2-way ANOVA Lab

Improving Product Performance

Researchers use planned experiments to study the effects of factors on the mean performance of a product or process. By performing planned experiments they can determine which factors affect the mean performance. In many cases the results of planned experiments are used to select levels of each factor in an attempt to optimize the mean performance.

**The Setting**: You are a member of a research team in the Product Design and Development Division of a Better Balsa Aerospace Corporation. Your research team is attempting to improve flight performance of the Model XJ2 glider aircraft. Your objective is to maximize the mean distance of flight. Budget and time constraints will allow for a maximum of 12 flights in your investigation.

Team Members:

|  |  |
| --- | --- |
| Pilot |  |
| Record Keeper |  |
| Data collection |  |
| Data collection |  |
| Team Leader |  |

**Background:** Previous experience with similar aircraft suggests that several factors can affect the mean flight distance. These included uncontrollable factors such as wind and humidity and controllable factors such as the size of the wings, the shape of the wings, the presence/absence of extra weight on the nose, the size of the tail, the shape of the tail, the angle of the wings relative to the ground at launch, the height off the ground at launch, and the amount of force used in the launch.

**Step 1:** Your research team is to **choose two controllable** factors for investigation in the study. W denote these factors by Factor A and Factor B. For each selected factor, choose **two** settings or levels. *In performing the test flights, attempt to hold all potential factors constant except for factors A and B*. An advantage of experiments that involve more than one factor is that we can collect information of all factors is a single experiment using the same number of observations required to evaluate a single factor.

For each test flight you will use a level of Factor A and a level of Factor B. The four treatment combinations are:

(1,1) Level 1 of factor A and level 1 of factor B

Level 1 of factor A and level 2 of factor B

(2,1) Level 2 of factor A and level 1 of factor B

(2,2) Level 2 of factor A an(1,2) d level 2 of factor B

We will have three test flights for each treatment combination. This is a two-factor experiment with replications.

**Step 2: Randomization**

**While we attempt to control all factors in our experiment, there are some factors that are beyond our control, such as wind currents. To guard against one treatment combination getting an unfair advantage we will use randomization. We can use a random number generator, table of random digits among other ways to select the run order.**

|  |  |
| --- | --- |
| Factor A is | Factor B is |
| Level 1 is | Level 1 is |
| Level 2 is | Level 2 is |

Flight Schedule by treatment combination

|  |  |
| --- | --- |
| **Flight Number** | **Treatment Combination** |
|  | (1,1) |
|  | (1,1) |
|  | (1,1) |
|  | (1,2) |
|  | (1,2) |
|  | (1,2) |
|  | (2,1) |
|  | (2,1) |
|  | (2,1) |
|  | (2,2) |
|  | (2,2) |
|  | (2,2) |

Flight Schedule by Flight Number

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Flight Number | Treatment  Combination | Flight  Distance | Flight Number | Treatment  Combination | Flight  Distance |
| 1 |  |  | 7 |  |  |
| 2 |  |  | 8 |  |  |
| 3 |  |  | 9 |  |  |
| 4 |  |  | 10 |  |  |
| 5 |  |  | 11 |  |  |
| 6 |  |  | 12 |  |  |

Step 3: Collecting the Data

We are now ready to make the flights. For each flight *make sure that the plane is configured according to the proper treatment combination.* Use a tape measure to measure the shortest distance in inches from the starting point of the plane. Record this data in the table above.

Step 4: Data Analysis

Conduct a complete analysis of this two-factor experimental design to include the following:

1. List your two factors their levels
2. State all null and alternative hypothesis statements
3. Construct an interaction plot
4. Analyze the results from the ANOVA table and residual plots
5. State a recommendation based on the current information of the treatment combinations that should be used to maximize mean flight distance.

Short Answer Writing Assignment:

1. Why did we attempt to keep the launching force constant for all flights?
2. Why did we randomize the order of the 12 flights?
3. What experiment would you suggest to further improve the mean flight distance?