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Section 1

# MANE 6313

Subsection 1

## Week 6, Module G

# Student Learning Outcome

- Select an appropriate experimental design with one or more factors,
- Select an appropriate model with one or more factors,
- Evaluate statistical analyses of experimental designs,
- Assess the model adequacy of any experimental design, and
- Interpret model results.

# Module Learning Outcome

*Judging models for factorial designs.*

# Judging Models

> *Fitting the correct regression model can be as much art as it is a science.*

Source: https://blog.minitab.com/en/adventures-in-statistics-2/when-should-you-fit-a-non-hierarchical-regression-model#:~:text=Topics%3A%20Design%20of%20Experiments%20-%20DOE%2C%20Regression%20Analysis,terms%3A%20A%2C%20B%2C%20C%2C%20A%2AB%2C%20A%2AC%2C%20and%20B%2AC.

- Parsimonious model
- Hierarchical Model
- Example Problem

## Parsimonious Model

*A **parsimonious model** is a model that achieves a desired level of goodness of fit using as few explanatory variables as possible*

Source: https://www.statology.org/parsimonious-model/

- Occam's Razor states that the simplest explanation is most likely the right one
- Statistical Reasons:
  - Parsimonious models are easier to interpret and understand
  - Parsimonious models tend to have more predictive ability
  - Parsimonious models are less likely to be impacted by multicollinearity

## Hierarchical Model

*In the world of linear models, a hierarchical model contains all lower-order terms that comprise the higher-order terms that also appear in the model. For example, a model that includes the interaction term ABC is hierarchical if includes these terms: A, B, C, AB, AC, and B*C*

Source: https://blog.minitab.com/en/adventures-in-statistics-2/when-should-you-fit-a-non-hierarchical-regression-model#:~:text=Topics%3A%20Design%20of%20Experiments%20-%20DOE%2C%20Regression%20Analysis,terms%3A%20A%2C%20B%2C%20C%2C%20A%2AB%2C%20A%2AC%2C%20and%20B%2AC.

## Example Problem

Consider two replicates of a factorial design with the following factors.

| Factor | Levels |
|---|---|
| A | 25,100 |
| B | 1,7 |
| C | 8,12,16 |
| D | .1,.15,.2 |
| E | 20,80 |

$2 \times 2 \times 3 \times 3 \times 2 \rightarrow 72$ obs/rep

# Initial Model

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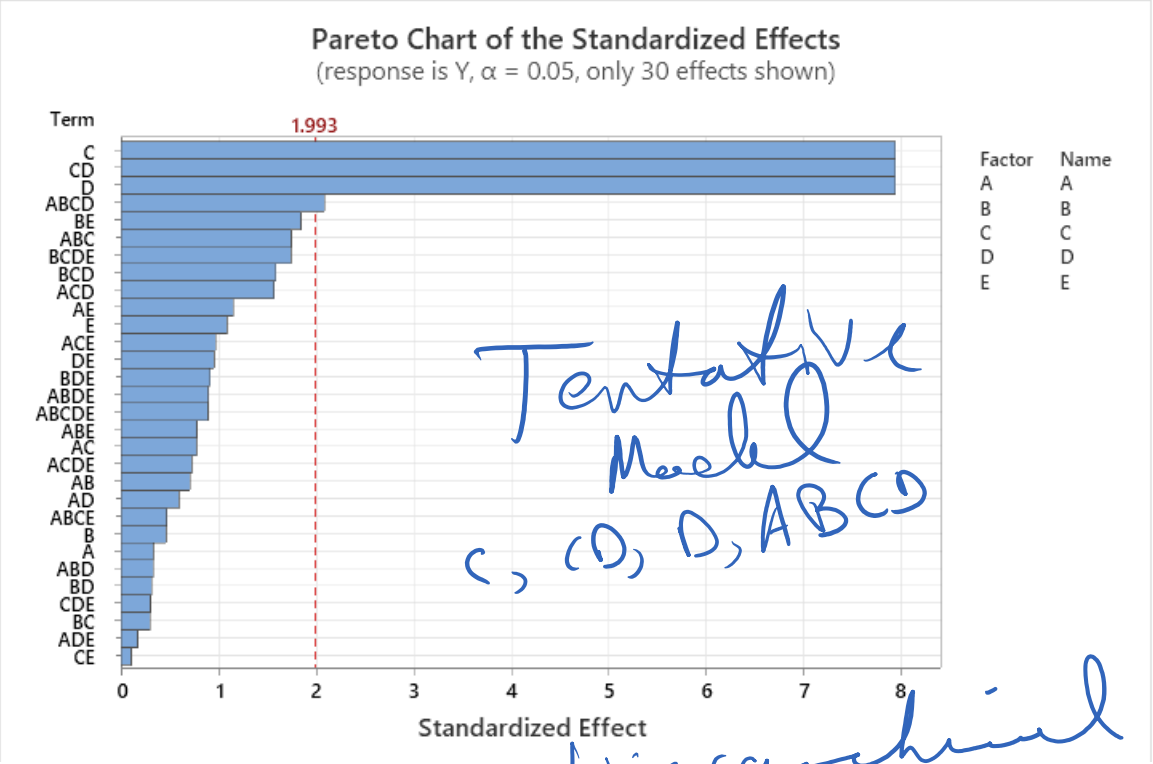


