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Modeling the behavior of anaerobic work capacity in cycling

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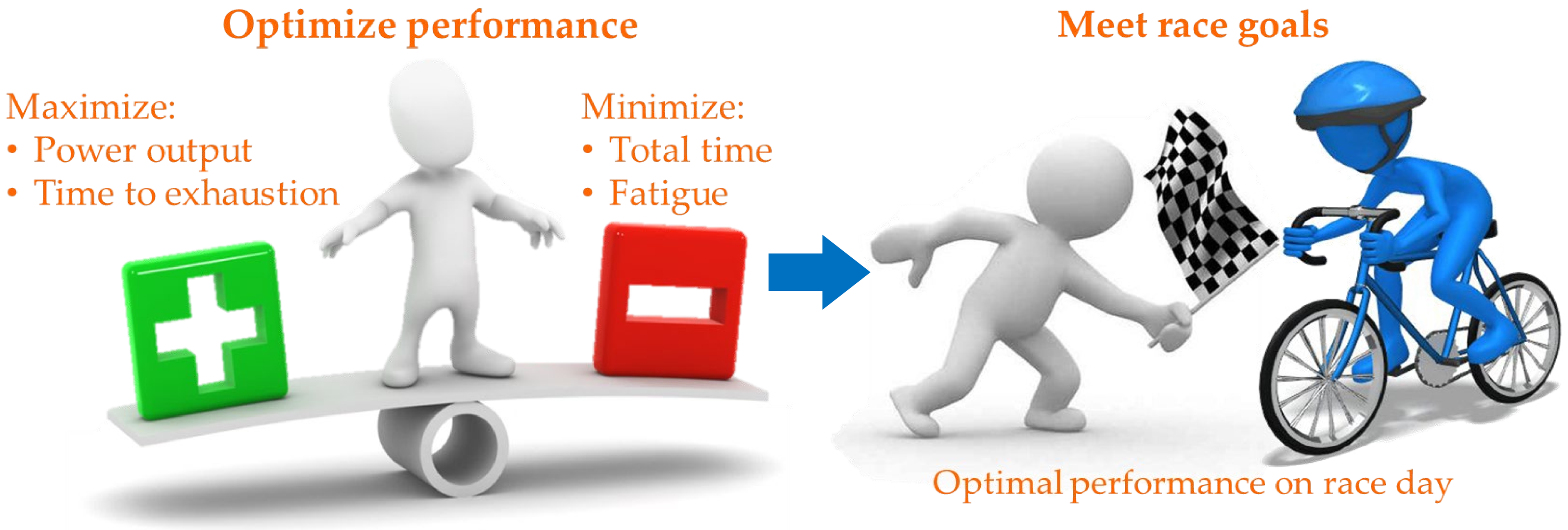
Graduate Research and Discovery Symposium

1. Overview

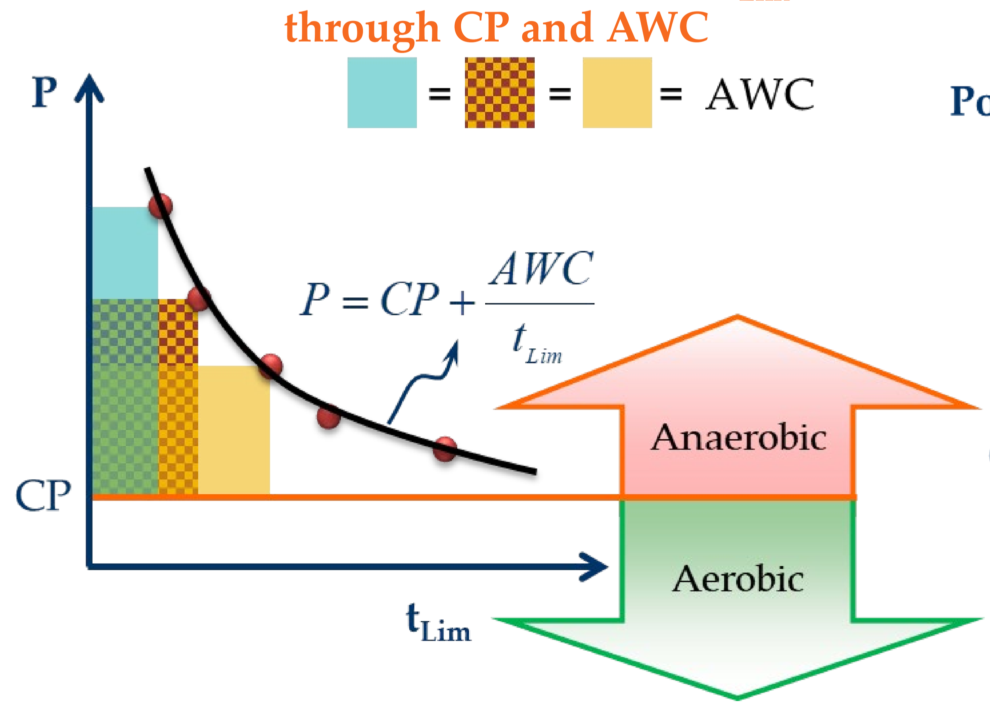
The goal of this research is to investigate the possibility an energy management system to optimize cycling performance by understanding expenditure and recovery of anaerobic energy.



