Day 2 Homework Exercises

Smarter Experimentation for Scientists and Engineers

Day 2 Homework Exercise 1

Designing a Full Factorial

You are studying a process for cleaning metal components. Your response is Particles, measured as particles per cm^2. You want to design an experiment to study three continuous factors, at the following settings:

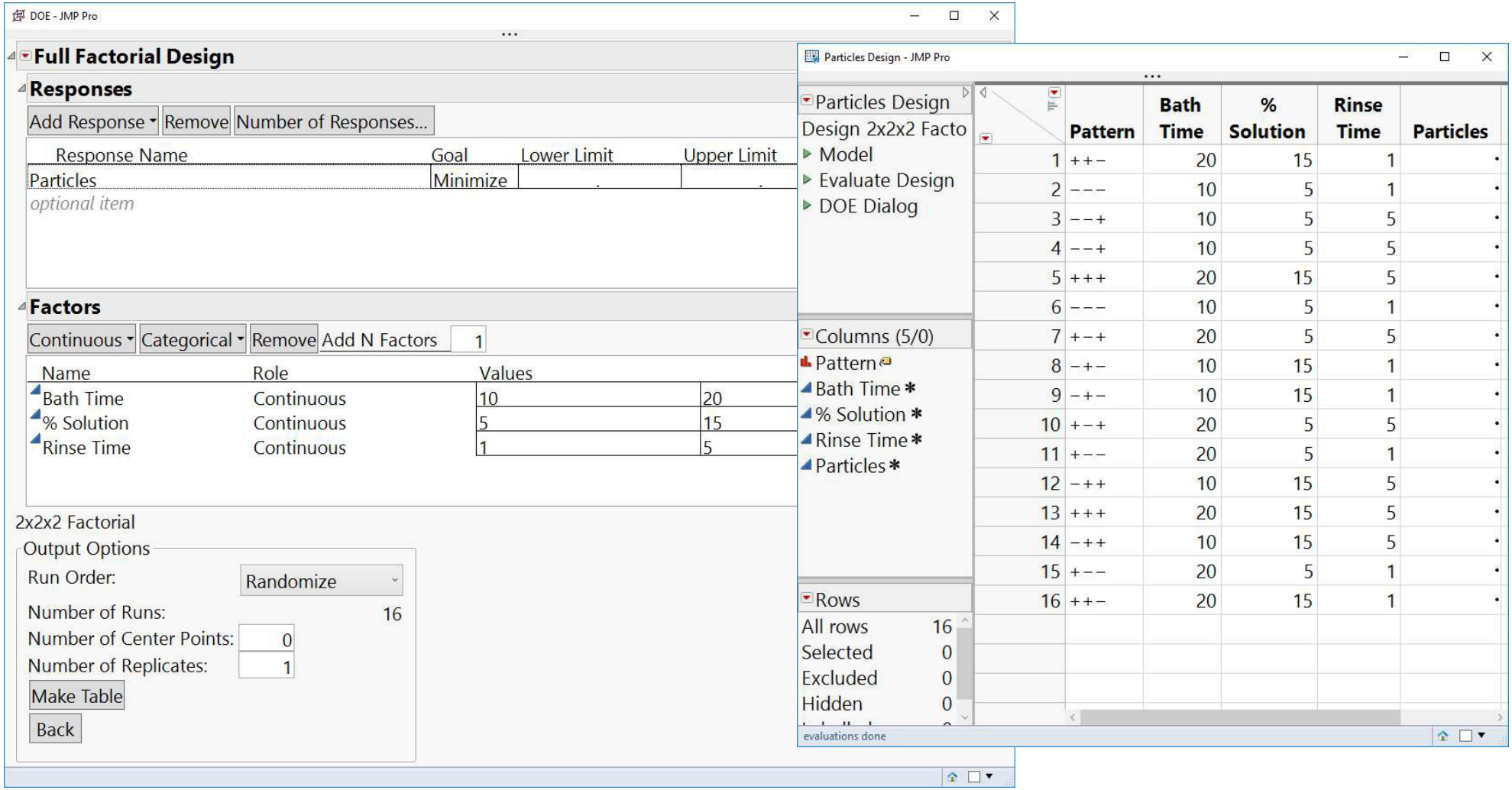
- **Bath Time** (hours): 10 and 20
- **% Solution**: 5 and 15
- **Rinse Time**: 1 and 5 hours

In JMP use the Full Factorial Design platform (from DOE, Classical) to design a randomized 2^3 full factorial experiment. Replicate the entire design once. Before you make the design table, click the top red triangle, select **Set Random Seed**, and enter the value 1234. (This ensures that you generate the design in the same randomized order as the one used in the solutions.)

