

Title: Multi-Scale Insights into the Interplay of Ski, Snow, and Skier Dynamics

Abstract: This study is aimed at the tribology between cross-country skis and snow, spanning multiple scales and emphasising the significance of ski geometry and base texture. On the macro scale, we employ machine learning and contact mechanics to understand ski-snow interactions, revealing relationships between contact area and the load asserted by an athlete performing the double-poling skiing technique. On the micro scale, we examine the contact between snow and six ski-base textures and, in line with empirical evidence, our findings also suggest that coarser textures may enhance high-speed performance. Merging insights, our multi-scale analysis clarifies the role of the ski camber and base texture in influencing ski-snow friction. Moreover, our approach uncovers important characteristics of the interaction between the ski, snow, and the skier. Conclusively, the study offers insights into optimising ski design and performance, bridging micro and macro characterisations.