

LIGHTWEIGHT WHEEL COVER PROTOTYPE DEVELOPED TO REDUCE AERODYNAMIC DISTURBANCE FOR THE BRUM ECO RACING SHELL ECO-MARATHON 2026 VEHICLE

CATEGORY :
FUTURE TRANSPORT AND CITIES

INTRODUCTION

Exposed wheels increase aerodynamic losses through flow separation and wake generation, leading to higher pressure drag around the rotating wheel assembly [1]. Previous CFD analysis of the Brum Eco Racing vehicle identified **turbulence exceeding 10%** in the wake region around the wheel assembly. Given that aerodynamic drag strongly affects energy consumption in ultra-efficient vehicles, reducing this disturbance is important. Furthermore, similar studies have shown that enclosing wheel spokes and optimising wheel geometry can significantly reduce aerodynamic losses [2–4].

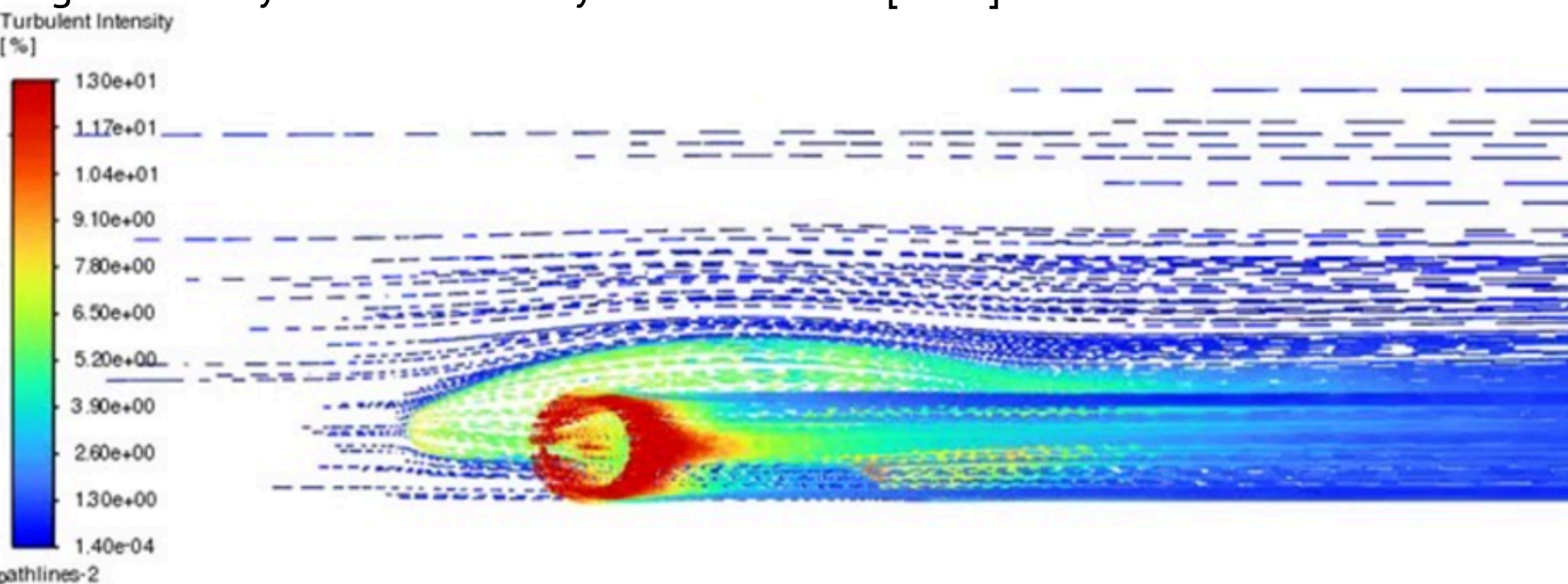


Figure 1. Turbulence intensity distribution around the exposed wheel assembly showing high disturbance in the wake region

OBJECTIVE

- Reduce wheel-induced aerodynamic drag, targeting a **2–5%** reduction in vehicle energy demand at constant speed.
- Design a wheel cover compatible with the existing wheel geometry, targeting an added mass below **0.5 kg** in the final carbon fibre design while maintaining sufficient stiffness.
- Prototype and validate the design using additive manufacturing.

RESULTS

The prototype was assembled from four printed segments and installed on the vehicle for fit validation. Post-processing was required at the hub interface to allow correct seating on the hub, confirming the need for ± 0.1 mm manufacturing tolerances. The assembled cover achieved the intended overall geometry, although future designs would benefit from filleted joints.

