Design of experiments

Sources:
-*DOE Simplified*, second edition, by Anderson and Whitcomb
-*An Introduction to Design of Experiments: A Simplified Approach* by Barrentine

Most of the definitions below are paraphrased or reproduced word-for-word from Barrentine.

A system: Inputs → process → response

Three kinds of variation in the response:
-Variation in known input or process variables
-Variation in unknown process variables
-Variation in the measurement of the response variable

Two kinds of variation in general:
-Special-cause variation – unusual compared to previous history
-Inherent variation – demonstrated as typical of that process, also known as experimental error or random variation

To carry out an experiment, we use experimental controls to limit inherent variation, then we can say that a relationship between inputs and responses in our experiments are due to a special cause-effect relationship.

Design of Experiments is the simultaneous study of several process variables
One-factor-at-a-time vs. Design of Experiments
DOE can detect interactions between factors
DOE can greatly reduce the amount of testing

Factors are process variables controlled at will during the experiment (think knobs)
Also called "independent variables," with the dependent variable being the response
Can be quantitative or qualitative

Levels: the different options or setting for each factor in the experiment

Experimental design: definition of the collection of trials to be run in the experiment
A *run* or *treatment* is a unique combination of the levels of factors
A *replicant* is the independent and random application of a run, including setup
A *repeat* is a repetition of a run without going through a new setup
(confetti example for replicant vs. repitition)
Randomization refers to randomizing the order or the trials – reduces *bias*, or *distortion* due to *unknown influence*
Sometimes *blocking* the experiment into sections defined by a factor is necessary
Interaction means two factors in combination produce an affect that is unexpected based on their main individual effects.

Full factorial design: vary every factor at every level
For example, a two-factor full factorial design, where each factor has two levels, has 4 treatments

Stuff we're not going to talk about in class but you can look into if it interests you: ANOVA and F-tests

Fractional factorial designs: good for if you just care about which factors matter, for example

Confounding of factors and interactions

Reproduced rom Wikipedia (http://en.wikipedia.org/wiki/Fractional_factorial_design)'

---snip---

> *...since D = AB and E = AC, then ABD and ACE are both columns of plus signs, and consequently so is BDCE. In this case the defining relation of the fractional design is I = ABD = ACE = BCDE. The defining relation allows the alias pattern of the design to be determined.*

Treatment combinations for a 25 − 2 design

Treatment combination	I	A	B	C	D = AB	E = AC
de	+	−	−	−	+	+
a	+	+	−	−	−	−
be	+	−	+	−	−	+
abd	+	+	+	−	+	−
cd	+	−	−	+	+	−
ace	+	+	−	+	−	+
bc	+	−	+	+	−	−
abcde	+	+	+	+	+	+

---snip---

FWIW, this looks like a good tutorial:

http://www.sciencedirect.com/science/article/pii/S0169743998000653