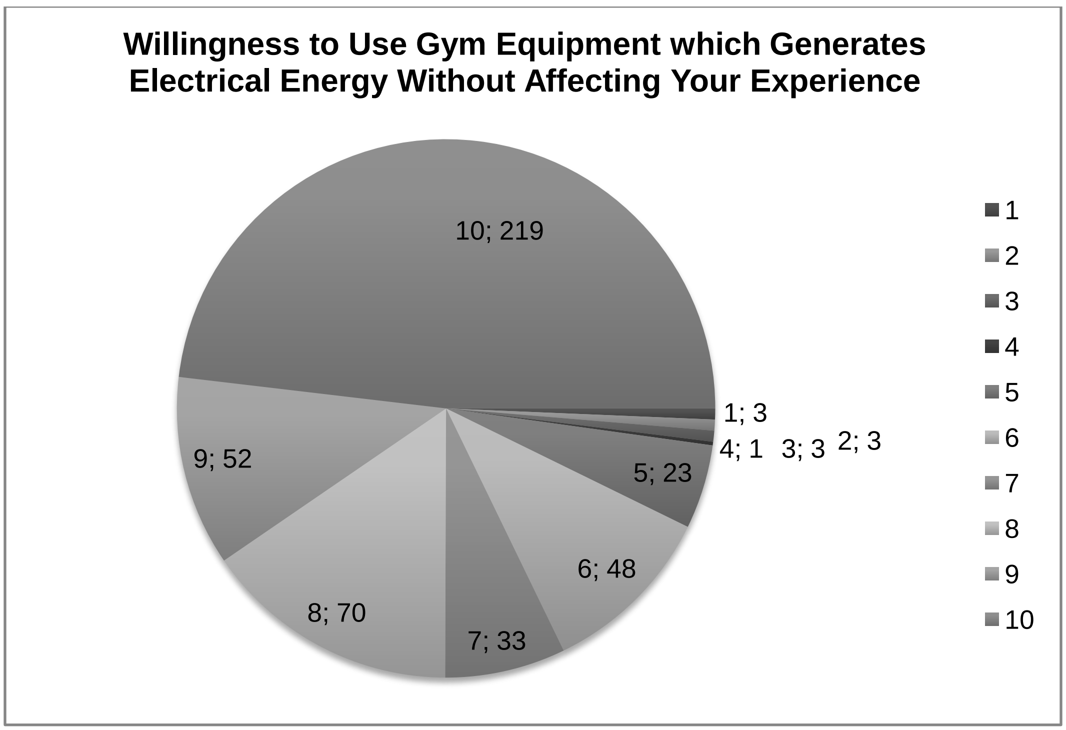


Figure 9: Willingness to use gym equipment that would not affect your exercise experience.

It is one thing to have the willingness to use the equipment, but it is even more important to pursue a gym that features this equipment. The next question focused on whether, given the option of the new gym or their existing gym, they would have the desire to choose this gym instead. The results show that people would be willing to use the gym. Overall, 48 percent answered that they were very likely to choose the gym while only 6 percent said they were unlikely to do so. The remaining survey population was more neutral to the idea.

It is important to understand that a large number of people are neutral to the possibility of change. The percentage of students without a set opinion is a large group that can be swayed with a successful marketing campaign. One marketing approach is to offer customers a lower cost. If a gym was able to offer membership at this gym for a lower cost than a regular gym, those neutral customers may lean towards using this gym. To answer this question, analysis of the survey results once again proves useful. Of the 450 students planning to join a gym after graduation, 376 said they would be very likely to join a gym that reduced membership fees. That is a jump from 48 percent up to 83 percent of the survey group. With the lower rates, only 1 percent of people said they would still be unlikely to use this gym. Of the 29 people that were unlikely to choose to use this technologically advanced gym, 27 were more likely to use it with a membership deduction. These numbers show that it is possible to save money through the use of this technology. Saved money could be put back into the pockets of consumers through gym programs and incentives. The numbers suggest that customers might flock to a gym with this technology.

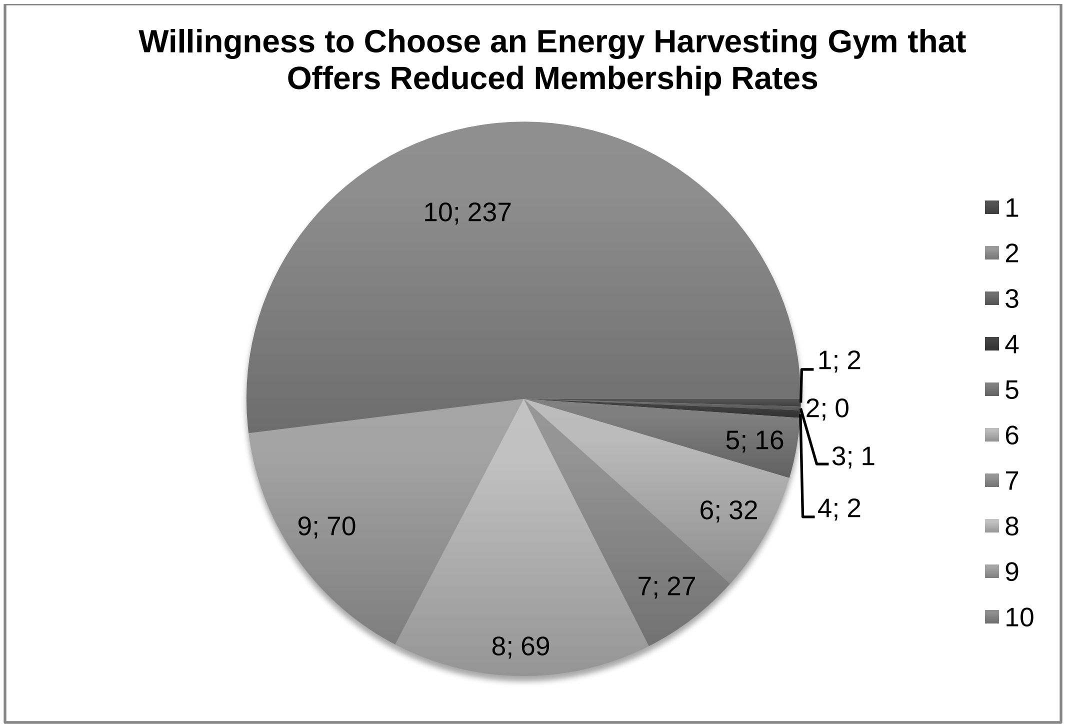


Figure 10: Willingness to join an energy harvesting gym with reduced membership rates.

Thus far, only students that already plan to use a gym post-graduation have been discussed. While the data mentioned satisfies the first aspect of converting regular gym users to this technology, another objective is to persuade those that did not have an interest in using a gym to begin with. This involves bringing in a completely new segment of the population. 29 percent of the 180 students that were not planning on joining a gym indicated that they would be very likely to join if the new technology was implemented. That percentage increased to 50 percent when the question involved the willingness to receive incentives to use equipment that could generate electrical energy. Possessing the capability to capture 50 percent of a new population segment and introduce them to any business could have a large positive impact upon that business. The current college population will be future customers for gym owners and the upward trend is a positive indicator. In an era when many companies are trying to go green, this technology could hit the market in stride. Many of the strongest advocates for this type of change in society are students, and changing membership to a green gym could be one of the first major impacts a student may make out of college.

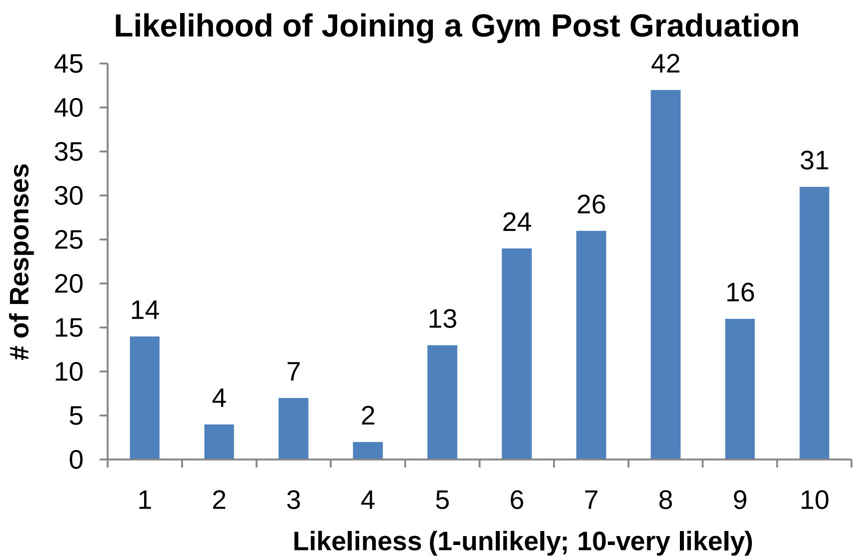


Figure 11: Likelihood of joining a gym post-graduation

Feasibility is an important aspect in creating a business. There are many angles to look at from product design to economic feasibility. Another angle includes figuring out whether the consumer not only wants what is being offered, but also more importantly if the consumer is willing to pay for what is being offered. In searching for this answer, the survey results show that approximately 28 percent of people that answered with a score of 7 or higher for their willingness to use new equipment, also are willing to pay higher rates. However, only the responses of the people that currently work out and have a high willingness to use energy harvesting equipment in general are being considered. It seems obvious that students who do not have an interest in the equipment in the first place will not be willing to spend extra money to use it. However, of the interested participants, over a quarter of them would be willing to spend extra money for a cause that will help the environment.

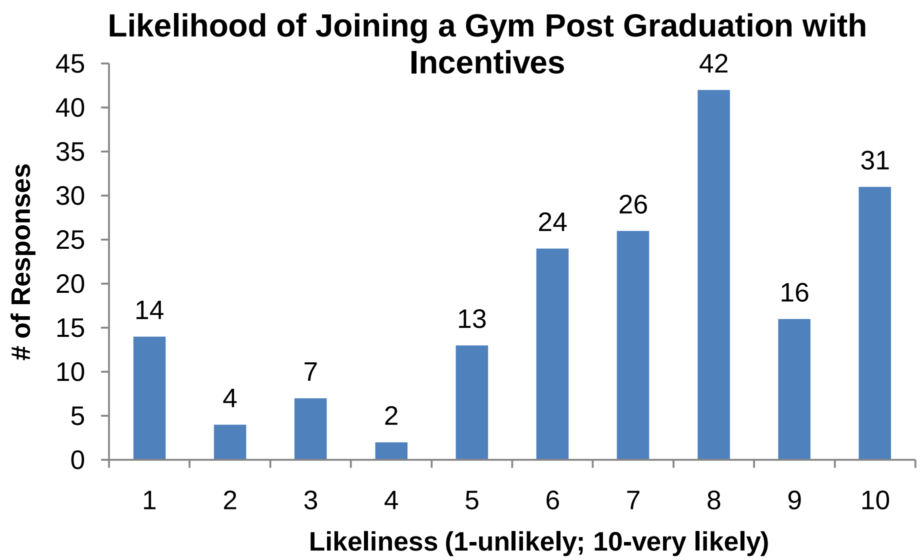
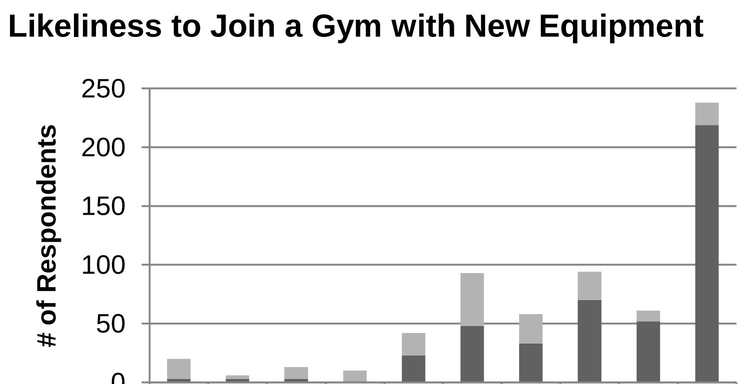


Figure 12: Likelihood of joining a gym post-graduation with incentives.

In comparison, when looking at the results of students that do not currently work out but showed a high willingness (7 or higher) to start working out if this new equipment was available, almost 25 percent of them agreed that they would be receptive to a higher fee. This means that 25 percent of people out of the market are not only willing to come into the market, but are also willing to pay extra to join the market.

On the other hand, 95 percent of the survey population that are not current gym users but would be willing to use the new equipment when they start working out said that they would be happy to receive incentives to use this new technology. Considering that 25 percent were willing to pay a premium for this service, it is not surprising that such a large percentage would be willing to receive incentives.

The conclusion that can be drawn from these statistics is that while the possibility of giving incentives for using the green gym would be ideal, it is not absolutely necessary. If it ends up that it is not economically feasible to give reductions in membership rates to all customers, the green gym could still be a success.



	1	2	3	4	5	6	7	8	9	10
New Gym Users	17	3	10	9	19	45	25	24	9	19
Current Gym Users	3	3	3	1	23	48	33	70	52	219

Figure 13: Likeliness to join a gym with energy-harvesting equipment.

In determining the willingness to use the new equipment that is being marketed, it would be helpful to categorize participants to see if there were any special trends. For example, women are slightly more willing to use this equipment than men with an average score of 8.56 as compared to 8.43 on a scale from 1-10. This is a very insignificant difference and it seems gender does not play a role.

However, an interesting trend was found when separating survey participants by age. There is a negative relationship between willingness to use the equipment and age. There is a clear decline in willingness to use the equipment as age increases. This can be observed in Figure 14 – 18 year old students have a willingness of 8.72, while 22 year olds are at 7.13. This is an interesting observation because it can be concluded that the younger college students are more open to trying a different, more environmentally friendly gym. This is a positive trend because it is the younger generation that will eventually make up a large portion of gym users in the future when this is implemented. To have the support of this age group is vital.

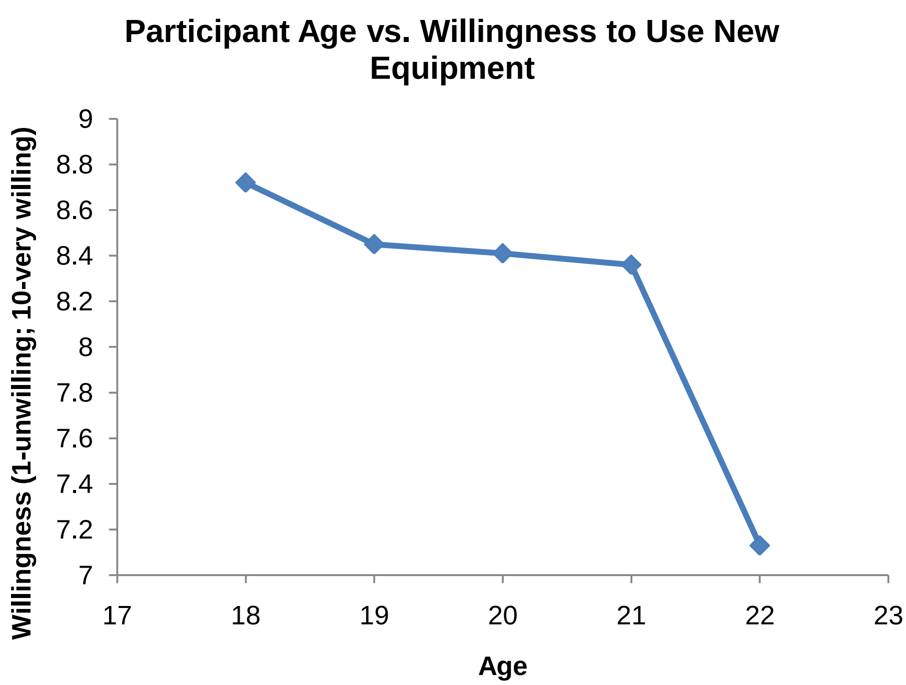


Figure 14: Participant age vs. willingness to use energy-harvesting equipment.

The third way that the demographics were broken up was by race. White and Hispanic students were most willing at around 8.6 and 8.5 respectively. Asian students came in at 8.3 and black students had an average willingness of 7.8. The differences between race may not be very significant and the variance may just be from the different sample sizes.

Survey Limitations

At the completion of survey distribution and data entry, the database was checked for unusable surveys that would improperly skew results. Guidelines were established for discarding a survey, with approximately 5% of surveys thrown out. These guidelines were:

- Proof of fabrication when filling out demographic information (e.g. fictional hometown)
- 50 percent of the survey containing unanswered questions
- Answering the entire back of the survey with the same answer to every question

Survey Discussion

Information concerning the receptiveness of the technology in gyms was another important set of data for analysis. This information was useful both from frequent gym users and also gym owners. Gym users were surveyed in order to analyze these factors by polling sample populations. Within this data, it was vital to assess whether the technology would make a gym user more likely to pick a gym using the device over one not using it. Likewise, finding correlations between demographics and gym preference sentiments had to be gathered to determine if gyms in certain areas would be more successful with the device. Furthermore, information concerning previously constructed devices had to be obtained in order to know which technology exists and which has to be invented. Moreover, price and energy efficiency data was needed from manufacturers of previous technology in order to complete the cost-benefit analysis.

The purpose of the survey was to determine how receptive current and future gym users would be to the possible implementation of human energy harvesting equipment. Dynamo technology would be relatively simple to retrofit into cardiovascular equipment where there tends to be a constant rotational motion. Of the 600 surveys distributed, 443 people work out at school. Of the 443 individuals that work out at school, 200 of those people also work out at gym facility when they are home. These results illustrate that not only is there a large exercise community at the University of Maryland, but that there are a significant number of individuals that are also willing to pay membership fees at a gym facility. The significant participation of gym users allows us to further draw statistically significant conclusions considering the relatively large sample size.

Of the 600 survey participants, 450 people stated that they were going to join a gym after graduating from the University of Maryland. The 450 individuals planning to continue exercising post graduation is more than the number of people that currently work out even when not staying on the University campus. A significant conclusion that can be drawn is that there will continue to be a large exercise community that chooses to go to gym facilities to work out. Knowing that there will continue to be consumers that choose a gym rather than at home work out options may encourage gym facilities to implement environmentally friendly exercise equipment. If gym membership was projected to decline, gym owners may be hesitant to invest in new equipment if a negative return was expected. Fortunately, gym owners can feel confident that despite the increasing numbers of work out DVD options and home work out systems, there will continue to be a gym consumer base.

An important factor about the implementation of dynamos into cardiovascular equipment would be the concern that the technology would create more resistance when using the equipment. A considerable result from the surveys was that 48 percent of the survey takers responded with a 10 indicating very strong willingness to use gym equipment as long as it did not affect their work-out. More impressive was the result that 75 percent of survey participants responded with an 8 or higher indicating a strong willingness to use this retrofitted gym equipment. These results demonstrate that there is strong support of human energy harvesting equipment. Gym facilities can be confident that as long as an individual's workout routine is not impaired by this new technology, gym members will continue visiting their normal gym facility. Thus, gym owners should not be worried about losing memberships because of the implementation of environmentally friendly cardiovascular equipment.

Monetary factors play a substantial role in an individual's day-to-day activities. When taken into consideration, the survey results revealed that if retrofitted gym equipment decreased gym membership rates, there would be a considerable increase in post graduation gym membership from 48 percent to 83 percent. Numerous positive outcomes would result from higher membership numbers due to lower membership prices. First, gym owners would benefit as long as the decreased membership prices were offset by the increase in membership numbers. An increased number of people joining gyms would also demonstrate that a higher percentage of individuals are making the effort to work out and practice healthy lifestyle habits. Lastly, if the gym implements human energy harvesting equipment, this demonstrates an effort by the gym owners and the gym users to try to be environmentally friendly. Being environmentally friendly may bring in even more new members if the public becomes aware of the gym's effort to help the environment. While the results may not be as impressive as the success of the all-green Green Microgym in Portland, Oregon (Boesel, 2008) it is doubtful that any gym would turn away any positive responses from the public.

Decreased membership prices revealed significant support from the sample. It was not surprising to discover that the survey results disclosed that the implementation of energy harvesting equipment would not receive as much support if the result was an increase in gym membership prices. Compared to the 237 survey participants responding with a '10' demonstrating that they would be very willing to choose a gym with this energy harvesting technology if membership prices were reduced, only 13 survey participants responded with a '10' stating that they would be willing to choose a gym with this technology if membership prices increased. Similarly, only 2 survey participants responded with a '1' indicating that they would not be willing to join a gym with the energy harvesting equipment if membership prices decreased compared to the 60 survey participants that responded with a '1' indicating that they would not be willing to join a gym with this equipment if membership prices increased. These results are a strong indicator of gym user preference. Monetary factors are more important to gym members than the environmental benefits of energy harvesting gym equipment. While the implementation of this environmentally friendly technology may be viewed as a success as long as the environment benefits, a gym acting as a business would not view this as a success. Implementation of energy harvesting energy equipment would only be an all-around success if the environment benefits and gym profits remain steady if not increasing. It is highly unlikely that a gym owner would implement this technology if membership numbers were going to decrease. While taking on an environmentally friendly investment, gym owners would run the risk of going out of business if members switch to cheaper gym facilities.

