Homework

A company is interested in creating a new blended fruit drink. There are four fruit juices that will be blended together to form the resulting drink. Preliminary testing has led to constraints on the ranges of each individual juice. The experimenter has a panel of ten experts to taste the blends, and the response is the average of the ten taste responses.

The component juices and ranges are as follows:

Apple juice, 0.33-0.67

Orange juice, 0.08-0.25

Pineapple juice, 0.12-0.29

Grapefruit juice, 0.04-0.21

1. Create a design that uses 35 or fewer runs and can estimate the Scheffé cubic model for the components. You can design the experiment from the start or use the **Fruit Juice Exercise** link in the journal.
2. Use the **Fruit Juice Exercise Simulator** link in the journal to populate your response data. Analyze the model and find settings which predict the highest **Taste**.

Solution

A company is interested in creating a new blended fruit drink. There are four fruit juices that will be blended together to form the resulting drink. Preliminary testing has led to constraints on the ranges of each individual juice. The experimenter has a panel of ten experts to taste the blends, and the response is the average of the ten taste responses.

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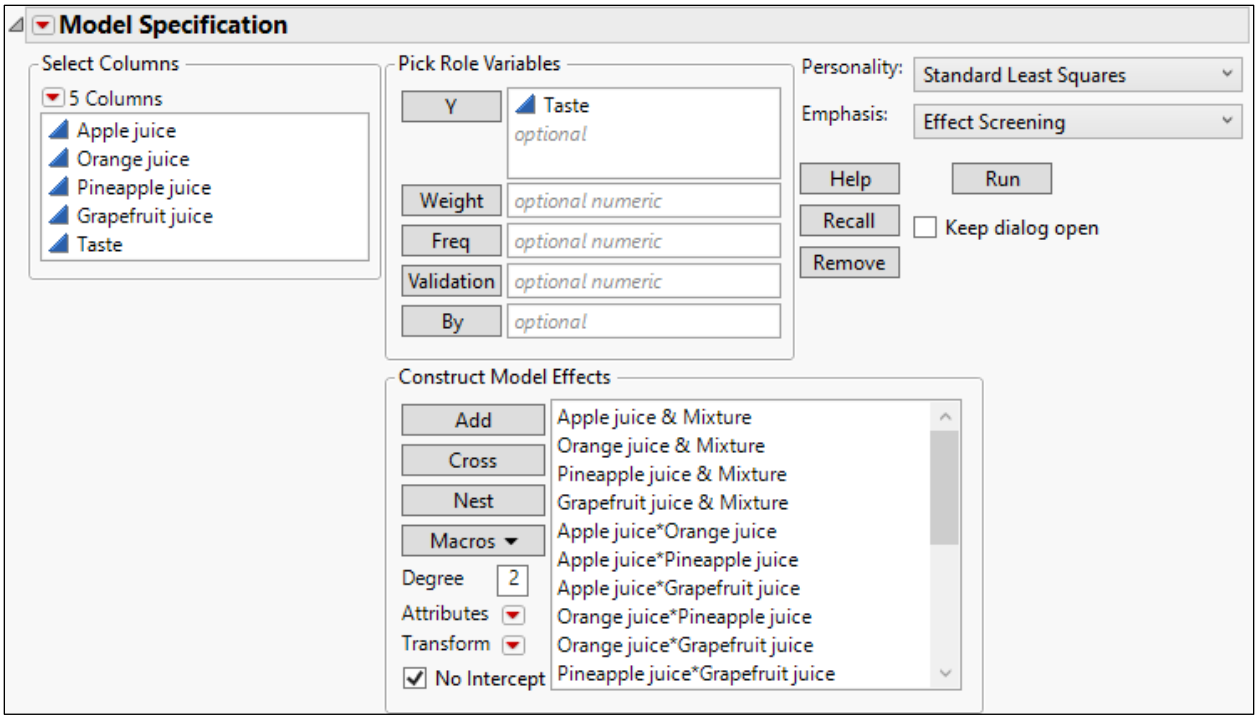
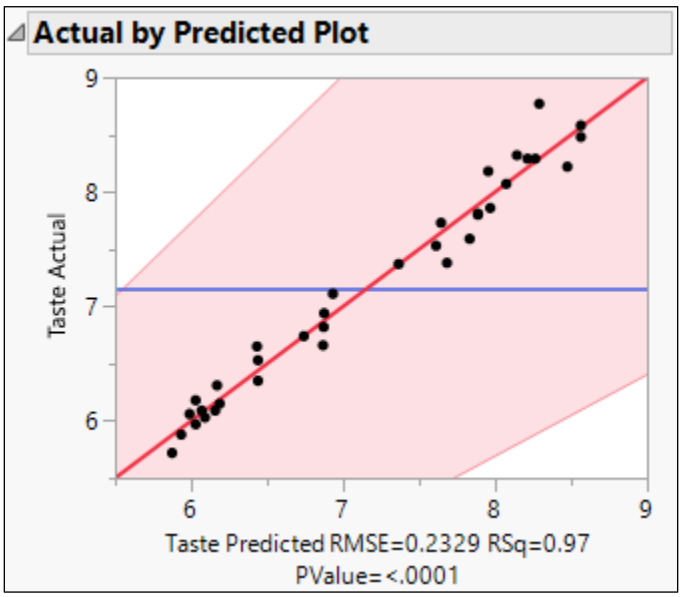
1. Create a design that uses 35 or fewer runs and can estimate the Scheffé cubic model for the components. You can design the experiment from the start or use the **Fruit Juice Exercise** link in the journal.
   a. If you want to load the responses and factors, click **Fruit Juice Exercise** in the journal, then go to step **f**.
   b. Select **DOE** > **Custom Design**.
   c. Double-click **Y**, then enter **Taste**.
   d. In the **Add N Factors** box, enter 4, then click **Add Factor** > **Mixture**.
   e. Enter the names and ranges of the factors as specified above.
   f. Click **Continue**.
   g. Click **Scheffe Cubic**.
   h. Enter **35** in the **User Specified** field.
   i. Click **Make Design**.
   j. Click **Make Table**.
2. Use the **Fruit Juice Exercise Simulator** link in the journal to populate your response data. Analyze the model and find settings which predict the highest **Taste**.
   a. If you want the same data as in this solution, return to the journal and click **Fruit Juice Data**.
   b. Otherwise, return to the journal and click **Fruit Juice Exercise Simulator**.
   c. Click **OK**, then click **OK** again.
   d. Click the green play button next to the **Model** table script.