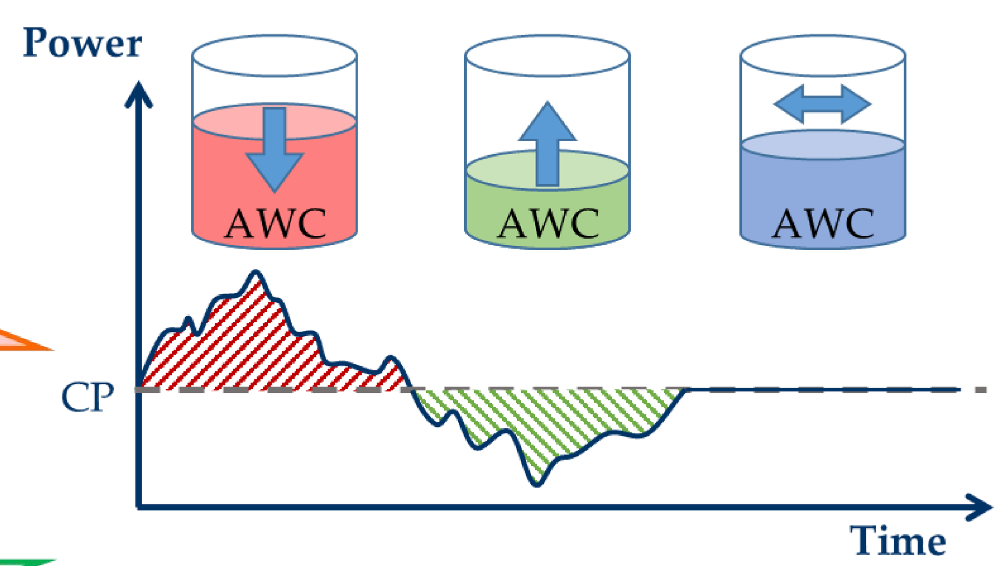
2. Background

- Fatigue is the inability to produce the "desired" power-output[1].
- Critical Power (CP) is theoretical power output that can be maintained indefinitely without fatigue[2].
- Anaerobic Work Capacity (AWC) is a finite anaerobic energy store for efforts above CP.

Power (P) and time-to-exhaustion (t_{Lim}) related through CP and AWC



Expenditure and recovery of AWC in relation to CP



- The amount of AWC remaining governs the instantaneous maximum power that can be generated, thus indicating the state of fatigue.

3. Motivation/State of the art

- The ability to predict the onset of fatigue during physical exertion and the systematic decrease in power output provides valuable insight into health, performance and injury.
- The expenditure of AWC is well established in literature, whereas the recovery of AWC is not.
- Existing models do not investigate the effect of both recovery power and duration on AWC recovery.
- Existing models are a good starting point, however, they need to be refined to be used for optimizing performance.

4. Methodology

Test1 (T1): VO_{2max} ramp test to determine VO_{2max} and gas exchange threshold (GET).

