

External Reviewer Comments

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To the Dean, University of Queensland Graduate School,

Please find my review of the PhD thesis entitled “Rock and Roll: The Effects of Centre of Mass Movement and Bicycle Lean on the Biomechanics of Cycling” by Ross D. Wilkinson.

After reading the thesis thoroughly, my evaluation is “Pass”. Below I provide my rationale for this evaluation based on the criteria provided to me by the university.

Sincerely,

Anthony P. Marsh PhD FACSM FGSA

Does the candidate demonstrate a significant and original contribution to knowledge (PhD candidates)?

Mr Wilkinson has completed a systematic and substantive evaluation of cycling at high power outputs with the aim of better understanding the biomechanical characteristics of seated compared to non-seated cycling with the bike frame fixed and freely moving. The information presented in this thesis adds unique information to the literature. The three studies completed during this thesis build upon each other in a logical way. The review of the literature is thorough. The methods are comprehensive and represent the state of the art in an investigation of this type. The writing is clear and the data are presented in a clear and accessible manner. In my opinion, the interpretation of the data and the conclusions reached are sound and well justified. The acceptance of two manuscripts in Medicine and Science in Sports and Exercise, a well-respected journal in the field, further validates that the work is significant and original. The smaller pilot studies undertaken as part of this thesis (bike lean and path, IMUs to measure CoM movement) that are described in the Appendix add to the novel information provided by this thesis. I hope they might be published as research letters in the future.

Does the candidate engage with the literature and the work of others?

The literature review is comprehensive but is also appropriately confined to the scope of the thesis. Mr Wilkinson acknowledges and builds upon the work of other researchers in the relevant areas. He does this by synthesizing the literature using his own words and perspective rather than just simply describing the work of others with no interpretation or interrogation of their results and conclusions. The thoroughness of the literature review and its organization help the reader to discern that the thesis

makes an original and substantive contribution to what is known about cycling biomechanics. All figures are appropriately credited to the original authors.

Does the candidate show an advanced knowledge of research principles and methods relating to the applicable discipline?

Yes. The research design is appropriate to the hypothesis-driven questions that are addressed in the three studies. The methods used in this thesis are state-of-the-art within the field of biomechanics. They require a substantial expertise on the part of the candidate to ensure that the data are valid. Integrating data collected from the motion capture system and the force pedals to derive the joint powers constitutes a substantive biomechanical analysis. Adding to the complexity of the analyses was the movement of the bicycle in the third study. The collection of motion capture data and EMG from the lower extremity muscles requires an in-depth knowledge of anatomy. All of the methods used (motion capture for kinetics, force pedals for kinematics, EMG for muscle activity) require a high level of knowledge about digital sampling and signal processing. The collection and analysis of these data required a level of knowledge in programming (Matlab, OpenSim) and statistics appropriate to an advanced degree in exercise science. The candidate also has the appropriate knowledge in human subjects research and institutional review board policies.

Is there a clear and discernible coherence in the presented research, its arguments and conclusions?

Yes. The progression of the three studies is logical and clear and each one builds on the former. Mr Wilkinson does not attempt to extend his conclusions outside the scope of each study. When he does offer some summary comments with the goal of integrating the studies, he does so by drawing on the previous literature and his own data to provide well-informed and reasoned speculative insight. Appropriately, each of the three studies has a paragraph in the Discussion section that summarizes the limitations of the study. The Discussion and Summary section expands on the limitations and offers reasonable directions for future research that address some of the limitations.

Is the thesis clearly, accurately, and cogently written?

The thesis represents a PhD level of writing. The grammar, clarity, and depth of the writing reflect the candidate's expertise and his high level of knowledge of the subject matter. His conclusions are well supported both by his own data and by the literature. He uses both very effectively in justifying his position to the reader. As an aside, I was impressed by the lack of grammatical and typographical errors in the 171 page PDF document.

#### **Other requirements provided by UQ to the examiner.**

The minimum requirement is that the work must have been carried out since the commencement of their candidature and be submitted for publication, accepted or published during the period of candidature.

This requirement has been met.

When incorporating published work, the minimum requirements are:

The scope and quality of the published work must be commensurate with the contribution to knowledge expected of a PhD candidate.

This requirement has been met.

The thesis must contain an introduction that contextualises the research in relation to the present state of knowledge in the field.

This requirement has been met.

Thesis chapters must be in a logical and cogent sequence leading to an argument that supports the main findings of the thesis.

This requirement has been met.

There must be an independent and original general discussion included that is entirely the work of the candidate and that integrates the most significant findings of the thesis.

This requirement has been met.

Clear statements of the candidate's contribution to each paper must be provided in the preliminary pages of the thesis.

This requirement has been met.

### **Other comments from the examiner**

There is a typo in Chapter 3 on page 31 (notably the anterior shift in the rider's CoM).

In section 3.3.4, there may be some typos related to the references provided with respect to the style required by MSSE.

There is a typo on page 53: to 'Hyperbolic' mode

There are typos in the caption of Figure 4.3: (Fv<sub>hb</sub> = F<sub>va</sub> + F<sub>vct</sub>). (i.e. F<sub>v</sub><sub>hb</sub>)

Typo on page 68. Should be Chapter 5.

The following reference is missing a date: Longstaff and Colquhoun.

In the Discussion and Summary you state: In our first experiment we attempted to uncover some clues about why cyclists transition from a seated to a non-seated posture when having to generate high torque and power on the cranks. It might be better to qualify this statement or make it more specific to what was done. You didn't assess the transition for each subject, per se, but rather two cadences likely to be on either side of an individual's transition cadence. This is something that occurs in a number of places in the thesis so perhaps revising the text to better reflect what was done is advisable.

Could you comment on whether or not you observed any evidence that the non-seated position, particularly when allowing the bike to lean, might be a muscle sparing mechanism to give the quadriceps a rest when power output is fixed. This most likely relates to your key finding 6.1.1 about net knee power. My question is more about why a rider might choose to transition to non-seated cycling during an extended climb requiring high, but sub-maximal, power output. Hansen and Waldeland 2008 might be relevant to some reasonable speculation.

In the discussion of additional mass on pages 91-92, you might expand on the practical aspects of doing this just to acknowledge that it might be great on a velodrome but not so much going uphill in the Pyrenees.