# CALIFORNIA STATE SCIENCE FAIR
## 2002 PROJECT SUMMARY

**Name(s)**
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**Project Number**
**J1219**

**Project Title**
## Rotational Symmetry of Third Order Magic Cubes

**Abstract**

**Objectives/Goals**
A project was undertaken to determine how many unique third order magic cubes exist. A third order magic cube is a 3x3x3 array if integers (1 through 27) arranged in such a way that the sum of any row, column, or stack of numbers is the same number.

**Methods/Materials**
It was proved mathematically that the center cell must contain the number 14. A computer program was written to generate all possible magic cube solutions.

**Results**
A total of 192 solutions were found. It was evident that many of these solutions are related by symmetry operations. Another computer program was written to determine which of the solutions are related by rotations and/or reflections. Four unique third order magic cubes were found.

**Conclusions/Discussion**
The 192 solutions can be divided into four distinct groups each containing 48 solutions. The remaining 24 solutions are reflections of the original 24. The second computer program was modified to graphically show how solutions can be transformed into one another by rotations in three-dimensional space.

**Summary Statement**
The researcher generated all possible third order magic cubes and determined which ones are related by rotational symmetry operations.

**Help Received**
My dad helped me with the three-dimensional rotations in the computer program.