Test2 (T2): 3 min all-out test (3MT)[3] to determine CP and AWC.

Test3 (T3): Intermittent cycling test to investigate the effect of different recovery powers and durations on AWC recovery.

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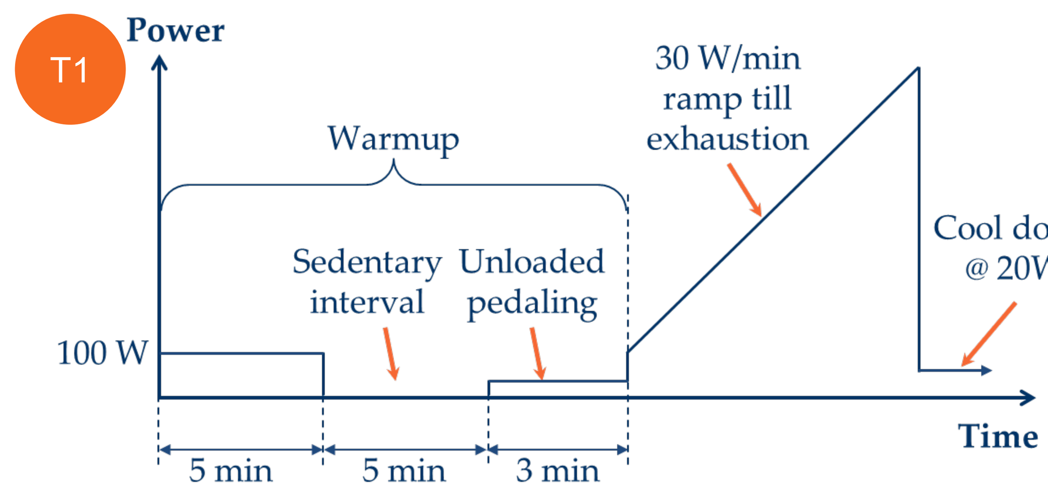
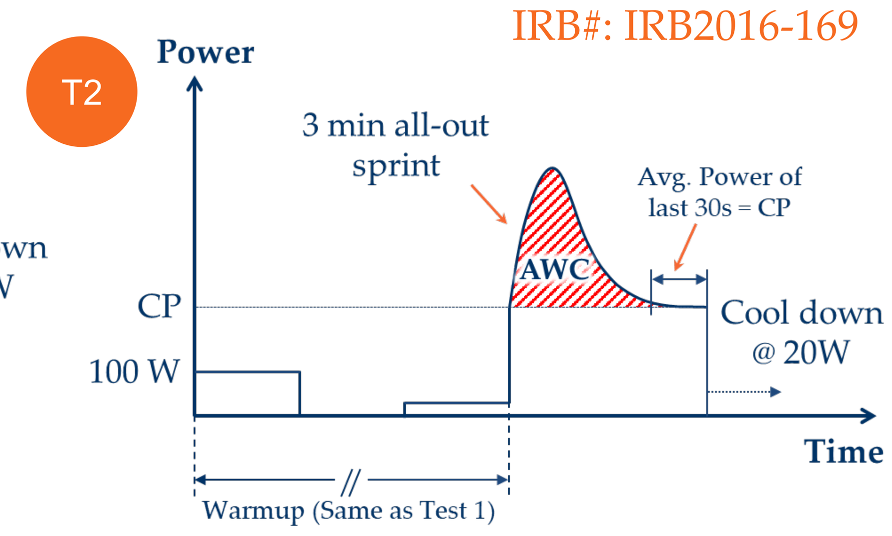
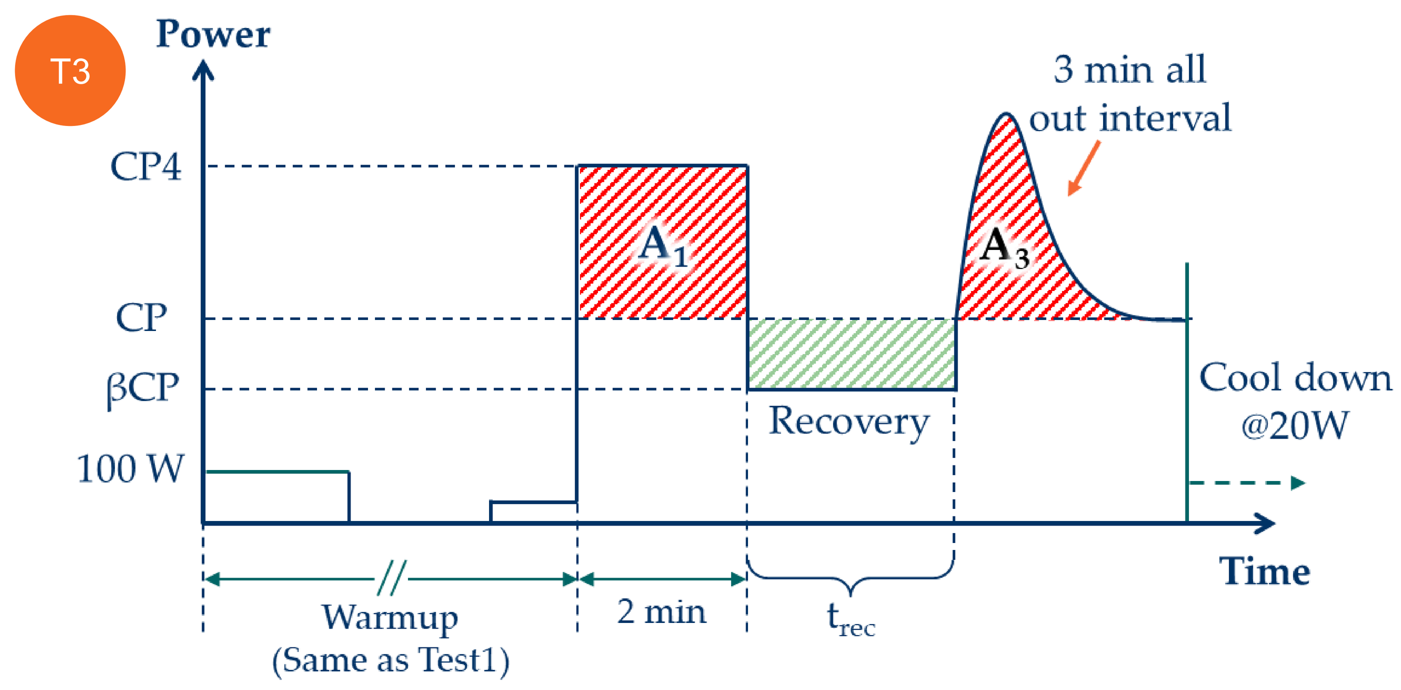






