**Introduction:**
I propose to build a power meter for a bicycle that can be cost effective and allow the user to keep their original parts on their bicycle. This power meter will calculate the real-time output power of the cyclist by measuring the torque and angular velocity of the crank arms on the bicycle. This information will then be sent wirelessly to a small display console located on the handlebars of the bicycle which will display the current power of the rider in watts. This power meter will be easy to set up and use on many types of bicycles.

**Description:**
The wireless bicycle power meter will use two microcontroller units, two RF modules (one module to transmit and one module to receive), one accelerometer, and two strain gauges. The microcontroller and RF modules may be on the same chip, since there are several MCU/RF units available. One microcontroller will be placed on the crank arm assembly to collect data from the accelerometer and strain gauges to be sent through the RF module. This data will then be collected by a receiving RF Module and sent to the second microcontroller mounted on the handlebars of the bicycle. This data will be processed and tabulated as necessary and displayed on a small LCD display. A block diagram of this data acquisition and data transfer can be seen in figure 1.

The microcontrollers I will select for this project do not need to be large nor robust. Their primary task will be sending and receiving data via the RF connection. The microcontroller on the crank arms will only need to collect data from the sensors and transmit the collected data. There will not be very much space on the crank arms for hardware, so the microcontroller will also need to be physically compact. The microcontroller on the handlebars will have a slightly heavier load, since it will need to receive the data, process the data, and display the data to a small LCD display. It will also interface with a keypad that will allow users to calibrate the strain gauges during installation. Different crank arms vary in stiffness, so a calibration interface will be necessary to allow the strain gauges to make accurate measurements. This calibration interface will allow my power meter to be compatible with many types of bicycle.

I have elected to transmit the collected data wirelessly because it will eliminate the complication of running wires from a rotating crank arm assembly. The RF modules will enable me to construct my project modularly, while providing an easy and reliable method for communicating between my two microcontrollers.

The sensors needed to collect the critical data to calculate the output power are two strain gauges (one for each crank arm) and an accelerometer. There will be one strain gauge bonded to each crank arm to measure the applied force from the rider. The crank arms used in my project will be made of aluminum so the strain gauges used will be matched for use on an aluminum surface. The summation of the force measured from each strain gauge will be converted into torque by multiplying the measured force by the length of the crank arm. The accelerometer will then be used to calculate the approximate angular velocity of the crank arms. Once the angular velocity and torque are measured, the power can be calculated by multiplying the two (power = torque x angular velocity).
Figure 1:

Benefits:
Power meters designed to measure the output power of a bicycle rider can be a valuable tool for athletes in training. By accurately measuring the output power while riding, a cyclist can gauge the effectiveness and progress of each training session. For many years, only professional cyclists could benefit from power meters, since they were only available in training labs. In recent years, several companies have made power meters commercially available that can be placed on bicycles and used to measure power while cycling. Unfortunately, the power meters commercially available are expensive and require the user to exchange parts on their bicycle. My wireless bicycle power meter will enable a cyclist to monitor their real time power output for a reasonable cost without having to make many major modifications to their bicycle.

Impact:
This project has the potential to have an impact on the way power meters are used in conjunction with bicycle training programs. My power meter will be a low cost, easy to use unit that could enable more cyclists to be able to afford power meters to train with. A low cost, simple power meter could improve the physical performance and endurance of a greater demographic of cyclists.

Comparison to Similar Products:
There are several similar products currently available on the market:

-SRM Training System (http://www.srm.de/englisch/index.html)
  -Fully replaces crank arms and bottom bracket
  -Measures torque and angular velocity
  -Data transferred via magnetic induction (mounted on crank and frame)
  -Battery life: 2000 hours
  -Added weight: about 272 grams
  -Different accuracies available with different number of strain gauges
  -Price: $2,200-$5,600 (depending on number of strain gauges)
Wireless Bicycle Power Meter

-Power Tap Power Meter:
- Replaces the rear hub/wheel assembly
- Measures torque via strain gauges and angular velocity
- Data transferred wirelessly via RF signal
- Added weight: about 351 grams
- Price: $700-$1000 (depending on type of wheel built on hub)

-IBike Pro (http://www.ibikesports.com/products.html):
- All inclusive computer placed on handlebars (replaces no parts)
- Estimates power by calculating the force of gravity, wind, and rolling resistance
- Reportedly less accurate and does not measure real-time power
- Many additional functions, but not usable on an indoor trainer
- Added weight: 62 grams
- Price: $430-$800 (depending on additional features)

**Project Development:**
This project will be developed in the ETEC 340 laboratory and at home. I will select an MCU that has development tools available for me to use on my computer at home or at school. This will enable me to do the software/MCU development anywhere I would like. Preferably, I would like to use a Freescale product since I am already familiar with their development tools and general MCU layout. This would speed and simplify my project development considerably. I will use the lab for the majority of my hardware construction since I will need to use the oscilloscopes, function generators, DMM’s, etc. I plan on installing the project on one of my bicycles from home. Since space is at a premium (see figure 2), I will need to take great care in the layout of the various modules and housing construction on the transmitter portion of my project.

**Project Demonstration:**
I will install my project on a bicycle I own and place this bicycle on a stationary trainer in the laboratory for the demonstration. Viewers will be able to ride the bicycle and witness first hand the ability of my project to measure the rider’s output power. Since the power is measured in real time, they will be able to instantly see the change in their power output depending on their pedaling rate and trainer resistance.