CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Elizabeth Kravtchenko

Project Number
S0310

Project Title
Crank It Up! Finding the Optimal Crank Arm Length

Abstract

Objectives/Goals
The purpose of this project was (a) to find out if using longer crank arms on my bicycle would allow me to ride faster and (b) to develop a computer-based system, model, and analysis to determine an optimal crank arm length. My hypothesis was: if I extend the crank arms on my bicycle by 1.5%, then I will increase my peak power output by 35% and achieve much higher speed.

Methods/Materials
In my research and analysis, I used mathematical and computer modeling to describe the physics of cycling and calculate pedaling force. In my experimental method, I completed three cycling tests with different crank arm lengths and generated large data sets. My independent variable was crank arm length. My dependent variables were power, pedaling force and cadence, wheel speed, and heart rate. I used the following materials and equipment: road bicycle, stationary rollers, 170/172.5/175 mm crank arm sets, crank arm RPM (cadence) meter, rear wheel RPM (speed) meter, rear wheel hub power meter, heart rate monitor, cycling computer, personal computer, online .fit to .csv file converter, and Excel modeling software. In my data analysis and visualization, I used numerical methods and statistics to compare my test results, and data slicing and dicing techniques to gain valuable insights.

Results
I noticed virtually no effect of the crank arm length on the speed vs. power efficiency. However, with the 172.5 mm crank arms, I was able to balance my neuromuscular and cardiovascular performance and output a lot more power and achieve much higher speed than with the other crank arms! By adjusting crank arm length, and measuring power, cadence, and heart rate, one may identify his/her neuromuscular and cardiovascular "bottlenecks" and find his/her optimal crank arm length. At this optimal length, both pedaling force and heart rate achieve their max simultaneously, producing the highest power output and speed.

Conclusions/Discussion
My hypothesis was correct! I was able to output 37.5% more power and achieve much higher speed with the 1.5% longer (optimal) crank arms. I have also developed a sophisticated computer-based system and a practical novel method to determine an optimal crank arm length based on power, cadence, and heart rate measurements. I am considering filing a patent for this. My innovative system and method may help other people to find their optimal crank arm length!

Summary Statement
In my project about cycling, I developed an innovative computer-based system and method to determine an optimal crank arm length based on power, cadence, and heart rate measurements to produce the highest power output and speed.

Help Received
Dmitriy Badeka (cycling coach) helped me to install the crank sets and connect the sensors. Tatiana Seletskaia (physics teacher), Bob Dubrow (mentor), and Vladimir Kravtchenko (mentor) reviewed my project and provided feedback and guidance.