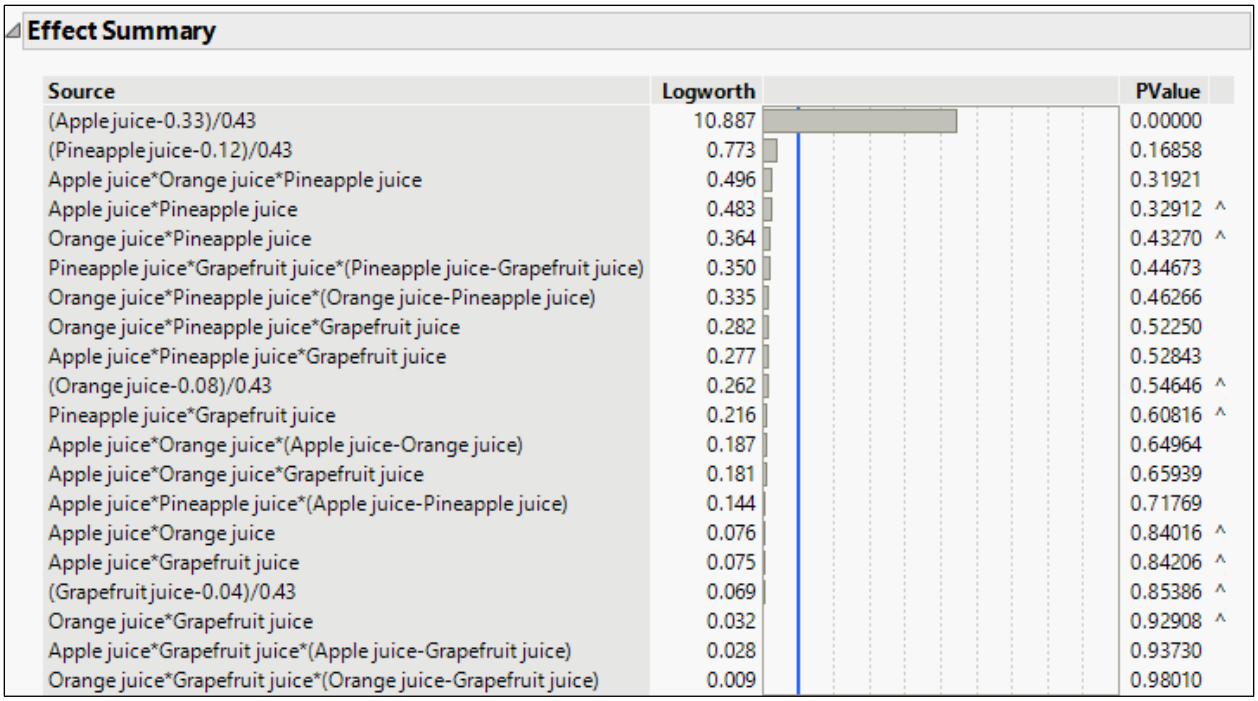


The full Scheffe cubic model is already specified by Custom Design.

e. Click **Run**.



The Actual by Predicted plot shows the model explains 97% of the variability in **Taste**. The standard deviation of the unexplained variation is 0.2329. The model is significant at α = 0.05.



