Open science: a novel face-shield that's more effective against airborne-virus transmission

Nick C. Howlett
Tessellate Data Science
Melbourne, Australia
www.tessellatedata.science

FullName2
Name of organization2
City2, Country2
Author2@domain.edu

***Abstract*—highlights current modelling development of a fluid-dynamics scenario where someone is talking (whom is emitting a virus out their mouth) to another person (whom is wearing a medical face shield. We also present results focusing on an improved design and associated quantification. We suggest optimising the design of face shields can lead to even more reduction of airborne-virus transmission.**

I. Introduction

It's argued the COVID-19 pandemic was a combination of crisis across public health, economic, and supply chain [1].

Our research is focused on catalysing innovation, of PPE in particular, that laterally bypasses the current limitations (forcing functions), aiming to ensure such novel pandemic interventions can be accessed by more people, more equitably.

The key presumption of our organisation (see Authors & Acknowledgement) is the failure again of all those dependencies during the next pandemic. However, we'd think this presumption is less probable now given a more equity-based international agreement for the next pandemic has been reached by countries that are part of the World Health Organization.

Nonetheless, the principle of 'open innovation' is advocated by a collective of professionals [2], which has similarities to 'co-design' which is known within the 'social enterprise' sector. We suggest such approaches are vitally important to ensure substantial adoption, by citizens of 'developing countries,' of any proposed intervention.

But before substantial catalysing & co-design occur, we first ask whether we should expend iterative effort on a particular idea (concept)? This conference article answers that.

II. Methodology

We leverage and further develop the freely-available CFD software *OpenFOAM*, while increasing confidence our computational modelling is representative of real-world speech airflow via mostly verification (and some validation) investigations.

1) Computational Fluid Dynamics: Specifically we used OpenFOAM and associated meshing software *cfMesh* & *Gmsh*. Modelling of the turbulent airflow is done using Large Eddy Simulation, with the modelling of the bioaerosols via Discrete Element Method, while the velocity out of the person's mouth (which determines the bioaerosols' initial trajectory) is modelled using a custom-developed boundary condition. OpenFOAM itself is based on the Finite Volume Method, where we used the transient-based PIMPLE solver. More information (including our open-source computational platform and documentation) is available online at our research space [3].

2) Verification & Validation: We investigated the effect of changing numerical parameters on the resultant computation (verification). We primarily assessed the number of bioaerosols inhaled by the person listening (quantitative metric). Generally we found sensitivity of this quantity upon time-step & convergence parameters.

We maintained moderate precision for lower computational cost by selecting a relatively relaxed time-step value, while convergence tolerance ('residuals') were a combination of tighter (for standard solvers) & relaxed (for PIMPLE-based solver) values.

We have also compared bioaerosols' 'cloud' shape to a very limited data-set of real-world results (validation). We adjusted the bioaerosols' dispersion controlling variable (within the custom-boundary condition) until approximate visual agreement was seen.

III. Results

We computationally modelled two differing face-shield designs: 'normal' an off-the-shelf medical shield, & 'enclosed' a novel shield with surfaces added to the bottom and back. Below we show preliminary results that mostly compare the quantity of bioaerosols inhaled across the designs.

IV. Conclusion

We have developed a freely-available (re-usable) computational modelling platform that predicts speech-driven airborne-virus transmission. We have preliminary results demonstrating better design can be achieved, which we suggest is indicative the design of face-shields can be optimised to protect the wearer better against transmission risk.

Authors & Acknowledgement

N. C. Howlett is a founding member of Tessellate Data Science. TDS is a boutique agency backed by a scientific approach that has experience in data science, web development, & online education. TDS is a social enterprise looking to

disrupt for the greater good. We most value: culture, resistance, & diversity, all for better equity. TDS thanks the People's Medicine Alliance for their advocacy of equitable treatment of every human being.

References

[1] Innovation in crisis: 'exaptive relations' for medical device development: https://pmc.ncbi.nlm.nih.gov/articles/PMC9276712/

[2] https://worldopeninnovation.com

[3] https://github.com/TessellateDataScience/faceShieldOptimisations