ERC Results

The ERC case study began with an examination of the energy usage data extracted from Itron's EEM suite. Since the total amount of energy needed to run the ERC directly affects the degree of impact energy harvesting will be able to make, one trend to make note of is how energy usage differs over time. The graphs following were generated using the Itron software and give a year-to-year comparison of energy usage, month-by-month for two years beginning September 1, 2006:

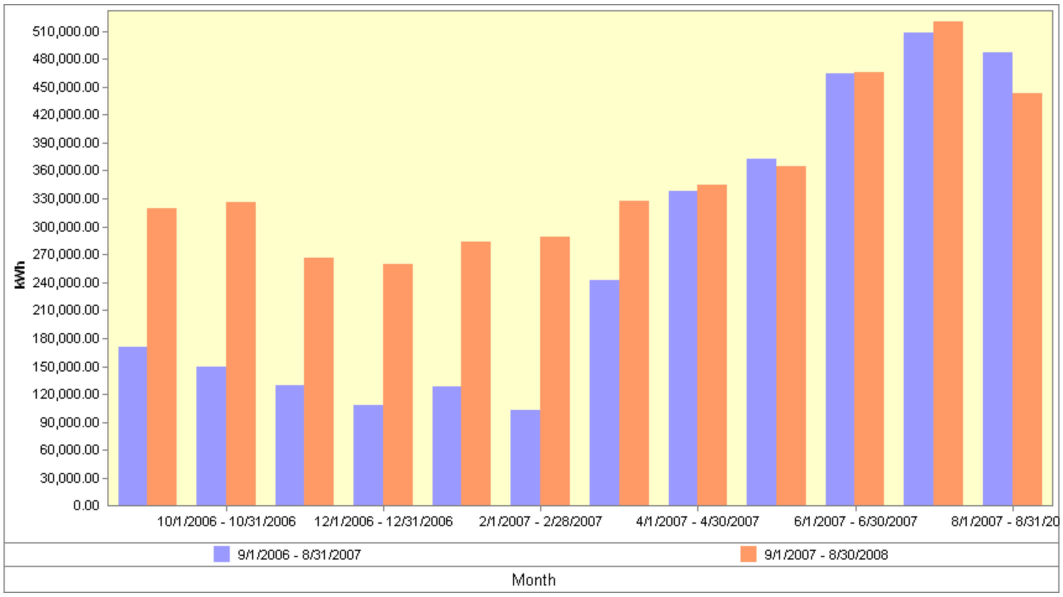


Figure 15: ERC Power Usage (Meter 153)

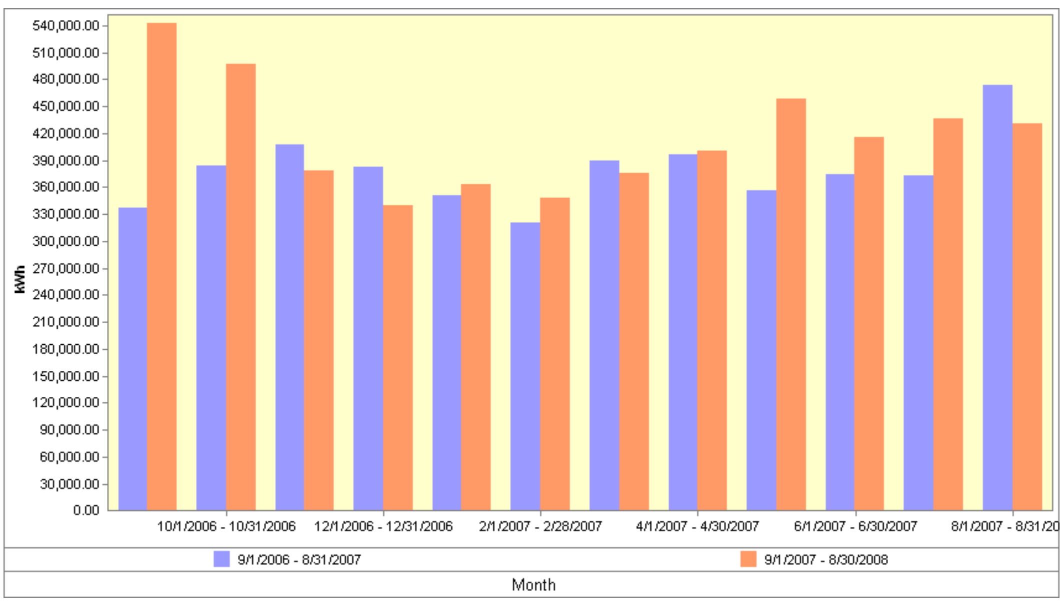


Figure 16: ERC Power Usage (Meter 154)

The blue columns display monthly energy usage in kilowatt-hours (kWh) from September 2006 through August 2007, while the orange columns do the same from September 2007 through August 2008. Viewing these graphs, it becomes apparent that the energy usage jumped significantly between the 2006-2007 and the 2007-2008 academic years. This observation is confirmed from downloading raw energy data and developing a table that combines the energy usage values from both meters, giving the exact amount used by the ERC over this two year period:

Table 1: ERC Year to Year Energy Usage Comparison

Time interval	Total (kWh) From Both Meters	Time interval	Total (kWh) From Both Meters	Variance (kWh)	Variance (%)
9/1/2006 - 9/30/2006	508,337.28	9/1/2007 - 9/30/2007	862,143.91	353,806.63	69.60%
10/1/2006 - 10/31/2006	534,162.06	10/1/2007 - 10/31/2007	824,276.74	290,114.68	54.31%
11/1/2006 - 11/30/2006	536,762.70	11/1/2007 - 11/30/2007	643,983.91	107,221.21	19.98%
12/1/2006 - 12/31/2006	490,171.50	12/1/2007 - 12/31/2007	600,284.74	110,113.24	22.46%
1/1/2007 - 1/31/2007	478,384.38	1/1/2008 - 1/31/2008	646,329.24	167,944.86	35.11%
2/1/2007 - 2/28/2007	424,247.22	2/1/2008 - 2/29/2008	637,181.42	212,934.20	50.19%
3/1/2007 - 3/31/2007	632,090.30	3/1/2008 - 3/31/2008	703,270.94	71,180.64	11.26%
4/1/2007 - 4/30/2007	733,691.95	4/1/2008 - 4/30/2008	744,827.40	11,135.45	1.52%
5/1/2007 - 5/31/2007	728,998.49	5/1/2008 - 5/31/2008	823,741.27	94,742.78	13.00%
6/1/2007 - 6/30/2007	838,607.47	6/1/2008 - 6/30/2008	881,202.02	42,594.55	5.08%
7/1/2007 - 7/31/2007	881,363.81	7/1/2008 - 7/31/2008	956,543.90	75,180.09	8.53%
8/1/2007 - 8/31/2007	960,642.50	8/1/2008 - 8/31/2008	873,654.98	-86,987.52	-9.06%

Since August is the only month where energy usage decreased between 2007 and 2008, it seems that the ERC increases its energy usage over time.

Unfortunately, the records do not extend far enough back to determine whether this is a trend or merely a one-time occurrence; however, the subsequent September, October, and November 2008 values are 857,600.78, 796,237.78, and 676,824.34 kWh respectively. Because the first two of these values are lower than their 2007 counterparts, it is most likely that the type of drastic jump in energy usage displayed above is not a frequent occurrence. A possible contributing factor to the increased energy usage during the summer months could be the air conditioning system.

The Associate Director of Campus Recreation Services was able to supply the utility data for the ERC, which provides a second look at this trend while also expanding upon it with the actual monetary values paid; the relevant portions of this file can be viewed in Appendix D. The kWh values are displayed in such a way that they must be multiplied by 1,000 to get the actual value. Due to a change in billing method, monthly kWh values are only available beginning in the 2007 fiscal year. While these monthly kWh values do not match up perfectly with the Itron data due to flaws within the Itron software, a similar trend regarding increasing costs becomes clear. Every fiscal year since 2003 – the earliest available data – the ERC has spent more to power the facility, and while the data for 2008 is incomplete, what is present shows it is on track to maintain the observation. In fact, between the 2003 and 2007 fiscal years, the ERC's total electricity bill has increased by $277,054.09, from $477,235.69 to $754,289.78. The ERC requires a large amount of power to operate, and any new sources of energy would undoubtedly be appreciated.

By analyzing energy use data, as well as records that indicate the number of users the gym hosts during various periods, the effectiveness of utilizing energy harvesting equipment can be accurately estimated. It is important to determine an accurate fiscal effect in order to gauge the practicality of this human energy harvesting method.

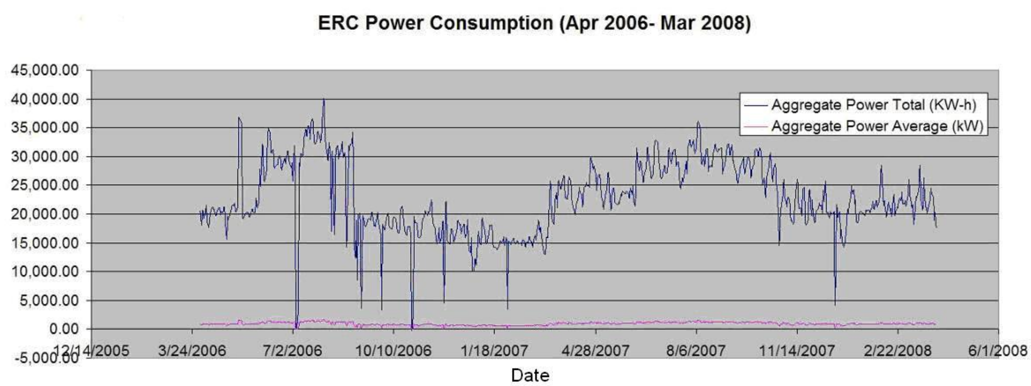


Figure 17: ERC Power Consumption

Using the power consumption information presented above, the feasibility of energy harvesting can be examined by applying a best-case scenario. In this situation, this would consist of forty-five stationary bicycles and elliptical trainers generating 0.1 kW of power each for eighteen hours per day. A plot can then be generated of how this 'best-case scenario' would affect the ERC's grid usage from April 2006 to March 2008; only a fraction of a percent decrease in grid-reliance can be expected.

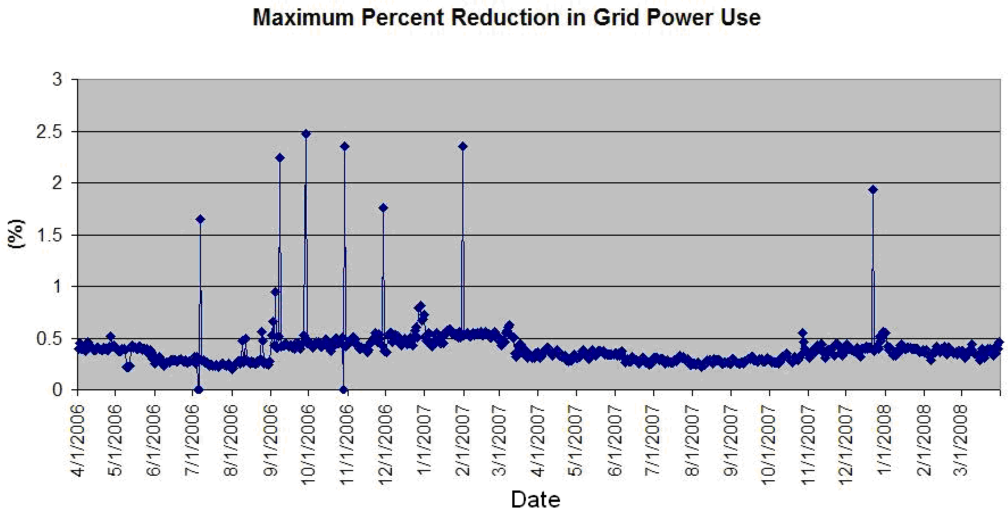


Figure 18: Potential power savings at the ERC

This data assumes a maximum energy harvest of 81 kWh per day. Using the utility data provided by the Associate Director of Campus Recreation Services (Appendix D), it was possible to divide the monthly dollars spent on electricity by the amount of electricity used, revealing that the ERC is charged $0.1082 per kWh. Based on this figure, an energy harvesting system employed at the ERC could harvest the equivalent of $8.76 of grid energy each day or approximately $3,200 per year. It must be stressed that these numbers represent a best-case scenario of continuous use. To gain a more accurate estimate of potential energy harvests, detailed information about ERC patronage must be examined.

From the attendance data (Appendix E), an average of 298.73 people used the FCA per day, with a standard deviation of 150.96 and a median attendance of 276.5 people. The distribution of this data is shown below with a bin size of 10 people:

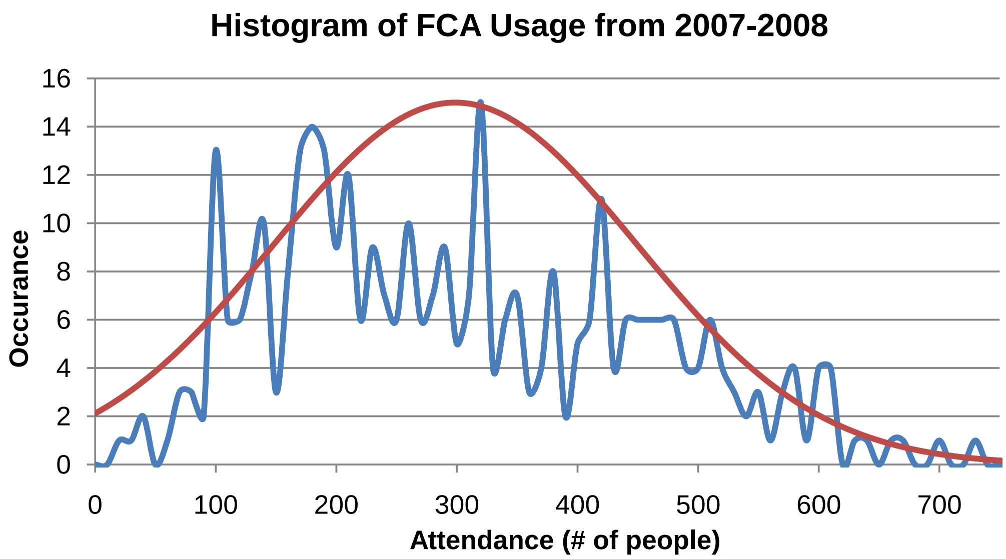


Figure 19: Histogram of FCA counts from September 2007 - September 2008 (blue) overlaid with a standard Gaussian distribution (red)

The data distribution was highly unexpected, and does not represent a standard Gaussian distribution. In an attempt to explain this discrepancy, the data was graphed chronologically and compared to the University of Maryland Academic Calendar for 2007-2008, as shown below:

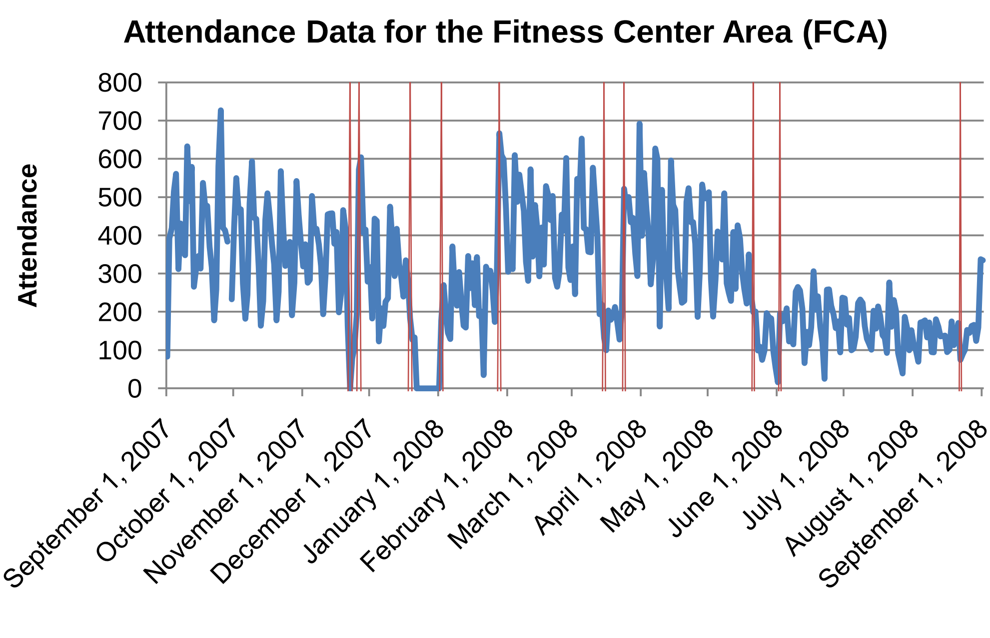


Figure 20: Attendance data for the Fitness Center Area (FCA) overlaid onto University Calendar.

The red lines coincide with major events on the University calendar such as the beginning of a new academic term, or times when the University is closed such as winter and spring break. From this information, it is clear that the shifts in attendance rates at the FCA directly coincide with events on campus. The sections of the graph were broken down as follows:

Table 2: University of Maryland Calendar

Section	Event	Start date	End date
1	Fall Term	09/01/07	11/21/07
2	Thanksgiving Holiday	11/22/07	11/26/07
3	Fall Term (cont…)	11/27/07	12/19/07
4	Winter Break	12/20/07	01/01/08
5	Winter Term	01/02/08	01/27/08
6	Spring Term	01/28/08	03/14/08
7	Spring Break	03/15/08	03/24/08
8	Spring Term (cont…)	03/25/08	05/21/08
9	Summer Break	05/22/08	06/02/08
10	Summer Term	06/03/08	08/22/08
11	Fall Term	08/23/08	09/01/08

After reconciling the FCA attendance data with the University calendar, proving its validity, the average number of people per hour was calculated to determine the average number of people in the FCA, per hour. Due to the fact that the ERC is operated during limited hours (i.e. M-F: 6am-midnight; Sat: 8am-10pm; Sun: 10am-midnight), an average number of hours per day was calculated and used instead to approximate the actual amount of time the ERC is open per day. It was found that the ERC is open for an average of 16.86 hours per day, which when divided by the total FCA count per day, results in a total of 17.72 people in the FCA, per hour.

In order to hypothesize the number of people using exercise bikes per hour, it was assumed that the number of people is directly proportional to the percentage of exercise bikes of the overall equipment in the FCA. Based on the equipment inventory provided by the ERC, a total of 102 pieces of equipment are in the FCA, with 25 of them being exercise bikes. Under the assumption that an equal proportion of FCA users use the exercise bikes (24.5%), a total of 4.34 bikes are used per hour.

To extrapolate potential energy generation, data was received from The Green Microgym, a Portland-based gym which uses dynamo technology. A phone interview with The Green Microgym revealed that a single bike could generate 50 W-hrs of energy. Combining this statistic with the average of 4.34 bikes used per hour, a total of 217.17 W-hr, or 0.217 kWh can be generated by the FCA.

Taking 0.217 kWh and scaling up yields a return of about $0.56 per day and $205.68 per year – certainly a much less impressive figure than the best-case scenario presented above, but still significant. This result can be more significant if energy costs continue to rise as was the case between fiscal years 2007 and 2008, or if the usage rates of energy harvesting equipment increases; it is also possible that the energy harvesting aspect of the bikes will cause more students to use them as the survey seems to suggest.

By extracting daily energy usage values from the "Time Interval" section of Itron's EEM suite and combining these values with the FCA attendance data discussed earlier, a correlation may be determined. After comparing the two sets of data from September 2007 to September 2008 (Appendix E) and running the standard correlation test in Microsoft Excel, the following table is produced:

Table 3: Correlation of Energy Usage vs. Attendance Data

	Column 1	Column 2
Column 1	1	
Column 2	-0.07217	1

When viewing this chart, the bottom-left number is the important figure; a value of '1' represents a perfect correlation, '0' represents no correlation at all, and '-1' represents an inverse relationship. It is generally considered that any value below 0.4 indicates any potential correlation is not very significant, while a number above 0.7 displays a fairly strong correlation. Since the correlation test presents a value of -0.07217, it is safe to conclude there is no meaningful relationship between ERC energy usage and the number of people present in the FCA.

Although this lack of correlation might seem counterintuitive, it can be explained through analysis. Unlike an apartment or house, a large public facility like the ERC will have most of its lights on during operating hours, whether or not a specific room is being occupied. Lighting is not user controlled therefore it cannot be optimized to lower overall energy usage. One might suspect that the body heat from a greater attendance could create a need for more air conditioning, but that impact must be negligible, especially compared to that of the outside temperature. This can be interpreted as a beneficial scenario, since it means that no matter how many more attendees the ERC is able to attract through the use of energy harvesting technology, it should not increase the amount of power necessary to run the facility.

ERC Limitations

While the conclusions drawn from the ERC case study are reasonably confident, there are a number of limitations that might have skewed the data. The first such issue is related to the Itron meters that track electricity usage for the ERC. Unfortunately, it was not feasible to attain a breakdown of which sections of the facility are included in each meter, and beyond having two separate meters, a more detailed record of energy usage does not exist. This means that the analysis of energy usage will rely on estimates and data for the entire ERC, as opposed to the individual rooms containing the exercise equipment of interest. This forced us to rely on estimates for how much of the ERC's total energy usage comes from the FCA, and a disproportionately high amount of the energy may have been allocated to the FCA, if heating the pool is more energy intensive than lighting a room for example.

Another limitation stemming from issues with the Itron meters is that there are occasional glitches with the detection system. For whatever reason, every once in a while the meters will miss recording a value, resulting in zeros for that particular five minute interval, which in turn force the energy usage numbers to be lower than they should be. In Appendix E, the December 22 reading is much lower than the surrounding data points, because while the occasional missing value is not uncommon, on this day more than half of the values were missing. Despite these technical shortcomings, Itron remains a useful tool, and the only way to obtain the more detailed breakdowns for timeframes shorter than the full months displayed within the utility data Appendix D.

Itron did not start monitoring the University of Maryland until the middle of 2006, which could be considered a limitation because it makes it hard to observe any long term trends. The data from Itron is available over a limited number of years, thus any trends noted may be a result of random occurrences. Fortunately, this should not hurt the conclusions too much because although the trends are generally good to consider, most have little bearing on whether or not the implementation of energy harvesting technology is profitable in the long run; averages can also be used to smooth over these variations across time. Additionally, the attendance data for the FCA is tabulated by ERC employees through a simple head count, and thus subject to human error.

ERC Discussion

Performing a case study of the ERC proved particularly useful in the analysis of the potential impact of implementing human energy harvesting technology and yielded a number of conclusions, both expected and otherwise. The ERC's electricity bill has increased significantly over time, and a continuance of this trend seems to be the most likely scenario for the near future due to rising energy costs. A similar trend with electricity usage was also found, but there is not enough evidence at this point to determine whether this will continue into the future. The ERC and the University have launched major initiatives to decrease power consumption and its overall environmental footprint, which may lead to lower energy usage in the future. The data that was gathered from Itron shows that energy usage varies significantly day-to-day, month-to-month, and year-to-year, but does tend to stay within a certain range. Between September 1, 2007 and

September 1, 2008, the average energy used per day was 25,132.86 kWh – a figure significantly larger than the energy harvested from exercise bikes. It would be beneficial to perform a follow-up investigation on implementing energy harvesting technology into other types of gym equipment. Still, it is important to remember that this number is the energy used by the entire four-story facility, and the bikes would have a much larger impact, percentage-wise, on the energy use of the two relatively small FCA rooms and other normal-sized gyms, or even households, which is perhaps another area for future study.

Next, the maximum savings of the ERC was determined using an ideal situation, resulting in annual savings of $3,200. However, using the estimate for FCA energy generation derived from the mathematical breakdown yielded a much more realistic figure of just over $200 in annual savings. This amount is only a very small percentage of the ERC's energy bill, but the project should still be considered if it can pay for itself over the long term. Projects to build, develop, and implement energy harvesting technology can be carried out by students, which can lower the costs to the University; classes are currently offered by the University in which students perform energy audits of buildings on campus – normally a costly procedure. These estimations must be analyzed in conjunction with the survey results and other findings as well, since using energy harvesting technology has the potential to attract more users, thus increasing the monetary savings and yielding certain indirect benefits.