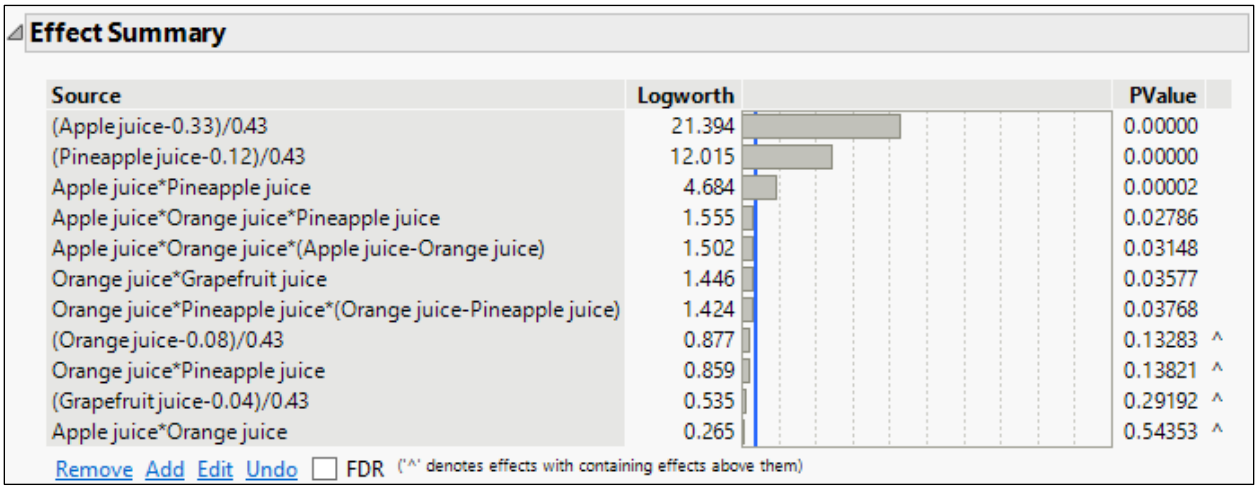
Effect Summary

Source	Logworth	PValue	
(Apple juice-0.33)/0.43	10.887	0.00000	
(Pineapple juice-0.12)/0.43	0.773	0.16858	
Apple juice*Orange juice*Pineapple juice	0.496	0.31921	
Apple juice*Pineapple juice	0.483	0.32912	^
Orange juice*Pineapple juice	0.364	0.43270	^
Pineapple juice*Grapefruit juice*(Pineapple juice-Grapefruit juice)	0.350	0.44673	
Orange juice*Pineapple juice*(Orange juice-Pineapple juice)	0.335	0.46266	
Orange juice*Pineapple juice*Grapefruit juice	0.282	0.52250	
Apple juice*Pineapple juice*Grapefruit juice	0.277	0.52843	
(Orange juice-0.08)/0.43	0.262	0.54646	^
Pineapple juice*Grapefruit juice	0.216	0.60816	^
Apple juice*Orange juice*(Apple juice-Orange juice)	0.187	0.64964	
Apple juice*Orange juice*Grapefruit juice	0.181	0.65939	
Apple juice*Pineapple juice*(Apple juice-Pineapple juice)	0.144	0.71769	
Apple juice*Orange juice	0.076	0.84016	^
Apple juice*Grapefruit juice	0.075	0.84206	^
(Grapefruit juice-0.04)/0.43	0.069	0.85386	^
Orange juice*Grapefruit juice	0.032	0.92908	^
Apple juice*Grapefruit juice*(Apple juice-Grapefruit juice)	0.028	0.93730	
Orange juice*Grapefruit juice*(Orange juice-Grapefruit juice)	0.009	0.98010	

