Paper helicopter Project 2

Summary of Project I: In the first phase of the project, you built and flew 3 helicopters and tested them to quantify the uncertainty in fall time and drag coefficient. You also calibrated the drag coefficient, finding the posterior distribution of its mean from the experiment, and you changed the number of paper clips in order to check which helicopters obeyed a quadratic drag law and which obeyed a linear drag law. Compared to the 2015 project, a smaller helicopter was chosen to reduce the change in shape due to the aerodynamic loading.

Objectives of Project II: With the data you have collected and an understanding of which helicopters behave linear or quadratic, you will proceed with further investigation. The first objective of this second phase is to formalize the comparison between simulation and experiments using the validation metrics described in class as documented in the paper by Park, Choi and Haftka. The second objective is to further explore the linear and quadratic behavior by using a helicopter built from stiffer paper and by estimating the speed of the helicopter as it hits the ground.

Project tasks:

1. **Additional helicopters built and tested:** Build and test 3 more helicopters from the stiffer card stock supplied by Prof. Haftka. Estimate the speed of the helicopter as it hits the ground either by changing the height by about one foot or by videotaping near the ground. This is intended to provide you with a check on steady state speed.
2. **Refinement of posterior distribution:** Drop the assumption that the standard deviation is the measured test standard deviation and obtain the joint distribution of the mean and standard deviation. For this part you can assume a non-informative prior.
3. **Initial validation metric**: Obtain the posterior distribution of the CD for the helicopters with 2 paper clips as the calibrating phase. Calculate the validation metric for the same helicopters with 2 paper clips. For the analytical CDF you can sample from the posterior distribution, or from the predictive distribution to generate many CDFs of 10 falls. Then take the 95% intervals for each CDF value (i.e. in the [0,1] interval) to generate the p-box.
4. **Predictive validation of the quadratic dependence** of drag on speed: Apply the posterior distribution from the two paper clips to your other experiments. This would be a comparison with helicopters that do not have two paperclips. This time you will also need to sample the uncertainty in the mass ratio due to the addition of the paper clips. Calculate the validation area metric again and draw conclusions on the success or failure of the validation.
5. **Repeat the process for assumed linear dependence** on speed. Note that you will get a different C_D from the calibration experiments
6. **Comparison with results in the paper by Park, Choi and Haftka:** Analyze the differences and explain them.
7. **Report and slide**: The report will need to provide enough information for you to be able to understand it without any additional documentation five years from now. Each one of the sections should be presented, and similarities to the paper on the first year of the project by Park et al. should also be included. Individual reports from each member of the team are expected, plus a single slide with notes from the entire team summarizing the key findings.