Lastly, because there is no correlation between ERC energy usage and FCA users, an increase in students coming to the ERC, primarily to use the energy harvesting bikes, will not increase overall energy costs, which is a positive impact on energy and financial savings. This supports an initiative to install energy harvesting technology into the ERC should the University ever decide to move forward with the project, as each additional person who comes to use the bikes will generate electricity without increasing the energy demands of the building. Some negative impacts must be considered, such as the possibility that the equipment will require more frequent maintenance due to heavier usage, but overall, more gym users should be considered a net positive.

Chapter 4: Conclusion

Environmental Benefits Section

The implementation of human-driven energy harvesting technology into gym exercise equipment yields significant environmental benefits. In an increasingly energy conscious society, adapting different forms of technology to become more eco-friendly is a worthwhile goal. The research has shown that dynamo technology, when implemented into gym exercise equipment, can help reduce gym overhead costs. This means that the gym could slightly reduce its reliance on oil, natural gas, and other energy sources that are potentially harmful to the environment and still generate the necessary amount of electricity to operate.

Perhaps more importantly, this research serves as a symbol that technological modifications can make the world more energy-friendly. Human energy harvesting technology is just one example of how technological innovation can help save energy. If businesses, homeowners, and other members of our society give an effort to make small changes in their lifestyle and equipment, the considerable energy savings would help reduce the amount of harmful emissions exposed to the environment.

In order to make these necessary changes, people must be willing to adopt a more energy efficient lifestyle. One aspect of this research focused on a segment of the general population's eagerness to make a small change in a portion of their life. By attending gyms that utilize human energy harvesting technology, college students could make their workouts more energy efficient. This study evaluated whether this segment of the overall population would be willing to alter this part of their lifestyle to become more energy efficient.

While there was a segment of those surveyed who seemed particularly enthusiastic about this idea, it was more encouraging to find out that an overwhelming majority of students would be willing to exercise at an energy efficient gym so long as their workout was not affected. People do not have to go far out of their way to follow a more environmentally conscious lifestyle. Turning out the lights when leaving a room, keeping the faucet off when brushing teeth, turning off the television when sleeping, all of these are easy ways to make society more energy efficient. It was heartening to find that most college students would be willing to make the slight adjustment of attending an energy efficient gym to have a positive impact on the environment.

Economic Benefits Section

The survey research illustrated that this generation of college students feels very strongly about making an effort to help the environment. Realistically, businesses will not adopt human energy harvesting technology unless there are real economic benefits. How does this technology help businesses achieve their financial goals? Human energy harvesting technology can help businesses in two ways. First, it can serve as a supplementary electricity source and help the company directly lower its energy costs. In the best-case scenario of implementing this technology at the ERC, it was estimated that with 45 retrofitted exercise bikes running for 18 hours a day, a gym could save up to $3,200 a year. For a facility as large as the ERC, $3,200 may not make a significant difference to its energy bill, but for a smaller business – one without a heated swimming pool, multiple athletic courts, a track, classrooms and offices – $3,200 would be considerable.

The benefits are not limited to cost savings, either. Based on the data collected from survey research, 75% of students would be "very willing" to use human energy harvesting technology. 48% of those surveyed would go as far as switching gym memberships to join a green gym. The survey also indicated that 180 students were not planning on joining a gym after graduation. However, 29% of the students in that group responded that would be very likely to join a gym that implemented this new human energy harvesting technology. This shows that the gym industry could expand its client base with an entirely new population by adopting this technology. It is clear that gyms using green technology could have a competitive advantage in the field. Added to the savings in their overhead costs, these gyms would attract more members and collect more membership fees.

Research Stakeholders

Businesses, college students, the University of Maryland, and society at large are each significant stakeholders in the research. Businesses are always looking for ways to cut costs and differentiate their products and services from their competitors. This research could potentially help businesses in the fitness industry accomplish both of these goals. Not only will gyms benefit from lower overhead costs, but human energy harvesting technology can serve as a point of emphasis in companies' marketing strategies. This can result in higher membership rates; which will lead to additional revenues. College students are the second set of stakeholders in our research. College students were selected as subjects for research due to their accessibility and likeliness to be environmentally conscious. The survey research that was done has confirmed that college students would be very receptive to the concept of working out at a gym utilizing human energy harvesting technology. Additionally, this research has demonstrated that a university fitness center could be modified to cater to the needs of environmentally friendly students.

The University of Maryland is another large stakeholder in the research. This study explored the ERC, its current energy consumption, and the possibility of modifying its workout area to make it more environmentally friendly. The research has shown that the ERC may be able to save money by investing in dynamo technology for its exercise equipment. Perhaps more importantly, by investing in energy efficient technology, the University of Maryland could continue to develop its reputation as being an institution on the cutting-edge of the green movement.

Finally, society is a major stakeholder in this research. It is true that the overall energy savings resulting from human energy harvesting technology will be miniscule as a percentage of total energy consumption. At the same time, however, our research serves as a symbol to remind people that little changes in their lifestyle can make a difference in the world's overall energy problem. Little modifications to peoples' lives, when done on a large scale, can make a substantial impact.

Basis for Conclusion

Three years ago, this project began by investigating different forms of human powered technology. Numerous devices utilizing human energy including hand-crank radios and floors utilizing piezoelectric materials were examined. The team decided to explore exercise bicycles because of their constant use and a general familiarity with the aspects of rotational energy among team members. After estimating the potential energy savings resulting from this technology, the goal was to find out why these devices had not found their way into all fitness centers.

It was postulated that perhaps the reason involved the lack of receptiveness towards the idea of working out at an energy-efficient gym by current customers. It was apparent that customer opinions needed to be investigated further. After careful deliberation, college students were chosen as the segment of the population that would be most accessible and receptive to the idea of working out at a fitness center utilizing human energy harvesting technology.

Survey results determined that college students, as a portion of the overall population, were not against the idea of human energy harvesting technology. In fact, research showed that college students were very open to the idea and a large portion was even willing to accept a higher membership fee for the opportunity to use this eco-friendly technology. After discovering this information, the team thought it would be interesting to explore the idea of implementing human energy harvesting technology at the ERC, since that is where most of the college students surveyed work out.

Data was collected and analyzed from the ERC in order to determine the facility's current energy consumption and the total cost spent on powering the gym. The Itron data helped to determine the ERC's total energy costs. Using estimation, determinations were made that human energy harvesting technology could help the ERC reduce its costs by a very small percentage. This could be seen as discouraging, but it is necessary to remember that the ERC is a very large facility with basketball and racquetball courts, swimming pools, and workout areas. The costs of heating and lighting a facility of this size would be much higher than those of a smaller gym that contains only a workout area. If there was the same amount of exercise equipment in a smaller gym, the total savings would be the same and would reflect a much larger percentage of the total energy cost of powering the gym.

Directions for Future Research

This research focused on the feasibility of implementing human energy harvesting technology into gym exercise bikes. There are opportunities to further this research by evaluating different ways of harvesting human power. As was discussed in the introduction, there are other technologies that utilize human power to generate electricity. Piezoelectric materials, for example, work by converting a mechanical deformation into electricity. This technology can be used in a variety of ways, such as implementation into a floor, thereby capitalizing on the large number of people that walk across a single floor tile.

More research could produce new ideas for the utilization of existing technologies and new methods of capturing energy.

Additionally, further research can be conducted regarding ways to make fitness centers more energy efficient. This could include a study of how windows with solar technology can help optimize a gym's energy efficiency or even studies of how to best reduce a gym's heating and water bills. There are infinite possibilities for making buildings more environmentally friendly, and unlimited means for people to be more energy conscious. If society is committed to solving the energy crisis that we face, research must continue.

Corporate Environmental Values

Many of today's companies have taken the initiative to become more environmentally friendly. The companies that have already "gone green" provide a variety of different services and represent today's major industries. Some green initiatives that are common among all of these companies include recycling, reducing paper use, and using renewable energy sources. Additionally, most of these companies have tried to involve their customer base in their attempts to become more environmentally friendly.

One company that has made an attempt to go green is Japanese car manufacturer Honda. With their newer car models, Honda has tried to address the problem of fuel efficiency and emissions. The car company has implemented alternative fuel technologies, like natural gas and hydrogen fuel cells. Specifically for hydrogen fuel cells, Honda has helped customers set up individual refueling stations that provide heat and electricity for the home as well as hydrogen for a fuel-cell-powered car. Honda also set goals of reducing its CO2 emissions from its factories as well as its vehicles by 5 percent between 2005 and 2010. (Fortune Magazine, 2007)

Another company that has made an effort to go green is British Airways. In 2008, the airline company introduced a new way to offset carbon emissions. Customers who purchase their tickets online are able to compensate monetarily for the carbon emissions from their flight. These funds go towards funding environmentally friendly projects in developing nations. The projects include a new wind farm in one of the poorest areas of China, and installing hydro electric plants in China and Brazil. Apart from the carbon emission offset plan, British Airways has invested in projects aimed at protecting the Brazilian rainforest. British Airways will also help finance research conducted at Cambridge University aimed at establishing scientific understanding for the non carbon dioxide effects of aviation by 2012. (Easier.com, 2008)

Continental Airlines is another airline company that has stepped up its efforts to go green. The company has invested a significant amount of money over the past ten years to replace its current planes with more efficient aircraft. It has also installed fuel-saving modifications on the wings of some of its aircraft that reduce emissions by up to 5 percent. Continental's environmentalists work with engine manufacturers; help design green terminals, and track carbon emissions and chemical recycling daily. The company also has an aggressive internal recycling plan. (Fortune Magazine, 2007)

Tesco, the international grocery store and retail chain, has employed a myriad of strategies to go green. The British based company has invested in wind-powered stores, high-tech recycling, and biodiesel delivery trucks. Its use of trains has reduced the need for trucks, and as a result, has cut thousands of tons of carbon dioxide emissions. For its individual stores, Tesco plans to estimate the carbon costs of each item. The company also determines the bonuses for its senior-management in part on meeting energy and waste reduction targets. Tesco has also encouraged its customers to be greener by rewarding them with free merchandise for those who bring their own shopping bags. (Fortune Magazine, 2007)

Green initiatives have not been exclusive to those companies that have a direct effect on the environment. Some of biggest efforts have been made by the world's most powerful banks. Bank holding company Goldman Sachs has helped to make a positive impact on the environment by investing in green businesses. The bank has invested in cellulosic ethanol, wind and solar energy companies. Goldman Sachs also factors environmental, social and governance issues into their reports for its equity analysis. On a smaller effort, the company allows its employees to take hybrid company cars when commuting home. (Business Pundit, 2008)

Another bank that has contributed to the green movement is Bank of America. One of its achievements has been reducing its paper use by 32 percent from the years 2000-2005 while still growing its customer base. Bank of America also has an internal recycling program that has recycled approximately 30,000 tons of paper each year or roughly 200,000 trees for each year of the program's operation. Similar to Goldman Sachs's efforts, Bank of America offers employees a $3,000 cash back reward for buying hybrid vehicles. (Fortune Magazine, 2007)

Innovest, an investment advisory firm, has made a concerted effort to cater towards the green interests of Wall Street. This firm provides ratings for firms similar to that of Standard and Poor's or Moody's, except that the ratings indicate how environmentally friendly the firm is. Some of Innovests's early data indicates that the stocks of companies with a higher "EcoValue" ranking outperform lower companies' stocks. (Fortune Magazine, 2007)

Hewlett-Packard is one of the leading technology companies that have gone green. One of HP's main green initiatives are its e-waste recycling plants, where shredders and granulators reduce four million pounds of computer detritus each month to bite-sized chunks. These centers recycle the steel and plastic as well as the toxic chemicals like mercury that are found in computers. HP will also take back any brand of equipment. In the near future, it hopes cut its energy consumption by 20 percent. HP also ensures that its suppliers are eco-friendly, and its Global Citizenship Report sets the standard for detailed environmental accountability. (Fortune Magazine, 2007)

The fact that so many companies have decided to make their major business operations more environmentally friendly is in part predicated on the surging demand by potential employees to work for green companies. For example, Net Impact, a nonprofit membership organization whose broad goals are to improve the world through ways such as making businesses more environmentally friendly, has seen its membership nearly double from 2004 to 2007. Of its student members, 80 percent want to work at jobs that are considered to be helpful to the environment. (Gunn, 2008)

In a survey conducted by human resources firm Adecco, 34 percent of all Americans would like to work for a company that "makes a conscious effort to promote socially and environmentally friendly practices." Also according to the survey, some are so enthusiastic about working for a green company that 31 percent would take a pay cut to do so. (Gunn, 2008)

Just as some would be willing to take a pay cut to work at a green company, others are willing to pay more for products that are environmentally friendly. In a study done by Accenture of 7,500 consumers in 17 countries, 64 percent of people would be willing pay a higher price for goods and services that result in lower greenhouse gas emissions. (Enviornmental Leader, 2007)

Perceptions of whether a company is environmentally friendly are also important for consumers. Also according to the Accenture study, 90 percent of those who participated in the study said they would have a negative perception of energy providers that are not currently taking actions to address the problem of climate change. People are also acting on these perceptions. 54 percent reported that they would be inclined to switch energy providers if their current energy provider were not taking steps to address climate change. Also according to the study, 71 percent frequently recycle paper or plastic, 62 percent shut down energy devices when they are not being used, 61 percent use less heating and air conditioning, 59 percent use energy efficient light bulbs, and 41 percent consciously buy products that were made from recycled material. (Enviornmental Leader, 2007)

Based on the corporate interest in environmental stewardship, a generic business plan was developed to evaluate the feasibility of a gym implementing human energy harvesting technology. The business plan includes marketing ideas, customer incentive programs, and a financial analysis. The financial analysis illustrates that an investment in the energy harvesting equipment by a gym would be very profitable. The rate of return on the investment, using our assumptions outlined in the complete business plan, is approximately 24 percent. The gym can explore incentive programs with their gym members to reward them for their electricity generation and their participation in enhancing the gym as a green gym. The rewards can be in the form of membership fee reductions or redeemable prizes. In exchange for the investment in this energy technology, the gym receives two economic benefits – reduced electricity costs and increased membership from green gym marketability. The full business plan was submitted to the 2009 University of Maryland $75K Business Plan Competition and can be found in Appendix F.

Appendix A: Survey Document

Please fill out the following demographic data about yourself. This data will not be used to personally identify you.

Age: ___________
Gender: Male Female
Race: ______________________
Hometown (City, State): _________________________________

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1. Do you go to a gym to work out?

   Yes No

If you answered "Yes" go to Question #2. If you answered "No" go to Question # 7.

2. How many days a week do you attend a gym during the academic year?

   1 2 3 4 5 6 7

3. Each time you attend the gym, what is the average amount of time that you spend on cardiovascular work-out equipment?

   0-10 mins 15-20 mins 25-30 mins 35-40 mins 45-50 mins 55-60 mins 60+ mins

4. Do you belong to a gym at home (not during the academic school year)?

   Yes No

If you answered "Yes" to Question # 4, go to Question #5.
If you answered "No" go to Question # 7

5. How many days a week do you attend the gym at home (outside of the academic year)?

   1 2 3 4 5 6 7

6. Each time you attend the gym at home, what is the average amount of time that you spend on cardiovascular work-out equipment

   0-10 mins 15-20 mins 25-30 mins 35-40 mins 45-50 mins 55-60 mins 60+ mins

7. Upon graduating from the university, do you plan on joining a local gym near your job, graduate school, or home?

   Yes No

If you answered "Yes" to Question #7, go to Question # 8.
If you answered "No" go to Question # 12

8. Would you be willing to use gym equipment which generated electrical energy from your exercise motions? (Note: this technology would not effect your experience on the gym

equipment)

Not Likely				Neutral					Very Likely
1	2	3	4	5	6	7	8	9	10

9. Would you choose a gym, upon graduation that offered equipment that could generate electrical energy over a gym that uses regular gym equipment?

Not Likely				Neutral					Very Likely
1	2	3	4	5	6	7	8	9	10

10. Would you be more willing to choose a gym that offers equipment that could generate electrical energy while at the same time offering a reduction in your membership rates over a gym that uses regular equipment?

Not Likely				Neutral					Very Likely
1	2	3	4	5	6	7	8	9	10

11. Would you be willing to accept higher membership rates at a gym if it offers equipment that could generate electrical energy?

Not Likely				Neutral					Very Likely
1	2	3	4	5	6	7	8	9	10

Thank you for your opinions. You are done with the survey. You do not need to answer question # 12

12. Would you be willing to join a gym after graduation if it offers equipment that could generate electrical energy? (Note: this technology would not effect your experience on the gym equipment)

Not Likely				Neutral					Very Likely
1	2	3	4	5	6	7	8	9	10

a. Would you be willing to accept higher membership rates at a gym if it offers equipment that could generate electrical energy?

Not Likely				Neutral					Very Likely
1	2	3	4	5	6	7	8	9	10

b. Would you be willing to receive incentives at a gym to use equipment that could generate electrical energy?

Not Likely				Neutral					Very Likely
1	2	3	4	5	6	7	8	9	10

Thank you for your opinions. You are done with the survey.

Appendix B: IRB Approval

UNIVERSITY OF MARYLAND, COLLEGE PARK
Institutional Review Board
Initial Application for Research Involving Human Subjects

Please complete this cover page AND provide all information requested in the attached instructions.

Name of Principal Investigator (PI) or Project Faculty Advisor Dr. Peter Kofinas **Tel. No** 301-405-7335
(NOT a student or fellow; must be UMD employee)

Name of Co-Investigator (Co-PI) ________ **Tel. No** ________

Department or Unit Administering the Project Gemstone

E-Mail Address kofinas@umd.edu **E-Mail Address of Co-** ________

Where should the IRB send the approval letter? 8717 Hugo Court, Columbia, MD 21046

Name of Student Investigator Alyson Blair **Tel.** 443-928-4659

E-Mail Address of Student Investigator ablair2@umd.edu

Check here if this is a student master's thesis ☐ **or a dissertation research project** ☐

Project Duration (mo/yr – mo/yr) 01/07 -- 05/09

Project Title Harvesting Human Energy

Sponsored Project Data	**Funding Agency** Gemstone	**ORAA Proposal** ________

(PLEASE NOTE: Failure to include data above may result in delay of processing sponsored research award at ORAA.)

Vulnerable Populations: The proposed research will involve the following (Check all that apply): pregnant women ☐, human fetuses ☐, neonates ☐, minors/children ☐, prisoners ☐, students ☒, individuals with mental disabilities ☐, individuals with physical disabilities ☐

Exempt or Nonexempt (Optional): You may recommend your research for exemption or nonexemption by completing the appropriate box below. For exempt recommendation, list the numbers for the exempt category(s)

☒ **Exempt----List Exemption Category** Number 2 ***Or*** ☐ **Non-Exempt**

If exempt, briefly describe the reason(s) for exemption. Your notation is a suggestion to the IRB Manager and IRB Co-Chairs.

5/9/07 Peter Kofinas PETER KOFINAS
Date **Signature of Principal Investigator or Faculty Advisor** *(PLEASE NOTE: Person signing above accepts responsibility for the research even when data collection is performed by other*

Date **Signature of Co-Principal Investigator**

5/9/07 Alyson Blair
Date **Signature of Student Investigator**

Rebecca Thomas
Date **REQUIRED Departmental Signature**
Name Rebecca Thomas, **Title** Gemstone Assistant Director
(Please also print name of person signing above)

(PLEASE NOTE: The Departmental signature block should not be signed by the investigator or the student investigator's advisor.)

***PLEASE ATTACH THIS COVER PAGE TO EACH SET OF COPIES**

1. **Abstract**

This research project hopes modify exercise equipment to harness human mechanical energy, and convert that energy into electrical energy. The survey research hopes to gauge public interest in such a device, as compared to standard exercise equipment. Every possible strategy will be used to ensure the confidentiality of our subjects. The surveys will be completely anonymous and will not contain information that may personally identify a subject. When we write a report or article about this research project, the identity of our subjects will be protected to the maximum extent possible.

2. Subject Selection

a. We will survey people on the University of Maryland - College Park campus. Subjects will be recruited through a variety of sources including introductory freshman courses (e.g. UNIV100, HONR100, GEMS100), and at several locations on campus (i.e. the Eppley Recreation Center, Adele H. Stamp Student Union, and South Campus Dining Hall). Subjects will be recruited in introductory courses through survey administrators with the permission from the professor. Subjects will be approached at the various locations on campus by survey administrators and asked if they would like to participate in the survey. There will be no advertisements, as the survey administrators will simply ask individuals if they could spare a few minutes of their time in order to complete the survey.

b. No.

c. Not Applicable

d. Our goal is to have around 600-800 usable surveys.

3. Procedures

Subjects will be approached by investigators and asked to fill out a survey. The subjects will fill out the survey with a pen or pencil. A writing utensil will be provided for the subjects if they do not have one. Subjects will be asked not to sign their name on the survey. The survey will then be collected from the subjects when they have finished. The survey will take approximately 2-5 minutes to complete. For taking the survey, students will be offered a candy incentive. As well, if necessary, students might have the chance to enter in a raffle for a gift certificate upon completing the survey. We hope to recruit approximately 500 subjects throughout campus between the Eppley Recreation Center, Stamp Student Union, ad the South Campus Dining Hall. We plan to administer surveys to approximately 200-300 students throughout freshman classes. In order to do so, we plan to ask the permission of the professor/ instructor through e-mail. Please refer to Appendix A for a sample of the e-mail that will be sent. As well, please refer to Appendix B for the survey.

4. Risks and/or Benefits

There are no direct risks or benefits to the subjects that will participate in the survey.

5. Confidentiality

The confidentiality of the data will be ensured because the data will be collected anonymously. Data collected by the surveyors will be transferred to other members of the team for further analysis. When we write a report or article about this research project, the identity of the subjects will be protected to the maximum extent possible by excluding names and other means of personal identification. As well, upon completing the survey, the students will be asked to separate the consent form from the actual survey to assure that their name will not be linked to their survey.

6. Information and Consent Forms

The subjects will not be told much about the investigation prior to completing the survey. They will be told that they are completing a survey to help with research that is being conducted by a Gemstone Team on campus. If they were told about the product that might be designed by our Gemstone team, this might allow for bias while completing the survey so they will not receive this description. Since they will not be told any specific information, none of the information will be deceptive. They will be told that they are not required to complete the survey and that the survey will be completely anonymous but that they must sign consent forms before hand. These consent forms as well as the surveys will only be conducted in English. See Appendix C for the consent form.