CP4- power at which AWC is completely expended in 4 min., β is the ratio of recovery power to CP, and t_{rec} is the duration of recovery interval.

Full factorial design

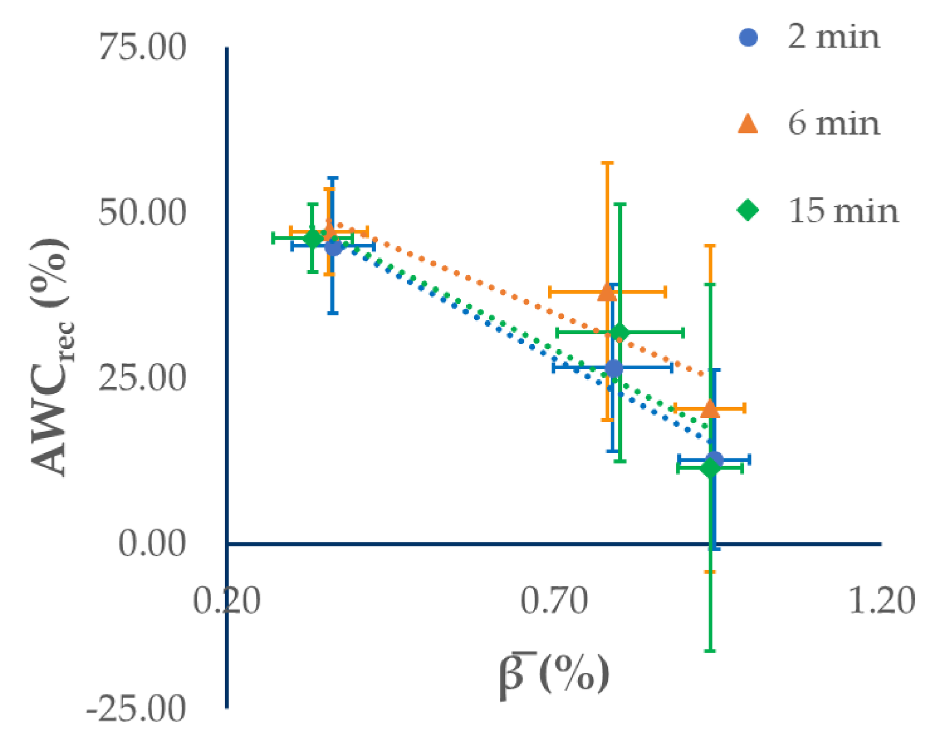
β × CP (Watts)	t_{rec} (min)
20	2
0.90 × P_{GET}	6
P_{GET} +0.5 ($CP-P_{GET}$)	15