The Effect Summary report shows many nonsignificant terms. Reduce the model by removing nonsignificant terms, one at a time, starting at the bottom and obeying hierarchy. Do not remove terms with the ^ symbol. Do not remove main effects. Use $\alpha = 0.05$.

f. Select **Orange juice*Grapefruit juice*(Orange juice–Grapefruit juice)** then click **Remove**.

g. Repeat for all nonsignificant effects.



Effect Summary

Source	Logworth	PValue	
(Apple juice-0.33)/0.43	21.394	0.00000	
(Pineapple juice-0.12)/0.43	12.015	0.00000	
Apple juice*Pineapple juice	4.684	0.00002	
Apple juice*Orange juice*Pineapple juice	1.555	0.02786	
Apple juice*Orange juice*(Apple juice-Orange juice)	1.502	0.03148	
Orange juice*Grapefruit juice	1.446	0.03577	
Orange juice*Pineapple juice*(Orange juice-Pineapple juice)	1.424	0.03768	
(Orange juice-0.08)/0.43	0.877	0.13283	^
Orange juice*Pineapple juice	0.859	0.13821	^
(Grapefruit juice-0.04)/0.43	0.535	0.29192	^
Apple juice*Orange juice	0.265	0.54353	^

Remove Add Edit Undo FDR ('^' denotes effects with containing effects above them)

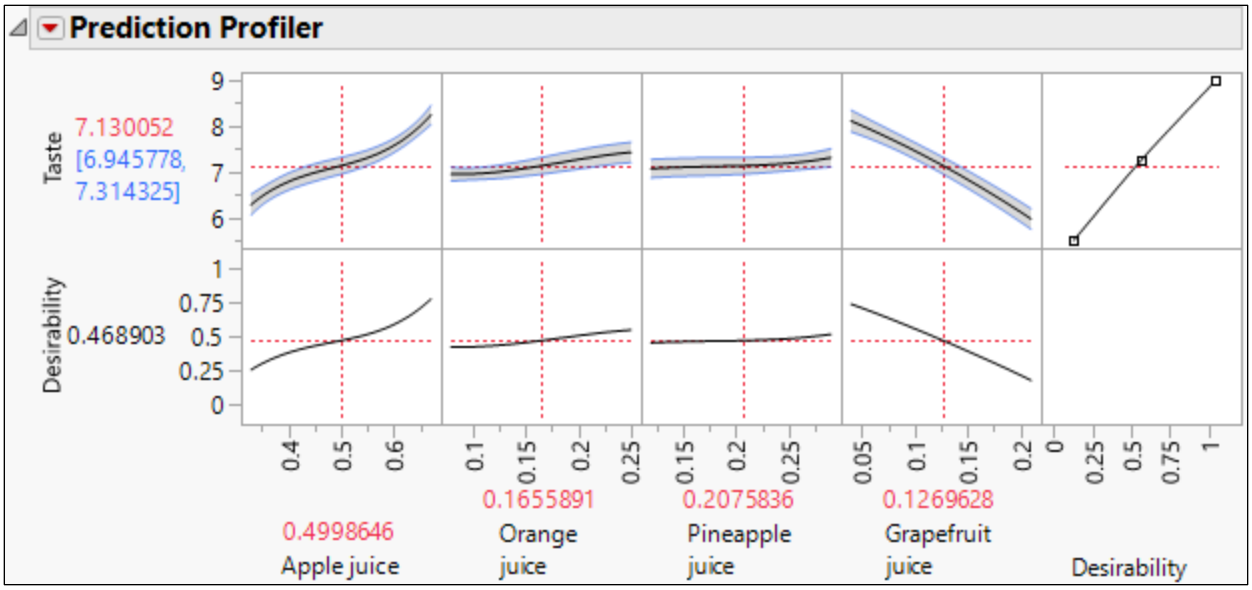
The reduced model is shown.

