Donald P. Shiley School of Engineering
University of Portland
ME 403/503 – Engineering Design, Product Realization
Fall 2016

0) ADDED Question (Created Tuesday September 27, 2016) Briefly describe (1-2 sentences), and include sketches, to answer the question "how do residential wells work." You may google "how do residential wells work" to answer the question.

1) Determine the 95% confidence intervals for the three sets of data given in the last assignment (2 sets of grinder data and the paperclip fatigue testing data). If the CI contains zero, did you reject the null hypothesis? If the CI did not contain zero, did you reject the null hypothesis?
2) Consider the previous DOE assignment that asked you to analyze grinder differences using pairing. The second set of grinder data, grinder #8 results seemed to not fit. Was the data from grinder 8 outlier data? You may use any of the three methods presented on Thursday (9/29).
3) Consider the data shown below. This is from a 2 factor, 2 level each experiment. This would require 2^2=4 total design points (test conditions) to student all possible combinations; what was done. Without doing any statistical analysis, create "response plots" (graphs showing response of for each factor at its "-" condition and at its "+" condition. You will need three graphs: one for factor 1, one for factor 2 and one for "factor" 1X2 (the interaction between factor 1 and 2).

Design Point	1	2	1X2 (to be filled out by you)	Xi (average of multiple data)
1	+	+		83.0
2	-	+		83.3
3	+	-		89.0
4	-	-		90.3

4) DOE's – we've been at this for a while, and we have a bit more to do before we conclude. But we have learned enough to at least start planning our final experiment. The following describes the experiment and your assignment for this week.

   Historical note: *(https://en.wikipedia.org/wiki/Silly_Putty, Sept. 2016) Silly Putty® is a toy based on silicone polymers that have unusual physical properties. It bounces, but breaks when given a sharp blow and can also flow like a liquid. It contains a viscoelastic liquid silicone, a type of non-Newtonian fluid, which makes it act as a viscous liquid over a long time period but as an elastic solid over a short time period.* ***It was originally created during research into potential rubber substitutes for use by the United States in World War II****.[1]*

Design problem: you are working for NASA and need to develop a very bouncy substance. No analytic model exists to define how to make really bouncy stuff (in other words, no equations exist). Since you cannot use analysis, you must use the other "leg of knowledge" – experimentation.

Alternative problem: you are working for a company that makes silly putty and they are happy with the basic formula. However, they would like to reduce the variability in the finished product. They would like to know what aspects of the manufacturing process should be most closely measured and which aspects are not sensitive to variation.

… regardless of which of the above situations we choose to investigate, begin the DOE process:

As teams of 2 or 3, you will *eventually* design, conduct and analyze a DOE to understand the effects of various materials and processes on the coefficient of restitution of homemade silly putty. There will be two different responses: coefficient of restitution based on a 60" drop-height, and based on dropping from the 3rd floor Shiley balcony onto the concrete 2nd floor. The silly putty should be formed into 1.0 to 2.0 inch diameter spheres.

Ingredients you may use:

- White glue (one brand)
- Liquid starch (2 brands)
- Food dye (one color)
- Liquid detergent (2 brands)
- Powdered detergent (1 brand)
- Baking soda
- Borax (one brand)
- Water (one brand)
- Any other ingredient if it is safe to use without personal protective equipment and you are willing to purchase it yourself
- You may consider process variable as well – baking, mixing, etc.

Assignment for this week:

- Form your teams (2 or 3 students per team)
- Do some online literature search – take advantage of what is known about homemade silly-putty
- Identify which factors you want to consider (at least at this point in time)
- Identify any pre-experiment testing you may want to do (see commentary below)

Keep in mind that you will be doing the entire experiment and analyzing the results. We may decide to divvy up the work and only do one DOE for the entire class, or each team will do their own DOE. TBD. None the less, I don't think we want a DOE with 50 runs even if we do only one DOE. To estimate error, we need replicates of each design point (or do we?). If so, 3 factors at 2 levels results in 8 combinations (2^3=8), with 2 runs for each condition (each design point) to estimate error would require 16 runs. That's probably manageable. Four factors doubles that (2^4 X 2 = 32)…getting ugly. Hopefully, statisticians have figured out some reasonable ways around this high cost. For now, let's limit the number of factors to 7 hoping that we'll get clever, but also pick your top 3 favorites just in case we don't. Also, we may be able to do more clever things if all factors are continuous (none are discrete/categorical).

<u>Commentary an pre-experimentation testing:</u> It is very common to do small simple tests help design the DOE. This is often done to test "reasonableness" of the experiment . For example in this DOE, will exposing the combined ingredients to elevated temperature (aka "cooking") cause it to catch fire? Sometimes in experiments, the combinations of factors to be investigated may cause very strange response (such as a fire) – those sorts of things should be avoided. Simple pre-experiment testing may be required to make sure the experiment does not cause the world to stop spinning (metaphorically).