P09007 Project Review

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Project Overview/Customer Needs

- The purpose of this project was to create a self contained system that would charge USB electronics (iPod, etc.) from the power generated by the user.
- The high level customer needs are as follows:
  - Safe, contained system
  - USB Power
  - Modular
  - Has a LCD screen/user interface GUI

Engineering Specs

- Mechanical Compliance

Specification	Design Value	Test Value
Generator Shaft Speed (rpm)	4000-7000	6200
Generator Input Torque (N)	>0.5	13
Box Impact Resistance	No critical structural damage	Pass

Engineering Specs

- Electrical Compliance

Specification	Design Value	Test Value
Rectifier Output (Vdc)	11.1	N/A
Rectifier Output (W)	40	N/A
Battery Charger Current (A)	2	N/A
iPod Charge Voltage (Vdc)	5	4.99
iPod Charge Current (mA)	250	N/A
Loaded Battery Life Operation (hrs)	1	N/A
Error Amp Gain (V/V)	0.5	.31
Error Amp Bandwidth (kHZ)	3.2	3.15

Engineering Specs

- Human Interface

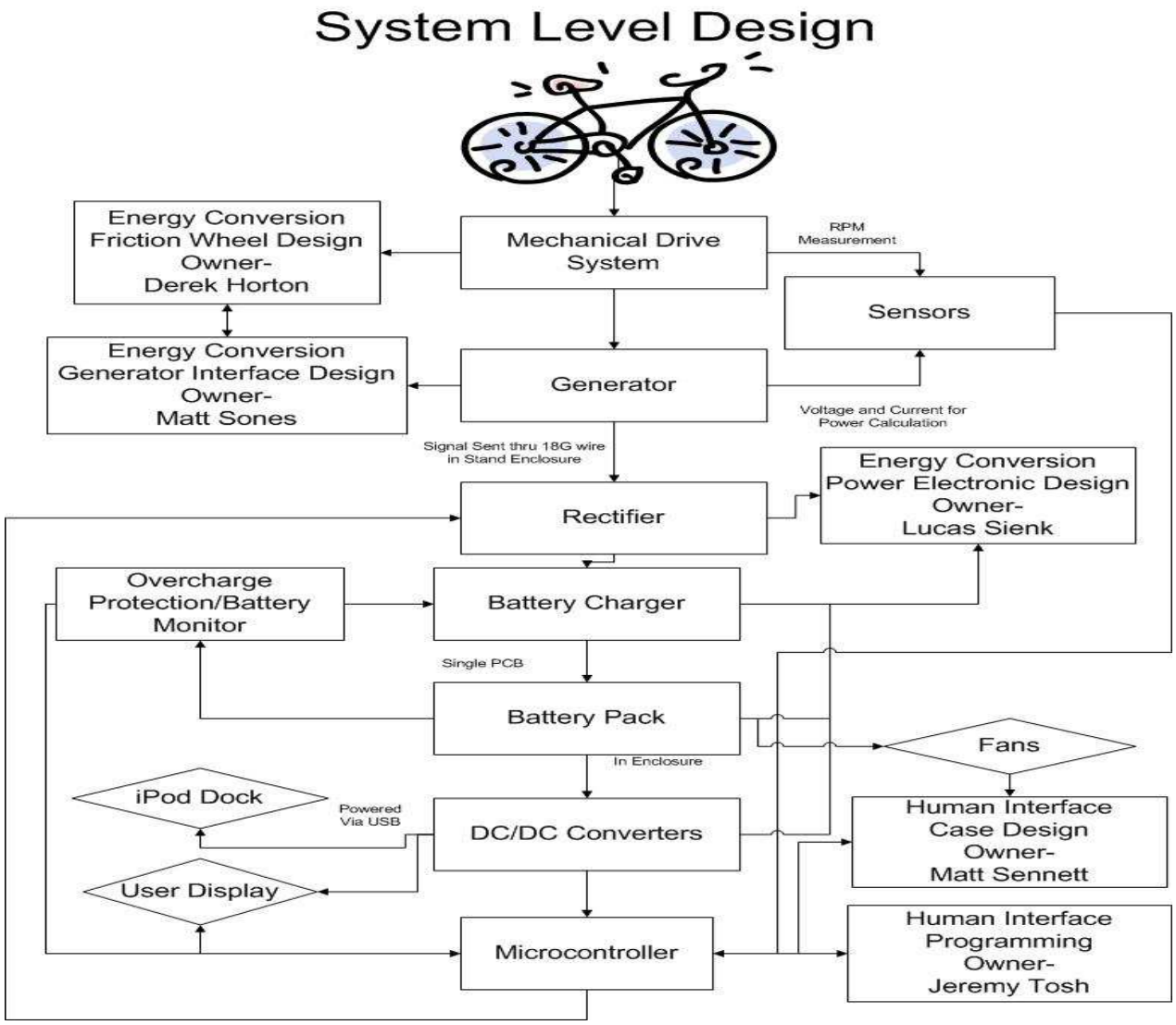
Specification	Design Value	Test Value
Ease of Adjustment	1 tool, 3-5 mins.	1 tool, 1-2 mins.
Ease of Repair	1 tool, 3-5 mins to open enclosure	1 tool, < 1 min to open enclosure
Height Range	2.5-3.5 ft.	2.75-5 ft.
Box Impact Resistance	No critical internal damage	Pass (mounted mock-up Inside enclosure and dropped)

