Spira Aer: A Novel Hurricane-Inspired Logarithmic Spiral Fan Design for HVAC System Applications

Prawira, Jordan (School: Mountain House High School)

Heating, cooling, and ventilation consume $122 billion/year in the US. Improving the systems' efficiency, even just slightly, will lead to significant cost savings. The goal is to develop high-efficiency fans for ventilation and HVAC systems, implementing the logarithmic spiral, called Spira Aer. Spira Aer was developed in 3 phases, each including designing in Solidworks, 3D-printing, testing, analyzing data in Excel and Solidworks Flow Simulations, and elimination/improvement processes. Design criteria were set for the fan design, motor interface, duct system, and the overall system, to discover how each design element affects performance, to create efficient and repeatable test processes, and to approximate real-world conditions. Pressure, airflow, RPM, and efficiency were measured to analyze the performance. Lower tip angles cut into the air more efficiently, enabling it to harvest more air in its sweep area, and reduces the fan's mass. Lower blade revolutions produce higher pressure, but higher revolutions generate higher airflow. Center passive areas reduce circular airflow, allowing more energy to be converted to lateral airflow, increasing efficiency. 18-Blade balances the surface/mass ratio, maximizing efficiency. The results supported the hypothesis, Spira Aer achieved higher pressure and efficiency than the propeller fan, with comparable airflow, and higher airflow than the centrifugal fan. Spira Aer performs best in medium-low system resistances with high airflow, can save 30-50% of costs in applications like cooling electrical equipment, heat exchangers, forced ventilation systems, and whole-house ventilation. It can easily replace existing propeller fans using a simple adaptor, keeping the same motor and frame design.

Awards Won:
Second Award of $2,000