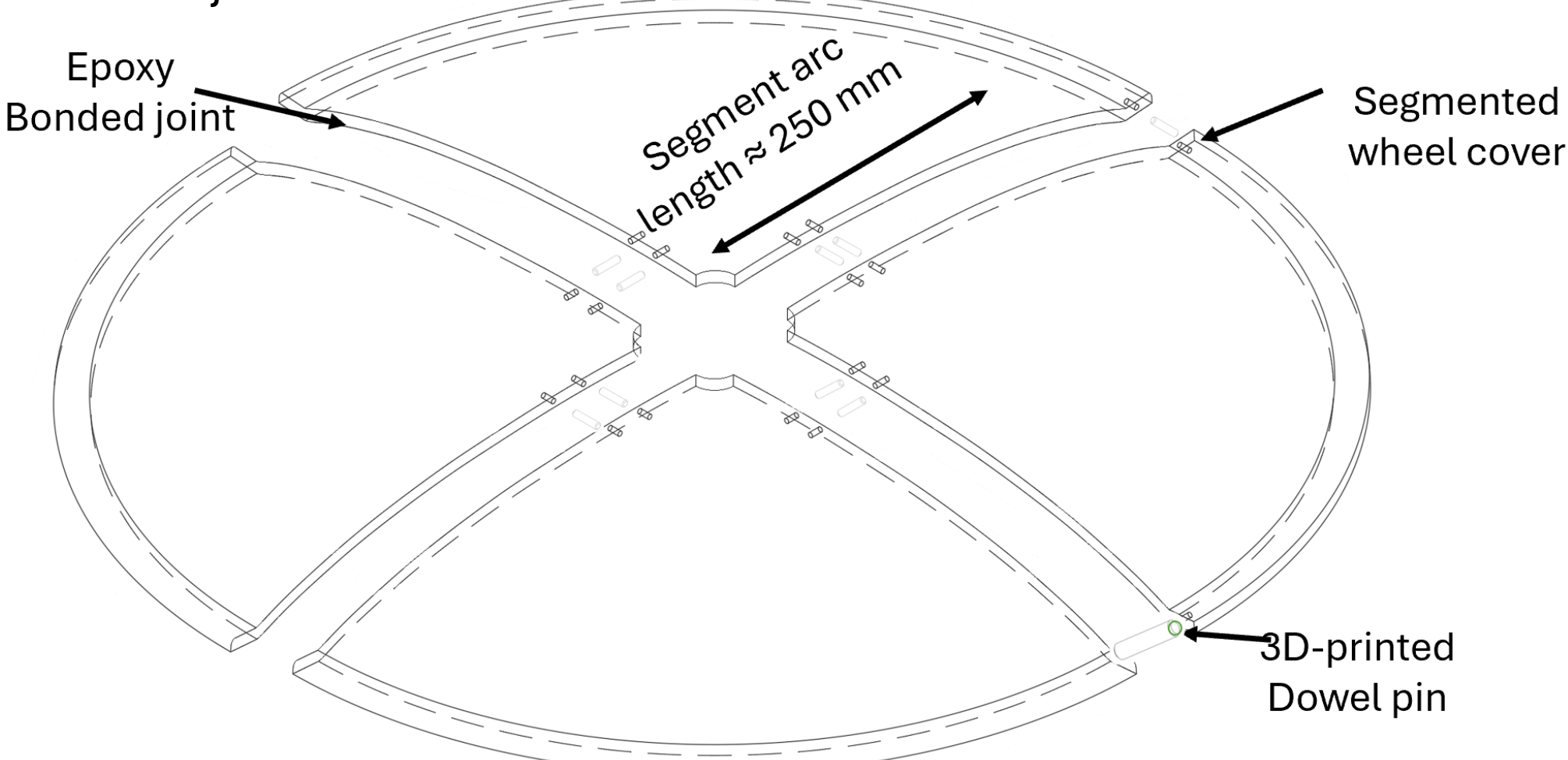


Figure 3. Segmented prototype assembly

This configuration reduces airflow interaction with the spokes and wake-region turbulence, and is expected to reduce wheel-induced aerodynamic drag, supporting a 2–5% reduction in vehicle energy demand [5].

