California Science Center

# CALIFORNIA STATE SCIENCE FAIR
## 2001 PROJECT SUMMARY

**Your Name** (List all student names if multiple authors.)
**Eric A. Ford**

**Project Title** (Limit: 120 characters. Those beyond 120 will be ignored. See pg. 9)
**Fair Dice?**

**Science Fair Use Only**

**J1111**

**Division**
X **Junior (6-8)** _ **Senior (9-12)**

**Preferred Category** (See page 5 for descriptions.)
**11 - Mathematics & Software**

**Abstract** (Include Objective, Methods, Results, Conclusion. See samples on page 14.)
Use no attachments. Only text inside these boxes will be used for category assignment or given to your judges.

My objective was to test my hypothesis that the regular polyhedral dice I was testing (a tetrahedron, an octahedron, a dodecahedron, an icosahedron, and a rhombic triacontahedron) would be fair dice and that a non-isohedral pentahedral solid, which I predicted would be more likely to land on its larger faces more frequently than its smaller ones, would not be fair. I determined if each die were fair by conducting a set number of throws (50 times the number of sides of the die) under the same conditions, which I recorded on separate tally sheets, using different colors for each set of ten times the number of sides of the die. I was then able to determine what values were reached for each increment and enter those data into a spreadsheet that I had set up to calculate the chi-square values. Next, I calculated the confidence percentages and confidence intervals for each set of rolls. I believed that if the chi-square values reached a confidence level of 95% for a given die, it could be considered fair. The results of my experiment showed that the tetrahedron, the octahedron, and the dodecahedron are fair dice with confidence percentages of 96%, 97%, and 99.3%, respectively. The confidence percentage for the icosahedron only reached 92.4%, and dropped to 11.8% for the final set of rolls. Values for five of the twenty sides were outside the confidence interval for all sets of rolls. The confidence percentage for the triacontahedron was 4.7%. Two opposing sides of this die were rolled a greater number of times than the other faces and two other opposing faces were rolled a smaller number of times than the other faces. For the non-isohedral pentahedron, the three larger faces of the five were rolled a greater number of times than the smaller faces. The confidence percentage for the non-isohedral pentahedron was 0%. I concluded that the regular tetrahedron, octahedron, and dodecahedron are fair dice. Although research shows that these, as well as the regular icosahedron and the rhombic triacontahedron are fair dice (based on Euler's Equation), the particular dice I tested are not fair, possibly due to manufacturing flaws. The non-isohedral pentahedron is not a fair die because the faces are not identical. Because the faces have different shapes and surface areas, the solid landed on the large rectangular faces more frequently than the small triangular ones.

**Summary Statement** (In one sentence, state what your project is about.)
To determine whether certain polyhedral shapes are fair dice (at a 95% confidence level), I analyzed a set number of throws for each one, calculating the chi-square values, the confidence intervals, and the confidence percentages.

**Help Received in Doing Project** (e.g. Mother helped type report; Neighbor helped wire board; Used lab equipment at university X under the supervision of Dr. Y; Participant in NSF Young Scholars Program) See Display Regulation #8 on page 4.
My teacher reviewed my project throughout the process and provided a very useful article. My dad explained the statistical concepts and helped me to set up the chi-square spreadsheet and my mom edited my report. Both of my parents helped me to attach the information on my display board.