



Design of Experiments

(Lecture I)

Dr. Adham Ragab



Outline

- Goals of course
- Objectives of current lecture
- Course Description
- What is DOE



Course Goals

- By the end of this course, the student should:
 - Understand the theoretical basis of experimental design.
 - Explain the sources of error.
 - Describe sampling, hypothesis testing and simple statistics.
 - Define experiments with a simple factor and solve them with analysis of variance technique.



Course Goals

- Explain randomized complete and incomplete designs.
- Design experiments using general factorial design with two or more factors.
- Learn how to analyze data using Minitab.



Lecture Goals

- By the end of this lecture, the student should be aware of:
 - Course contents, goals and grading schema.
 - The meaning and nature of DOE.



Course Description

- **Course Title:**
 - Design of Experiments, IE 333
- **Instructor:**
 - Dr. Adham Ragab, Assistant professor
- **Text book:**
 - Design and Analysis of Experiments, D. C. Montgomery



Course Description

- Course Topics
 - Introduction
 - Basic Statistics
 - Tests of hypothesis
 - Experiments with a Single Factor: The Analysis of Variance
 - Randomized Blocks, Latin Squares and Related Designs
 - Introduction to Factorial Designs
 - The 2^k Factorial Designs



Course Description

- **Grading System:**
 - 35 % Midterms (2 midterms)
 - 10 % Project
 - 15 % lab work
 - 40 % Final exam



Course Description

- Course organization
 - 3 hours lecture per week
 - 1 hour tutorial per week
 - 1 hour lab per week
- Software
 - Minitab



What is DOE

Experiment

- “A test or investigation, esp. one planned to provide evidence for or against a hypothesis” **World English Dictionary.**

