Chapter 06.00F

Physical Problem for Regression
Industrial Engineering

Problem Statement

An industrial engineer working for a manufacturing company has noticed a deviation in the accuracy of a machine after it runs for long periods without a cool down cycle. This is especially concerning because the company wants to increase production (longer machine operating times without a cool down) because of a large contract the company will start in 3-4 months. The industrial engineer decides to monitor the machining process to determine the point (hours of operation) when the machine is producing parts that could be out of tolerance. Over the course of several months, the industrial engineer monitored the machining process to determine a relationship between hours of machine use and millimeters off target the machine was. The data collected is shown in tabular form (Table 1) and scatter plot (Figure 1).

Table 1. Off target measured as a fubtion of machine use.

Hours of machine use	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Millimeters off target	1.10	1.21	1.00	1.21	1.25	1.23	1.24	1.28	1.30	1.30	1.38	1.35	1.38	1.38	1.40	1.42

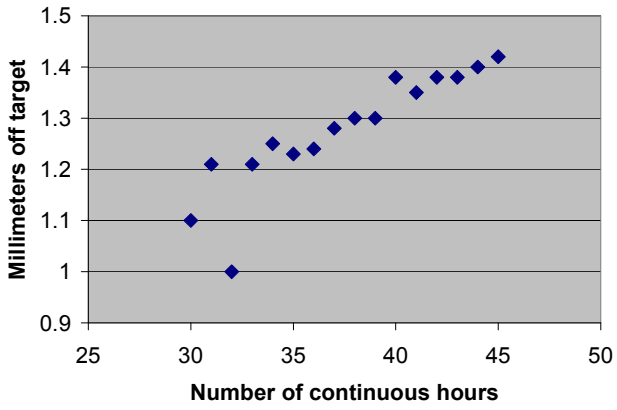

Figure 1. Off target measurement as a function of machine use.

Based on the above data, the industrial engineer would like to determine the number of hours of machine use that would produce a 2 millimeters off target because many parts would fail

quality check at that point. Determine the number of hours of operation that produces 2 millimeter off target based on a least squares fit for the data.

Background

In order to determine a relationship between millimeters off target and hours of machine use, a curve (for example, a linear polynomial) needs to be fit to the data. This is done by regression where we best fit a curve through the data given in the previous table. In this case, we may best fit the data to a first order polynomial, that is

$$h = a_0 + a_1 t$$

Where h is the hours of machine use and t is the millimeters off target. The values of the coefficients in the above equations will be found by linear regression. Knowing the values of a_0 and a_1, we can determine the millimeters off target as a function of hours of machine use. For example, if we want to find the time when the machine will be 2 mm off target, then

$$2 = a_0 + a_1 t$$

giving

$$t = \frac{2 - a_0}{a_1}$$

Questions

1. Fit the data in the previous table using a linear regression, and determine the hours of machine use that will make the machine 2 mm off target.
2. Fit the data in the previous table using a second order polynomial regression, and determine the hours of machine use that will make the machine 2 millimeters off target.
3. Find whether a linear or second order polynomial regression is a better fit to the data.

REGRESSION	
Topic	A physical problem for regression.
Summary	Find the number of toys a company should manufacture per day to maximize their injection molding and assembly line.
Major	Industrial Engineering
Authors	Glen Besterfield
Date	December 7, 2008
Web Site	http://numericalmethods.eng.usf.edu