Questions:

1. How many treatments are in this design?
2. How many runs are in this design?
3. Interpret the pattern for the first trial. What are the factor settings for this trial?
4. Which row is a replicate of row 1?

Day 2 Homework Exercise 1



Day 2 Homework Exercise 1

Designing a Full Factorial

Solutions:

1. How many treatments are in this design?

   In a 2^3 full factorial experiment, there are 8 treatments. Remember that a treatment is a unique combination of factor levels.

2. How many runs are in this design?

   There are 16 runs. Each treatment is replicated once.

3. Interpret the pattern for the first trial. What are the factor settings for this trial?

   The pattern is ++-. The trial should be run with the high level of Bath Time (20), the high level of % Solution (15), and the low level of Rinse Time (1).

4. Which row is a replicate of row 1?

   Row 16 is a replicate of row 1.

Day 2 Homework Exercise 2

Analyzing a Replicated Full Factorial Experiment

Open the file **Particles 2.jmp**. This is based on the 2^3 full factorial experiment that you designed in the previous exercise, but it includes a fourth factor: the two-level categorical variable **Type**.

The response is **Particles** (measured in Particles/cm2).

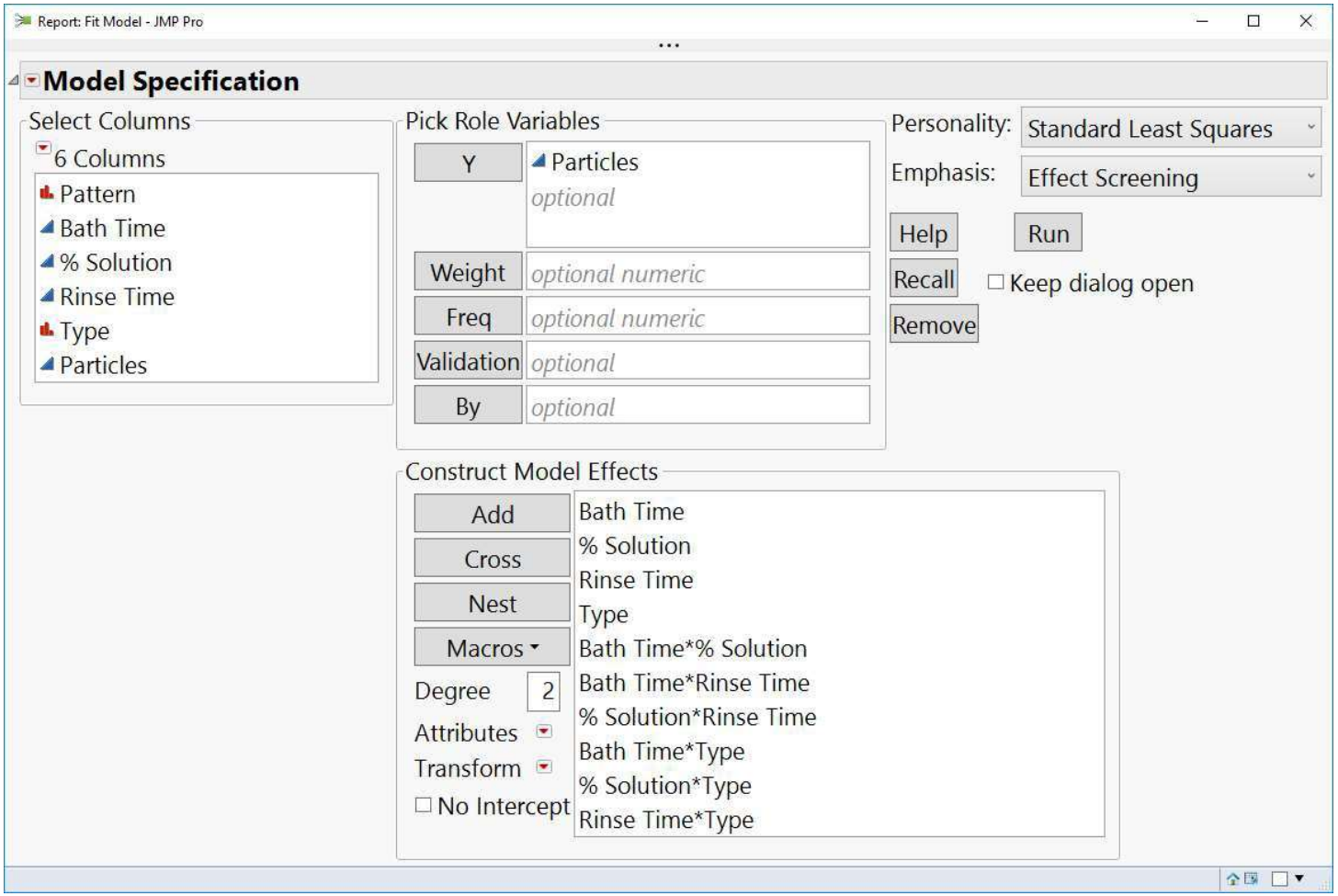
The experiment has been conducted, and the measured particle values have been added to the design table.

