CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)
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Project Number
J0203

Project Title
Boat Stability: What Shaped Boats Are Least Likely to Tip Over?

Abstract

Objectives/Goals
The objective of this project was to investigate the relative lateral stability of boats (or other floating objects) with different cross-sectional shapes. For feasibility, I restricted the cross-sectional shapes investigated to those with the same area and height, top and bottom parallel, and linear sides with angles of #45 (bottom longer than the top), 0, 45, and 60 degrees relative to an axis perpendicular to the top.

Methods/Materials
To determine stability I designed (and built with Legos) an apparatus that allows the application of a torque to a floating cross-sectional shape and measures the degree of tilt. This was difficult. The design consists of a wheel at the center of gravity of the cross-sectional shape with strings going left from the top and right from the bottom. These are then routed over many pulleys to bring them down, on one side of the apparatus, were they are connected together to a bar to which a varying weight (by the use of a container filled with varying volumes of water) is attached. The strings going from the wheel on the cross-sectional assembly to the next set of pulleys need to be level because if these strings are not level they will create a vertical force which would cause the results to be incorrect. The angle of tilt is measured by a protractor attached to the cross-sectional shape.

Results
The 60-degree shape required the most torque to flip. The greater the angle of the sides of the shape, the more stable the shape.

Conclusions/Discussion
The objective of this project to investigate the relative lateral stability of boats (or other floating objects) with different cross-sectional shapes was achieved for the restricted set of shapes considered. The 60 degree shape was the most stable in the sense that it took the most torque to cause it to flip over.
The investigation of other shapes (those with non-linear sides) and the investigation of stability at small angles of tilt would answer the general objective of lateral boat stability in more depth but was not possible within the time constraints of this project, but might well be the objective of another project.

Summary Statement
To determine lateral boat stability for a set of cross-sectional shapes an apparatus was designed and constructed to measure the degree of tilt as a function of torque.

Help Received
Help from Ivan P. Bottlik: Guidance in restricting the scope of the project. Fetching Lego parts to build the apparatus. Help in sawing and varnishing the shapes and procuring material and in threading the strings. Guidance in data reduction and documentation.