Aircraft Cabin Airflow: Curbing Disease Transmission

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Recent Influenza, SARS and Ebola epidemics invoke fear of infection among billions of air travelers worldwide. Isolated air in densely packed aircraft cabins propagate disease via direct airborne and large droplet routes; treatment and contact tracing of exposed passengers incur substantial socioeconomic costs. Current understanding of cabin airflow in industry is constrained by low resolution empirical measurement equipment and unphysical Computational Fluid Dynamics (CFD) predictions that lack attention to cabin detail and interactions among multiple physical phenomena. This interdisciplinary project pioneered high-resolution CFD simulations of pathogen flow in aircraft, using a coupled implicit finite volume solver. Precise 15 & 20 million cell Boeing 737 cabins, with seated human mannequins, were modeled referencing official technical drawings and statistical anthropometric data. Employing a multi-iterative systems engineering approach, 32 cabin airflow scenarios were analyzed, considering the Navier Stokes equations along with convection, turbulence, and other phenomena. Two solutions emerged from CFD testing: an innovative global cabin inlet system which increases passenger fresh air availability by over 190% and reduces pathogen inhalation concentrations by up to 55 times versus conventional designs; and a novel bulkhead outlet system that generates local high filtration zones which isolate pathogens emitted by high-risk passengers. Physical testing and feasibility studies with real world models concurred with CFD findings. Both economically feasible innovations leverage existing cabin infrastructure to enable rapid installation, thus improving breathing air quality and efficiently curbing disease transmission in modern aircraft.

Awards Won:

First Award of $5,000

Intel ISEF Best of Category Award of $5,000

Intel Foundation Cultural and Scientific Visit to China Award