7. Conflict of Interest:

Not Applicable

8. HIPAA Compliance

Not Applicable

9. Research Outside of the United States:

Not Applicable

10. Research Involving Prisoners:

Not Applicable

Appendix C: Survey Consent Form

Page 1 of 2
Initials _______ Date ______

CONSENT FORM

Project Title	*Harvesting Human Energy*
	This is a research project being conducted Team Heat, an undergraduate Gemstone team at the University of Maryland, College Park. We are inviting you to participate in this research because you are at least 18 years of age and you have been randomly selected to gauge your interest in environmentally friendly exercise equipment.
	The procedure involves you answering a two page survey.
	We will do our best to keep your personal information confidential. To help protect your confidentiality the surveys are anonymous and will not contain information that may personally identify you. If we write a report or article about this research project, your identity will be protected to the maximum extent possible. *Your information may be shared with representatives of the University of Maryland, College Park or governmental authorities if you or someone else is in danger or if we are required to do so by law.*
	There are no known risks associated with participating in this research project.
	This research is not designed to help you personally, but the results may help the investigator learn more about the interests of everyday students and gym users in relation to environmentally friendly exercise equipment.
	Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate in this survey, you may stop taking the survey at any time and your survey will be destroyed. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized.

	Harvesting Human Energy
	This research is being conducted by Team Heat, an undergraduate Gemstone team at the University of Maryland, College Park. If you have any questions about the research study itself, please contact Alyson Blair at: ablair2@umd.edu. *If you have questions about your rights as a research subject or wish to report a research-related injury, please contact:* Institutional Review Board Office, University of Maryland, College Park, Maryland, 20742; (e-mail) irb@deans.umd.edu; (telephone) 301-405-0678 *This research has been reviewed according to the University of Maryland, College Park IRB procedures for research involving human subjects.*
	Your signature indicates that: *-you are at least 18 years of age;,* *-the research has been explained to you;* *-your questions have been answered; and* *-you freely and voluntarily choose to participate in this research project.*

Signature and Date	**NAME OF SUBJECT**	
	SIGNATURE OF SUBJECT	
	DATE	

Appendix D: ERC Utility Data

Electric Account 068A01ME

Month	FY03 KWH	FY03 Dollars	FY04 KWH	FY04 Dollars	FY05 KWH	FY05 Dollars	FY06 KWH	FY06 Dollars	FY07 KWH	FY07 Dollars	FY08 KWH	FY08 Dollars
June	*	23,432.81	*	31,711.89	*	32,203.59	*	31,736.89	443.25[1]	40,912.31	463.51	50,151.92
July	*	24,924.44	*	33,999.61	*	29,532.41	*	36,266.86	541.86	50,013.46	507.67	54,930.24
August	*	23,855.83	*	30,248.07	*	28,869.00	*	27,877.77	515.99	47,625.47	486.74	52,665.53
September	*	23,368.93	*	25,512.30	*	36,866.07	*	26,054.10	443.09	40,896.80	325.23	35,190.39
October	*	12,810.26	*	15,845.76	*	28,020.79	*	28,361.15	379.81	35,056.20	330.40	35,749.41
November	*	9,256.35	*	14,855.14	*	23,032.66	*	27,820.23	292.21	26,971.17	266.64	28,850.35
December	*	14,541.67	*	14,373.09	*	21,592.55	*	26,229.93	288.46	26,625.13	283.87	30,714.26
January	*	14,931.12	*	14,231.29	*	24,835.82	*	26,163.61	313.75	28,959.31	-	-
February	*	14,122.68	*	13,454.72	*	22,015.01	*	25,660.39	247.78	22,870.00	-	-
March	*	16,390.43	*	16,195.49	*	25,389.21	*	27,195.42	315.38	29,109.63	-	-
April	*	17,444.56	*	15,788.24	*	31,135.34	*	28,097.48	337.84	31,182.66	-	-
May	*	26,474.89	*	29,516.60	*	32,672.26	*	45,760.09	379.87	35,062.29	-	-
Total	n/a	221,553.97	n/a	255,732.20	n/a	336,164.71	n/a	357,223.92	4,499.29	415,284.43	2,664.07	288,252.10

Electric Account 068A02ME

Month	FY03 KWH	FY03 Dollars	FY04 KWH	FY04 Dollars	FY05 KWH	FY05 Dollars	FY06 KWH	FY06 Dollars	FY07 KWH	FY07 Dollars	FY08 KWH	FY08 Dollars
June	*	24,000.21	*	31,989.63	*	35,416.90	*	32,226.71	335.19[1]	30,938.07	272.47	29,481.45
July	*	38,883.85	*	25,434.37	*	44,827.85	*	33,588.21	337.04	31,109.00	267.00	28,889.00
August	*	31,503.36	*	32,580.38	*	35,613.60	*	37,214.04	336.90	31,096.10	357.79	38,713.06
September	*	29,099.56	*	36,044.02	*	23,362.46	*	34,053.13	284.54	26,263.00	445.02	48,151.58
October	*	16,010.45	*	21,310.90	*	23,583.03	*	36,335.61	318.67	29,413.36	402.66	43,568.29
November	*	8,441.37	*	18,791.12	*	25,234.77	*	35,690.60	332.88	30,724.49	301.20	32,589.91
December	*	13,885.67	*	19,170.16	*	22,969.71	*	28,024.95	306.65	28,303.94	274.94	29,749.02
January	*	15,625.86	*	17,338.86	*	22,574.14	*	27,644.69	277.77	25,638.56	284.95	30,831.25
February	*	13,556.23	*	16,374.55	*	21,898.56	*	25,816.07	252.49	23,305.26	-	
March	*	17,275.53	*	19,098.60	*	23,606.88	*	33,266.67	309.63	28,579.11	-	
April	*	17,494.75	*	19,443.39	*	23,589.55	*	34,075.22	306.97	28,333.25	-	
May	*	29,904.88	*	31,618.60	*	22,296.40	*	21,825.03	274.12	25,301.21	-	
Total	n/a	255,681.72	n/a	289,194.58	n/a	324,973.85	n/a	379,760.93	3,672.86	339,005.35	2,606.04	281,973.56

[1] Chg in billing method
* Not itemized
(1) Jun 07 electric consumption includes $10,933.28 calculated credit for HHP usage of chilled water supplied from the ERC
(2) Jul 07 electric consumption includes $11,507.53 calculated credit for HHP usage of chilled water supplied from the ERC
(3) Aug 07 electric consumption includes $12,545.84 calculated credit for HHP usage of chilled water supplied from the ERC
(4) Sept 07 electric consumption includes $11,442.45 calculated credit for HHP usage of chilled water supplied from the ERC
(7) Oct 07 electric consumption includes $10,889.94 calculated credit for HHP usage of chilled water supplied from the ERC
(8) Nov 07 electric consumption includes $8,435.46 calculated credit for HHP usage of chilled water supplied from the ERC
(9) Dec 07 electric consumption includes $8,042.03 calculated credit for HHP usage of chilled water supplied from the ERC
(8) Jan 08 electric consumption includes $8,449.91 calculated credit for HHP usage of chilled water supplied from the ERC
(11) Feb 07 electric consumption includes $6,339.64 calculated credit for HHP usage of chilled water supplied from the ERC

(12) Mar 07 electric consumption includes $7,920.39 calculated credit for HHP usage of chilled water supplied from the ERC
(13) Apr 07 electric consumption includes $8,171.25 calculated credit for HHP usage of chilled water supplied from the ERC
(14) May 07 electric consumption includes $8,287.62 calculated credit for HHP usage of chilled water supplied from the ERC

Appendix E: ERC Usage Data

Date	Fitness Center Counts	ERC kWh Total	ERC kWh Meter 153	ERC kWh Meter 154
September 1, 2007	83	27,136.73	9,859.97	17,276.76
September 2, 2007	392	27,809.35	10,053.07	17,756.28
September 3, 2007	419	28,500.77	10,106.21	18,394.56
September 4, 2007	515	29,909.09	10,657.01	19,252.08
September 5, 2007	561	30,300.70	10,790.50	19,510.20
September 6, 2007	312	31,886.78	11,124.86	20,761.92
September 7, 2007	431	32,214.89	11,155.97	21,058.92
September 8, 2007	361	30,390.12	10,316.16	20,073.96
September 9, 2007	348	30,313.44	10,413.36	19,900.08
September 10, 2007	633	32,030.42	10,865.66	21,164.76
September 11, 2007	490	29,484.65	10,410.77	19,073.88
September 12, 2007	579	29,299.54	10,706.26	18,593.28
September 13, 2007	266	28,416.31	10,500.19	17,916.12
September 14, 2007	317	27,120.10	10,336.90	16,783.20
September 15, 2007	346	26,803.87	9,904.03	16,899.84
September 16, 2007	313	25,336.37	9,406.37	15,930.00
September 17, 2007	537	25,497.72	9,862.56	15,635.16
September 18, 2007	478	27,893.81	10,825.49	17,068.32
September 19, 2007	477	28,000.73	10,780.13	17,220.60
September 20, 2007	370	28,658.23	10,791.79	17,866.44
September 21, 2007	317	29,475.36	10,938.24	18,537.12
September 22, 2007	178	29,788.56	10,406.88	19,381.68
September 23, 2007	259	27,023.54	10,016.78	17,006.76
September 24, 2007	581	27,546.91	10,500.19	17,046.72
September 25, 2007	727	29,342.09	10,864.37	18,477.72
September 26, 2007	420	29,961.58	10,926.58	19,035.00
September 27, 2007	413	29,950.78	14,898.82	15,051.96
September 28, 2007	384	28,883.09	12,678.77	16,204.32
September 29, 2007	**0**	26,288.50	9,799.06	16,489.44
September 30, 2007	233	26,879.90	10,081.58	16,798.32
October 1, 2007	424	28,028.81	10,631.09	17,397.72
October 2, 2007	550	28,813.97	10,657.01	18,156.96
October 3, 2007	460	30,609.14	11,034.14	19,575.00
October 4, 2007	468	31,268.59	11,096.35	20,172.24
October 5, 2007	274	31,251.74	11,468.30	19,783.44
October 6, 2007	182	30,235.46	11,183.18	19,052.28
October 7, 2007	245	29,942.35	10,966.75	18,975.60
October 8, 2007	484	31,462.13	11,564.21	19,897.92

October 9, 2007	594	30,744.58	11,334.82	19,409.76
October 10, 2007	446	28,510.92	11,022.48	17,488.44
October 11, 2007	443	25,176.10	9,766.66	15,409.44
October 12, 2007	319	26,223.70	10,369.30	15,854.40
October 13, 2007	164	24,867.22	10,518.34	14,348.88
October 14, 2007	228	22,927.10	9,206.78	13,720.32
October 15, 2007	441	25,807.68	10,886.40	14,921.28
October 16, 2007	510	27,595.30	11,133.94	16,461.36
October 17, 2007	445	28,818.72	11,774.16	17,044.56
October 18, 2007	378	29,240.35	11,530.51	17,709.84
October 19, 2007	325	30,463.34	11,824.70	18,638.64
October 20, 2007	178	26,404.27	10,493.71	15,910.56
October 21, 2007	253	25,595.14	10,628.50	14,966.64
October 22, 2007	568	27,493.56	11,190.96	16,302.60
October 23, 2007	421	28,680.26	11,455.34	17,224.92
October 24, 2007	320	26,606.23	11,362.03	15,244.20
October 25, 2007	365	24,474.31	11,122.27	13,352.04
October 26, 2007	383	23,878.80	11,197.44	12,681.36
October 27, 2007	191	14,755.39	7,953.55	6,801.84
October 28, 2007	276	17,700.98	5,791.82	11,909.16
October 29, 2007	542	20,508.77	8,434.37	12,074.40
October 30, 2007	454	22,420.15	9,430.99	12,989.16
October 31, 2007	376	23,771.66	9,634.46	14,137.20
November 1, 2007	319	26,024.11	10,169.71	15,854.40
November 2, 2007	377	23,323.68	9,901.44	13,422.24
November 3, 2007	276	22,022.06	8,681.90	13,340.16
November 4, 2007	284	21,179.02	8,716.90	12,462.12
November 5, 2007	503	22,916.30	9,206.78	13,709.52
November 6, 2007	409	22,561.20	9,130.32	13,430.88
November 7, 2007	417	20,542.03	8,245.15	12,296.88
November 8, 2007	376	18,917.93	7,494.77	11,423.16
November 9, 2007	320	18,910.80	7,620.48	11,290.32
November 10, 2007	194	18,291.31	7,143.55	11,147.76
November 11, 2007	297	18,488.95	7,098.19	11,390.76
November 12, 2007	455	21,924.65	8,045.57	13,879.08
November 13, 2007	457	22,994.50	8,308.66	14,685.84
November 14, 2007	458	25,986.53	10,469.09	15,517.44
November 15, 2007	378	23,745.10	10,447.06	13,298.04
November 16, 2007	409	20,986.78	9,999.94	10,986.84
November 17, 2007	199	21,125.45	9,652.61	11,472.84
November 18, 2007	247	20,657.16	8,767.44	11,889.72
November 19, 2007	466	19,875.24	8,994.24	10,881.00
November 20, 2007	417	23,993.06	10,036.22	13,956.84

November 21, 2007	165	24,524.42	9,239.18	15,285.24
November 22, 2007	**0**	19,082.30	7,288.70	11,793.60
November 23, 2007	78	18,040.97	7,870.61	10,170.36
November 24, 2007	106	18,700.20	8,223.12	10,477.08
November 25, 2007	193	19,458.58	8,438.26	11,020.32
November 26, 2007	572	23,358.24	9,551.52	13,806.72
November 27, 2007	604	24,256.58	9,686.30	14,570.28
November 28, 2007	407	19,720.58	8,662.46	11,058.12
November 29, 2007	415	22,403.30	9,926.06	12,477.24
November 30, 2007	279	19,972.87	8,860.75	11,112.12
December 1, 2007	317	18,474.70	7,401.46	11,073.24
December 2, 2007	183	19,074.74	8,027.42	11,047.32
December 3, 2007	444	20,320.85	9,244.37	11,076.48
December 4, 2007	438	20,622.38	9,362.30	11,260.08
December 5, 2007	123	20,968.20	9,979.20	10,989.00
December 6, 2007	209	21,916.44	10,750.32	11,166.12
December 7, 2007	163	21,432.38	9,867.74	11,564.64
December 8, 2007	227	21,554.64	10,193.04	11,361.60
December 9, 2007	236	19,947.60	8,903.52	11,044.08
December 10, 2007	475	24,140.38	10,771.06	13,369.32
December 11, 2007	391	22,191.19	9,780.91	12,410.28
December 12, 2007	294	25,762.32	10,432.80	15,329.52
December 13, 2007	417	20,286.29	9,069.41	11,216.88
December 14, 2007	325	20,330.14	9,189.94	11,140.20
December 15, 2007	290	20,254.10	9,303.98	10,950.12
December 16, 2007	240	19,354.03	8,329.39	11,024.64
December 17, 2007	335	20,369.45	9,166.61	11,202.84
December 18, 2007	285	20,077.63	8,970.91	11,106.72
December 19, 2007	184	19,991.02	8,716.90	11,274.12
December 20, 2007	127	20,105.06	8,772.62	11,332.44
December 21, 2007	133	20,409.84	9,065.52	11,344.32
December 22, 2007	**0**	4,192.34	1,774.22	2,418.12
December 23, 2007	**0**	21,569.33	8,816.69	12,752.64
December 24, 2007	**0**	19,589.26	9,131.62	10,457.64
December 25, 2007	**0**	19,438.70	8,850.38	10,588.32
December 26, 2007	**0**	20,278.51	9,962.35	10,316.16
December 27, 2007	**0**	15,835.82	6,848.06	8,987.76
December 28, 2007	**0**	17,203.97	7,047.65	10,156.32
December 29, 2007	**0**	15,303.60	3,842.64	11,460.96
December 30, 2007	**0**	14,324.04	3,920.40	10,403.64
December 31, 2007	**0**	14,965.78	4,543.78	10,422.00
January 1, 2008	**0**	14,884.78	4,278.10	10,606.68
January 2, 2008	177	19,530.29	7,598.45	11,931.84

January 3, 2008	270	20,867.11	9,314.35	11,552.76
January 4, 2008	202	20,053.87	9,346.75	10,707.12
January 5, 2008	145	21,693.31	10,869.55	10,823.76
January 6, 2008	129	22,989.10	11,529.22	11,459.88
January 7, 2008	371	24,963.12	11,054.88	13,908.24
January 8, 2008	253	23,527.58	9,595.58	13,932.00
January 9, 2008	216	24,218.14	9,760.18	14,457.96
January 10, 2008	304	21,803.90	9,705.74	12,098.16
January 11, 2008	221	22,450.39	9,560.59	12,889.80
January 12, 2008	164	18,768.24	7,996.32	10,771.92
January 13, 2008	159	18,498.02	7,787.66	10,710.36
January 14, 2008	346	19,646.71	8,821.87	10,824.84
January 15, 2008	262	20,095.99	8,990.35	11,105.64
January 16, 2008	327	20,383.92	9,389.52	10,994.40
January 17, 2008	218	20,306.38	8,833.54	11,472.84
January 18, 2008	343	20,168.35	8,692.27	11,476.08
January 19, 2008	189	20,105.71	8,575.63	11,530.08
January 20, 2008	201	19,696.18	8,185.54	11,510.64
January 21, 2008	35	20,729.74	9,112.18	11,617.56
January 22, 2008	318	20,727.79	9,398.59	11,329.20
January 23, 2008	298	20,569.25	9,373.97	11,195.28
January 24, 2008	308	20,741.18	8,986.46	11,754.72
January 25, 2008	256	20,259.94	8,289.22	11,970.72
January 26, 2008	174	20,304.00	8,624.88	11,679.12
January 27, 2008	313	21,472.13	9,814.61	11,657.52
January 28, 2008	667	22,242.17	10,592.21	11,649.96
January 29, 2008	610	21,518.78	9,874.22	11,644.56
January 30, 2008	599	20,811.60	9,246.96	11,564.64
January 31, 2008	469	22,301.57	10,358.93	11,942.64
February 1, 2008	305	22,060.94	10,399.10	11,661.84
February 2, 2008	333	21,263.04	9,758.88	11,504.16
February 3, 2008	312	22,284.07	10,325.23	11,958.84
February 4, 2008	610	23,929.34	10,690.70	13,238.64
February 5, 2008	488	25,737.26	10,723.10	15,014.16
February 6, 2008	559	28,438.34	11,578.46	16,859.88
February 7, 2008	514	22,836.60	9,998.64	12,837.96
February 8, 2008	463	21,520.73	10,112.69	11,408.04
February 9, 2008	331	22,376.30	9,414.14	12,962.16
February 10, 2008	281	19,453.61	8,706.53	10,747.08
February 11, 2008	573	20,418.91	9,379.15	11,039.76
February 12, 2008	345	20,678.54	9,627.98	11,050.56
February 13, 2008	479	22,051.01	10,261.73	11,789.28
February 14, 2008	420	20,553.91	9,094.03	11,459.88

February 15, 2008	293	20,953.51	9,800.35	11,153.16
February 16, 2008	421	19,547.35	8,886.67	10,660.68
February 17, 2008	324	20,786.98	9,650.02	11,136.96
February 18, 2008	529	23,403.60	10,679.04	12,724.56
February 19, 2008	504	19,663.13	9,134.21	10,528.92
February 20, 2008	440	20,177.21	8,952.77	11,224.44
February 21, 2008	503	21,248.57	9,691.49	11,557.08
February 22, 2008	289	21,040.13	9,931.25	11,108.88
February 23, 2008	266	22,089.24	10,614.24	11,475.00
February 24, 2008	303	22,741.34	10,872.14	11,869.20
February 25, 2008	454	22,309.56	10,704.96	11,604.60
February 26, 2008	412	23,761.51	10,726.99	13,034.52
February 27, 2008	602	21,832.85	9,937.73	11,895.12
February 28, 2008	316	21,736.73	9,535.97	12,200.76
February 29, 2008	283	22,287.10	10,032.34	12,254.76
March 1, 2008	371	21,401.71	9,813.31	11,588.40
March 2, 2008	246	21,676.46	10,295.42	11,381.04
March 3, 2008	548	24,012.50	9,498.38	14,514.12
March 4, 2008	510	26,060.18	9,316.94	16,743.24
March 5, 2008	653	24,101.71	9,314.35	14,787.36
March 6, 2008	419	21,392.42	9,511.34	11,881.08
March 7, 2008	416	21,153.31	9,223.63	11,929.68
March 8, 2008	357	21,643.63	9,683.71	11,959.92
March 9, 2008	356	18,268.63	7,461.07	10,807.56
March 10, 2008	577	21,801.96	10,005.12	11,796.84
March 11, 2008	491	22,982.62	10,848.82	12,133.80
March 12, 2008	396	22,904.42	10,599.98	12,304.44
March 13, 2008	194	24,088.32	11,910.24	12,178.08
March 14, 2008	220	25,855.63	13,331.95	12,523.68
March 15, 2008	132	28,422.58	15,034.90	13,387.68
March 16, 2008	100	23,661.72	11,981.52	11,680.20
March 17, 2008	204	20,714.62	9,455.62	11,259.00
March 18, 2008	179	21,586.39	9,897.55	11,688.84
March 19, 2008	189	26,321.11	13,597.63	12,723.48
March 20, 2008	213	22,891.25	10,922.69	11,968.56
March 21, 2008	170	20,817.43	8,970.91	11,846.52
March 22, 2008	128	20,198.81	8,460.29	11,738.52
March 23, 2008	209	21,028.90	9,209.38	11,819.52
March 24, 2008	522	22,664.88	10,303.20	12,361.68
March 25, 2008	479	22,808.95	10,623.31	12,185.64
March 26, 2008	500	24,991.85	12,620.45	12,371.40
March 27, 2008	435	23,977.51	12,282.19	11,695.32
March 28, 2008	446	23,288.69	12,315.89	10,972.80