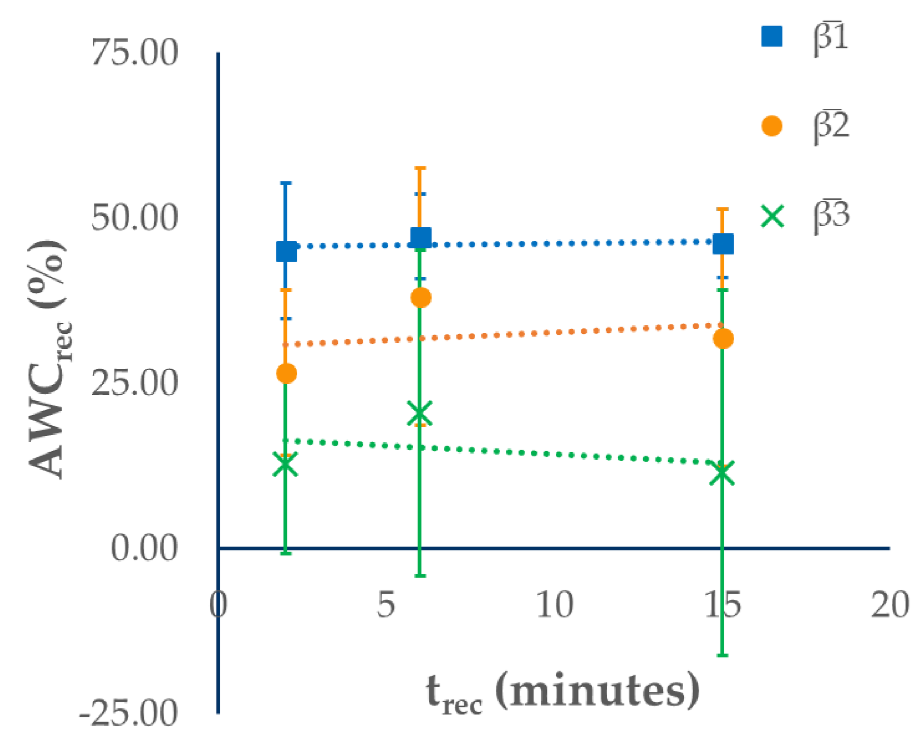
P_{GET} is the power @ GET

AWC recovered is given by, $AWC_{rec}(\%) = \frac{A_1 + A_3 - AWC}{AWC}$

5. Preliminary results and conclusions

- Larger AWC recovery seen at lower β across all 4 subjects; no trends seen with respect to t_{rec}.





- No trends seen between subjects due within-subject variability (WSV) of CP.
- None of the available models accommodate for WSV.
- Need to quantify WSV for accurately estimating and optimizing performance.

6. Intellectual merit and broader impacts

Accurate models of fatigue can potentially lead to

(i) understanding the physiological underpinnings of fatigue,

(ii) application of learnings to other physical activities, and

(iii) investigating the influence of exercise on overall health.

7. Acknowledgements

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8. References

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