Homework #9

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4/21/25

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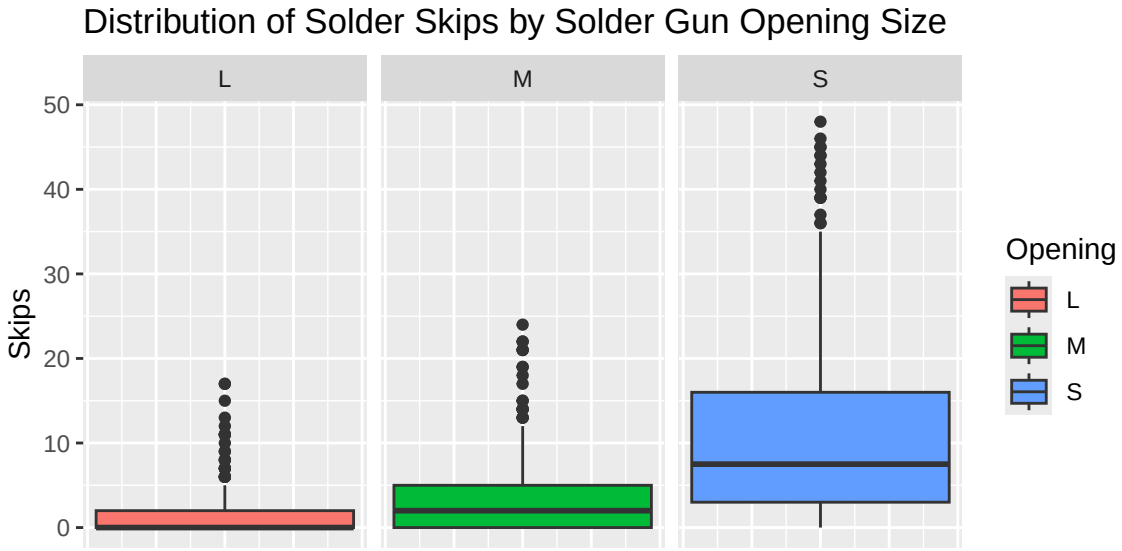
Introduction

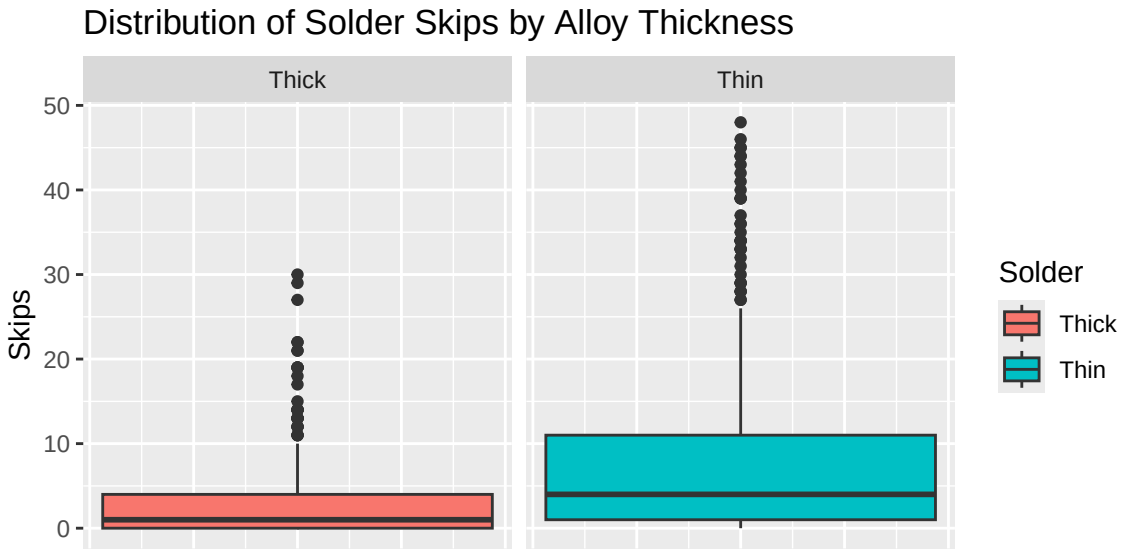
I'm Advay Vyas, EID: av37899, and this is my submission for SDS 315 Statistical Thinking Homework #9. The GitHub repository for my code is at this link.

Problem 1

Part A



From this plot, we can easily see that the size of the opening affects the amount of solder skips by examining the faceted box plots' vertical placement.



From this plot, we can see that alloy thickness has an effect on the amount of solder skips, with thinner alloys contributing to usually higher amounts of solder skips.

Part B

Table 1: Coefficients of the fitted linear regression model

Condition	Estimate	CI_Lower	CI_Upper
Baseline	0.395	0.23077	0.59396
SolderThin	2.281	1.70992	2.90189
OpeningMid	2.404	1.71335	3.12207
OpeningSmall	5.135	4.17674	6.15757
SolderThin:OpeningMid	-0.741	-1.95046	0.47085
SolderThin:OpeningSmall	9.640	7.34981	11.89140

Part C

If we round every coefficient to 0, we now create the equation below representing the amount of skips as $\hat{y}$ and the corresponding effect variables and y-intercept.

$$\begin{aligned}\hat{y} = \; & 0 + 2 \cdot \text{SolderThin} + 2 \cdot \text{OpeningMid} + 5 \cdot \text{OpeningSmall} \\ & - 1 \cdot \text{SolderThin} \cdot \text{OpeningMid} + 10 \cdot \text{SolderThin} \cdot \text{OpeningSmall}\end{aligned}$$

- The y-intercept indicates that the predicted skips for SolderThick & OpeningLarge is 0 (the baseline)
- The effect of the SolderThin variable is 2, so you add two skips when you have SolderThin
- Similarly, this means the effect of having the OpeningMid variable raises the prediction by 2
- Having OpeningSmall raises the predicted amount of skips by 5
- Having both SolderThin and OpeningMid together reduces the predicted amount of skips by 1
- Having both SolderThin and OpeningSmall greatly increases the predicted amount of skips by 10

Part D

We first have to tabulate every possible combination. For SolderThin, we immediately have 2 for the expected amount of skips. Considering small, medium, and large openings, we have that OpeningMid adds 2 and OpeningSmall adds 5 so 7, 4, 2 respectively. Considering the interactions, SolderThin and OpeningMid reduces the predicted skips by 1 and SolderThin and OpeningSmall increases the predicted skips by 10 resulting in 17, 3, 2 for SolderThin and OpeningSmall, OpeningMed, OpeningLarge respectively.

The calculations become much simpler for SolderThick due to no interaction variables. We simply add the effect variable to 0 since SolderThick has "no effect." With OpeningSmall (+5), OpeningMid (+2), and OpeningLarge (+0 b/c no effect variable and it is the baseline) and we get 5, 2, 0 respectively. The results are tabulated in the table below.

Table 2: Combinations of Solder Thicknesses and Solder Gun Openings and Predicted Skips

Solder	Opening	Skips
Thin	S	17
Thin	M	3
Thin	L	2
Thick	S	5
Thick	M	2
Thick	L	0

Since soldering skips are manufacturing defects, I'd like to recommend the combination with the least amount of defects which is **SolderThick and OpeningLarge**. This trend is also seen in the earlier plots, as a thick solder and a large solder gun opening each had the least average skips in their categories.

Problem 2

Part A

Part B

Part C

Part D

Part E

Part F

Problem 3

Statement A

Statement B

Statement C

Statement D

Statement E