Analyze these experimental results. (Hint: Run the **Model** script to launch the Model Specification window. Run the analysis with the default model.)

Questions:

1. How many main effects are in the model?
2. How many two-way interactions are in the model?
3. Which three effects are the most significant?
4. Slowly remove nonsignificant terms one at a time, starting with the least significant two-way interactions. Keep all terms with a p-value of 0.05 or less. Which terms are in your reduced model?
5. Your response goal is to minimize Particles. Use the Prediction Profiler to find the best (most desirable) factor settings. What are these settings, and what is the predicted **Particles** value at these settings?

Day 2 Homework Exercise 2

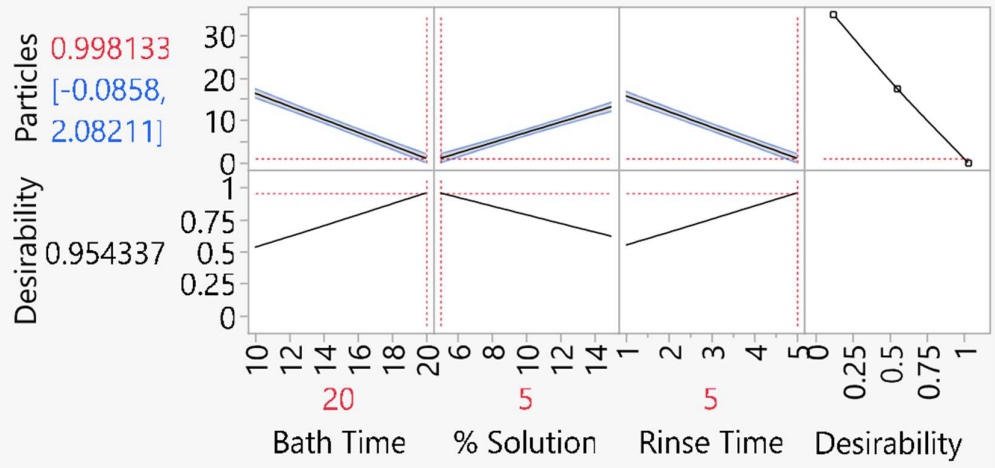


Day 2 Homework Exercise 2

Effect Summary

Source	LogWorth	PValue
Bath Time(10,20)	11.117	0.00000
% Solution*Rinse Time	9.632	0.00000
Rinse Time(1,5)	6.500	0.00000 ^
Bath Time*% Solution	1.968	0.01077
% Solution(5,15)	1.362	0.04347 ^

Prediction Profiler



Day 2 Homework Exercise 2

Analyzing a Replicated Full Factorial Experiment

Solutions:

1. How many main effects are in the model?

   There are four main effects

2. How many two-way interactions are in the model?

   There are six 2-way interactions

3. Which three effects are the most significant?

   Bath Time, the **%Solution*Rinse Time** interaction, and **Rinse Time**

4. Slowly remove nonsignificant terms one at a time, starting with the least significant two-way interactions. Keep all terms with a p-value of 0.05 or less. Which terms are in your reduced model?

   Bath Time, the **%Solution*Rinse Time** interaction, **Rinse Time**, **Bath time*%Solution**, and **% Solution**

5. Your response goal is to minimize Particles. Use the Prediction Profiler to find the best (most desirable) factor settings. What are these settings, and what is the predicted **Particles** value at these settings?

   The best settings are the high level of **Bath Time** (20), the low level of **% Solution** (5), and the high level of **Rinse Time** (5). At these settings, the predicted response is 0.998. (Hint: To find the optimal settings, click the red triangle for the Prediction Profiler and select **Optimization and Desirability**, and then **Maximize Desirability**.)