# CleanUp

Materials needed: * A large box of styrofoam packing peanuts with orange dots on about 20% of them.
* TI-82/3 calculator or a spreadsheet or some way of easily getting a regression line.
* A watch that displays seconds.

What do oil spills, shattered bones, and industrial air pollutants have in common? These ideas are not so different as you might expect, mathematically speaking. In each case, there is a clean up job to be done, and, in each case, it is virtually impossible to clean up 100% of the contaminants.

With air pollutants, money is the independent variable. A cement plant may spend $1.5 million to clean 95% of the pollutants from their stacks. It may take $3.2 million to clean another 3% (so that the smoke is free of 98% of the cement dust), and 5.4 million to increase the efficiency just one percentage point more. No amount of money can make the process perfectly clean. At some point, a management decision must be made to curtail the attempt and settle for "almost clean". Money is management's independent variable.

A bullet that strikes a bone may leave hundreds of particles of bone fragment, metal, dirt, and torn tissue. A surgeon may be able to clean away 95% of the fragments in 10 minutes, 98% in 25 minutes, and 99% in 60 minutes. Again, some point must be reached at which the surgeon determines that more damage will be done by leaving the wound open than by the remaining fragments. Time is the surgeon's independent variable.

Oil spills at sea are expensive to clean up, and, if left to the winds and tides, become even more difficult to contain. And, as before, 100% success is virtually impossible. Both time and money are critical factors to consider here, but since quicker response has an associated cost, we can consider money as the independent variable.

In this exercise, we will use a simple rational function to model a clean up. We wish to predict the amount of contaminant cleaned as a function of the independent variable (time or money). We choose a rational function because it has a horizontal asymptote. Why is it necessary to choose a function with a horizontal asymptote? ______________________________

______________________________________________________________________

______________________________________________________________________

You are given a box with packing peanuts in it. Each peanut represents one hundred persons in a large community. Many members of the community have contracted the deadly "tiger virus", a condition that can be recognized by a patch of orange on top of the head. The Center for Disease Control has determined that a large team of experts can be hired for $50,000/day to seek out these individuals, and quarantine them in Williams-Brice Stadium where medication may be administered in the absence of other viruses of the same family. They will fund the community with a grant to find 99% of the ill citizens if you, as mayor, will determine what that cost will be.

You must build a model of clean up cost as follows: **First**, gather data. **Second**, transform that data so that a hyperbolic model (rational function) can be constructed. **Third**, find a hyperbolic model of the form $Y = A + B/X$ that best fits the data. And, **fourth**, use your model to determine the amount of money you need to request from the CDC.

Before we begin, answer these questions:

1. Why do we choose a model of the form $Y = A + B/X$ instead of, say, $Y = A \ln(X)$ or $Y = A X^B$? (This is a very important question. Think about it.)

2. What do we mean by *rational function*, anyway? [What is the *definition*?]

3. If we are to use the linear regression capabilities of our technology, **how must we transform the data to make it suitable for our model?** *You must answer this in order to proceed to the next page.*

4. Once we have found our model, how will we use it to answer the question posed by the CDC? [Describe the mathematical steps you will take to arrive at a projected cost for the clean up.]

We simulate the search process with the box of packing peanuts. The box represents our community, and, as stated previously, each peanut represents 100 people. A day's search is represented by a *twenty second* search through the contents of the box, removing those found with the virus. Repeat the process for five or six "days", shaking or stirring the box after each twenty second search. DO NOT replace the infected peanuts after each day's search. Work as a team, in pairs, or as a whole class to gather data for the table on the next page. Your correct answer to question 3 will determine what values you put in the column labeled Transformed Data. Ordered Pairs for Graphing are your original data pairs ( Day, Cumulative # Peanuts removed). Ordered Pairs for Analysis are the pairs you enter into the calculator or spread sheet for use in linear regression. Reference the Data Transformation section of your booklet. Think about it.

| Day | Transformed Data (see #3) | # Contaminated Peanuts removed | Cumulative # Peanuts removed | Ordered Pairs for Graphing | Ordered Pairs for Analysis |
|---|---|---|---|---|---|
| 1 | ______ | ______ | ______ | __________ | __________ |
| 2 | ______ | ______ | ______ | __________ | __________ |
| 3 | ______ | ______ | ______ | __________ | __________ |
| 4 | ______ | ______ | ______ | __________ | __________ |
| 5 | ______ | ______ | ______ | __________ | __________ |
| 6 | ______ | ______ | ______ | __________ | __________ |

Perform the regression and record your answers here:

1. For the TRANSFORMED data: slope =________ intercept = ________

2. For the MODEL, Y= ______ + ______ / X Here X represents __________

____________________________ and Y represents ______________________

____________________________________________________________________

3. What does the model predict to be the total number of infected citizens in the community? Answer in hundreds of people.

__________

Tell how you used your model to get this answer:

4. Now use this model to solve for the number of days it will take to find 99% of the infected citizens. Show your work:

5. Finally, **write a request to the CDC specifying how much money you will need**. The request must include a description of the logical and mathematical processes you used to arrive at your answer. Remember that if you ask for too much, you may lose credibility with the CDC and jeopardize your status as mayor. If you ask for too little, your community will have to pay more of the total bill. **Use a word processor such as Word or WordPerfect.** Attach your request to this completed handout.

Rev 2/99