March 29, 2008	352	19,316.45	9,328.61	9,987.84
March 30, 2008	294	20,694.10	10,602.58	10,091.52
March 31, 2008	692	22,542.19	11,400.91	11,141.28
April 1, 2008	399	26,818.34	14,014.94	12,803.40
April 2, 2008	563	22,579.34	10,826.78	11,752.56
April 3, 2008	467	21,321.14	9,757.58	11,563.56
April 4, 2008	402	22,550.62	10,764.58	11,786.04
April 5, 2008	272	23,887.87	11,860.99	12,026.88
April 6, 2008	343	22,413.46	10,518.34	11,895.12
April 7, 2008	627	21,191.76	9,493.20	11,698.56
April 8, 2008	600	21,346.63	9,677.23	11,669.40
April 9, 2008	162	23,751.58	11,723.62	12,027.96
April 10, 2008	519	25,990.42	13,667.62	12,322.80
April 11, 2008	317	26,688.10	14,373.94	12,314.16
April 12, 2008	286	26,492.40	14,366.16	12,126.24
April 13, 2008	208	23,335.56	11,463.12	11,872.44
April 14, 2008	596	22,013.86	10,174.90	11,838.96
April 15, 2008	480	22,749.55	10,811.23	11,938.32
April 16, 2008	467	23,718.74	11,695.10	12,023.64
April 17, 2008	313	23,929.34	12,006.14	11,923.20
April 18, 2008	266	25,438.32	13,614.48	11,823.84
April 19, 2008	224	25,737.05	12,439.01	13,298.04
April 20, 2008	229	28,636.42	13,136.26	15,500.16
April 21, 2008	488	28,935.14	13,373.42	15,561.72
April 22, 2008	523	27,507.38	11,967.26	15,540.12
April 23, 2008	435	28,099.22	11,753.42	16,345.80
April 24, 2008	435	26,647.92	10,154.16	16,493.76
April 25, 2008	378	26,789.83	10,610.35	16,179.48
April 26, 2008	187	27,633.74	11,286.86	16,346.88
April 27, 2008	304	24,466.75	9,392.11	15,074.64
April 28, 2008	533	25,950.67	10,629.79	15,320.88
April 29, 2008	497	24,873.91	9,936.43	14,937.48
April 30, 2008	497	23,332.32	9,383.04	13,949.28
May 1, 2008	513	23,911.85	9,821.09	14,090.76
May 2, 2008	285	27,827.50	10,965.46	16,862.04
May 3, 2008	188	27,781.06	10,615.54	17,165.52
May 4, 2008	283	26,505.58	9,824.98	16,680.60
May 5, 2008	410	27,057.24	10,504.08	16,553.16
May 6, 2008	366	27,244.30	10,323.94	16,920.36
May 7, 2008	337	27,817.78	10,641.46	17,176.32
May 8, 2008	510	28,831.03	11,472.19	17,358.84
May 9, 2008	275	27,668.09	11,181.89	16,486.20
May 10, 2008	250	25,953.26	10,062.14	15,891.12

May 11, 2008	229	24,957.72	9,752.40	15,205.32
May 12, 2008	409	24,300.22	10,278.58	14,021.64
May 13, 2008	260	26,201.23	10,668.67	15,532.56
May 14, 2008	426	25,440.70	12,248.50	13,192.20
May 15, 2008	392	28,573.13	14,920.85	13,652.28
May 16, 2008	304	28,038.74	14,034.38	14,004.36
May 17, 2008	260	25,505.71	11,757.31	13,748.40
May 18, 2008	222	24,952.75	11,135.23	13,817.52
May 19, 2008	350	24,804.79	10,979.71	13,825.08
May 20, 2008	248	24,730.92	10,866.96	13,863.96
May 21, 2008	199	25,634.45	11,739.17	13,895.28
May 22, 2008	201	25,565.54	11,831.18	13,734.36
May 23, 2008	99	25,506.14	11,740.46	13,765.68
May 24, 2008	109	26,144.42	12,388.46	13,755.96
May 25, 2008	75	26,415.50	12,725.42	13,690.08
May 26, 2008	100	26,868.67	13,105.15	13,763.52
May 27, 2008	197	29,325.89	15,134.69	14,191.20
May 28, 2008	186	26,609.69	12,607.49	14,002.20
May 29, 2008	183	26,592.19	12,696.91	13,895.28
May 30, 2008	98	28,189.08	14,178.24	14,010.84
May 31, 2008	56	28,786.10	14,831.42	13,954.68
June 1, 2008	16	27,643.68	13,718.16	13,925.52
June 2, 2008	196	27,504.79	13,325.47	14,179.32
June 3, 2008	175	28,563.41	14,616.29	13,947.12
June 4, 2008	179	28,009.15	14,245.63	13,763.52
June 5, 2008	209	28,650.24	14,884.56	13,765.68
June 6, 2008	123	28,473.12	14,793.84	13,679.28
June 7, 2008	129	29,907.79	13,843.87	16,063.92
June 8, 2008	115	30,834.00	13,549.68	17,284.32
June 9, 2008	253	32,058.07	16,494.19	15,563.88
June 10, 2008	265	30,719.30	18,051.98	12,667.32
June 11, 2008	256	29,579.69	16,203.89	13,375.80
June 12, 2008	207	29,648.38	16,279.06	13,369.32
June 13, 2008	66	30,681.07	17,103.31	13,577.76
June 14, 2008	148	30,583.44	17,243.28	13,340.16
June 15, 2008	113	29,482.27	16,267.39	13,214.88
June 16, 2008	160	28,459.08	15,072.48	13,386.60
June 17, 2008	306	27,981.50	14,611.10	13,370.40
June 18, 2008	206	27,909.14	14,604.62	13,304.52
June 19, 2008	241	28,349.35	14,945.47	13,403.88
June 20, 2008	161	29,174.04	15,590.88	13,583.16
June 21, 2008	120	29,903.04	16,297.20	13,605.84
June 22, 2008	25	29,771.06	16,263.50	13,507.56

June 23, 2008	258	29,648.59	15,943.39	13,705.20
June 24, 2008	259	28,630.37	14,875.49	13,754.88
June 25, 2008	216	29,137.75	15,237.07	13,900.68
June 26, 2008	193	30,789.72	17,055.36	13,734.36
June 27, 2008	158	31,007.88	17,217.36	13,790.52
June 28, 2008	175	30,121.63	16,487.71	13,633.92
June 29, 2008	94	29,160.22	15,624.58	13,535.64
June 30, 2008	237	28,820.23	15,049.15	13,771.08
July 1, 2008	235	28,121.90	14,267.66	13,854.24
July 2, 2008	167	29,234.74	15,326.50	13,908.24
July 3, 2008	184	30,469.82	16,386.62	14,083.20
July 4, 2008	100	29,855.95	16,040.59	13,815.36
July 5, 2008	104	30,321.00	16,465.68	13,855.32
July 6, 2008	135	29,887.06	16,110.58	13,776.48
July 7, 2008	223	31,691.74	17,536.18	14,155.56
July 8, 2008	232	30,501.36	16,698.96	13,802.40
July 9, 2008	223	31,383.29	17,324.93	14,058.36
July 10, 2008	163	31,874.47	17,673.55	14,200.92
July 11, 2008	130	31,717.44	17,599.68	14,117.76
July 12, 2008	115	33,092.28	19,064.16	14,028.12
July 13, 2008	101	32,889.02	18,991.58	13,897.44
July 14, 2008	203	29,826.79	15,690.67	14,136.12
July 15, 2008	156	28,149.12	14,152.32	13,996.80
July 16, 2008	214	28,184.54	14,157.50	14,027.04
July 17, 2008	190	29,926.15	15,645.31	14,280.84
July 18, 2008	139	31,055.40	16,964.64	14,090.76
July 19, 2008	132	31,894.56	17,969.04	13,925.52
July 20, 2008	93	32,221.58	18,350.06	13,871.52
July 21, 2008	277	32,741.28	18,493.92	14,247.36
July 22, 2008	161	31,911.84	17,567.28	14,344.56
July 23, 2008	231	30,643.06	16,428.10	14,214.96
July 24, 2008	204	27,513.00	13,329.36	14,183.64
July 25, 2008	93	28,277.64	14,139.36	14,138.28
July 26, 2008	64	29,687.04	15,629.76	14,057.28
July 27, 2008	39	29,822.90	15,939.50	13,883.40
July 28, 2008	187	31,511.81	17,201.81	14,310.00
July 29, 2008	158	33,774.62	19,529.42	14,245.20
July 30, 2008	100	33,636.60	19,569.60	14,067.00
July 31, 2008	152	34,725.89	20,143.73	14,582.16
August 1, 2008	114	34,605.79	19,857.31	14,748.48
August 2, 2008	99	31,730.18	17,727.98	14,002.20
August 3, 2008	70	30,706.56	16,880.40	13,826.16
August 4, 2008	172	30,220.78	15,734.74	14,486.04

August 5, 2008	174	30,890.81	16,417.73	14,473.08
August 6, 2008	178	29,373.84	15,513.12	13,860.72
August 7, 2008	133	28,408.97	14,357.09	14,051.88
August 8, 2008	172	27,548.21	13,631.33	13,916.88
August 9, 2008	95	26,548.78	12,877.06	13,671.72
August 10, 2008	94	26,518.75	12,904.27	13,614.48
August 11, 2008	181	27,104.76	13,199.76	13,905.00
August 12, 2008	162	27,486.86	13,528.94	13,957.92
August 13, 2008	136	27,891.43	13,928.11	13,963.32
August 14, 2008	137	28,127.74	14,108.26	14,019.48
August 15, 2008	138	27,934.85	13,987.73	13,947.12
August 16, 2008	95	26,997.41	13,223.09	13,774.32
August 17, 2008	101	26,749.44	13,044.24	13,705.20
August 18, 2008	175	27,928.37	14,013.65	13,914.72
August 19, 2008	113	28,400.11	14,491.87	13,908.24
August 20, 2008	138	27,785.59	13,941.07	13,844.52
August 21, 2008	171	27,426.60	13,627.44	13,799.16
August 22, 2008	75	27,631.37	13,884.05	13,747.32
August 23, 2008	90	27,369.14	13,768.70	13,600.44
August 24, 2008	101	29,242.30	15,721.78	13,520.52
August 25, 2008	153	27,868.32	13,731.12	14,137.20
August 26, 2008	145	26,357.40	12,785.04	13,572.36
August 27, 2008	163	26,012.23	12,243.31	13,768.92
August 28, 2008	166	26,713.15	12,807.07	13,906.08
August 29, 2008	124	26,834.54	13,049.42	13,785.12
August 30, 2008	159	27,447.77	13,773.89	13,673.88
August 31, 2008	338	27,792.94	13,998.10	13,794.84
September 1, 2008	335	26,317.87	12,321.07	13,996.80

Appendix F: Business Plan

Summary

The Green Gym will be a full functional recreation facility that will allow environmentally conscious customers to exercise in a fitness center that is dedicated to energy efficiency. There is a growing population of young adults who wish to make their lifestyle more energy-friendly. The Green Gym will serve as an outlet for these people so that they can feel good about their bodies and at the same time feel good about the imprint that they leave on their environment. The exciting part about this business is the opportunity to utilize cutting edge technology that allows recreational enthusiasts to generate energy for everyday use while they burn calories on exercise equipment. Their own work will help power the gym's lighting, televisions, and even the exercise equipment itself.

Marketing

The Green Gym will be marketed in a number of ways. First, television can serve as a strong medium to relay a message to potential consumers. The target audience can be reached by positioning strategic advertisements during television programs that the potential consumers are more likely to watch.

It is believed that the target market will consist of people between the ages of 21-30. Younger adults appear more likely to be interested in environmental issues and are more likely to be at an age where they would belong to a gym. Research can be conducted to learn how 21-30 year olds could most effectively be reached through television.

Placing magazine advertisements will be another marketing strategy for the Green Gym. By positioning an advertisement in a fitness magazine, it is certain that a portion of the intended audience will discover the gym. Exercise enthusiasts are likely to be interested in the idea, though it is possible that they do not prioritize the environment over other factors. Nonetheless, a percentage of fitness magazine readers will be intrigued enough by the advertisement to make a change. "Men's Fitness" and "Women's Fitness" are two examples of magazines that could potentially be targeted.

Third, advertisements can be placed at specific websites on the internet. The advantage of online advertising is that it can be highly specialized whereas television is much more general. It is possible that there are websites already dedicated to the idea of environmentally conscious fitness programs. If advertisements are placed on these websites, there is a better chance of gaining more subscriptions than through a fitness magazine or a television advertisement that targets a much larger population. The website may not reach as many people as other methods, but it will reach the target group.

Fourth, it is believed that there may be significant media attention generated from this new business. When an energy efficient microgym was founded in Portland, Oregon, media companies such as CNN, NBC, and the LA Times all provided journalistic pieces on the business. Indeed, this gym may receive greater media attention due to its larger size. The media attention should attract new customers who hear about the business through the news. The popularity of the gym could continue to grow by the snowball effect of the media coverage.

Lastly, there is a plan to establish partnerships with local businesses surrounding the gym. This is a more intriguing method of marketing the Green Gym. These marketing partnerships will provide advertisements for both the Green Gym and a local business. These advertisements will be free and will benefit both the Green Gym and the local business that wishes to partner with the gym. People might be excited about the idea of receiving monetary benefits for working out and it may expose consumers to local establishments they may not have otherwise patronized.

Strategic Partnership

The success of this business is dependent upon the relationship with a company that can retrofit existing gyms with energy efficient equipment. Rerev.com is a company that specializes in retrofitting exercise equipment to make it energy efficient and connect the equipment to the power grid. We will establish an agreement with Rerev.com to have them outfit our gymnasium equipment. Because of the large scale of our order, we expect Rerev.com to offer our clients a significant discount for their products. The large volume of orders we send to Rerev.com will outweigh the reduced cost of equipment.

Sales

To ensure the success of the business, an experienced sales team is required that will meet directly with potential consumers. Like many businesses, the Green Gym's success will hinge upon customer satisfaction. It will be the sales team's job to explain to potential customers both the benefits and the costs associated with the services. It is imperative that the sales team be honest. Repeat business will only occur if clients feel that this company provided the services that were promised at the time of the sale.

As these services become more widely accepted, the sales team will be responsible for finding new sales leads, listening to potential clients who come to them, and closing the sale. Also, the Green Gym can benefit from viral marketing, as the popularity of the gym will spread by people telling friends and family about how they prefer this gym to other establishments. New strategies will be implemented as the Green Gym gains a larger client base because the idea will no longer be novel and media attention will diminish.

Competition and Competitive Advantage

The whole appeal of a gym with human energy harvesting technology is the opportunity for customers to work out in an atmosphere that has never before been designed to meet the needs of their lifestyle. One of the major competitors to the Green Gym would be first and foremost, the original gyms that are currently in business, such as Bally's. Another competitor would be home gyms that consumers can purchase and set up in their basements. A third competitor would be University gyms. All of these competitors have strengths that would have to be overcome, but also some weaknesses that can be capitalized on.

First, Bally's already has the brand power. People recognize the name and know it is a reliable, successful gym. Its strength is in its name and the amount of consumers that are loyal to Bally's. They have many locations around the country and a variety of machines for members to take advantage of. Home gyms have an advantage over all other gyms in that they are the most convenient choice for busy people. With a home gym, a user can find free time to work out without ever having to leave the home and travel to a gym. Also, the equipment is always accessible whereas in public, or even private gyms there is the possibility that all of the equipment will be occupied. One of the bonuses of a University gym is that it can have a near monopoly over its consumers. Most college students are offered the use of a gym, as is the case at the University of Maryland, for "free" after paying tuition. Therefore, students tend not to have a desire to apply elsewhere for a gym membership once they become members of the University gym as they enroll for classes.

Along with these individual strengths, each of these competitors also has some weaknesses. For example, a weakness for the typical gym such as Bally's is that there is not much to differentiate it from any other public gym. Due to this relatively perfect competition, the market forces prices for membership to a static level. The Green Gym could capitalize on this weakness because it has differentiated itself from the other gyms through its equipment. If it can offer members an alternative that will help the earth and possibly help their bank accounts, the gym can attain a higher percentage of the market. As seen in our survey statistics, students have proclaimed that they are more willing to join a green gym as opposed to a regular gym.

There are many weaknesses to purchasing a home gym. For starters, many people do not have the space to put gym equipment in their home, whether it is an apartment or house. Also, this equipment is expensive to buy and can be confusing to put together and alter in such instances where the machine can have multiple functions. Most of all, people tend to have more discipline and better workout habits if they physically force themselves to go to a gym as compared to getting sidetracked at home. Going to a gym can be an escape for people to take some alone time away from work and children. The Green Gym equipment could technically be added to home gym setups, however, the energy savings that one person generates is less significant and would have little effect. Therefore, this technology should only be used in an actual gym setting where many people can together harvest more energy.

The third competitor, University gyms, also has its share of weaknesses. The main weakness is that it only has a certain population of members and does not market to the rest of the world. In essence, they have a fixed income each year and there is not much incentive to market the gym because they have already achieved their maximum market segment. The difference between this type of gym and the Green Gym is that the goal is to increase its segment of the population by marketing the gym and bringing in a new customer group that is not currently in the market. There would be no ceiling on the amount of people that were signed up with memberships to the Green Gym as compared to the University gym.

All three of the previous competitor types have been around for a while, but as was discussed earlier, only the traditional gym can benefit from this because the Green Gym would be very different from the latter two competitors and longevity would not come into play. Once it enters into the market, it is uncertain how competitors will react. In the future, it is possible that most current gyms will transform their equipment to more eco-friendly machines if it is proven that our gyms can be a success. University gyms also will feel pressure to become green from students and faculty if the technology is proven to be energy efficient.

The effects of a new gym on companies like Bally's will be negative at first because it is a goal to change customers' preferences from Bally's to this new alternative. However, in the future, if Bally's and other such gyms are able to adapt to similar technology, the effect will be beneficial towards our society as a whole. Current competitive advantages lie in the perception of our customers. People are excited about the "green" movement and are leaning towards green services, products, and ideas. If we can use this idea, we can gain a large consumer base for our gym and therefore achieve a competitive advantage over companies not currently implementing this technology.

Management Team and Relevant Skills

The management team of this business plan is comprised of a team from the Gemstone Program within the University of Maryland Honors Program. The team members are from all different academic disciplines ranging from Business to Engineering. To achieve optimal growth in revenue and net income over the first 5 years, the Green Gym will require a number of strategic hires. First, a Chief Executive Officer must be hired to oversee all financial decisions, and will be responsible for all conclusions regarding our corporate budget. The Chief Executive Officer is the most important hire that will be made, because of this responsibility to meet the company's financial milestones.

Current Stage of Development

Our company is currently in the formative stage of development. We know of 2 companies that could supply us with the technology necessary to retrofit standard exercise equipment. We believe that within the year, we could procure a base location for the first Green Gymnasium.

Personnel Needs:

To achieve optimal growth in revenue and net income over the first five years, the Green Gym will require a number of strategic hires. First, as noted in “Management Team” above, a Chief Executive Officer must be hired to oversee all financial decisions.

Second, a qualified sales team must be hired. An experienced sales team will be necessary to ensure growth in revenues. The sales team must have experience working directly with customers. The sales team must be trained to know all of the businesses' services, the costs of services, their benefits, etc. The sales team must have excellent interpersonal skills to meet with potential clients.

Finally, an executive staff must be formed that will be working directly with the clients to fulfill their business needs. The executive staff will perform all consulting services and be the engine behind this company's success. Their job will be to guide client companies toward a profitable business venture through the medium of energy efficient recreational centers.

Financial Analysis

Assumptions

In order to evaluate the financial benefit of investing in the bike equipment, several variables had to be determined. Some variables were obtained using real world comparables while others were estimated by using assumptions. The cost of the bike was taken from an actual bike constructed with the dynamo technology. Furthermore, the membership fee was determined by looking at the average price of different gym companies. The average price of membership was around thirty dollars a month or an equivalent annualized fee of three hundred and sixty dollars. In addition, current energy prices are approximately ten cents per kilowatt-hour after taking into account generation, transmission, and other fees. Another variable was the amount of time gyms operate. This was estimated to be twelve hours a day as most gyms open up early and close late to appease customers with jobs. The next assumption that had to be made was a membership to bike ratio. This ratio describes the relationship between how many bikes would have to be implemented in a gym based on their membership size. Since all members of a gym are not at the gym at one time and since all members at the gym are most likely using different types of equipment, a thirty to one membership to bike ratio seemed appropriate. Lastly, a few percentages had to be evaluated.

These percentages include inflation, energy price growth, subscription growth, and operating margins. Inflation was important in order to realize present value of future cash flows. Based on historical data, this value was found to be 3.5 percent. Also, energy price growth more accurately takes into account future savings in energy cost. Based on current energy price volatility, a 5.0 percent growth rate was used. Also, two subscription growth rates had to be determined – one for the first five years and the other for the remaining years. Since there would be a stronger effect on membership in the initial introduction of the bike equipment, the first five years would see a growth rate of 5.0 percent whereas the remainder would be lower at 1.0 percent. Lastly, in order to assess the increase in profit of new gym subscriptions, the revenue had to be multiplied by an operating margin percentage. Based on comparable public company financial statements, an operating margin of 65.0 percent was used.

Profitability

A pro forma discounted cash flow analysis for the investment of the bike technology reveals very favorable results. Overall, the investment carries a high twenty four percent internal rate of return on the initial outlay. This ten-year analysis includes reinvestment costs in years three and seven to take into account for additional bike purchases as gym membership grows. The analysis also shows that the profitability is easily scalable based on gym size. For example, keeping all assumptions constant, a gym of either three hundred members or three thousands members has the same internal rate of return of twenty four percent. Likewise, the dollar value of profitability is equally scaled with the three hundred and three thousand member gyms having net present values of $10,265 and $102,646, respectively.

Sensitivity Analysis

While the project remains profitable using the assumptions mentioned earlier, a sensitivity analysis was performed to determine each variables effect on profitability. First, an analysis of subscription growth was made. The profitability model takes into account to separate subscription growth values – one for the first five years and another for the last five years. The first five years value was determined to be five percent whereas the remainder value was one percent. The sensitivity analysis fluctuated the first five years subscription growth between zero and seven percent in increments of one percent and changed the remainder value from zero to three and a half percent in increments of half percents. The table below shows the results of the analysis. The red highlighted region shows areas that are unprofitable whereas the yellow and green reveal values of moderate to high profitability. All values are in terms of internal rate of returns.

