



**CALIFORNIA STATE SCIENCE FAIR
2007 PROJECT SUMMARY**

Name(s) Joshua Navarette	Project Number J1312
Project Title The Nautilus Shell: Golden Mean or Logarithmic Spiral?	
Abstract	
Objectives/Goals My objective for this project was to understand the mathematical nature of the growth pattern of the Nautilus shell. I wanted to determine if the growth pattern of the Nautilus shell in fact follows the Golden Mean or the Logarithmic Ratio. My hypothesis was that the Nautilus shell would follow the Logarithmic Ratio instead of the Golden Mean because during my research I found out that people often confuse the Logarithmic ratio with the Golden mean.	
Methods/Materials	
Materials # A 12 inch Ruler # A protractor # A number two pencil # A camera # 2 Nautilus shells and 16 Nautilus shell photos # A calculator # An Apple Computer	
Methods I used 16 photos of unique Nautilus shells for my investigation. First, I found the center of a Nautilus shell and made an X and Y-axis through it. Then I rotated the photo 45 degrees and drew another X and Y-axis. This gave me a picture with 8 radii from the center of the shell to the edge of the last part of the spiral of the shell. I labeled every point where the radii intersected the Nautilus spiral. I then used a ruler to measure the line segments that were a part of each radius. Next I created ratios with neighboring line segments to see if they produced the Golden Mean. Finally, I recorded the given ratios into a list and plotted them on a scatter plot.	
Results In my graph it shows specifically where the Golden Mean (1.6) and Logarithmic Ratio (1.3) were located. In doing so it shows that only 6 of the ratios out of 212 fell on 1.6, and 13 fell on 1.3. But most of the ratios that are on the graph are below the 1.3 line. My hypothesis was supported by these results.	
Conclusions/Discussion In the end of my experimentation I found that Nautilus shells do not appear to follow the Golden Mean, but more likely the Logarithmic Ratio.	
Summary Statement I studied Nautilus shell growth patterns using line-segments created by radii that intersected the spiral of the shell, and calculated ratios to see if the shell grows according to the Golden Mean.	
Help Received My science teacher, Mr. Quintrell, helped me learn how to study the shells. My math teacher, Mr. Simonsen, helped edit the project and taught me about quadratics.	