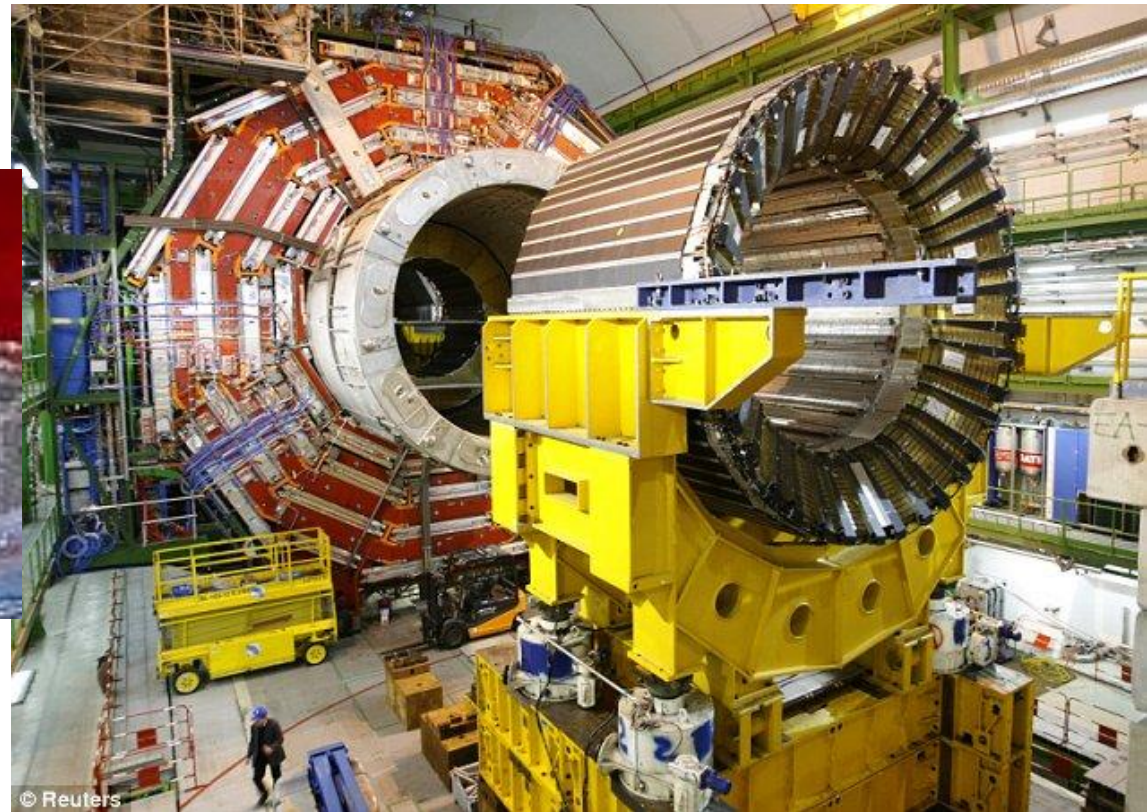




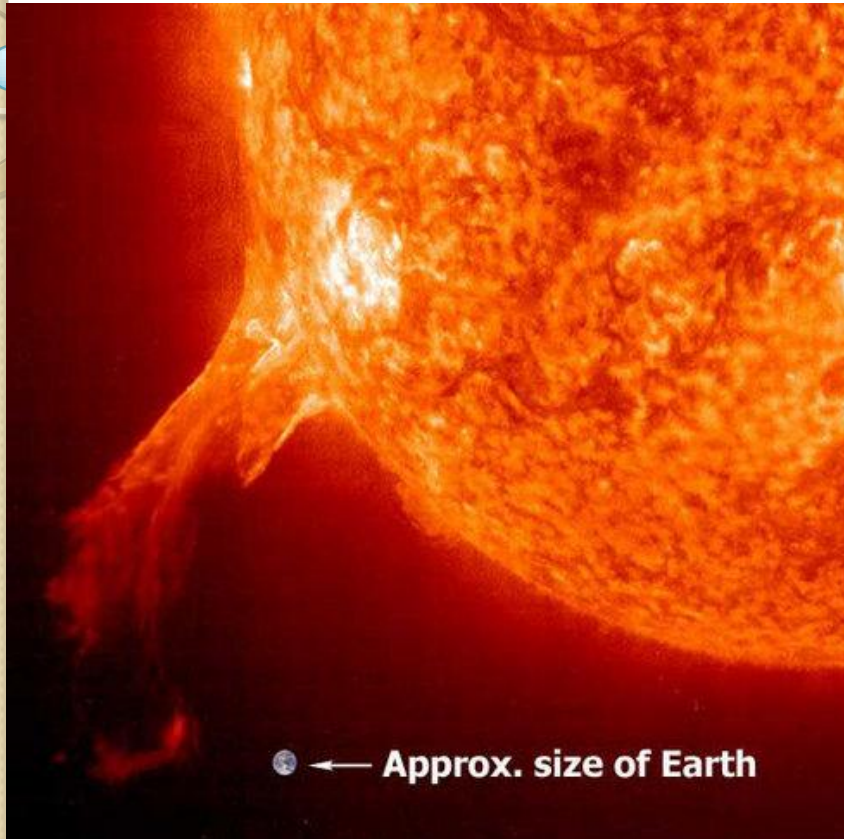
Experiment

- “A test or procedure carried out under controlled conditions to determine the validity of a hypothesis or make a discovery” **Science Dictionary.**

Experiment



Observation





Experiment

- An experiment yields a sample data
 - For example: Boiling temperature of water.
- Data are processed (analyzed, organized, structured, etc.) to produce information.
- Information might then be further processed to produce knowledge.

Design

- “To work out the structure or form of (something), as by making a sketch, outline, pattern, or plans” **World English Dictionary.**



“He who fails to plan is planning to fail”
Winston Churchill



Design

- “The approach that engineering (and some other) disciplines use to specify how to create or do something. A successful design must satisfy a (perhaps informal) functional specification (do what it was designed to do); conforms to the limitations of the target medium (it is possible to implement); meets implicit or explicit requirements on performance and resource usage (it is efficient enough). A design may also have to satisfy restrictions on the design process itself, such as its length or cost, or the tools available for doing the design”

Computing Dictionary.