Subscription Growth – First 5 Years

Subscription Growth (Remainder)

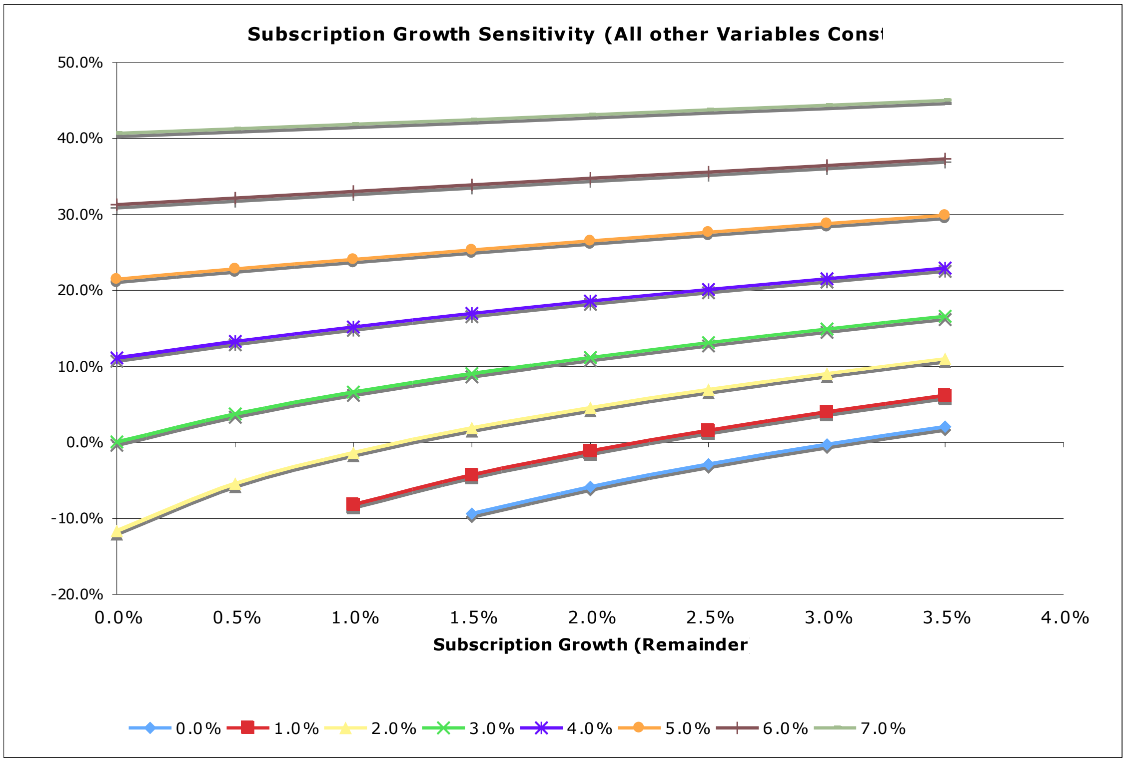
	0.0%	0.5%	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%
0.0%	-	-	-	*-9.4%*	*-5.9%*	*-2.9%*	*-0.3%*	*2.1%*
1.0%	-	-	*-8.2%*	*-4.3%*	*-1.1%*	*1.6%*	*4.0%*	*6.2%*
2.0%	*-11.7%*	*-5.4%*	*-1.3%*	*1.9%*	*4.6%*	*6.9%*	*9.1%*	*11.0%*
3.0%	*0.1%*	*3.7%*	*6.6%*	*9.0%*	*11.2%*	*13.1%*	*14.9%*	*16.6%*
4.0%	*11.1%*	*13.3%*	*15.2%*	*17.0%*	*18.6%*	*20.1%*	*21.6%*	*22.9%*
5.0%	*21.5%*	*22.8%*	*24.1%*	*25.3%*	*26.5%*	*27.7%*	*28.8%*	*29.9%*
6.0%	*31.3%*	*32.2%*	*33.0%*	*33.9%*	*34.7%*	*35.6%*	*36.4%*	*37.3%*
7.0%	*40.7%*	*41.3%*	*41.9%*	*42.5%*	*43.1%*	*43.7%*	*44.4%*	*45.0%*

As the table shows, the project is profitable as long as subscription growth in the first five years stays above approximately two percent. The last five years growth does not seem to have that much of an effect on profitability as long as the first five years growth is above two percent.

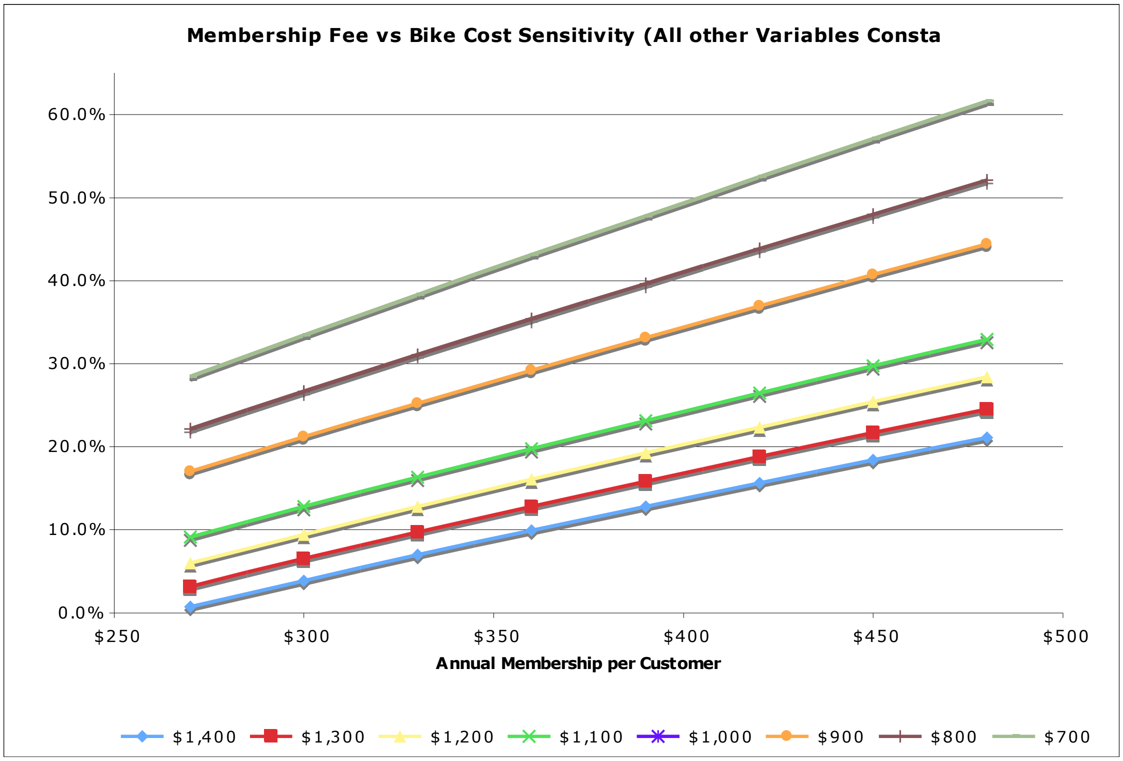
Another two important variables in the project financial analysis were bike costs and membership fees. Since these two values accounted for much of the total costs and total revenues of the analysis, it was important to determine the effect of changes in these values on the overall profitability of the project. Just as with the previous sensitivity analysis, values of the two variables that lead to the project being unprofitable are highlighted in red whereas moderate to high profitability are highlighted in yellow and green. Also, the values are in terms of internal rate of returns.

Bike Cost	Annual Membership per Customer: $270	$300	$330	$360	$390	$420	$450	$480
$1,400	*0.7%*	*3.9%*	*6.9%*	*9.9%*	*12.8%*	*15.6%*	*18.4%*	*21.1%*
$1,300	*3.2%*	*6.5%*	*9.7%*	*12.8%*	*15.8%*	*18.8%*	*21.7%*	*24.5%*
$1,200	*6.0%*	*9.4%*	*12.8%*	*16.0%*	*19.2%*	*22.4%*	*25.4%*	*28.4%*
$1,100	*9.1%*	*12.8%*	*16.3%*	*19.8%*	*23.1%*	*26.5%*	*29.7%*	*32.9%*
$1,000	*12.7%*	*16.6%*	*20.4%*	*24.1%*	*27.7%*	*31.3%*	*34.7%*	*38.2%*
$900	*17.0%*	*21.2%*	*25.2%*	*29.2%*	*33.1%*	*36.9%*	*40.7%*	*44.4%*
$800	*22.1%*	*26.6%*	*31.1%*	*35.4%*	*39.7%*	*43.8%*	*48.0%*	*52.1%*
$700	*28.4%*	*33.4%*	*38.3%*	*43.1%*	*47.8%*	*52.5%*	*57.1%*	*61.6%*

While the upper left corner of the table shows low profitability when bike costs are $1,300-$1,400 and annual membership are $270-$330, there are no areas when the IRR is less than zero. Indeed, profitability becomes very high with an IRR of up to 60% as bike costs fall to $700 and annual membership rises to $480. Furthermore, the following two graphs illustrate more clearly the extent of sensitivity across the range of values for bike costs, annual membership, first five years subscription growth and last five years subscription growth.



Subscription Growth Sensitivity (All other Variables Const
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
-10.0%
-20.0%
0.0%
0.5%
1.0%
1.5%
2.0%
2.5%
3.0%
3.5%
4.0%
Subscription Growth (Remainder
0.0%
1.0%
2.0%
3.0%
4.0%
5.0%
6.0%
7.0%



Membership Fee vs Bike Cost Sensitivity (All other Variables Consta
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
$250
$300
$350
$400
$450
$500
Annual Membership per Customer
$1,400
$1,300
$1,200
$1,100
$1,000
$900
$800
$700

ASSUMPTIONS	
Individual Bike Cost	$1,000
Annual Membership Fee	$360
$ / Kw/Hr	$0.10
Gym Hours/Day	12
Bike Generation (Kw/Hr)	0.05
Gym Days	300
Gym Membership	300
Number of Bikes	10
Inflation	3.50%
Energy Price Growth	5.00%
Subs. Growth(First 5 Years)	5.00%
Subs. Growth(Remainder)	1.00%
Operating Margin	65.00%

Year	0	1	2	3	4	5	6	7	8	9	10
Revenues											
Energy Savings	-	$189	$198	$208	$219	$230	$241	$253	$266	$279	$293
New Subscriptions	-	$5,400	$5,670	$5,954	$6,251	$6,564	$1,135	$1,146	$1,158	$1,169	$1,181
(Marginal Membership)	*0*	*15.00*	*15.75*	*16.54*	*17.36*	*18.23*	*3.15*	*3.18*	*3.22*	*3.25*	*3.28*
	-	**$5,589**	**$5,868**	**$6,162**	**$6,470**	**$6,793**	**$1,376**	**$1,400**	**$1,424**	**$1,449**	**$1,474**
Expenses											
Bike Cost	$10,000	-	-	$1,109	-	-	-	$1,272	-	-	-
Increased Operating Costs	-	$1,890	$1,985	$2,084	$2,188	$2,297	$397	$401	$405	$409	$413
	$10,000	**$1,890**	**$1,985**	**$3,192**	**$2,188**	**$2,297**	**$397**	**$1,674**	**$405**	**$409**	**$413**
Profit/(Loss)	**$(10,000)**	**$3,699**	**$3,884**	**$2,969**	**$4,282**	**$4,496**	**$979**	**$(274)**	**$1,019**	**$1,039**	**$1,061**
Discounted Cash Flow	*$(10,000)*	*$3,574*	*$3,626*	*$2,678*	*$3,732*	*$3,786*	*$796*	*$(215)*	*$774*	*$763*	*$752*

Net Present Value	**$10,265**
IRR	**24.10%**

Bike Investment Analysis (3000 Member Gym)

ASSUMPTIONS	
Individual Bike Cost	$1,000
Annual Membership Fee	$360
$ / Kw/Hr	$0.10
Gym Hours/Day	12
Bike Generation (Kw/Hr)	0.05
Gym Days	300
Gym Membership	3000
Number of Bikes	100
Inflation	3.50%
Energy Price Growth	5.00%
Subs. Growth(First 5 Years)	5.00%
Subs. Growth(Remainder)	1.00%
Operating Margin	65.00%

Year	0	1	2	3	4	5	6	7	8	9	10
Revenues											
Energy Savings	$-	$1,890	$1,985	$2,084	$2,188	$2,297	$2,412	$2,533	$2,659	$2,792	$2,932
New Subscriptions	$-	$54,000	$56,700	$59,535	$62,512	$65,637	$11,351	$11,464	$11,579	$11,695	$11,812
(Marginal Membership)	*0*	*150.00*	*157.50*	*165.38*	*173.64*	*182.33*	*31.53*	*31.85*	*32.16*	*32.49*	*32.81*
	$-	**$55,890**	**$58,685**	**$61,619**	**$64,700**	**$67,935**	**$13,763**	**$13,997**	**$14,238**	**$14,487**	**$14,744**
Expenses											
Bike Cost	$100,000	$-	$-	$11,087	$-	$-	$-	$12,723	$-	$-	$-
Increased Operating Costs	$-	$18,900	$19,845	$20,837	$21,879	$22,973	$3,973	$4,013	$4,053	$4,093	$4,134
	$100,000	**$18,900**	**$19,845**	**$31,924**	**$21,879**	**$22,973**	**$3,973**	**$16,735**	**$4,053**	**$4,093**	**$4,134**
Profit/(Loss)	**$(100,000)**	**$36,990**	**$38,840**	**$29,694**	**$42,821**	**$44,962**	**$9,790**	**$(2,738)**	**$10,186**	**$10,394**	**$10,610**
Discounted Cash Flow	*$(100,000)*	*$35,739*	*$36,257*	*$26,783*	*$37,316*	*$37,856*	*$7,964*	*$(2,152)*	*$7,735*	*$7,626*	*$7,521*

Net Present Value	**$102,646**
IRR	**24.10%**

Appendix G: Raw Survey Data

Note: All survey data provided is raw data, exactly as entered by survey participants. If no value was recorded for a required field, '-blank-' was entered.

#	Demographics			Question Number													
	Age/ Gender	Race	City/State	1	2	3	4	5	6	7	8	9	10	11	12	12a	12b
1	20/F	White	Columbia, MD	Y	6	7	N			Y	6	5	9	4			
2	18/F	Black	Olney, MD	Y	1	2	Y	3	3	Y	9	9	10	5			
3	18/F	White	Huntingtown, MD	N						N					6	5	8
4	21/F	Asian	Jacksonville, FL	Y	2	3	N			Y	8	8	10	4			
5	20/F	Asian	Ellicott City, MD	N						Y	5	5	6	2			
6	19/F	Hispanic/White	North Potomac, MD	Y	3	5	Y	2	3	Y	10	10	10	8			
7	20/F	Black	Clinton, MD	Y	2	5	N			Y	7	8	8	3	8	3	8
8	20/F	Hispanic	Upper Marlboro, MD	Y	3	5	N			Y	10	10	10	6	10	6	7
9	21/F	Asian	Bordentown, NJ	N						Y	7	4	8	2			
10	21/M	Arab	Tunis, Tunisia	Y	4	2	Y	4	2	Y	8	8	10	2	8	3	9
11	25/F	White	Crofton, MD	Y	4	2	Y	4	2	Y	10	10	10	4			
12	20/F	White	Aberdeen, MD	Y	1	2	N			N					6	6	10
13	20/F	White	Columbia, MD	Y	4	4	Y	6	6	Y	10	10	10	4			
14	19/F	Asian	Livinston, NJ	N						Y	10	7	10	5			
15	20/F	Black	Laurel, MD	Y	2	5	N			Y	8	10	10	4	10	4	10
16	21/F	-blank-	Annapolis, MD	N						Y	10	6	9	4			
17	21/M	Black	Frederick, MD	Y	2	3	Y	2	2	Y	2	5	5	3			
18	19/M	Middle Eastern/White	Olney, MD	Y	4	4	N			Y	10	10	10	10			
19	19/F	White	Baltimore, MD	Y	4	4	N			Y	9	7	7	5			
20	20/F	White	Bel Air, MD	Y	3	4	N			Y	9	8	8	6			
21	19/F	White	Bel Air, MD	Y	5	5	Y	4	5	Y	9	7	9	4			
22	18/F	White	Damascus, MD	Y	3	2	Y	4	3	Y	8	7	10	6			
23	19/F	White	Baltimore, MD	Y	1	2	N			Y	9	8	9	6			

24	20/F	White	Parkton, MD	Y	3	3	Y	3	3	Y	10	10	10	1			
25	22/F	White	Reisterstown, MD	Y	4	3	N			Y	8	8	8	4			
26	18/F	White	Middletown, NJ	Y	1	7	Y	4	7	Y	9	9	9				
27	20/F	White	Avon, CT	Y	5	4	N			Y	10	10	10	6			
28	21/F	White	Baltimore, MD	Y	3	5	Y	4	5	Y	9	6	8	4			
29	21/F	White	Olney, MD	Y	3	3	N			Y	9	9	8	7			
30	19/F	White	Frederick, MD	Y	2	4	Y	5	4	Y	8	7	8	4			
31	18/F	White	Ellicott City, MD	Y	3	3	Y	3	3	Y	6	6	8	4			
32	21/F	White	Ellicott City, MD	N						Y	6	7	8	7			
33	18/F	White	Montgomery Village, MD	Y	1	3	N			Y	7	5	7	1			
34	18/F	White	Silver Spring, MD	Y	1	4	N			Y	9	9	10	4			
35	20/F	White	Columbia, MD	Y	5	6	Y	4	5	Y	10	7	10	5			
36	19/F	White	Teaneck, NJ	Y	4	4	Y	4	3	Y	7	1	9	1			
37	21/F	White	Ellicott City, MD	Y	1	6	Y	2	6	Y	10	8	10	3			
38	18/M	White	Columbia, MD	Y	3	6	N	2 or 3	6	Y	10	7	10	Neutral			
39	18/F	White	Silver Spring, MD	Y	2	5	Y	3	5	Y	6	6	8	4			
40	18/M	Asian	College Station, TX	Y	4	2	Y	3	2	Y	8	6	7	3			
41	18/F	Asian	Gaithersburg, MD	Y	1	1	N			N					2	7	7
42	18/F	Asian	Ellicott City, MD	Y	2	4	N			Y	10	7	10	7			
43	18/F	Asian	Bethesda, MD	N						Y	10	10	8	1			
44	18/M	Asian	Bel Air, MD	Y	4	3	N			Y	7	6	7	7			
45	18/M	White	Fair Lawn, NJ	N						Y	10	10	10	3			
46	18/F	White	Elkton, MD	Y	2	3	N			Y	10	8	10	7			
47	18/M	Asian	Rockville, MD	N						Y	7	7	8	7			
48	18/M	White	Bela Lynwyd, PA	N						Y	6	6	7	5			
49	19/M	White	Hammonton, -blank-	Y	4	7	N			N					7	4	8
50	18/F	White	University Park, MD	Y	3	5	N			Y	10	10	10	4			
51	18/F	White	Germantown, MD	Y	4	7	Y	5	7	Y	10	6	10	3			
52	18/F	White	Rockville, MD	Y	3	7	N			Y	10	10	10	6			
53	18/F	White	Sparks, MD	Y	3	3	N			Y	6	6	8	3			
54	18/F	White	Rockville, MD	N						N					6	10	10
55	18/F	-blank-	Potomac, MD	Y	3	4	Y	3	7	Y	9	8	8				

56	18/F	White	Potomac, MD	Y	2	3	N			Y	5	5	5	1			
57	18/M	Asian	Rockville, MD	Y	2	2	N			N					4	4	8
58	18/F	White	Potomac, MD	Y	2	1	N			Y	10	7	10	4			
59	18/F	Mixed	Washington, DC	N						Y	10	8	10	6			
60	18/M	White	Germantown, MD	Y	5	2	Y	5	1	Y	10	8	10	5			
61	18/M	White	Rockville, MD	Y	2	7	Y	3	7	Y	10	6	10	1			
62	-blank-/-blank-	-blank-	Silver Spring, MD	Y	3	2	Y	4	3	Y	10	10	10	10			
63	10/F	Asian	Fairfax, VA	Y	4 or 5	2	N			N					9	6	9
64	18/M	White	Silver Spring, MD	Y	3	1	N			Y	10	8	9	7			
65	18/F	White	Emporia, KS	Y	5	3	N			Y	10	10	10	7			
66	18/F	Asian	Potomac, MD	Y	1	2	Y	1	3	N					5 or 6	1	3
67	18/M	Asian	Ellicott City, MD	Y	4	5	N			Y	10	10	10	4			
68	18/F	White	Myersville, MD	N						N					8	8	8
69	18/M	White	Columbia, MD	Y	1	2	Y	2	1	Y	10	7	10	4			
70	18/F	White	New City, NY	Y	5	3	N			Y	10	10	10	10			
71	18/F	White	Greensboro, MD	N						N	-blank-	-blank-					
72	18/M	White	Laurel, MD	N						Y	10	10	10	7			
73	18/F	Asian	East Hanover, NJ	Y	1	1	N			Y	10	10	10	7			
74	18/F	Asian	-blank-							Y	8	8	8	8			
75	18/F	-blank-	Columbia, MD	Y	3	4	Y	3	4	Y	10	9	10	8			
76	20/M	White	Lutherville, MD	Y	3	5	N	5	5	N	8	6	6	5	3	3	3
77	19/M	White	Richboro, PA	Y	1	1	Y	2	1	Y	7	6	10	2			
78	19/M	White	Dunkirk, MD	Y	2	7	N			Y	9	5	10	4			
79	20/M	White	Dunkirk, MD	Y	2	6	N			Y	8	6	8	7			
80	20/M	White	Hurtingtown, MD	N						N					6	7	9
81	20/F	White	Bel Alton, MD	N						Y	10	4	10	4			
82	20/M	White	Monkton, MD	Y	6	7	Y	5	7	Y	10	6	10	5			
83	20/M	White	Drexel Hill, PA	Y	6	7	N			Y	10	9	9	6			
84	20/M	White	Silver Spring, MD	Y	1	5	N			Y	8	5	10	3			
85	19/M	Indian	Middletown, NJ	Y	1	6	N			Y	9	6	9	2			

86	20/M	White	Cleveland, OH	N						N					5	3	6
87	20/F	White	Pittsburgh, PA	Y	4	4	N			Y	8	5	8	2			
88	19/F	White	N. Bellmore, NY	Y	1	3	N			Y	10	10	10	5			
89	20/F	White	Pittsburgh, PA	Y	4	4	N			Y	10	9	10	4			
90	20/F	European	Elkton, MD	Y	3	3	N			Y	10	10	10	8			
91	20/F	Asian	Chevy Chase, MD	Y	2	3	N			Y	10	8	10	8			
92	20/M	-blank-	Chevy Chase, MD	Y	1	3	N			Y	10	10	10	10			
93	20/M	Black	Bowie, MD	Y	2	6	Y	1	6	Y	8	6	9	4			
94	19/M	White	Middletown, MD	Y	2	1	Y	2	2	Y	10	6	8	5			
95	18/M	Other	Silverspring, MD	N			N			N					1	1	1
96	19/M	White	Gaithersburg, MD	Y	4	7	Y	4	1	Y	5	5	5	2			
97	22/M	White	Hagerstown, MD	Y	4	3	Y	4	3	Y	6	6	9	2			
98	/		,														
99	20/F	White	Damascus, MD	Y	4	5	N			Y	8	8	6	6			
100	20/F	White	Gaithersburg, MD	Y	3	4	Y	3	3	Y	10	5	10	7			
101	20/F	Korean	Baltimore, MD	Y	2	3	Y	2	2	Y	6	10	10	1			
102	20/F	Chinese	Rockville, MD	N						Y	8	8	9	3			
103	20/F	Indian-American	Bethesda, MD	Y	2	3	N			Y	7	7	9	6			
104	20/F	Asian	Gaithersburg, MD	Y	1	4	N			N					8	5	6
105	20/F	White	Towson, MD	Y	1	4	Y	3	5	Y	9	10	10	6			
106	20/F	White	Manalapan, NJ	Y	1	3	N			Y	10	10	10	1			
107	20/F	White	Scotch Plains, NJ	Y	2	3	Y	3	3	Y	7	6	8	2			
108	20/M	White	Silver Spring, MD	Y	6	3	Y	6	3	Y	5.5	5.5	9	2			
109	20/M	White	Wantagh, NY	Y	3	6	Y	5	7	Y	10	6	10	1			
110	22/M	White	Bethesda, MD	Y	3	2	Y	2	1	Y	6	3	9	1			
111	20/M	White	Wantagh, NY	Y	2	3	Y	3	3	Y	8	5	5	1			
112	19/M	White/Asian	Bethesda, MD	Y	2	3	N			N					7	6	8
113	18/F	White	Ellicott City, MD	Y	6	3	N			Y	10	10	10	7			
114	18/M	White	Baltimore, MD	Y	2	6	Y	3	6	Y	10	10	10	3			
115	18/F	White	Baltimore, MD	Y	3	3	N			Y	8	7	9	6			
116	18/M	European-American	Columbia, MD	Y	3	2	N			N					6	2	9
117	18/M	Asian	Jackson, NJ	Y	3.5	4	N			Y	5	5	10	5			

