JMP Instructional data set 021

Medical Supply Packaging Adhesive

JMP STATISTICAL DISCOVERY

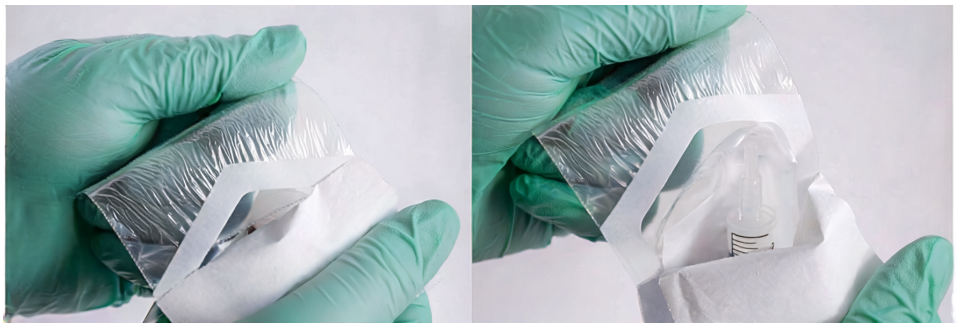
JMP platforms and statistical methods

Graph Builder:	Comparative dot plots and box plots
Distribution:	Histograms; summary statistics; one-sample inference for population mean and standard deviation; process capability analysis
Fit Y by X:	Two-sample inference comparing population means and variances

Problem statement

Engineers in a product development team for a manufacturer of medical equipment packaging are evaluating the performance of two different formulations of adhesive that's used to seal the packaging.

An important characteristic is that the adhesive is strong enough to withstand the usual sterilization and handling rigors while not so strong that it is difficult for a medical practitioner to open easily.



The engineers produce a sample of n=50 pouches sealed with each of these two new adhesive formulations (A and B). The peel strength on each specimen is measured using a device known as a universal testing machine (Figure 1).

Figure 1.
Image of Universal Testing Machine grips from Instron®.
https://www.instron.com

The tester records the force (in Newtons) being applied across a range of peel displacement. The average force across a defined range of peel displacements is used as a single data value summarizing a test. Figure 3 shows this for 3 specimens.

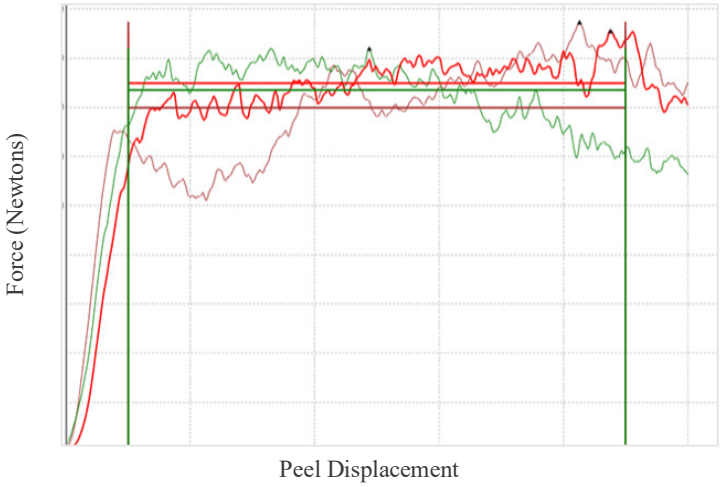


Figure 3.
Image of data produced by Universal Testing Machine from Instron®. https://www.instron.com

The specification for the adhesion is an average peel strength (μ) of 11.0 N, along with +/- 3 standard deviations (3σ) ≤ 1.5 N (i.e., $\sigma \leq 0.5$ N).

Data

IDS_021.jmp

Formulation	Identification of the adhesive formulation (A, B)
Peel Strength	Average Force (in N) to separate packaging material

Exercises

1. Produce univariate graphical and numerical summaries of the peel strength of the two adhesive formulations. Summarize, in a few brief sentences, the performance of each adhesive using these graphical and numerical summaries.