Concept Summary

- Generator
  - DC Brushless motor was used as a generator, functioning as a 3-phase AC generator. Chosen due to it's increased efficiency, minimal maintenance, and smaller mechanical resistance as opposed to the easier to design for DC motor.
- Controlled Rectifier
  - This was also selected for it's higher efficiency and controllability over a passive rectifier
- LCD

- Human Interface Case
  - Electrical enclosure houses LCD, ipod dock, all items user will interact with
  - Mounted on two posts; adjustable for viewing angle and height

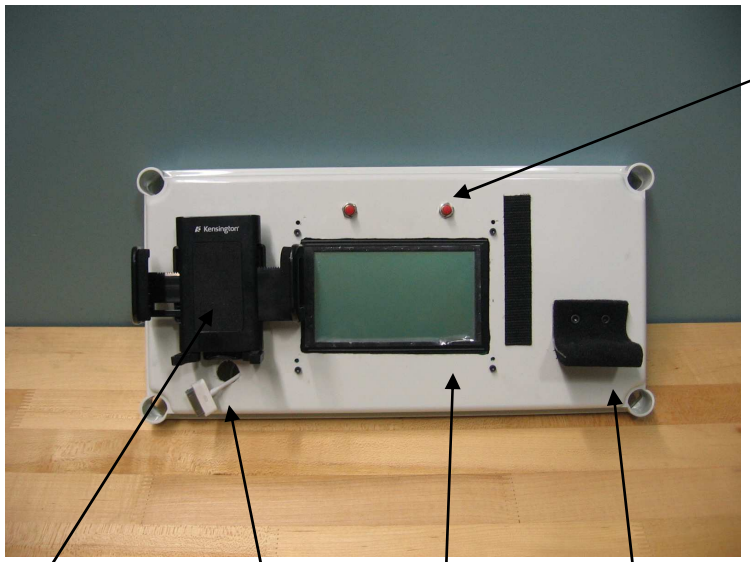
System Architecture



Design Summary

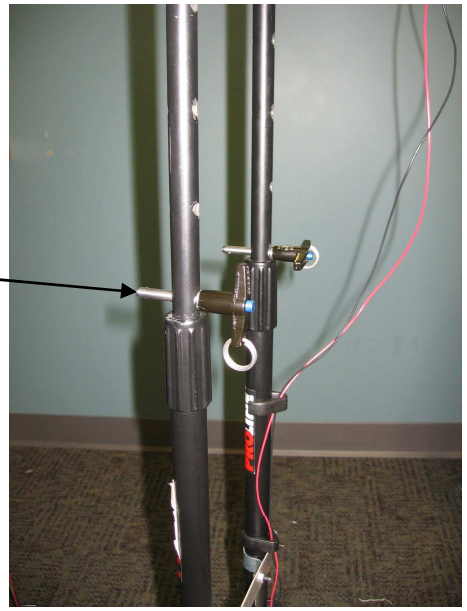
- Mechanical Design
  - Self-aligning friction wheel drive system was implemented to transfer energy from bike's spinning wheel to generator.
  - Gears used to step up generator shaft speed.
  - Mechanical drive system enclosed in protective box.
  - System adjustable for use with any spinning wheel stationary bike.
- Human Interface – Mechanical
  - Stable, two post mounting
  - Tool-less height adjustment, 1-tool angle adjustment
  - Enclosure securely houses electrical components and accomodates user-interactive items (LCD, ipod dock, etc)

