Name(s)	Project Number
Eric A. Ford	**S1207**

Project Title

Can You Hear Me Now? A Mathematical Model for the Optimal Arrangement of Cell Phone Towers

Abstract

Objectives/Goals

The objective of my project was to determine the optimal arrangement of cell phone transmission towers for the best service coverage in Kern County using a mathematical model.

Methods/Materials

I placed a coordinate plane over a map of Kern County and established a set of nodes within the county boundaries as coordinate pairs in an Excel spreadsheet. I assigned a population density value to each node based on a population density map. A list of nodes that represent the major highways was created using linear equalities. Areas of unusable land, such as Department of Defense property, were marked by a set of linear inequalities and were not included in the experiment. I created Visual Basic macros to find the total population density and the total number of highway nodes to which service would be provided. The results of the macros were combined to create an optimization value that was used to determine which nodes would be feasible tower locations. A minimum optimization value was selected to exclude locations that were not feasible. The model was executed with minimum optimization values of 6.5 and 40.5 because they represented the optimization values of towers with no significant population or highway coverage for two different tower ranges. The model was also executed with 40, 60, 80, and 100 total towers.

Results

When the model was run with different minimum optimization values and total numbers of towers, different arrangements of towers resulted. The towers generally were arranged in the same basic pattern, clustered around the population density centers and spread along the major highways.

Conclusions/Discussion

The different arrangements of towers have unique strengths and weaknesses. Different models may be suitable for different conditions in the region. Different models may also be suitable for different service providers. A company that is not concerned with immediate profits may wish to implement the arrangement of towers that was produced by the 100-tower model or the model with the minimum optimization value of 6.5. While the network would provide coverage to almost every possible area where a person might use a cell phone, it would be very expensive to build and maintain so many towers, especially in remote locations.

Summary Statement

My project is a mathematical model that utilizes linear programming to determine the optimal arrangement of cell phone transmission towers in Kern County.

Help Received

Maps were obtained from ESRI#s Geography Network ArcExplorer program. My father explained how to create the macros and my mother edited my writing. Both parents assisted in the assembly of my display. Mr. Bob Tranter of the Bureau of Land Management provided information regarding regulations