3.7.3 Example of a 2^3 Factorial

To illustrate the design and analysis of a 2^3 factorial experiment, consider the following example (see Lawson and Erjavec, 2001). Students in a university electronics lab often complained that voltage measurements made on a circuit they constructed in class were inconsistent. The lab teaching assistant (TA) decided to conduct an experiment to try to identify the source of the variation. The three factors he varied were A=the ambient temperature where the voltage measurement was made, B=the voltmeter warm-up time, and C=the time the power was connected to the circuit before the measurement was taken. The response was the measured voltage in millivolts. The two levels for factor A were − = 22°C (room temperature) and + = 32°C (close to the temperature in some industrial settings). An oven was used and the circuit was allowed to stabilize for at least five minutes prior to measurements. The settings for factors B and C were − =30 seconds or less, and + =5 minutes. The same circuit was measured for each combination of treatment factors so the experimental unit was nothing more than the trial or point in time at which the particular combination of treatment factor levels were applied to make the measurement. Two replicates of each of the eight experimental combinations were run in a random order to help prevent biases. The results of the experiment are shown in Table 3.6.

Table 3.6 *Factor Settings and Response for Voltmeter Experiment*

	Factor Levels			Coded Factors					
Run	A	B	C	X_A	X_B	X_C	Rep	Order	y
1	22	0.5	0.5	−	−	−	1	5	705
2	32	0.5	0.5	+	−	−	1	14	620
3	22	5.0	0.5	−	+	−	1	15	700
4	32	5.0	0.5	+	+	−	1	1	629
5	22	0.5	5.0	−	−	+	1	8	672
6	32	0.5	5.0	+	−	+	1	12	668
7	22	5.0	5.0	−	+	+	1	10	715
8	32	5.0	5.0	+	+	+	1	9	647
1	22	0.5	0.5	−	−	−	2	4	680
2	32	0.5	0.5	+	−	−	2	7	651
3	22	5.0	0.5	−	+	−	2	2	685
4	32	5.0	0.5	+	+	−	2	3	635
5	22	0.5	5.0	−	−	+	2	11	654
6	32	0.5	5.0	+	−	+	2	16	691
7	22	5.0	5.0	−	+	+	2	6	672
8	32	5.0	5.0	+	+	+	2	13	673

In this table, the actual factor settings are shown on the left, and the coded − and + levels are shown on the right. The actual settings on the left form a list of recipes or directions for performing each experiment. The order number on