   Instructions:
   Analyze > Distribution. Place 'Peel Strength' in the Y, Columns. Place 'Formulation' in the By role. Click OK.

2. Conduct a hypothesis test for each formulation to determine if there is statistical evidence indicating the average peel strength is different than 11.0 N. Summarize the results. Examine the 95% Confidence Intervals for the mean peel strength for each formulation. Provide an interpretation of these interval estimates?

   Instructions:
   In the Distribution report, select Test Mean under the red triangle for both Formulation A and B. Use "11" for the Hypothesized Mean.

3. Perform analyses to evaluate if the normal distribution is a reasonable model to use for these variables (i.e., an assumption for the analyses above and the ones that will be conducted in Exercise 4). Is the Normal Distribution a reasonable model use? If not, are there any substantial concerns you have with the interpretations reached in the analyses above?

   Instructions:
   In the Distribution report, select Normal Quantile Plot under the red triangle for both Formulations. Select Continuous Fit > Fit Normal under the red triangle for both Under the red triangles next to the Fitted Normal Distribution tables, select Goodness of Fit. Examine the quantile plots, and fitted normal distribution curve added to the histograms, and the goodness of fit tests.

4. Conduct a hypothesis test to determine if there is statistical evidence to conclude the standard deviation in peel strength is > 0.5 N. (i.e., H_0: $\sigma \leq 0.5$ vs. H_A: $\sigma > 0.5$). Interpret the results. Examine the confidence intervals for the standard deviation produced in the analysis done in Exercise 3.

Instructions:
In the Distribution report, select Test Std Dev under the red triangle for Formulations.
Use "0.5" for the Hypothesized Standard Deviation.
Examine the p-values for "Prob > ChiSq".

5. Create dot plots and boxplots showing the peel strength for each formulation. Add reference lines for the target of 11.0 N, along with +/- 1.5 N for the lower and upper specification limits.
Provide brief comments on how they compare to each other relative to central tendency being close to the target of 11.0 and the variation being within the specification limits (9.5, 12.5). Formal statistical tests will be conducted in the next Exercise comparing the means and variances. Based upon examining this graph, do you have a sense of if there Is significant difference in either the means and/or the variation?

Instructions:
Graph > Graph Builder. Place 'Strength' on the Y axis, and 'Formulation' on the Y axis.
Add box plots to the graph by selecting the icon in the graph palette. 

Double-click on the Y axis to open the axis setting. Add reference lines at the values of 9.5, 11, and 12.5.

6. Conduct a statistical test to determine if the average peel strength between the two formulations is not equal. Is there significant statistical evidence of a difference? Is this what you thought when examining the comparative dot plots and box plots in Exercise 5? Examine the confidence interval for the difference in means. Interpret this interval.

Instructions:
Analyze > Fit Y by X. Place 'Peel Strength' in the Y, Response. Place 'Formulation' in the X, Factor. Click OK. Select t Test. Examine the p-values for Prob > |t|.

7. Conduct a statistical test to determine if the variation in peel strength between the two formulations is not equal. Is there significant statistical evidence of a difference? Is this what you thought when examining the comparative dot plots and box plots in Exercise 5? Examine the confidence interval for the difference in variances. Interpret this interval.

Instructions:
Select Unequal Variances under the red triangle in the Fit Y by X report created in Exercise 6. Note: five different tests are shown for comparing the variances.

8. Perform a process capability analysis for each formulation comparing to the specifications. For each formulation, provide an estimate of the % of pouches that would be below the lower specification limit (LSL) and above the upper specification limit (USL) if these formulations were used in mass production.

Instructions:
Analyze > Distribution. Place 'Peel Strength' in the Y, Columns. Place 'Formulation' in the By role. Click OK. In the report, select Process Capability under the red triangles for each Formulation. Specify the LSL=9.5 and the USL=12.5.
Examine the Expected Overall % values in the Nonconformance table.