Design Summary



Switches

Pin locks/tool-less adjustment



Wing-nuts for easy angle adjustment

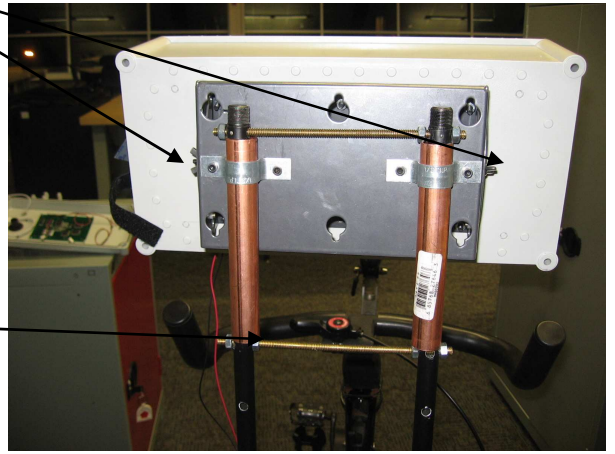
Ipod dock

Ipod charge cord

Electrical Device Tray

LCD

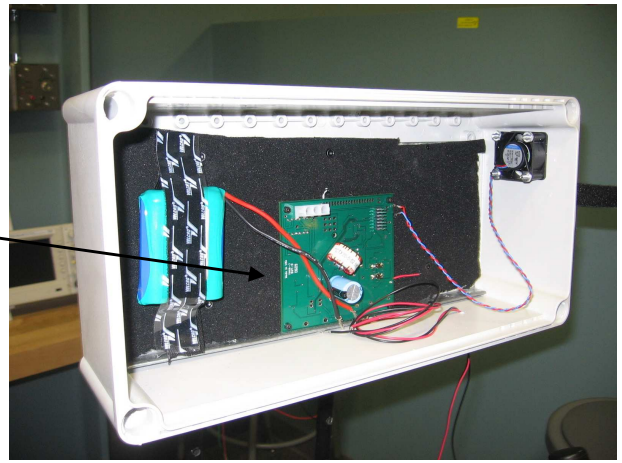
Adjustment handle



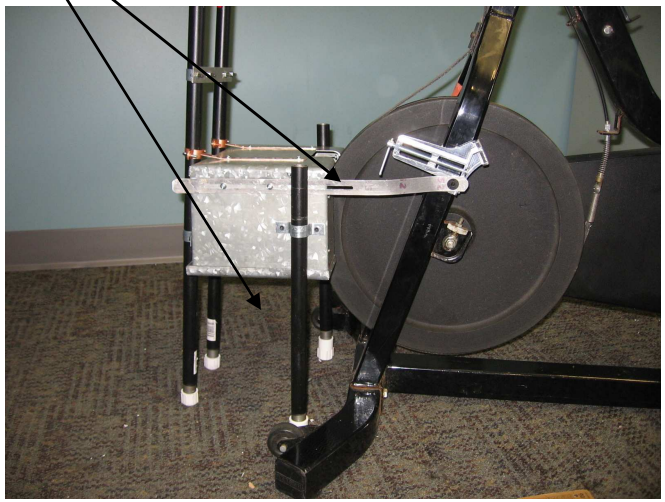
Design Summary

Overall Mechanical System

Housing electrical components



Stable base/connection to bike



Design Summary

- Electrical Design
  - Controlled Rectifier design involved both hardware (Rectifier transistors, Gate Driver, and Error Amp) and software interface (MSP430)
  - Power Electronics were all off the shelf components that were modified to provide desired outputs using different value components based on manufacturer information
  - Battery Charger was implemented using only hardware, even though a software solution was possible
- Human Interface - Electrical

Test Results

Mechanical

- Generator Shaft Speed
- Generator Input Torque
- Output Voltage

- Electrical
  - Buck Converters
    - 5Vdc from output one
    - 3Vdc from output two
- Human Interface
  - Ease of repair
    - 1 tool to open enclosure
  - Ease of adjustment
    - 1 tool, ~1-2 mins

Objective Project Evaluation

- Successes
  - Mechanical Design – met expectations for quick assembly, modular application and robust enclosure. The design exceeded the expectations in regards to the output voltage from the generator.
  - Electrical Design – Buck converters for microcontroller and USB power work as designed, although they need to be tested for specified power
  - Human Interface
    - Front face incorporates all design ideas
    - System does not shake with bike use
    - Very easy to adjust both height and angle

Objective Project Evaluation

- Failures
  - Mechanical Design – metal box creates loud operation, not rigidly connected to bike well.
  - Electrical Design – LCD screen did not function because the boost converter needed to power the back light did not work properly on the PCB. Battery Charger could not be tested because components were not received in time. Rev 1 of the PCB Layout was as failure as it did not function as intended.
  - Human Interface – not aesthetically pleasing, tray/velcro system could be improved. Angle adjustment could be made tool-less with weld nut.

Conclusion/Suggestions for Future Projects

- Mechanical design/prototype is sound and is a good base for future projects, with minor improvements.
- Electrical design needs further prototyping and possible redesign for this phase of project
  - USB power is available from selected components, preliminary testing has been performed, but more thorough testing show be completed
  - Design of rectifier is sound, testing and debug needs to be completed
  - Battery Charger design should be reviewed and tested
  - LCD software and hardware needs to be examined and tested
  - Battery Monitor software needs to be tested
- A more elegant, self-contained, and aesthetic design of the system has been completed, and any future run of the project should incorporate that
- Other options, such as charging other sources and returning the power to the grid should be looked into in the future

Conclusion/Suggestions for Future Projects