In the Actual by Predicted plot, you can see that RSq remains at 97%, but RMSE has been reduced.

In the Residual by Predicted plot, there are no unusual patterns.

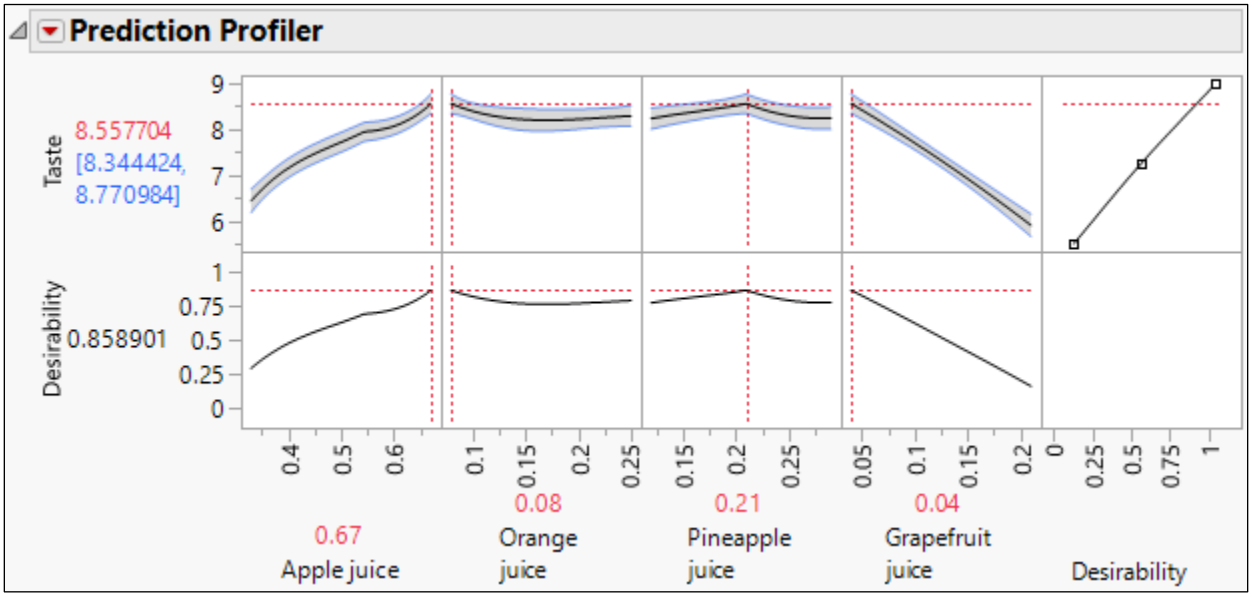
Proceed to finding settings which optimize **Taste**.

h. Examine the **Prediction Profiler**.



Taste is predicted to be about 7.1 when all factors are set to their middle level. The nonlinearity of the cubic design can clearly be seen. Changing the values of a factor setting will change the values of the other factor settings since the factors are mixture components. Optimize the response.

i. Click the red triangle next to **Prediction Profiler** and select **Optimization and Desirability** > **Maximize Desirability**.



The optimal settings of 2/3 apple juice, 1/5 pineapple juice, and a small amount of orange and grapefruit juice predict a **Taste** value of about 8.5. It's time to confirm these settings. Juice, anyone?