

PAINT WEAR ACCELERATED TESTING

RELEVANT JMP PLATFORMS AND STATISTICAL TECHNIQUES

Graph Builder : Scatterplot

Fit Y by X : Linear Regression

PROBLEM STATEMENT

Manufacturers of coating materials such as paint are very interested in having reliable estimates of the material's durability against undesired effects such as "fading of color", "cracking/peeling", "blistering", among others. (Figure 1).



Figure 1

R&D teams for these types of manufacturers are constantly conducting tests in order to describe and quantify a material's durability. One type of testing subjects the paint to different real natural environments (e.g, hot humid weather of Florida, long hot dry heat of Arizona, extreme yearly temperature fluxations of Minnesota, etc.) (Figure 2).



Figure 2

These effects take many years to manifest in these environments. These manufacturers need a much quicker way to see these undesired effects take place during product development efforts. Scientists will use environmental chambers that can vary temperature, humidity, UV levels, among other factors to simulate the long term effects caused by real environmental conditions, but in a greatly accelerated time frame (Figure 3).



Figure 3.

Image of Accelerated Weathering Tester from Q-Lab®
<https://www.q-lab.com>

Determining the settings for the accelerated testing chamber so that those results match the results that would occur in the real environments conditions is necessary to establish so that reliable estimates can be produced.

In this study, historic data from many samples over many years of real world testing from field labs in Florida, Arizona, and Minnesota was gathered. Characteristics such as amount of fading, cracking, and blistering were quantified through a series of measurements made through instrumentation and visual assessment. Resulting data is a value from 0 to 1 representing the severity of the damage.

Test panels were prepared and placed in 3 different environmental chambers each set to simulate three locations (Florida, Arizona, and Minnesota) with the intent of one week in these chambers to equate to one year in the field.

DATA SET

PAINT_WEAR_ACCELERATED_TESTING.JMP

Condition	The three real and simulated conditions
Years_Real	Years paint samples were in the field
Fading_Real	Amount of fading (0-1 scale)
Peeling_Real	Amount of peeling (0-1 scale)
Blistering_Real	Amount of blistering (0-1 scale)
Years_Simulated	Simulated years produced by accelerated tester
Fading_Lab	Amount of fading (0-1 scale)
Peeling_Lab	Amount of peeling (0-1 scale)
Blistering_Lab	Amount of blistering (0-1 scale)

EXERCISES

1. For each type of wear (Fading, Peeling, and Blistering), create some visualizations that provide a comparison between the data from the real environmental conditions to the simulated conditions from the accelerated testing.
 - a. A set of scatterplots (one for each type of wear) is one type of visualization.
Tip: A good idea would be to add a line on the graph at $y=x$ that would correspond to perfect agreement between the two (right-click on graph. Choose Customize. Click "+". Then select "Y Function" under "Templates". Edit "Y Function(_function_of_x_,x)" to "Function($y=x$,x)"). Consider color coding the data to distinguish the three environmental conditions.
 - b. Another set of visualizations would be a line graphs (one for each type of wear and environmental condition) with the data from both the real and simulated conditions on the Y axis, and years on the X axis.
 - c. Another set of would be to create a similar set as was done in b. above but to instead plot the difference between the data from the real environmental conditions to the lab on the Y axis. Adding a reference line at "0" would be a good way to help show the difference. *Hint: You'll need to create a new set of variables using the formula editor.*
2. Based upon the graphs you created, describe any difference you see in the amount of agreement between results from the lab and the real environmental conditions. Is the amount of agreement/disagreement consistent across the 3 types of wear and/or the 3 environmental conditions? If not, describe how it differs. Which type of conditions and wear have the best/worst agreement?

3. For each type of wear and environmental condition, fit a linear regression model with the difference variables (created in 1c.) as the Y and Years as the X.
 - a. Provide an explanation of why these linear regression equations could be useful and how they could be used by the R&D team. Illustrate that usage with a 4-5 examples.
Hint: Use the appropriate equation to estimate what the the amount of wear would be in an real environmental condition based upon a specific result from the lab.
 - b. Augment the estimates you produced in 3a. above with 95% confidence intervals.
Tip: This is easiest to do by launching the profiler in each report. Choose a particular year as the X. CI for the difference between real and simulated condition will be displayed. editor.
4. What are some ideas for further experimentation the R&D team could take to help them in their efforts to get closer agreement between the results from the testing chambers to what happens in real environmental conditions?
5. What are some reasons why it would not be possible to produce perfect predictions regardless of how much testing and data collection is done?