METHODOLOGY

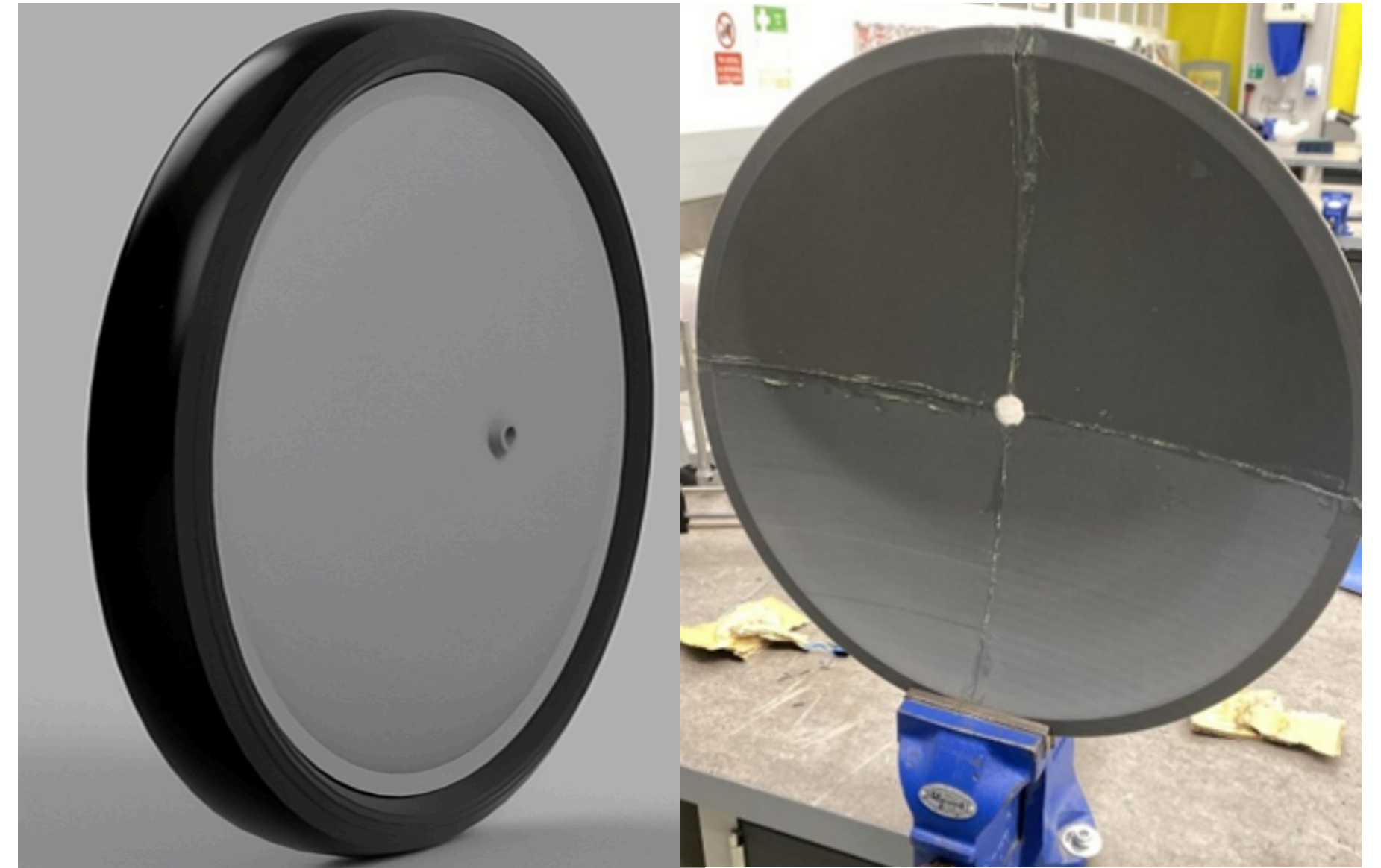


Figure 2. CAD model and 3D-printed wheel cover prototype

- 1 A wheel cover was designed in Fusion 360 to match the existing **500 mm** wheel geometry, with an initial thickness of **3 mm**.
- 2 Due to printer size limitations, the prototype was manufactured in four sections using additive manufacturing with **80% infill** for stiffness.
- 3 The segments were assembled using 3D-printed dowel pins and epoxy adhesive before vehicle fit validation.

KEY FINDINGS

- The installed cover created a continuous outer surface, fully enclosing the wheel spokes and rotating elements.
- Manufacturing **tolerances of ± 0.1 mm** are required at the wheel hub interface.
- The 3 mm prototype thickness provided sufficient rigidity for testing, but a thinner cover is preferred to improve seating on the wheel edge and reduce mass.



Figure 4. Full-scale prototype installed on the Brum Eco Racing vehicle for integration testing

CONCLUSION

The project demonstrated the feasibility of integrating an aerodynamic wheel cover into the Brum Eco Racing vehicle. Prototype validation identified key improvements for the final carbon fibre design, including hub tolerances, filleted joints, and reduced thickness. These findings support mould design and refinement of the final wheel cover, which is expected to reduce aerodynamic drag and vehicle energy demand.

Future work:

- Apply CFD analysis to an iterated version of the current design.
- Validate aerodynamic performance through coast-down, tuft, or powered testing with and without the wheel cover.

REFERENCES AND ACKNOWLEDGEMENTS

- [1] Moore JK. Aerodynamics of high performance bicycle wheels. Christchurch: University of Canterbury; 2008
- [2] Chowdhury et al., A Comparative Aerodynamic Study of Commercial Bicycle Wheels
- [3] Rai & Kedare, Aerodynamic Performance Analysis of Wheel Covers
- [4] Kyle & Burke. Improving the Racing Bicycle. Mechanical Engineering.
- [5] Korkut TB, Goren A, Ozaydin O, Armakan E. Aerodynamic effects of composite wheel cover on electric vehicle (EV) (Part B) [Internet]. Izmir: Dokuz Eylül University; 2019
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