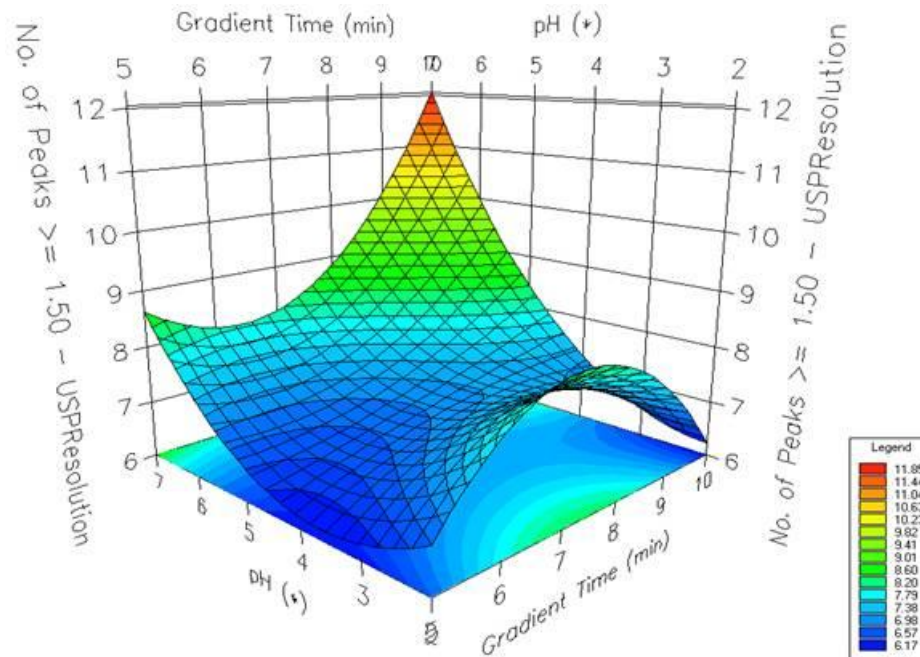
DOE

- “He who fails to plan is planning to fail”
Winston Churchill during WWII



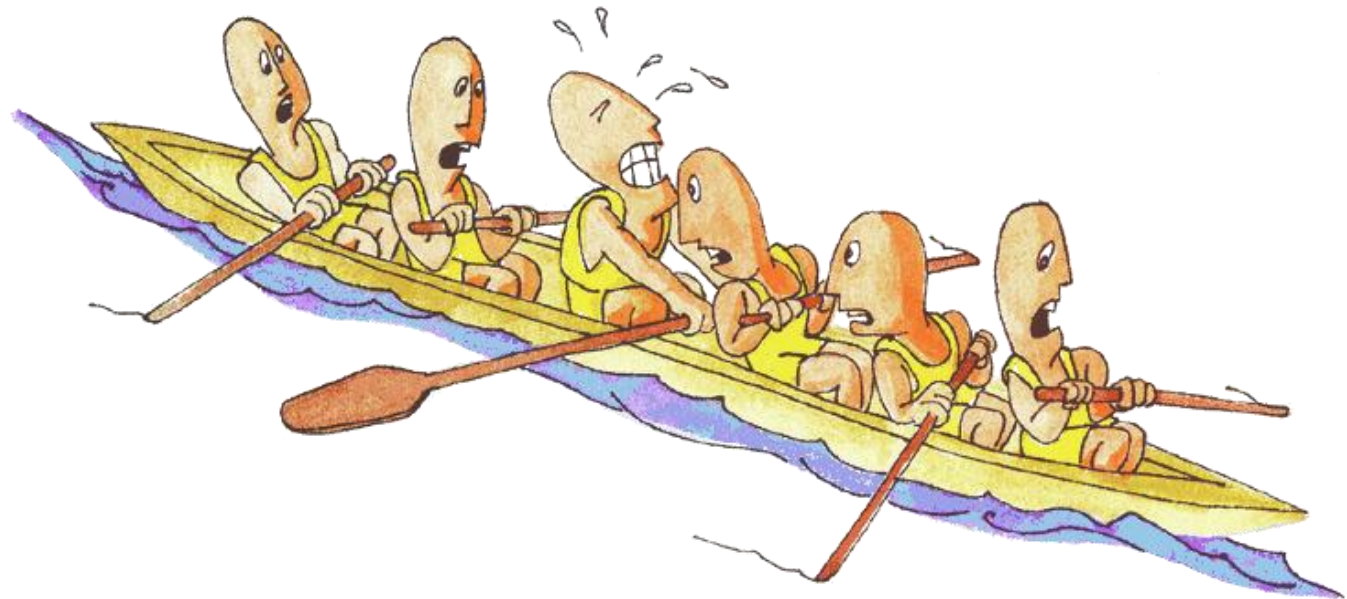
DOE

- “Design of Experiments is a formal structured technique for studying any situation that involves a response that varies as a function of one or more independent variables”.



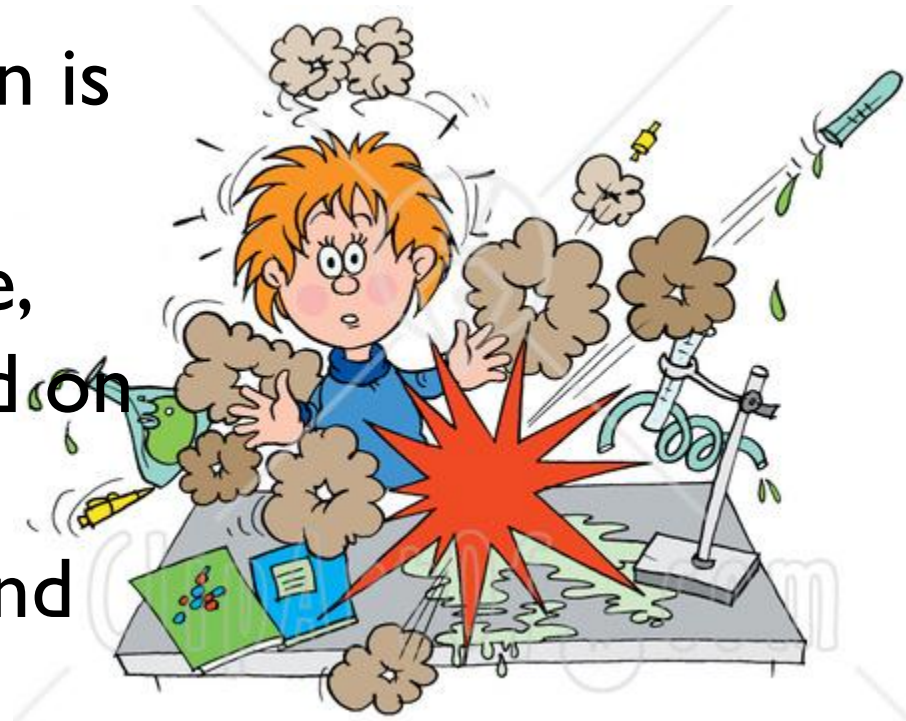
DOE

- “DOE is specifically designed to address complex problems where more than one variable may affect a response and two or more variables may interact with each other”.



DOE

- “Experimental design is a strategy to gather empirical knowledge, i.e. knowledge based on the analysis of experimental data and not on theoretical models.”



http://www.camo.com/rt/Resources/design_of_experiment.html



Why DOE?



Example





DOE Terminology*

- Response variable
 - Measured output value
- Factors
 - Input variables that can be changed
- Levels
 - Specific values of factors (inputs)
- Replication
 - Completely re-run experiment with same input levels

*David J. Lilja



DOE Terminology

- Design Matrix
 - The design matrix will show combinations of different levels for each input factor.
- Randomization
 - “RANDOMIZATION IS THE INSURANCE POLICY AGAINST INTRODUCING BIAS INTO THE STUDY” George A. Milliken, Kansas State University



Summary

- DOE is an important tool to gather empirical data.
- It might be used in scientific experiments or **industrial experiments**.