118	19/M	Asian	Nishinomiya City, Japan	Y	6	1	Y	4	1	Y	8	4	7	3			
119	18/M	White	Catonsville, MD	N						Y	10	10	10	8			
120	18/F	White	Montgomery, -blank-	Y	5 to 6	3	Y	4	3	Y	10	10	10	8			
121	18/F	White	Darnestown, MD	Y	6	7	Y	3	3	Y	10	1	10	1			
122	18/M	Asian	Silver Spring, MD	Y	4	5	N			N					3	3	7
123	18/F	Asian / Pacific Islander	Rockville, MD	Y	2	3	N			N					9	6	10
124	18/F	White	Kings Park, NY	N						Y	10	10	10	6			
125	18/F	Indian	Elkridge, MD	N						N					7	6	7
126	18/M	White	Keyser, WV	Y	3	2	N			N					8	7	10
127	18/M	White	Yardley, PA	Y	3	1	N			Y	10	7	10	5			
128	18/M	White	Lansing, MI	Y	2	6	N			Y	10	6	10	1			
129	18/F	White	Catonsville, MD	N						Y	9	10	10	5			
130	18/M	Asian	Columbia, MD	Y	4	1	Y	2	1	Y	2	6	6	2			
131	18/F	White	Silver Spring, MD	N						N					7	7	8
132	18/M	Asian	Rockville, MD	Y	4	5	N			N					10	5	10
133	18/M	White	Salisbury, MD	N						N					7	2	4
134	19/F	White	Lansdale, PA	Y	1	2	N			Y	10	10	10	3			
135	18/F	White	Clarksville, MD	Y	4	3	N			Y	6	8	9	6			
136	18/F	White	Weston, FL	N						Y	5	5	6	3			
137	18/F	Asian	Hangzhen, Zhujiang, China	N						N					6	8	8
138	18/F	White	Pasadena, MD	N						Y	10	10	10	1			
139	18/M	White	Rockville, MD	N						N					1	1	1
140	18/M	White	Arnold, MD	Y	5	1	N			Y	10	10	10	1			
141	19/M	White	Brinklow, MD	Y	2	2	N			Y	10	8	10	4			
142	-blank-/-blank-	-blank-	-blank-	-blank-	2	4	N			Y	10	8	10	8			
143	18/F	Asian	Potomac, MD	Y	2	5	Y	3	3	N					6	8	9
144	20/F	Asian	Timonium, MD	N						Y	10	10	10	5			
145	18/F	Latin	Melville, NY	Y	4	3	Y	4	4	Y	10	5	10	1			
146	19/F	White	Ellicott City, MD	Y	3	2	N			Y	10	9	10	5			
147	20/F	Hispanic	Silver Spring, MD	Y	3	3	Y	4	3	Y	10	9	10	1			

148	22/M	White	Elkton, MD	Y	4	1	Y	5	1	Y	10	5	8	3			
149	20/M	White	Chicago, IL	Y	4	1	Y	4	1	Y	10	6	8	3			
150	21/F	White	Mason, OH	Y	5	6	Y	7	6	Y	10	7	10	7			
151	20/M	White	Parsippany, NJ	Y	2	1	Y	1	1	Y	10	10	10	7			
152	20/M	White	Columbia, MD	Y	3	1	N			Y	10	1	9	3			
153	20/M	White	Westminster, MD	N						Y	9	7	10	5			
154	18/F	White	Annapolis, MD	Y	6	3	N			Y	5	5	7	5			
155	20/F	White	Stevensville, MD	Y	2	7	Y	5	7	Y	8	6	9	3			
156	21/M	White	Framingham, MA	Y	4	5	N			Y	5	5	7	2			
157	18/M	White	Mt. Airy, MD	Y	3	1	N			Y	6	7	8	4			
158	17/M	White	Tucson, AZ	Y	3	4	N			N	8		8	3			
159	18/M	White	Gaithersburg, MD	Y	2	3	N			Y	6	5	10	3			
160	18/F	White	Dededo, Guam	Y	2	5	Y	2	5	Y	9	6	10	5	6	4	8
161	20/F	White	Gaithersburg, MD	Y	3	3	N			Y	8	8	8	8	8	8	8
162	18/F	Taiwanese	Rockville, MD	Y	1	3	N			N					8	5	9
163	18/F	Asian	Rockville, MD	Y	3	7	Y	5	2	Y	10	10	10	1			
164	18/M	White	Ocean City, NJ	Y	3	5	Y	3	6	Y	10	6	10	3			
165	19/F	Asian	Towson, MD	Y		4	Y		4	Y	10	8	10	7			
166	18/M	White	Silver Spring, MD	Y	3	2	N			Y	10	9	10	5			
167	18/F	Asian	Gaithersburg, MD	Y	3	6	Y	3	6	Y	9	9	10	1			
168	18/F	Asian	North Potomac, MD	Y	2	3	N			Y	10	9	10	6			
169	18/M	White	Novosibirsk, Russia	Y	3	3	N			Y	10	8	7	4			
170	20/M	White	Cambridge, MD	Y	2	2	Y	4	3	Y	10	7	9	6			
171	18/F	Asian	Silver Spring, MD	Y	3	4	N			Y	6	6	6	2			
172	18/F	White	Baldwin, MD	Y	1	3	Y	5	7	Y	6	5	9	2			
173	18/M	White	Rockville, MD	Y	2	1	N			Y	10	9	10	8			
174	18/M	White	Baltimore, MD	Y	5	3	Y	6	4	Y	10	8	10	6			
175	19/M	White	Mohnton, PA	Y	7	6	Y	7	6	Y	8	6	6	4	7	6	7
176	18/F	White	Dayton, OH	Y	3	2	N			Y	10	9	10	8			
177	18/M	White	Rockville, MD	N						N					6	6	6
178	18/M	Asian	Olney, MD	Y	2	4	N			N	10	8	10	7	8	8	9
179	18/M	White	Potomac, MD	N						N					7	1	7

180	18/F	White	Baltimore, MD	Y	3	3	Y	4	5	Y	5	5	5	5	5	5	5
181	18/F	White	Elkridge, MD	Y	2	3	Y	1	3	Y	9	8	10	4			
182	18/F	White	Butler, PA	Y	5	3	Y	4	3	Y	5	5	5	5			
183	18/M	White	Cockeysville, MD	N						N					6	7	8
184	18/M	Asian	Rockville, MD	Y	4	2	Y	3	2	Y	10	10	10	5	10	5	10
185	18/F	White	Glenwood, MD	N						N					5	3	7
186	18/F	Hispanic	Potomac, MD	Y	2	2	Y	5	3	Y	10	8	10	5			
187	18/F	White	Highland Park, IL	Y	6	5	Y	3	4	Y	8	5	8	5			
188	18/F	Asian	Germantown, MD	Y	2	4	N			Y	10	9	10	2			
189	18/M	Indian	Flemington, NJ	Y	1	3	N			N					6	6	6
190	18/M	Asian	Silver Spring, MD	Y	4	2	N			N	10	10	10	8			
191	18/M	Asian	Potomac, MD	Y	6	3	N			Y			8	1			
192	18/F	Asian	Rockville, MD	N						N					8	5	8
193	18/F	White	Reisterstown, MD	Y	5	3	N			Y	10	10	10	8	10	8	10
194	18/F	Indian	Rockville, MD	Y	5	3	N			N	9	6	10	1			
195	18/M	Chinese	Piney Point, MD	Y	4	3	N			Y	8	8	9	7			
196	18/F	-blank-	Brookeville, MD	N			N								5	1	5
197	17/M	White	Bethesda, MD	Y	6	5	N		5	Y	10	10	10	8			
198	21/M	White	Owings Mill, MD	Y	6	1	Y	6	1	Y	10	5	10	1	5	1	10
199	19/M	White	Westminster, MD	Y	2	3	Y	4	3	Y	8	9	10	7			
200	22/M	-blank-	Annapolis, MD	Y	6	2	Y	6	2	Y	10	10	10	3			
201	19/M	White	Owings Mill, MD	Y	1	2	Y	3	3	Y	8	5	5	1			
202	20/M	White	Massapeana, NY	N						Y	8	8	10	8			
203	20/M	Vietnamese	Webster, TX	Y	2	6	Y		6	Y	8	9	10	7	9	7	10
204	20/M	White	Damascus, MD	Y	2	1	N			Y	10	10	10	7			
205	19/M	White	Baltimore, MD	Y	1	5	Y	3	6	Y	6	6	6	6			
206	20/M	White	Staten Island, NY	Y	3	1	Y	4	1	Y	7	6	7	7			
207	19/M	Asian	Montville, NJ	Y	1	1	N			N					7	6	7
208	21/M	White	Owings Mills, MD	N						Y	7	4	7	2			
209	18/M	White	Seaville, NJ	Y		4	Y	5	4	Y	8	6	9	4	6	4	8
210	19/M	African American	North Brunswick, NJ	Y	4	6	Y	4	7	Y	5	5	5	5	5	5	6
211	20/M	-blank-	-blank-, CT	Y	4	1	Y	4	1	Y	8	8	8		8	6	9

212	19/M	Hispanic	Westminster, MD	Y	1	3	N			Y	6	6	6	4			
213	20/M	Russian	Germantown, MD	Y	5	6	N			Y	10	10	10	1			
214	20/M	-blank-	Randolph, NJ	Y	2	5	N			Y	10	10	10	1	10		
215	21/M	White	Pittsburgh, PA	Y	2	3	Y	3	3	Y	6	4	8	3	3	3	6
216	19/M	White	Linwood, NJ	N						Y	10	10	10				
217	21/M	-blank-	-blank-	N						Y	8	7	9	6			
218	21/M	White	Plainsboro, NJ	N						N					3	2	5
219	19/M	White	Somers Point, NJ	Y		1	Y	5	7	Y	6	6	8	1			
220	20/M	White	Manalopan, NJ	Y	2	1	Y	5	1	Y	9	6	9	1			
221	20/F	White	Scarsdale, NY	Y	4	4	Y	3	3	Y	10	10	10	10			
222	20/M	White	Hewlett, NY	N						Y	8	8	9	3			
223	20/F	White	Gaithersburg, MD	Y	3	3	Y	4	3	Y	10	8	9	5			
224	19/F	White	Clarksville, MD	Y	1	3	N			N					5	5	5
225	20/F	White	Baltimore, MD	Y	3	6	Y	5	6	Y	6	6	10	3			
226	20/F	White	Baltimore, MD	Y	2	6	N			Y	8	6	9	2			
227	20/F	White	Baltimore, MD	N						N					7	5	8
228	21/F	White	Denton, MD	N						N					8	6	9
229	18/F	Asian	Gaithersburg, MD	Y	2	3	N			Y	9	5	8	6			
230	22/F	Hispanic	-blank-, Ecuador	Y	3	6	N			Y	7	6	8	3			
231	20/M	White	Livingston, NJ	Y	2	1	Y	4	1	Y	10	9	10	3			
232	20/M	White	Sharon, MA	Y	3	4	Y	4	4	Y	3	2	5	2			
233	20/M	Hispanic	College Park, MD	Y	4	3	N			N					6	4	4
234	19/M	-blank-	-blank-	Y	2	1	Y	2	1	Y	10	7	10	1			
235	18/F	White	Brick, NJ	Y	2	2	Y	4	3	Y	5	5	8	6			
236	19/F	White	Egg Harbor Township, NJ	Y	3	6	Y	3	6	Y	10	9	10	7			
237	20/M	Indian	Gaithersburg, MD	Y	3	5	Y	6	5	Y	8	8	9	3			
238	18/M	White	York, PA	Y	2	4	N		4	N	10	5	9	5			
239	18/F	White	Jenkintown, PA	Y	3	4	Y	5	4	Y	5	5	10	7			
240	20/F	White	Hampstead, MD	Y	2	3	N			Y	8	5	8	3			
241	19/F	White	Ellicott City, MD	N						Y	5	5	5	5	5	5	5
242	22/M	White	Owings, MD	Y	3	6	N			Y	6	6	6	6			
243	20/F	White	New City, NY	Y	4	3	Y	4	3	Y	10	9	10	6			

244	21/F	White	Roswell, GA	Y	3	6	Y	5	7	Y	10	6	10	1			
245	22/F	White	Cecil County, MD	N						Y	9	8	8	8			
246	21/M	White	Gaithersburg, MD	N						N					5	7	10
247	21/M	White	Teaneck, NJ	Y	4	3	Y	4	3	Y	9	5	9	7			
248	19/M	Asian	Columbia, MD	Y	4	1	N			Y	10	10	10	6			
249	19/M	White	Mt. Airy, MD	Y	1	3	Y	2	3	Y	8	7	9	3			
250	19/M	White	Mt. Airy, MD	Y	4	1	Y	3	1	Y	9	7	9	5			
251	19/F	White	Clarksville, MD	Y	1	3	N			Y	6	6	8	3			
252	20/M	-blank-	Randallstown, MD	Y	2	6	N			N					5	5	8
253	21/M	White	Conowingo, MD	Y	4	3	Y	3	4	Y	10	10	10	5			
254	25/M	-blank-	Takoma Park, MD	N						N					6	3	10
255	22/M	-blank-	Whitehall, MD	N						N					3	5	5
256	21/M	White	Jarrettsville, MD	Y	2	5	N			N					1	1	1
257	19/F	White	La Plata, MD	Y	2	3	N			Y	10	10	10	7			
258	-blank-/M	African American	Chicago, IL	Y	2	4	N			N					10	8	8
259	26/F	White	Baltimore, MD	Y	5	6	Y (N/A)	5	6	Y (N/A)	10	8	8	7			
260	19/F	White	Baltimore, MD	N			N			N					1	1	1
261	19/F	White	Hampstead, MD	Y	2	3	Y	3	4	Y	10	10	10	7			
262	21/F	White	Princeton, NJ	Y	2	3	N			Y	6	9	10	4			
263	31/M	White	Baltimore, MD	Y	5	3	N			Y	10	9	10	9			
264	42/M	White	Beltsville, MD	Y	4	7	Y	4	7	Y	5	5	8	1			
265	28/M	White	Oshkosh, WI	Y	4	7	Y	4	7	Y	10	8	10	1			
266	19/M	White	Columbia, MD	N						Y	9	9	9	7			
267	20/M	Asian	Cranford, NJ	Y	3	2	N			Y	10	9	9	5			
268	21/M	White	Cherry Hill, NJ	N						N						1	1
269	21/M	White	Potomac, MD	N						N					1	1	1
270	21/F	Hispanic	Potomac, MD	N						Y	10	10	10	8			
271	21/M	White	Potomac, MD	N						N					6	5	8
272	23/M	-blank-	Austin, TX	Y	3	1	N			Y	10	6	6	3			
273	23/M	Filipino	Jagna Bohol, Phillipines	N						N					6	8	8
274	20/F	White	Clarksville, MD	N						N					6	8	8

275	21/M	White	-blank-	N						Y	7	5	6	4			
276	20/M	Black	Upper Marlboro, MD	Y	5	3	N			Y	5	5	8	3			
277	20/M	White	Stamford, CT	Y	2	2	N			Y	9	7	7	3			
278	20/M	White	Los Angeles, CA	N						N					2	1	1
279	19/M	White	Glenwood, MD	Y	3	1	Y	4	1	Y	10	8	8	3			
280	18/F	Asian	Silver Spring, MD	N						Y	9	8	10	3			
281	20/M	White	Wilmington, DE	Y	1	1	Y	1	1	Y	8	7	10	3			
282	19/F	White	Frederick, MD	Y	2	3	N			Y	10	10	10	8			
283	24/M	White	Mobile, AL	N						Y	10	10	10	5			
284	20/F	White	Arnold, MD	Y	3	2	N			Y	10	10	10	6			
285	20/F	White	Sykesville, MD	N						N					7	4	8
286	21/M	White	Washington, DC	N						Y	7	8	8	7			
287	21/M	White	Medford, NJ	Y	3	2	N			Y	8	8	10	6			
288	21/M	Asian	Burtonsville, MD	Y	2	2	N			Y	10	9	10	7			
289	19/F	White	Odenton, MD	N						N					6	6	6
290	21/F	Asian	Ellicott City, MD	Y	1	4	Y	2	4	Y	10	10	10	5			
291	21/F	White	Trappe, MD	Y	2	3	Y	2	3	Y	6	6	7	4			
292	20/F	White	Silver Spring, MD	Y	3	3	N			Y	10	6	10	10			
293	20/F	White	Ellicott City, MD	N						Y					10	5	8
294	21/M	White	Columbia, MD	Y	4	3	Y	4	3	Y	10	10	10	8			
295	19/M	Middle Eastern	Columbia, MD	Y	2	2	Y	5	4	Y	10	10	10	10			
296	20/M	Asian	Burtonsville, MD	Y	4	3	N	4	3	Y	10	10	10	7			
297	20/M	Asian	Burtonsville, MD	N						N					3	5	8
298	20/M	White	Wescosville, PA	N						N					6	5	7
299	20/F	White	Ellicott City, MD	Y	2	4	N			Y	7	6	8	4			
300	20/F	Asian	Ellicott City, MD	Y	2	4	N			Y	7	8	3	2			
301	20/M	Asian	Germantown, MD	N						N					6	7	7
302	19/M	Asian	Suwahesa, GA	Y	4	1	N			Y	10	7	10	6			
303	19/M	Asian	Silver Spring, MD	Y	3	1	N			Y	10	5	10	3			
304	21/M	Asian	Silver Spring, MD	Y	7	3	N			Y	10	9	9	6			
305	19/M	White	Severna Park, MD	Y	1	3	N			N					4	4	8
306	22/M	White	Abington, PA	N						N					5	1	6

307	18/M	Asian	College Park, MD	N						N					5	1	10
308	21/F	Asian	Gaithersburg, MD	Y	6	7	Y	6	7	Y	7	7	7	4			
309	18/M	White	Burtonsville, MD	Y	5	7	N			Y	10	5	10	1			
310	17/M	White	Lusby, MD	Y	3	1	N			N					5	5	7
311	18/M	Asian / Pacific Islander	Wharton, NJ	Y	4	6	Y	4	6	Y	6	6	9	3			
312	20/M	Asian	Rockville, MD	Y	3	2	N			N					1	1	1
313	19/M	White	New Orleans, LA	Y	2	6	Y	3	4	Y	6	6	6	1			
314	18/F	Asian	Rockville, MD	N						N					9	8	8
315	18/F	White	Little Silver, NJ	Y	5	3	Y	4	3	Y	10	10	10	7			
316	18/M	White	Coopersburg, PA	Y	2	1	Y	4	1	N					1	1	5
317	19/M	White	Downingtown, PA	Y	1	1	N			N					3	2	5
318	18/M	White	Hagerstown, MD	Y	2	2	Y	2	2	Y	10	7.5	6.5	1			
319	18/F	White	Silver Spring, MD	Y	5	2	Y	6	3	Y	10	10	10	1			
320	18/M	White	Olney, MD	Y	3	3	N			Y	10	5	7	4			
321	18/M	White	Damascus, MD	Y	3	1	Y	3	1	Y	8	8	8	4			
322	18/F	White	Cherry Hill, NJ	Y	1	1	N			Y	10	8	10	7			
323	18/M	White	Brandywine, MD	Y	5	1	N			N					10	1	10
324	18/M	White	Ossining, NY	Y	6	3	Y	6	3	Y	10	10	10	1			
325	19/M	White	Gambrills, MD	Y	4	1	N			Y	9	7	10	6			
326	18/M	White	Eldersburg, MD	N						Y	10	10	10	7			
327	18/F	White	Lusby, MD	Y	2	5	Y	5	4	Y	9	9	10	6			
328	18/F	Asian	Germantown, MD	Y	2	5	Y	4	5	Y	7	7	9	9			
329	19/F	-blank-	Fair Lawn, NJ	N						N					6	1	6
330	18/M	White	Annapolis, MD	Y	2	3	N			N					4	2	3
331	18/M	White	Gaithersburg, MD	N						N					1	1	2
332	18/M	White	Upper Marlboro, MD	Y	3	3	N			Y	10	8	9	7			
333	18/M	White	Derwood, MD	Y	1	6	N			Y	6	5	8	4			
334	18/F	White	Salisbury, MD	Y	2	5	Y	2	5	Y	10	10	10	2			
335	18/M	White	Merrick, NY	N						N					3	2	2
336	18/M	White	Flemington, NJ	Y	2	3	Y	2	3	Y	10	8	10	7			
337	18/F	Asian	Tucson, AZ	Y	5	2	N			N					8	9	10
338	19/M	White	Potomac, MD	N						Y	10	10	10	4			

