



CALIFORNIA STATE SCIENCE FAIR 2008 PROJECT SUMMARY

Name(s) Daniel J. Wirtz	Project Number J1324
Project Title Identifying Critical Nodes on the Monterey Peninsula Road Network	
Abstract Objectives/Goals To determine if the network of major roads on the Monterey Peninsula is subject to single point failure Methods/Materials Google maps was used to identify about 30 bridges, overpasses, and intersections (nodes) along the major road network on the Monterey Peninsula. I acquired data on the average number of cars that traveled the major roads. I estimated the cost to fix two different sized bridges and I hand drew the road network, noting links, nodes (bridges and intersections) and traffic flows. I used the data from the hand drawn model to populate the computer model. I entered the following data into #Model-Based Vulnerability Analysis# (MBVA): the number of days it would take to fix a node or link, replacement costs, and how the absence of a node or link would affect the traffic flow by recording the average number of cars carried by the node or link. Results The Monterey Highway Network is a non-random, scale free, network -- a few nodes play a critical role and the links and nodes in the network are not randomly distributed. Moreover, most of the nodes in the system possess a small degree # that is they only contain two links. 74% of the network nodes have only 2 links, 11% have three and 2% have four. The model identified the critical node in the network, the node that had the greatest number of links that also carried the greatest volume of traffic. Using the capital loss function on the model, I estimated which bridge in the road network was the most critical. The hypothesis was disconfirmed. The Monterey Peninsula road network is not subject to single point failure: The destruction of any one node would not curtail movement across the network. Conclusions/Discussion The techniques that I am using are usually employed to model attacks on critical infrastructure. I wanted to used these programs to model the road network to see how it would fare if any number of nodes failed and how other routes could be used to get to a destination regardless of that failure. This could be important, especially if a natural disaster # earthquake or windstorms # destroys some part of the road network.	
Summary Statement The project undertakes a #Model-Based Vulnerability Analysis# (MBVA) to characterize of the Monterey Peninsula Road Network and to assess its vulnerability to single point failure.	
Help Received Dr. Ted Lewis at the Naval Postgraduate School provided me with the computer model used in the project. My father helped me cut and paste graphics from the model for my presentations.	