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Hierarchical Model Keep all terms associated with ABCD

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Model | 35 | 67660.6 | 1933.2 | 65.61 | 0.000 |
| Linear | 6 | 60846.8 | 10141.1 | 344.18 | 0.000 |
| A | 1 | 3.3 | 3.3 | 0.11 | 0.739 |
| B | 1 | 6.3 | 6.3 | 0.22 | 0.643 |
| C | 2 | 11169.2 | 5584.6 | 189.54 | 0.000 |
| D | 2 | 49667.9 | 24834.0 | 842.85 | 0.000 |
| 2-Way Interactions | 13 | 5874.3 | 451.9 | 15.34 | 0.000 |
| A*B | 1 | 14.9 | 14.9 | 0.51 | 0.479 |
| A*C | 2 | 49.3 | 24.6 | 0.84 | 0.436 |
| A*D | 2 | 35.5 | 17.8 | 0.60 | 0.549 |
| B*C | 2 | 15.8 | 7.9 | 0.27 | 0.766 |
| B*D | 2 | 16.7 | 8.4 | 0.28 | 0.753 |
| C*D | 4 | 5742.1 | 1435.5 | 48.72 | 0.000 |
| 3-Way Interactions | 12 | 625.0 | 52.1 | 1.77 | 0.063 |
| A*B*C | 2 | 152.3 | 76.2 | 2.58 | 0.080 |
| A*B*D | 2 | 17.8 | 8.9 | 0.30 | 0.740 |
| A*C*D | 4 | 226.0 | 56.5 | 1.92 | 0.113 |
| B*C*D | 4 | 228.9 | 57.2 | 1.94 | 0.109 |
| 4-Way Interactions | 4 | 314.5 | 78.6 | 2.67 | 0.036 |
| A*B*C*D | 4 | 314.5 | 78.6 | 2.67 | 0.036 |
| Error | 108 | 3182.1 | 29.5 | | |
| Lack-of-Fit | 36 | 1035.6 | 28.8 | 0.96 | 0.536 |
| Pure Error | 72 | 2146.5 | 29.8 | | |
| Total | 143 | 70842.7 | | | |

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Simplify to C, D, C*D

## Analysis of Variance

| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
|---|---|---|---|---|---|
| Model | 8 | 66579 | 8322.4 | 263.52 | 0.000 |
| Linear | 4 | 60837 | 15209.3 | 481.59 | 0.000 |
| C | 2 | 11169 | 5584.6 | 176.83 | 0.000 |
| D | 2 | 49668 | 24834.0 | 786.35 | 0.000 |
| 2-Way Interactions | 4 | 5742 | 1435.5 | 45.46 | 0.000 |
| C*D | 4 | 5742 | 1435.5 | 45.46 | 0.000 |
| Error | 135 | 4263 | 31.6 | | |
| Lack-of-Fit | 63 | 2117 | 33.6 | 1.13 | 0.310 |
| Pure Error | 72 | 2147 | 29.8 | | |
| Total | 143 | 70843 | | | |

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$H_0$: LOF is not present
$H_1$: LOF is present

fail to reject $H_0$ → no LOF