

## 20th Annual High School Mathematical Contest in Modeling (HiMCM) Summary Sheet

**Team Control Number: 7845****Problem Chosen: A**

In this paper, we present plans to three types of aerial light shows by using clusters<sup>®</sup> of Intel<sup>®</sup> Shooting Star<sup>TM</sup> drones. Because we assume that the ideal viewing angle of the audience is 45 degree, we first use matrix transformation to rotate the 3-dimensional coordinate system. In addition, we take the maximum number of drones, required launch area, required air space, safety considerations, and duration of the aerial light show all into consideration. In order to minimize the danger of collision and maximize the visual aesthetics during the takeoff process, we calculate the best flightpath for each show.

For the Ferris wheel display, we use two circles inclining 45 degree toward the audience to describe the flight paths.

For the dragon display, we decide on a dragon that rise up in a spiral movement, and use the combination of cone and ellipse to model the flight path. The curves that connect the points that are not at the same height on two opposite generatrices of the cone resemble the shape of a complete coil. To obtain the formula of the coil-shaped flight paths, we solve for interceptions between the cone and the planes cutting the cone, the solutions of which turns out to be connecting curves that resemble the shape of a swirl.

The third display simulates the visual appearance of an actual firework. In order to simulate the effect of a firework, we use circular motion to describe the takeoff trail of and let the drones “explode” from the original position - to fly on the lines that are equally angled on the plane.

For each of the three display, we derive the mathematical formulas and plot the track in MATLAB to obtain the figure for the trail. Then we solve for the velocity of each drone by using MATLAB to calculate the total length of the trail and dividing it by time.

By doing this, we obtain each drone’s ideal flightpath, including taking off, moving velocity and initial positions, which all can be varied based on required size of light show and available amount of drones.