Today, we will:

- Do a review example problem – Experimental design and Taguchi arrays
- Review the pdf module: **Taguchi Orthogonal Arrays**
- Review the pdf module: **Response Surface Methodology (RSM)**, and do examples

Example - Continued from last time.

Given: A toy gun that shoots Nerf bullets is being designed. The engineers want to maximize the distance traveled by the bullet. Three parameters are to be varied:

- a = spring constant
- b = weight of the bullet
- c = diameter of the bullet

The engineers decide to test 4 levels for each of these 3 parameters.

(*a*) To do: Calculate how many runs are required for a full-factorial analysis.

Solution:

$$N = L^P = 4^3 = \boxed{64}$$

(*b*) To do: Design a Taguchi array such that each level of each parameter appears twice.

Solution:

We need 8 runs since we have four levels, and we want each level of each parameter to appear twice; thus, $N = 4 \times 2 = \boxed{8}$ for a fractional factorial design array.

We come up with the following Taguchi design array:

run #	***a***	***b***	***c***
1	1	1	1
2	1	2	4
3	2	3	3
4	2	4	2
5	3	1	2
6	3	2	3
7	4	3	1
8	4	4	4

(*c*) To do: Now that the Taguchi design array is set up, experiments are performed, with the following results. Calculate the level averages, and determine which levels are optimum.

run #	*a*	*b*	*c*	*X* (m)
1	1	1	1	5.5
2	1	2	4	6.2
3	2	3	3	6.0
4	2	4	2	7.3
5	3	1	2	7.6
6	3	2	3	8.1
7	4	3	1	9.7
8	4	4	4	7.2

Solution: [See also Excel file on the course website – **Example_Taguchi_array.xls**]

(*d*) To do: Recommend follow-up experiments if only two parameters can be tested.

Solution:

Example: Experimental design using RSM

Given: Cory uses RSM to increase the performance (speed) of a photocopier machine. He changes three parameters simultaneously, but in no particular pattern. He takes enough data to determine the direction of steepest ascent. Here are the variables:

- *a*, the tension on a belt drive, varied from 400 to 550 N.
- *b*, the volume flow rate of cooling air supplied, varied from 1.8 to 4.5 L/min.
- *c*, the voltage supplied to a component, varied from 20 to 35 V.

To do:

(***a***) Calculate the *range* of coded variable x_2 corresponding to physical variable *b*.

(***b***) Calculate coded variable x_1 corresponding to physical variable a = 475 N.

Solution: