INDUSTRIAL ENGINEERING
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DECISION MODELS
IE 2086
PROF. DANIEL JIANG

Project Description

SUBMITTED BY

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Project Setting

Vehicle Performance Optimization
Every year, the American Society of Mechanical Engineers (ASME) organizes the E-Fest Human Powered Vehicle Challenge. This event challenges university teams to design and manufacture a recumbent bicycle to compete in an endurance race, drawing awareness to bicycle power and its impact on climate change.

Recumbent bicycles, unlike traditional road bikes, are designed to achieve recording-breaking speeds. In this project, we will consider a simple recumbent bicycle with 21 unique gear-shifting combinations and a team of riders. Our goal is to maximize the expected number of laps completed over the course of the race based on gear selection, shift timing, and driver changes.

We will model over 15 different variables tied together by principles of physics and human factors engineering.

Decision and State Variables
Decision variables: When to shift gears, what gear to shift into, when to switch riders, which rider to switch to
State variables: Cog radius, tangential velocity of drive wheel, gear number, time left before the rider collapses, distance travelled by riders, time required to switch riders

Optimization
The duration of the race is limited to a certain time period. The number of riders eligible to participate in the race is also constrained. When riding in higher gears, riders will travel faster but deplete their energy at a quicker rate. Conversely, when riding in lower gears, the rider will travel slower but be able to ride longer. When a rider runs out of energy, the team will need to change riders, costing valuable time.
The graph below shows how long a rider can sustain a given exertion level in terms of percent of maximum.

The goal of this project is to optimize (maximize) the number of laps achieved with proper use of time, rider substitutions and gear shifting sequence.
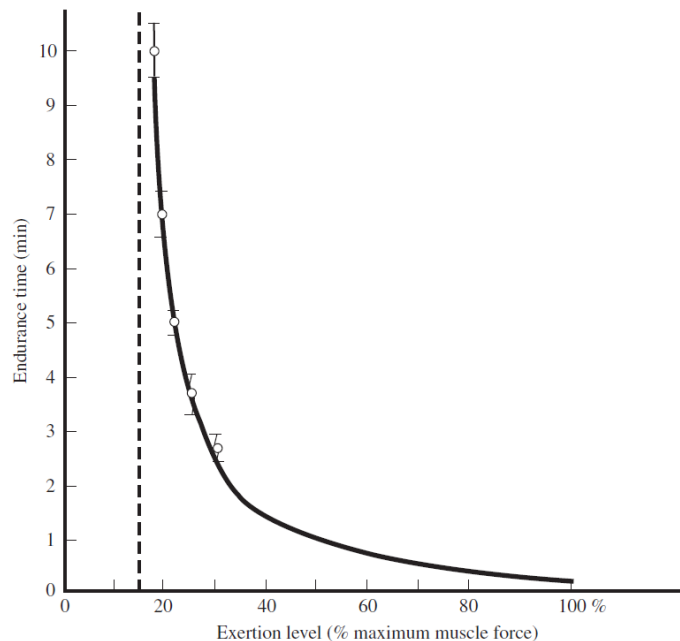

Figure 4.8 Static muscle endurance–exertion level relationship with ± 1 SD ranges depicted.
(*From*: Chaffin and Anderson, 1991). Reprinted by permission of John Wiley & Sons, Inc.

Responsibilities
Tyler handles most of the coding part necessary to solve and optimize for the solution.
Prasanna will deal with mathematical modelling and formulations.