

# Interaction Effects

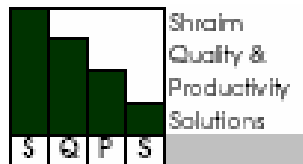
ASQ-Columbus Tutorial

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# Outline

- ◆ What are interaction effects?
- ◆ Why are they important?
- ◆ How can they be measured?
- ◆ How can their negative impacts be minimized?

## Interaction Effects: Definition

- ◆ The output of a process is determined the settings of input factors.





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## Interaction Effects: Definition

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- ◆ Factors (or independent variables) can have their own individual effects on the response as well as interactions between them.
- ◆ Interaction between two factors exists when the impact of one factor on the response depends on the setting of the other factor.

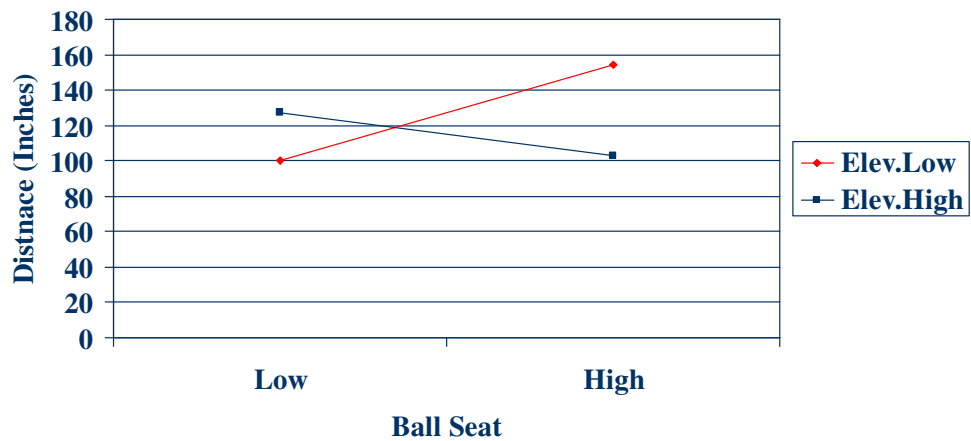
# Measuring Interaction Effects

- ◆ Interaction effects can be measured using line graphs or analysis of variance (ANOVA).
  - If lines cross or have the tendency to do so then there is an interaction effect
  - This is a subjective way of measuring interactions, a more precise way can be done using ANOVA
- ◆ Many statistical software provide both methods
- ◆ Catapult Example (using simple line graphs):
  - Controlled Factors: Ball Seat, Elevator
  - Response: Distance (in inches)

# Estimating Interaction Effects

	Low	High
Elev.Low	100	154
Elev.High	127	103

This Example shows the presence of interaction between the 2 factors



# Estimating Interaction Effects

Using Analysis of Variance in  $2^3$  factorial with no replicates

-Adding another factor (Arm Tension) L1 is Low Level and L2 is High Level for each factor

Ball	Arm		
<u>Seat</u>	<u>Ten</u>	<u>Elev.</u>	<u>Distance</u>
L1	L1	L1	80
L2	L1	L1	101
L1	L2	L1	136
L2	L2	L1	148
L1	L1	L2	85
L2	L1	L2	65
L1	L2	L2	137
L2	L2	L2	104

# Estimating Interaction Effects

## Analysis of Variance (JMP)

### Summary of Fit

RSquare	0.987508
RSquare Adj	0.970851
Root Mean Square Error	5.18009
Mean of Response	107
Observations (or Sum Wgts)	8

### Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	4	6363.5000	1590.88	59.2873
Error	3	80.5000	26.83	Prob > F
C. Total	7	6444.0000		0.0035

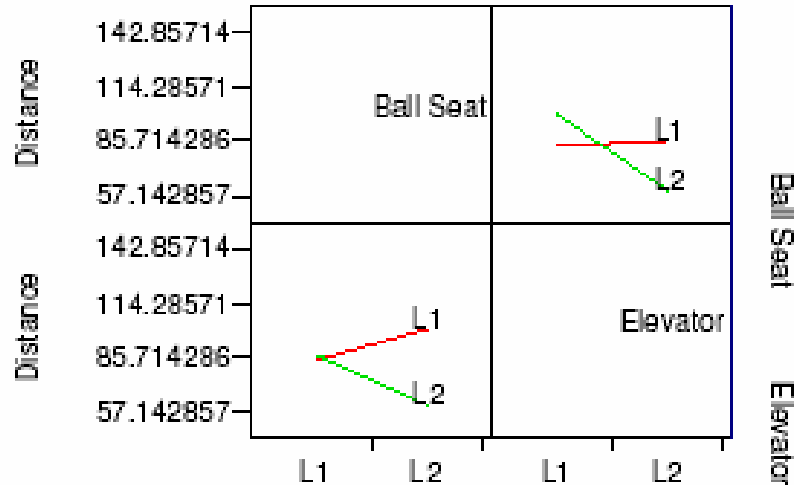
### Effect Tests

Source	DF	Sum of Squares	F Ratio	Prob > F
Ball Seat	1	50.0000	1.8634	0.2656
Arm Tension	1	4704.5000	175.3230	0.0009
Elevator	1	684.5000	25.5093	0.0150
Ball Seat*Elevator	1	924.5000	34.4534	0.0099

# Estimating Interaction Effects

## Interaction Plot (JMP)

Interaction Profiles



## Importance of Estimating Interaction Effects

- ◆ If interaction effects are significant but not included in the analysis then:
  - That portion of variability resides in the error term
  - When such terms include significant variability, the results / conclusions drawn from the analysis of variance would be erroneous.
- ◆ Interaction effects could be important while one of the factors included might not.



## Impact on Process Setup

- ◆ After analyzing the experiment, the process can be set up at the best combination of factor levels
- ◆ However, when interaction effects are significant, it is imperative to consider how such effects influence the process
- ◆ Such consideration involves trade-off and control decisions on process variables.