339	18/F	White	Baltimore, MD	Y	2	3	Y	5	3	Y	9	10	10	1			
340	18/M	White	Rockville, MD	Y	1	6	N			Y	10	10	10	1			
341	18/F	White	Centreville, VA	Y	1	4	N			Y	10	7	10	1			
342	18/M	White	Westminster, MD	Y	1	3	N			N					7	1	10
343	18/M	White	Bel Air, MD	Y	1	2	N			N					7	3	7
344	17/M	White	Hampstead, MD	N						Y	10	8	10	4			
345	19/M	White	Doylestown, PA	Y	3	3	N			Y	10	10	10	6			
346	18/M	Asian	Gaithersburg, MD	Y	4	2	N			Y	10	6	7	3			
347	18/M	Polynesian	Potomac, MD	Y	2.5	2	Y	4	2	Y	10	10	10	5			
348	18/M	White/Chinese	Silver Spring, MD	Y	1	3	N			N					4	6	6
349	19/M	Norweigen/Irish	Grass Valley, LA	Y		3	N			N	10	10	10	5			
350	19/M	White	Bowie, MD	N						Y	10	1	8	1			
351	19/M	White	Chevy Chase, MD	Y	4	4	Y	4	4	Y	10	6	10	1			
352	19/M	White	Silver Spring, MD	Y	2	2	N			Y	10	5	9	2			
353	19/M	White	Mount Airy, MD	Y	3	3	Y	1	2	Y	10	6	8	5			
354	19/M	White	Baltimore, MD	Y	3	6	Y	3	4	Y	6	4	6	3			
355	19/M	White	Germantown, MD	Y	1	3	N			N					6	3	8
356	19/F	White	Gaithersburg, MD	Y	4	5	Y	5	5	Y	8	7	9	6			
357	19/M	White	Chevy Chase, MD	Y	2	5	Y	1	5	Y	8	6	10	3			
358	19/M	African American	North Wales, PA	Y	4	2	Y	4	2	Y	7	3	8	2			
359	19/M	White	Silver Spring, MD	Y	4	2	N			N					6	4	5
360	19/M	White	Damascus, MD	Y	4	5	N			Y	10	6	10	3			
361	21/M	Asian	North Potomac, MD	Y	2	2	Y	2	2	Y	7	6	10	3			
362	19/M	White	Silver Spring, MD	N						N					5	5	7
363	19/M	White	Pikesville, MD	Y	1	5	Y	3	5	Y	6	6	6	3			
364	19/M	White	Silver Spring, MD	N						N					1	1	1
365	18/M	Black	Silver SPring, MD	Y	2	7	Y	3	5	Y	10	6	10	2			
366	19/M	White	Baltimore, MD	Y	4	7	Y	4	6	Y	7	7	8	5			
367	19/M	White	Baltimore, MD	Y	5	1	Y	5	2	Y	8	7	8	3			
368	18/M	White	Burtonsville, MD	Y	4	7	N	4	6	N					10	1	10
369	18/M	Indian	Silver Spring, MD	Y	4	7	Y	2	4	Y	6	6	6	4			
370	19/F	White	West Orange, NJ	Y	2	1	N			Y	9	7	10	4			

371	19/F	Asian	Silver Spring, MD	Y	1	3	N			Y	10	10	10	3			
372	20/M	Asian	Wayne, NJ	Y	5	2	Y	5	2	Y	7	8	7	3			
373	19/M	African American	Houston, TX	Y	6	7	Y	7	7	Y	5	5	5	5			
374	19/F	White	Columbia, MD	Y	5	3	Y	6	3	Y	10	8	8	5			
375	-blank-/-blank-	-blank-	-blank-	Y	3	1	N			N					5	5	5
376	20/M	-blank-	Olney, MD	N						Y	10	5	10	1			
377	21/M	White	Mystic, CT	N			Y	1	2	Y	5.5	5.5	10				
378	18/M	Filipino	Civingston, NJ	Y	3	7	N			Y	10	10	10	10	10	10	
379	19/F	White	Mt. Airy, MD	Y	3	3	N			Y	10	9	10	5			
380	20/F	White	Waldorf, MD	Y	3	4	N			Y	9	9	9	5			
381	18/F	White	Dummus, NJ	N						Y	8	6	9	6			
382	21/F	Human	College Park, MD	N						N					7	3	8
383	19/M	White	Gaithersburg, MD	N						N					12	5	6
384	18/F	White	Easton, MD	Y	4	2	N			N					10	5	10
385	20/M	White	North Brunswick, NJ	N						Y	9	7	9	5			
386	18/M	-blank-	N.Kingstown, RI	Y	3	2	N			Y	8	5	9	3			
387	20/M	White	Buffalo, NY	Y	2	3	N			Y	10	8	10	4			
388	19/F	White	Dasdena, MD	Y	3	4	Y	4	4	Y	10	10	10	9			
389	19/M	White	Medford, NJ	Y	1	2	N			Y	8	4	10	6	8	6	9
390	19/F	White	Frederick, MD	N						N					5	6	6
391	20/M	Asian	Mitchellvile, MD	Y	3	2	Y	3	3	Y	8	8	9	5			
392	20/M	Irish-American	Kensington, MD	N						N					4	3	8
393	20/M	White	Crofton, MD	N						N					3	2	10
394	19/M	White	Baltimore, MD	N						N					2	2	2
395	18/M	White	Stamford, CT	Y	5	3	Y	5	5	Y	4	4	4	7			
396	23/M	White	Rockville, MD	N						N					7	4	7
397	21/M	Asian	Hampstead, MD	N						Y	5	5	8	5			
398	19/M	White	Derwood, MD	Y	3	3	N			Y	10	7	10	7			
399	21/M	Hispanic	Alexandria, VA	Y	3	4	N			Y	6	6	6	1			
400	21/M	White	Silver Spring, MD	N						N					1	1	1
401	21/M	White	Timonium, MD	Y	2	2	N			N					4	4	8
402	21/F	White	Eldersburg, MD	Y	5	4	N			Y	10	7	10	4			

403	20/F	White	Hagerstown, MD	N						Y	8	6	10	1			
404	21/F	White	Frederick, MD	Y	2	2	Y	2	2	Y	10	10	10	10			
405	20/M	White	Urbana, MD	N						Y	2	5	8	3			
406	21/M	Asian	Fort Washington, MD	Y	1	3	Y	3	3	Y	8	8	8	5			
407	20/F	Korean	Ellicott City, MD	N						Y	8	6	7	4			
408	19/M	Chinese	Syracuse, NY	Y	2	1	N			Y	5	6	9	3			
409	20/M	White	Hatboro, PA	N						N					6	5	8
410	20/F	Asian	Silver Spring, MD	Y	2	4	N			N					9	5	10
411	23/F	Taiwanese	Rockville, MD	Y	2	3	N			Y	10	10	10	1			
412	20/M	Asian	Gaithersburg, MD	Y	4	7	N			Y	6	3	4	3			
413	18/M	White	Milltown, NJ	N						Y	10	1	10	1			
414	20/M	Asian	Potomac, MD	Y	3	7	N			Y	9	3	6	3			
415	19/M	Asian	Rockville, MD	Y	2	7	Y	3	7	Y	10	10	10	2			
416	20/M	Asian	Potomac, MD	N						Y	10	7	10	3			
417	19/M	Asian	Potomac, MD	Y	4	7	Y	3	7	Y	8	1	10	1			
418	19/M	Asian	Rockville, MD	Y	2	1	N			Y	1	1	8	1			
419	18/M	Black	Laurel, MD	Y	4	2	N			Y	10	10	10	5			
420	21/F	Vietnamese	Olney, MD	N						N					8	5	7
421	21/F	Asian	Rockville, MD	Y	1	3	Y	1	3	Y	6	6	8	5			
422	21/M	Asian	Lutherville, MD	N						Y	10	7	10	3			
423	21/M	Asian	Ellicott City, MD	N						N					6	6	6
424	20/M	Asian	Boyds, MD	Y	3	1	Y	2	1	Y	3	2	5	1			
425	19/M	Black	Queens, NY	Y	3	2	N			Y	10	7	9	3			
426	18/F	Asian	Rockville, MD	Y	1	3	Y	1	5	Y	9	9	10	5			
427	19/F	Black	Upper marlboro, MD	Y	5	4	N			Y	6	6	9	4	7		
428	19/F	White	Crofton, MD	Y	2	3	N			Y	10	5	5	1			
429	19/F	White	Clarksville, MD	Y	2	4	N			Y	10	8	10				
430	19/F	White	Huntington, MD	Y	1	1	N			Y	6	6	6	1			
431	19/F	White	Salisbury, MD	Y	1	5	N			N					8	8	9
432	21/M	White	Dunkirk, MD	Y	3	4	Y	2	5	Y	6	1	8	1			
433	21/M	Chinese	Rockville, MD	Y	2	1	N			Y	7	6	9	4			
434	20/M	Korean	Potomac, MD	Y	2	1	N			Y	10	5	10	1			

435	4/F	African American	Silver Spring, MD	N		1				N					1	1	1
436	21/F	Asian	Ellicott City, MD	Y	3	4	Y	4	5	Y	10	10	10	4			
437	20/M	South Asian	Ellicott City, MD	Y	4	2	Y	7	2	Y	10	5 or 6	5 or 6	1			
438	20/F	Asian	Hyattsville, MD	N						N					6	6	6
439	18/F	Black	Beltsville, MD	Y	2	2	N			Y	8	8	6				
440	20/M	Chinese	Silver Spring, MD	Y	2	7	N			Y	10	8	10	1			
441	20/F	Asian	Columbia, MD	Y	1	4	N	1	4	Y	10	10	10	8			
442	20/F	Asian	Rockville, MD	Y	1	3	N			N					6	1	10
443	19/F	Asian	Potomac, MD	N						Y	9	7	10	7			
444	21/M	Hispanic	Frederick, MD	Y	4	1	N			Y	10	10	10	7			
445	20/F	White	Hillsdale, NJ	Y	1	3	Y	4	3	Y	10	10	10	8			
446	18/M	White	Hampstead, MD	N						N					6	1	1
447	18/M	European-American	Columbia, MD	Y	1	7	Y	7	1	Y	5	10	1	10			
448	21/M	White	Salisbury, MD	N						N					3	2	10
449	19/F	White	Columbus, OH	N						N					5	5	5
450	19/M	-blank-	Jefferson, MD	Y	2	1	N			N					10	1	10
451	20/M	White	Ogdensburg, NY	N						N					9	3	6
452	20/F	White	Pasadena, MD	N						N					7	4	5
453	21/F	White	Randolph, NJ	Y	1	4	N			Y	10	10	10	8			
454	24/M	White	Ridgewood, NJ	N						N					6	3	7
455	20/F	White	Gaithersburg, MD	Y	3	3	N			N					4	1	3
456	18/F	Black	Wheaton, MD	N						Y	8	8	9	4			
457	18/F	White	Medford, NJ	Y	2	3	Y	3	3	Y	9	10	10	1			
458	20/F	White	Beltsville, MD	Y	1	3	N			Y	9	10	10	7			
459	19/F	White	Gaithersburg, MD	Y	1	2	N			Y	10	8	10	7			
460	19/M	Asian	Gaithersburg, MD	N						Y	10	6	10	6			
461	21/F	White	Birmingham, AL	N						N					7	4	7
462	18/F	White	Bethesda, MD	Y	1	4	Y	1	4	Y	8	1	7	6			
463	18/F	White	Crofton, MD	N						N					8	1	8
464	21/F	Black	Richmond, VA	N						N					7	3	7
465	19/M	White	Ellicott City, MD	N						N					1	6	8
466	18/M	White	Derwood, MD	N						N					1	1	1

467	19/F	Asian	Potomac, MD	Y	2	4	N			N					8	3	8
468	18/F	Asian	Gaithersburg, MD	N						N					6	4	9
469	18/F	White	Parsonsburg, MD	Y	5	2	N			Y	10	10	10	4			
470	19/M	Asian	Ellicott City, MD	N						N					8	6	7
471	18/M	White	-blank-	Y	4	1	N			Y	10	10	10	5			
472	18/F	White	Basking Ridge, NJ	Y	1	2	Y	5	3	Y	10	10	10	10			
473	18/M	White	Forest Hill, MD	Y	3	3	N			Y	9	8	9	4			
474	18/M	White	Montgomery Village, MD	Y	3	1	N			Y	8	6	10	4			
475	18/F	Hispanic	Silver Spring, MD	N						N					6	6	6
476	18/M	Asian	Gaithersburg, MD	N						N					5	1	6
477	18/F	White	Bethesda, MD	Y	4	3	N			N					6	5	7
478	18/F	White	Columbia, MD	Y	4	3	Y	5	3	Y	10	7	10	7			
479	20/M	White	Frederick, MD	Y	6	5	Y	4	2	Y	10	10	10	7			
480	18/-blank-	-blank-	-blank-	Y	4	3	Y	5	3		8	6	9	5			
481	18/M	White	Hamilton, NJ	N						N					9	6	7
482	18/M	White	Adamstown, MD	N						Y	10	5	10	1			
483	18/M	White	Silver Spring, MD	Y	3	2	N			Y	10	10	10	7			
484	18/M	White	Drexel Hill, PA	Y	5	1	Y	5	2	Y	10	7	10	1			
485	18/F	Asian	Gaithersburg, MD	N						Y	9	9	9	7			
486	18/F	Asian	Rockville, MD	N						Y	6	6	6	3			
487	18/M	White	Chesapeake City, MD	Y	4	5	N			Y	10	10	10	1			
488	19/M	White	Sheffield, England	Y	2	1	N			Y	8	5	8	3			
489	19/F	Hispanic	Cordebo, Argentina	Y	1	2	N			Y	10	10	10	9			
490	19/M	White	Olney, MD	N						Y	10	10	10	7			
491	19/F	Asian	Ellicott City, MD	Y	1	5	N			N					6	5	8
492	21/F	Asian	Ellicott City, Md	Y	1	4	N			Y	10	10	10	7			
493	20/M	Anglo-Canadian-Germano-Irish Amerian	Sudbury, MA	N						N						5	10
494	22/F	White	Olney, MD	Y	1	2	N			Y	10	10	10	7			
495	21/F	White	Silver Spring, MD	Y	2	4	N			Y	10	6	10	4			
496	21/F	Other (mixed)	-blank-, NY	Y	2	4	Y	3	4	Y	10	6	10	10			
497	21/F	White	Elkton, MD	Y	4	6	N			Y	10	6	8	3			

498	21/F	White	Baldwin, MD	Y	3	4	N			N					4	3	3
499	22/F	White	Annapolis, MD	Y	4	5	N			Y	6	6	9	3			
500	21/F	White	Glen Mills, PA	Y	1	3	N			Y	7	1	8	2			
501	20/F	White/Asian	Gaithersburg, MD	N						Y	8	8	9	8			
502	21/F	Asian	Potomac, MD	Y	1	6	N			Y	6	8	9	3			
503	22/F	White	Rockville, MD	Y	1	3	N			Y	1	1	10	1			
504	20/F	White	Rochester, NY	Y	4	3	Y	3	3	Y	5	5	5	7	7	8	8
505	19/F	White	Mechanicsville, MD	Y	1	3	N			Y	8	7	8	6			
506	19/F	White	Elkton, MD	Y	6	4	Y	5	4	Y	7	8	7	7	6	7	7
507	19/F	White	Newark, DE	Y	5	3	Y	4	3	Y	9	9	10	9	10	6	10
508	21/F	White	Salisbury, MD	Y	1	3	N			Y	10	7	10	2			
509	21/F	White	Potomac, MD	Y	3	2	N			Y	10	8	10	5			
510	20/F	White	Crofton, MD	Y	5	5	Y	5	5	Y	7	7	6	7	7	7	7
511	21/F	White	Toms River, NJ	Y	4	3	Y	6	3	Y	10	10	10	7			
512	18/F	White	Rockville, MD	Y	3	4	N			Y	7	5	7	3			
513	19/F	White	Gaithersburg, MD	N						Y	7	6	7	1			
514	19/F	White	Hyattsville, MD	Y	2	6	Y	2	6	Y	10	10	10	1	10	1	10
515	18/F	White	Riverside, CA	N	1	3	N			Y	10	10	10	8			
516	19/F	White	Greensboro, MD	N						N					7	5	10
517	19/F	White	Ellicott City, MD	Y	3	3	N			Y	7	5	8	4			
518	18/F	White	Wilmington, DE	Y	4	2	Y	3	2	Y	8	5	9	4			
519	18/F	White	Boston, MA	Y	4	4	Y	4	4	Y	10	5	10	1			
520	19/F	White	Suffern, NY	Y	3	3	Y	3	6	Y	10	6	10	5.5			
521	19/F	White	Annapolis, MD	Y	3	3	Y	1	3	Y	10	10	10	3			
522	20/F	White	Kensington, MD	Y	3	3	N			Y	6	6	6	6	6	6	6
523	21/F	White	Monroe Twp, NJ	Y	3	2	N			Y	10	8	10	6			
524	20/F	White	Fallston, MD	Y	1	2	N			Y	9	9	10	7			
525	22/F	White	Annapolis, MD	Y	1	3	N			Y	6	6	7	6			
526	18/F	White	Potomac, MD	N						N					7	5	8
527	19/F	White	Reisterstown, MD	Y	3	4	Y	5	5	Y	7	6	7	4			
528	18/F	White	Owings Mills, MD	Y	6	3	Y	4	3	Y	10	10	10	7			
529	19/F	White	Annapolis, MD	N						N					6	6	8

530	19/F	White	Abingdon, MD	N						N					1	1	1
531	20/F	White	Crofton, MD	Y	2	2	N			Y	10	10	10	6	10	1	10
532	18/F	White	Bethesda, MD	Y	4	3	Y	4	5	Y	8	9	8	6			
533	19/F	White	California, MD	Y	4	3	Y	6	3	Y	6	6	6	6			
534	18/F	White	Wayne, NJ	Y	4	3	Y	4	4	Y	8	7	7	6			
535	19/F	White	Severna Park, MD	Y	4	6	Y	4	6	Y	7	7	9	5			
536	18/F	Black	Washington, DC	Y	1	2	N			N					1	1	2
537	18/F	White	Bethesda, MD	Y	1	4	N			N					6	6	6
538	20/F	Hispanic	Germantown, MD	N		4	N			Y	6	6	8	4			
539	19/F	White	Queenstown, MD	N						Y	6	6	6	6	6	6	6
540	18/F	White	East Rockaway, -blank-	Y	3	3	Y	4	3	Y	10	5	5	6			
541	19/F	White	Georgetown, IN	Y	4	4	N			Y	9	9	9	5			
542	18/F	White	Cranston, RI	Y	1.5	4	Y	2.5	4	Y	10	7	7	7			
543	19/F	White	Baltimore, MD	N						Y	8	5	9	4			
544	19/F	White	White Plains, MD	Y	3	5	Y	2	5	Y	10	10	10	7			
545	20/F	White	Jacksonville, MD	Y	1	3	Y	5	4	Y	9	2	9	2			
546	18/F	White	Sparks, MD	Y	3	3	N			Y	8	8	10	2			
547	20/F	White/Asian	-blank-, MD	Y	1	3	N			N					4	3	3
548	21/F	Hispanic	Easton, MD	N						N					6	3	9
549	20/F	EurAsian	Gladwyne, PA	Y	5	2	Y	5	2	Y	10	10	10	5	10	5	10
550	21/M	White	Rockville, MD	N						N					1	5	5
551	20/F	White	Damascus, MD	Y	1	4	N			Y	10	10	10	4			
552	20/F	White	Damascus, MD	N			N			N					8	2	8
553	21/M	White	Clarksville, MD	Y	3	2	Y	4	2	Y	10	5	10	1			
554	22/F	White	Brick, NJ	N						Y	5	6	8	4			
555	20/F	White	Pittsburgh, PA	Y	1	4	Y	4	5	N					7	6	8
556	21/F	White	Wynnewood, PA	Y	3	3	N			Y	10	8	10	2			
557	22/F	White	Silver Spring, MD	Y	2	3	N			Y	8	8	9	5			
558	19/F	White	Hyattsville, MD	N						Y	8	5	6	6			
559	18/F	White	Bowie, MD	Y	2	3	N			Y	9	9	9	1			
560	20/F	White	Annapolis, MD	Y	1	5	N			Y	7	5	7	7	7		
561	20/F	Asian	-blank-, MD	N						N					6	6	7

562	21/M	White	Meadhan, NJ	Y	3	1	Y	5	1	Y	5	2	9	5			
563	21/F	White	Wyckoff, NJ	Y	1	5	N			Y	9	5	10	5	5	2	9
564	22/F	White	Spenville, NJ	Y	6	6	Y	4	5	Y	9	6	10	3			
565	21/F	White	Baltimore, MD	Y	3	4	N			Y	10	10	10	8			
566	20/F	White	Pittsburgh, PA	Y	4	3	Y	5	3	Y	7	8	10	1			
567	18/M	White/Asian	Columbia, MD	Y	3	3	Y	2	3	Y	10	8	9	4			
568	20/M	White	Cape May, NJ	Y	2	1	Y	4	1	Y	10	5	8	6			
569	19/M	White	Chevy Chase, MD	Y	5	1	Y	5	1	Y	8	8	8	1			
570	18/M	Asian	Gaithersburg, MD	Y	1	4	N			N					7	8	9
571	18/M	White	Parkton, MD	Y	3	1	N			N					8	4	7
572	18/M	White	Glen Burne, MD	Y	3	2	Y	3	2	Y	10	10	10	7			
573	19/M	White	Street, MD	N						N					6	1	6
574	19/M	Chinese	Chicago, IL	N						N					8	6	8
575	18/M	White	Baltimore, MD	N						N					6	3	3
576	19/M	-blank-	Lutherville, MD	Y	6	1	Y	7	1	Y	1	1	1	0			
577	19/M	Hispanic-American	Beltsville, MD	Y	3	2	N			Y	10	10	10	8			
578	19/M	White	Woodbine, MD	Y	3.5	1	N			N					1	1	6
579	20/M	Asian/Middle Eastern	Germantown, MD	Y	2	7	N			Y	6	6	6	6	6	6	6
580	18/M	White	Finksburg, MD	Y	2	3	N			Y	9	9	10	2			
581	18/M	White	Needham, MA	Y	6	1	Y	5	1	Y	10	10	10	8			
582	18/M	Black	Southfield, MI	Y	2	1	N			Y	10	6	10	3			
583	18/M	Black	Burtonsville, MD	N						Y	8	8	8	8	8	8	8
584	19/M	White	Annapolis, MD	Y	3	2	N			Y	10	9	9	8			
585	18/M	White	Baltimore, MD	Y	5	5	N			Y	6	5	8	6	6	6	6
586	18/M	White	Colonia, NJ	Y	6	1	Y	6	1	Y	9	7	8	3	9	6	10
587	20/M	White	Bel Air, MD	N						Y	8	6	9	3			
588	21/M	Asian	Elkton, MD	Y	1	5	Y	4	5	Y	9	8	9	9	9		
589	19/M	White	Silver Spring, MD	Y	3	3	Y	5	2	Y	8	8	10	1			
590	18/M	Moroccan	Macungie, PA	Y	3	3	N			Y	10	8	10	1	8	8	8
591	18/M	Asian American	Gaithersburg, MD	N						Y	6	7	6	5			
592	21/F	Hawaiian	Panama	Y	5	3	N			Y	3	8	6	6	6	8	7
593	20/M	Asian	Silver Spring, MD	Y	3	2	Y	2	1	Y	6	3	5	7	8	1	9

594	21/M	White	Olney, MD	Y	1	1	N			Y	10	7	10	4			
595	19/F	White	Beavercreek, OH	Y	6	6	Y	5	5	Y	8	6	6	6			
596	19/F	White	Ellicott City, MD	Y	3	5	Y	5	7	Y	10	10	6	3			
597	21/F	White	Pittsford, NY	N						Y	9	5	8	5			
598	18/F	White	Middletown, NJ	Y		3	Y	3	2	Y	6	5	6	5			
599	20/F	White	Columbia, MD	N						Y	5	10	10	10	10	10	10
600	21/M	White	New York, NY	Y	4	4	Y	4	8	Y	8	9	7	9			

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