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Harnessing human power to charge batteries (and more?)

A large amount of what I have learned at Oberlin College I have learned in the Bike Co-op while trying to fix broken down bikes, and I suppose that building a bicycle wheel from a hub, rim and spokes is a benchmark in my bicycle mechanics education. I had always wanted to build a set of custom wheels for my bicycle so, I turned to Jobst Brandt's *The Bicycle Wheel*, a Bike Co-op favorite, for guidance and advice on where to start, what components to buy, and what cross pattern in which to lace the spokes. Brandt's book is more than a list of directions on how to build a bicycle wheel. In it he also explains the theory behind the methods wheel craftsmen have used for generations: it is the spokes at the bottom of the wheel which support the weight of the bicycle and rider, and that pretensioning the spokes is necessary for the wire spoke to act appropriately as a compression member in the wheel's structure. Brandt's analogy relating the bicycle wheel to an electronic circuit inspired my project.

> For electrical engineers the concept of prestressing should be familiar since it is common in electrical circuits. Circuits with components (spokes) that cannot withstand reverse currents (compression) are often designed to accept oscillating signals with positive and negative currents. To make this possible, such circuits are biased (tensioned) so that no reverse currents occur. This pretensioned network is analogous to a tensioned wire [spoke] wheel. (Brandt, 12)

I used a hub engineered by Shimano for the purpose of generating electrical power for a headlight/ taillight system for safe night riding. The hub converts the mechanical energy of the wheel's rotation into electrical energy in a similar manner to the way a hydroelectric plant produces electricity from a spinning turbine as water falls over the blades causing them to rotate, but at a much smaller scale. The stainless steel spokes and reinforced aluminum alloy rim were selected for their durability and economy. Calculating the correct spoke length was difficult, but once I had the correct length spokes following the direction for building straight and strong wheels outlined in Jobst Brandt's book was straightforward. Feeling as though I was progressing in skill, I decided to build a rear wheel as well because it posed a different challenge since the gears on the right side of a rear wheel dictate that all of the spokes on the right side be tensioned higher than those on the left.

After the front dynamo wheel was complete (and during construction of the rear wheel) I began designing an electronic device to charge my cell phone battery as well as four AA sized NiCd rechargeable cells. Bill Mohler, electrical engineer for the natural sciences division, provided me with electronic components first to prototype with, and then to construct the final circuit board. Essentially the circuit is a standard rectifier diode bridge with capacitors and an out-

put regulator to smooth out the signal to a straight 5V direct current. The NiCd cells came from a salvaged R/C car battery pack, and the plastic case that protects the circuit board from the elements and cables are salvaged from old AC/DC adapters.

The AA cells serve two purposes. As I ride my bike, I may occasionally need to stop, meaning the dynamo stops generating electricity. So the first purpose of the NiCd cells is to continue to supply the Li-ion cell phone battery with power while at a stand-still because the cell phone's battery is susceptible to damage from stop and start charging. Their second purpose is to store any power that is not used to charge the cell phone. Because the weather is a bit nippy at the moment I haven't actually tested how long it will take to completely charge the batteries from a complete discharge, but lab tests and approximate calculations lead me to believe it would require a full hour of bike riding.

My favorite parts of the project were its focus on sustainability, renewable resources and development of off-the-grid power technology that has many possibilities for future applications of bike-mounted portable electronic devices, besides all of the fun I had working on it.