

HOMEWORK #2

This is an **individual homework**: students **MUST complete it in a totally independent manner**.

Objective: *optimization* of a roller compaction to manufacture a pharmaceutical tablet.

Problem: a multinational pharmaceutical company manufactures a novel pharmaceutical product through roller compaction (Figure 1). Its R&D manager would like to understand the effect of three factors (specific compaction force x_1 , roller gap width x_2 and roll speed x_3) on the ribbon density, to maximize the response variable y . Data are available from an experimental campaign, whose values of the factors are collected in Table 1, together with the corresponding response y . Data are also available in the `dataset.mat` file, where X is the design matrix of the factors, X_c the coded matrix of the factors, and Y the vector of the response.

QUESTIONS: solve the problem using Matlab[®] and/or Minitab[®].

1. What type of design was planned and carried out?
2. Build the main effect plot and comment on it.
3. Build the interaction plot and comment on it.
4. Build a response surface model:
 - a. estimate the regression model and comment on its structure, considering the parameters uncertainty (provide the parameters values in vector b of a Matlab[®] file `surname_homework2.mat` and the parameters' uncertainty in b_{unc});
 - b. discuss the outcome (in terms of regression parameters) considering what were the results of both the main effect plot and the interaction plot;
 - c. comment on model fitting and adequacy through the determination coefficient and residuals (provide the coefficient of determination R^2 and the vector r of the residuals);
 - d. refine and update the model structure, if needed, and determine the updated values of regression coefficients, uncertainty of the coefficients, R^2 , and residuals (provide the parameters in vector b_2 , parameters' uncertainty in b_{unc2} , coefficient of determination R^2_2 and the residuals vector r_2). Comment on the results;
 - e. build the response surface plots adding the experimental points and comment it.
5. Identify the optimal formulation which guarantees the maximum ribbon density and comment the difference between the model prediction and the real response of the confirmation point, if present, with respect to the prediction uncertainty.

Deadline: 1 week before the final exam.

Deliverables: send an email to:

pierantonio.facco@unipd.it
edoardo.tamiazza@phd.unipd.it
marco.brendolan@phd.unipd.it

including:

1. the solution of the problem in a file: `surname_homework2.pdf` of **maximum 8 pages** (in Times New Roman, 12 pt, line-spacing 1.5) providing the answers and the necessary figures and/or tables;
2. a Matlab® file `surname_homework2.mat` with the required mathematical entities;
3. a Minitab® file `surname_homework2.mpx` with the required solutions.

Homework evaluation:

- correctness and completeness of the provided solution;
- clearness of the presentation.

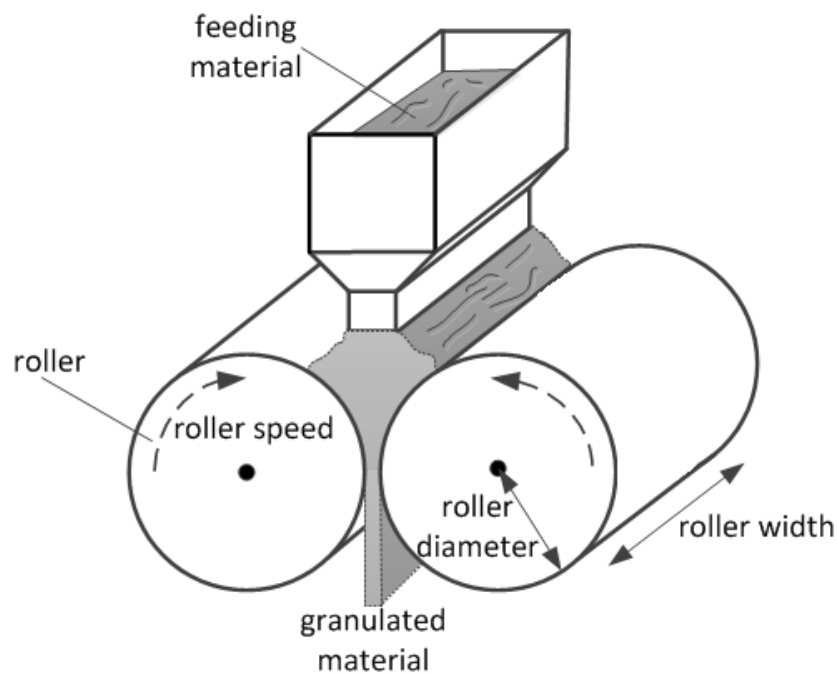


Figure 1. Schematic of the roller compaction.

Table 2. Design matrix and corresponding response for the experimental campaign.

exp.	specific compaction force x_1 [kN/cm]	gap width x_2 [mm]	roll speed x_3 [rpm]	ribbon density y [%]
1	4	1.50	2	59.0
2	4	3.00	2	55.5
3	4	1.50	4	58.9
4	4	3.00	4	55.4
5	8	1.50	2	67.7
6	8	3.00	2	66.5
7	8	1.50	4	68.1
8	8	3.00	4	66.9
9	6	2.25	3	63.7
10	6	2.25	3	63.0
11	6	2.25	3	62.8